Chapter 4
Conclusions

Abstract In this chapter, we summarize our contribution in this book and provide several new directions for the research of future work.

The concept of massive MIMO enables the communication system to be scaled up into a regime where antenna arrays at base stations greatly exceed the number of active end users, thus resulting in tremendous diversity gain. Such gain not only provides opportunity to improve capacity through spatial multiplexing, but also powers new directions to rethink the network design.

This book provides an overview for new aspects of system design that utilizes the large amount of spatial dimensions in massive MIMO to enhance network performance. Particularly, we propose two approaches to exploit the vast antenna array: (1) by exploiting spatial degree of freedom to suppress interference from BSs to the most vulnerable cell-edge UEs, we propose the cell-edge aware zero forcing (CEA-ZF) precoding scheme; (2) by noticing the tremendous diversity gain at the antenna array, we propose applying massive MIMO for wireless backhaul in a two-tier small cell network such that one macro base station can transmit to several small access points simultaneously through spatial multiplexing. In order to take a complete treatment of all the key features of a wireless network, such as wireless channel, random base stations location, and large antenna array, we combine tools from random matrix theory and stochastic geometry to develop an analytical frameworks which is general and accounts for all the key network parameters. With the analytical results, we show that CEA-ZF outperforms the conventional CEU-ZF in terms of aggregated per-cell data rate, coverage probability, and a significant 95 %-likely, or edge-user rate. On the other hand, we show that in a small cell network with wireless backhaul, irrespective of the deployment strategy, it is critical to control the network load in order to maintain a high energy efficiency. Moreover, a two-tier small cell network with wireless backhaul can achieve a significant energy efficiency gain over a one-tier deployment, as long as the bandwidth division between radio access links and wireless backhaul is optimally allocated.

In the future work, we can extend the framework developed in this book to the investigation of pilot contamination issues in massive MIMO cellular network, also the analysis with full duplex in a small cell network.

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