

# Preface

The past several decades have witnessed revolutionary progress in wireless networks, from the early first-generation systems to the current fourth-generation systems. Since the 1980s, the coverage, capacity, and capability of wireless networks have been marvelously improved, in correspondence with the dramatically increasing number of mobile subscribers. The market is now demanding fifth-generation (5G) systems, to be deployed in the coming years, that can support higher capacity, higher mobility, lower latency, lower cost, and better service. In addition to these requirements, 5G cellular networks are also anticipated to be more environmentally friendly to tackle the global warming crisis. As a by-product, the rapid growth of the worldwide information and communication industry also contributes a large amount of carbon emissions, which is comparable to the aviation industry and marks an undesirable increasing trend. Therefore, reducing carbon emissions and operating expenditure costs becomes more and more important goals for network infrastructure design. Meanwhile, from the perspective of user devices, how to reduce their battery consumption is also a major concern for network evolution. Faced with these challenges, energy efficiency has become an important metric for 5G cellular networks, and so-called green communications have been a growing trend.

On the other hand, by leveraging programmable control, management, and data planes, software-defined networking (SDN) makes it possible to enable flexible, scalable, configurable, and reliable mobile networks. Therefore, the industry and academia have launched several research initiatives on SDN-enabled 5G cellular networks worldwide. The soft design of cellular networks can be implemented in many aspects, such as cloud radio access network (C-RAN), baseband processing virtualization, and the software-defined air interface (SDAI).

Aiming at providing green and soft network architecture, infrastructure, and protocol, the traditional design philosophy of cellular networks should be revisited. For instance, the classical Shannon theory suggested a monotonic relationship between the energy efficiency (EE) and spectral efficiency (SE). However, with circuit power being considered, the SE–EE relation is no longer monotonic, therefore optimal SE and EE may be achieved simultaneously. Moreover, the idea of cell-centric design has been adopted for every generation of cellular networks. However, the soft concept enables a user-centric network architecture that no longer relies on the traditional cellular topology. Other design philosophies that can also be revisited include the decoupling of data and control

planes, the reconfiguring of spectrum and air interference, and the application of big data analytics for wireless communications, just to name a few.

This book aims to provide a comprehensive overview of green and software-defined wireless networks, covering both theory and practice aspects. We start from the theoretical framework of green communications, including the information theoretical analysis of energy-efficient design and some fundamental trade-offs in green radio networks. Then, we introduce several design principles and practical architectures to facilitate green networks, with emphases on C-RAN and big-data-enabled networks. After that, several strategies on energy-efficient signaling design and resource management for next-generation networks are presented. The framework of SDAI for SDN-enabled 5G networks and some key design issues, are also provided. The book ends with some practices for energy saving solutions for different cellular networks, most of which are from China Mobile, the largest cellular operator in the world.

This book serves as an important reference for both academic students and engineers in this area. It includes both theoretical and practical results on future green and soft wireless networks, aiming at providing a compressive overview from both academic and industrial viewpoints. The theoretical part of this book is mainly contributed by Professor G. Yu and Professor G. Y. Li, while the practical part is mainly contributed by Dr. C.-L. I and Dr. S. Han. Although we try to include recent progresses on green and soft wireless networks as much as possible, we cannot cover all important results in this field due to the rapid development of 5G wireless techniques. The authors would like to thank the experts in the Green Communication Research Center of the China Mobile Research Institute for their contribution to the book, particularly Qi Sun, Jinri Huang, Sen Wang, Jiqing Ni, Gang Li, Siming Zhang, Guozhen Xu, Wei Zhou, Jun Zuo, Zhiming Liu, Yami Chen, Ailing Wang, Kai Yan, Zhiming Fan, Guizhen Wang, Junshuai Sun, Xueyan Huang, Xingyu Han, Sen Bian, Ke Li, Xidong Wang, Yaxing Qiu, Zecai Shao, Tian Xie, Ran Duan, and Chunfeng Cui.