MOBILE COMMUNICATIONS AND NETWORKS




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The rise of the fifth generation of mobile wireless communications (5G) is driving significant scientific and technological progress in the area of mobile systems and networks. This first appearance of the new Mobile Communications and Networks Series addresses some of the most significant aspects of 5G networks, providing key insights into relevant system and network design challenges, as well as the advanced signal processing algorithms and efficient protocols required to cope with unstable connections.

Millimeter-wave (mmWave) systems offer great promise for 5G, but also present substantial implementation challenges when compared to traditional microwave links. Just getting semiconductors to work at 30+ GHz is difficult! The article "Hardware-Constrained Millimeter-Wave Systems for 5G: Challenges, Opportunities, and Solutions" summarizes some of these challenges: for example, the difficulty of achieving low phase noise and linear power amplification, as well as beamforming with the hundreds of antennas needed to overcome high path losses. Processing the enormous data rates available from mmWave systems is a challenge, too. The article surveys some ways to address these challenges, and proposes a hybrid analog/digital architecture. Finally, some useful directions for future research are suggested, such as machine learning to deduce and compensate for manufacturing imperfections in the RF hardware. Those who are interested in learning more about the difficulties overcome by mmWave designers will find this article useful.

Due to the harsh propagation conditions experienced at microwave and mmWave frequencies, 5G mobile wireless systems would not be feasible without suitable multi-antenna signal processing techniques. Directional beamforming is a key enabler for mobile wireless transmission, and has been deeply investigated and thoroughly developed. The article "Introduction to a New Array Processing Concept: Orientational Beamforming" goes beyond conventional approaches by proposing a novel beamforming concept. Orientational beamforming spatially spreads transmitted signal energy over a given angular range using a pseudo-randomly distributed array of transmitting antennas. The authors envisage a promising new orientation division multiple access technique, and conclude their article with a discussion of the advantages of orientational beamforming over conventional schemes.

In order for modern mobile networks to benefit from gains of coordinated beamforming, it is vital to ensure rapid exchange of channel state information over a backhaul linking the collaborating base stations. However, taking advantage of coordinated beamforming in real-life scenarios is challenging due to impairments of the backhaul. Hence, the authors of the article "Distributed Coordinated Transmission with Forward-Backward Training for 5G Radio Access" focus on distributed schemes for multi-cell coordination, where only minimal or even zero information exchange between the base stations is required. The authors investigate several coordinated beamforming approaches, and specifically focus on distributed coordination based on forward-backward (F-B) training; this enables base stations and user equipment to gradually adjust their transmitters and receivers using only locally measured channel state information. Additionally, the authors also show that F-B training can be utilized to manage interference in a dynamic time-division duplex (TDD) system. Finally, it is worth noting that this article also discusses two very important prerequisites for enabling the proposed F-B training schemes to be used in 5G radio access: standardization activities as well as practical requirements.

TCP is the standard reliable data transport protocol for the Internet, and is at the heart of virtually all client-server models of communication. However, TCP performance in wireless networks (e.g., ad hoc and sensor) has been, and continues to be, below that seen in wired networks. The primary reason is that TCP congestion control is triggered when the round-trip time (RTT) between TCP endpoints exceeds certain thresholds. In wireless links, dynamic link quality changes and frequent disconnections can result in an increase in RTT even if there are no signs of congestion on the route. Against this backdrop, M. Zhang *et al.*, in the article "Will TCP Work in mmWave 5G Cellular Networks?," revisit the question of TCP performance in mmWave networks, which are inherently prone to erratic propagation behavior, intermittent link connectivity, and severe vulnerabilities due to blockages and directional searches.

The Mobile Communications and Networks Series receives the legacy of the outstanding Radio Communications Series. We are in debt to the previous Series for the excellent contributions published throughout a long period of successful appearances. We are, of course, grateful to the authors who submitted their manuscripts to this Series for their efforts toward achieving high-quality articles, and to our many committed reviewers for helping us to provide authors with sound guidance as well as to select the highest-quality submissions for publication. We express our gratitude to the Editor-in-Chief for his continuous support during the initial period of this Series. Finally, we would like to invite our readership to submit contributions to the Series.