MOBILE COMMUNICATIONS AND NETWORKS


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With the evolution of mobile communications, we are seeing expanding scopes and an increasing number of topics within the mobile technology area. It is important to address different topics, so that the technology remains relevant and continues meeting the advancing needs in a consistent manner. This issue of the Mobile Communications and Networks Series explores such an expansion, with a few topics complementing each other. On one hand, it discusses new techniques of spectrum management to address the continued issue of spectrum scarcity. On the other hand, it also discusses the use cases and applications in the industry, in terms of industrial mid-end applications. One networking and a couple of radio topics also came under focus in the issue in terms of federated machine learning at the network edge, challenges of beam management in millimeter Wave, and predictor antennae for connecting multiple devices in a high-speed vehicle. Some of these topics go beyond 5G to lay the foundation for 6G.

As spectrum scarcity continues to be a major issue for wireless communications, novel advanced radio network management strategies have been developed to allow concurrent spectrum usage by multiple systems and users. Dynamic Spectrum Sharing (DSS) methods have been adopted in 5G networks to allow concurrent usage of the same frequency bands by 4G systems. The first article, "In-Band Full-duplex Dynamic Spectrum Sharing in Beyond 5G Networks", presents a survey of current DSS approaches and discusses their shortcomings. The article then presents in-band full duplex DSS – FD-DSS networks that can transmit and receive or sense the transmission status of other nodes at the same time and in the same frequency band, thereby producing multiple benefits to radio transmissions.

Information and communication technologies are largely exploited nowadays in smart factories to support automation of manufacturing sites. The next article, "Cellular Connectivity and Wearable Technology Enablers for Industrial Mid-End Applications", focuses on the role of cellular connectivity and wearable technologies as enablers of new industrial applications. The article discusses the relevant cellular network features that may be needed to construct industrial wearable networks and to support the requirements of the corresponding applications on reduced-capability devices.

Federated learning (FL) is a hot topic within the Machine Learning area, which targets a distributed learning approach, where a set of learning nodes cooperate to form a model with the assistance of a server, without the need to share their local data. The two important tasks of this server are: a) assigning a weight to the information received from each node; and b) to drop slow nodes from the learning process. The article "Federated Learning at the Network Edge: When Not All Nodes are Created Equal" discusses the merits and drawbacks of different techniques for these two tasks, i.e., model-weighting and node-dropping decisions, for federated learning. Through experiments on a "handwritten digits dataset," the authors show the substantial impact of the choice of the methods on the learning performance.

Wireless networks' insatiable need to achieve higher data rates and denser connectivity is pushing cellular networks toward higher frequencies. As most of the radio spectrum below 100 GHz has already been settled, researchers and engineers are looking at the portions of spectrum above 100 GHz as the next evolution opportunity. The article "Six Key Challenges for Beam Management in 5.5G and 6G Systems" argues that at such high frequencies, beam management will become the most relevant limiting factor in terms of latency, link reliability and even terminal power consumption. The article identifies six key challenges of beam management and provides recommendations as to how the corresponding open problems can be addressed.

To provide Internet inside vehicles (such as public transportation vehicles), a futuristic approach is the use of moving relays (MRs), where an access point installed on top of the vehicle acts as a relay between the network and the in-vehicle users. Several benefits of this approach are listed in the article "Predictor Antenna: A Technique to Boost the Performance of Moving Relays". Yet, dealing with rapid channel variations is a challenge for MRs, for which the article presents and evaluates the predictor antenna (PA) solution. In such a solution, two groups of antennas are deployed on top of the vehicle, where the PAs mounted in front are used for predicting the channel for the actual receive antennas aligned behind the PAs, which will have a similar channel several time slots later. The authors assess different scenarios (e.g., urban and rural scenarios) to compare the performance of the PA solution with different non-PA solutions, in terms of end-to-end (E2E) throughput and prediction accuracy. Up to 50 percent backhaul throughput boost is observed for the evaluated PA solution.

We thank the authors for bringing up these timely topics in a tutorial style so they can be understood by a wider audience. The reviewers played their critical part behind the scenes to

make all the papers appealing with their constructive and timely feedback. We also acknowledge the tedious efforts from the supporting staff of the Series for making it possible with the promised timetable and quality.

Biographies

Wanshi Chen [SM] (wanshic@qti.qualcomm.com) 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 RAN WG1 Chair from August 2017 to May 2021 and a 3GPP RAN WG1 Vice-Chair from August 2013 to August 2017. As RAN WG1 Chair, he successfully led the group to deliver both the first 5G release (Release 15) and the second 5G release (Release 16) 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, Los Angeles, CA, USA.

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Alberto Perotti [S'01, M'03, SM'14] (alberto.perotti@ieee.org) received his M.Sc. and Ph.D. degrees in telecommunications from Politecnico di Torino, Italy, in 1999 and 2003, respectively. He is a senior research engineer at Huawei Technologies, where he is involved in wireless networks' PHY layer research and 5G standardization. Previously, he carried out research on mobile wireless and satellite communications at Politecnico di Torino. His interests cover coding and modulation, multiple access, and software-defined radios. He is the lead editor for the Mobile Communications and Networks Series in *IEEE Communications Magazine*.