The explosive growths of wireless multimedia service are continuous to promote the waves of developing many potential wireless communication standards and systems in the foreseeable future. The demands of ample licensed bands can therefore be anticipated to support numerous wireless applications in the next decade. The precious limited radio resource, however, obstructs this exciting progress in wireless technologies due to the fact that the static spectrum allocation policy is widely used. Recently, some research reports have indicated that most of licensed spectrum resource is underutilized, and Federal Communications Commission is taking initiative in revising the spectrum usage policies to improve the spectrum utilization. For this purpose, cognitive radio has emerged as a new paradigm shift, which allows different systems to dynamically access and opportunistically exploit the same frequency band in an efficient way.

The advances in software defined radio technology nowadays also tremendously push this prospective trend from practical implementation aspects. The successful realization of cognitive radio, however, faces many challenges since the interference among many coexisting systems is becoming an important factor degrading the system performance. Many research activities and even standardization frameworks such as IEEE wireless regional area network are boosted to handle this critical interference problem. Three essential paradigms, interweaving, underlying, and overlaying, then drive a wide range of research topics and directions such as spectrum sensing, spectrum mobility, multi-antenna interference mitigation, resource allocation and scheduling, dirty paper coding, et cetera. The rapid developments in this area also inspire a burst of research avenues from networking viewpoints, such as cooperative, cognitive, competitive strategies, to effectively manage the interference and dramatically improve the spectrum utilization. It can be expected that all relevant issues and design concepts will play key roles in providing technology roadmap for the next-generation wireless communications in the near future.

In recent years, a lot of research activities and remarkable advances in cognitive radio and interference management have been emerging. Relevant topics in this area still gather significant attention, and researchers from both academia and industry continue making contribution to this emerging area. This book examines the issues, challenges, and immediate state-of-art research results on the evolutionary communication technology: cognitive radio and interference management. Several topics are addressed, including spectrum sensing methodologies, interference mitigation schemes, cognitive radio network analyses, resource allocation and scheduling strategies, spectrum access and mobility management, cross-layer designs, cognitive radio network security, real applications and experiments, and so on. The book is organized in a manner from the communication lower-layer to the communication upper-layer and covers both academic theories and practical applications. This book should enable a wide audience of readers to immediately keep pace to the evolution of their concerned topics. This book intends to serve
as a useful bridge between people who are working on the theoretical and practical research in cognitive radio and interference management. Moreover, this book presents several open research problems which could serve as future research topics for interested readers.

This book is composed of sixteen chapters as follows. Chapter 1 gives an introduction to cognitive radios, as well as a comprehensive survey to a wide variety of spectrum sensing approaches. It also addresses several challenges to design cognitive radio networks. Chapter 2 designs collaborative spectrum sensing approaches and fusion center rules for multi-node cognitive radios. The problem is formulated through the likelihood ratio test framework over various fading channels. Chapter 3 focuses on the single-user and multi-user spectrum sensing with unknown distributions of primary users. In addition, a robust spectrum sensing optimization problem is solved by analyzing the lower bound performance of the spectrum detection probability. Chapter 4 discovers an interesting relationship that the throughputs of secondary and primary networks are mutually influenced by the transmission attempt probabilities of both networks, and a progressive algorithm is proposed to jointly optimize the throughputs and transmission probabilities. Chapter 5 presents distributed multicell precoders for efficiently mitigating the interference among cellular networks, studies the effect of imperfect channel state information on precoders, and proposes robust precoders in the presence of channel information uncertainty.

Chapter 6 applies the fuzzy logic for designing power control strategies in spectrum sharing cognitive radio networks. Chapter 7 is focused on the application of game theory to overcome spectrum scarcity problem in cognitive radio networks. Several design examples regarding to game theory are provided in this chapter. Chapter 8 investigates resource allocation strategies for cognitive femtocells and the total throughput subject to the fairness criterion is maximized by using game theory. Chapter 9 is devoted to jointly considering opportunistic spectrum access and multimedia data scheduling for cognitive radio networks. Chapter 10 studies a vertical handover through cognitive cooperation in a composite network so as to improve the radio resource usage. Chapter 11 provides hierarchical fuzzy-based solutions for spectrum access and mobility management in cognitive radio networks. Chapter 12 comprehensively covers the cross-layer design issues and optimization across different layers for cognitive radio networks. Chapter 13 is dedicated to the security issues for cognitive radio networks, and a complete study of numerous challenges and attack types, along with the respective solutions, is discussed. Chapter 14 gives an overview of resource management architectures of IEEE P1900.4 which is being standardized to improve the capacity and quality-of-service in a composite/hybrid network, and resource management protocols are investigated under the IEEE P1900.4 framework.

Chapter 15 discusses the influence of the time delay, caused by cognitive radio hardware platforms, on the spectrum sensing performance, and channel state prediction algorithms with or without cooperation are proposed to enhance the sensing performance. Chapter 16 provides solutions to enhance security from the physical layer perspective in cognitive radio and addresses an idea of distributed computing to save the computing power.

It is our hope that this book will contribute to a better understanding of the cognitive radio and interference management and may motivate further investigation into this new technology.

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