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Conclusion and Future Research Directions

Considering the increasing mobile data demands and the future wireless network technology innovations, key technologies are proposed and analyzed in this book to improve the system capacity, enhance the small cell network coverage, and guarantee the fairness based interference mitigation in the densely deployed small cell networks. Both system models and problem formulations are theoretically proved and verified by simulation results. In this chapter, a brief conclusion and future research directions are proposed with analyses.

5.1 Concluding Remarks

Driven by the increasing wireless Internet applications and smart devices, the mobile traffic demand of 5G will surge exponentially. Small cell network containing a number of low power nodes (such as picocell, femtocell, relay nodes) is one of the promising solutions to improve the network capacity. However, due to the flexible deployment and independent operation schemes of small cells, it is important to coordinate different small cell nodes to maximize the network performance and improve the quality of service for users.

In terms of the emerging challenges in small cell networks, this book focuses on the key technologies, such as the capacity analysis, coverage self-optimization technology, and interference mitigation technology, for the self-optimization of densely deployed small cells by using the artificial intelligent technologies. Furthermore, a hybrid frequency allocation scheme based on geographical division has been proposed to increase the capacity of hierarchical networks. Then, the joint antenna pattern selection and dynamic power allocation scheme is proposed in this book by using ANN model to realize an intelligent small cell coverage self-optimization and numerical results verify the performance of proposed schemes. Finally, the inter-cell interference coordination scheme among multi-tier small cell networks is proposed in terms of the fairness among users to decrease the inter-cell interferences and improve the network capacity.

And the fairness guaranteed optimal CRE bias and ABS ratio solution has been proposed to mitigate the interference among multi-tier small cells and the performances are verified by numerous results in this book.

5.2 Potential Future Works

In 5G wireless networks, a huge amount of machine type devices and human type devices will coexist which has a huge requirement for various radio resources, leading to new challenges in cellular networks. In addition, the surge of interworking among different wireless networks, such as LTE, WiMAX, and WLAN, also brings about new challenges to the wireless network operators. Small cell network is one of the solutions to these challenges. But, how to employ small cell networks to support the access and cooperative operation among a huge amount of various devices is still a hot topic for further studies. Therefore, potential future research areas are foreseen as depicted below.

1. The extraction of the characteristics of user behaviors in future 5G heterogeneous networks by using data mining and artificial intelligent processing algorithms to guide the deployment of small cell networks is a challenging issue.

2. The application of wireless network function virtualization or cloud computing technologies to improve the efficiency of radio resource usage and the scalability of network topologies will be a new research direction.

3. In face of the extensive deployments and applications of unmanned aerial vehicles (UAVs) and robotics in the future, the cooperative communication technologies for both machine type devices and human type devices will be a new challenging problem in terms of the high data rate services and the low latency real-time control information delivery.

4. Considering the scarcity of licensed spectrum resources under 6 GHz, new spectrum access and spectrum aggregation technologies should be considered as potential key technologies to explore new spectrum resource of both licensed and unlicensed spectrum bands on the high frequency spectrum bands, such as the millimeter wave communication bands on 28GHz, 60GHz, and above. Therefore, new technologies are needed to minimize the co-channel interference on the licensed band and minimize the collision probability on the unlicensed band.