COGNITIVE RADIO, SOFTWARE DEFINED RADIO, AND ADAPTIVE WIRELESS SYSTEMS

Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems

Edited by

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Preface

Today's wireless services have come a long way since the roll out of the conventional voice-centric cellular systems. The demand for wireless access in voice and high rate data multi-media applications has been increasing. New generation wireless communication systems are aimed at accommodating this demand through better resource management and improved transmission technologies.

The interest in increasing Spectrum Access and improving Spectrum Efficiency combined with both the introduction of Software Defined Radios and the realization that machine learning can be applied to radios has created new intriguing possibilities for wireless radio researchers.

This book is aimed to discuss the cognitive radio, software defined radio (SDR), and adaptive radio concepts from several perspectives. Cognitive radio and cognitive networks are investigated from a broad aspect of wireless communication system enhancement while giving special emphasis on better spectrum utilization. Applications of cognitive radio, SDR and cognitive radio architectures, cognitive networks, spectrum efficiency and soft spectrum usage, adaptive wireless system design, measurements and awareness of various parameters including interference temperature and geo-location information, physical layer access technologies, and cross-layer adaptation related concepts are some of the important topics that are covered in this book.

Broad Topical Coverage

Following the Introduction (Chapter 1), the structure of the book consists of basically four parts:

- Fundamental concepts and architectures (Chapters 2–7)
- Awareness, measurements, and sensing (Chapters 8–10)
- Physical layer access technologies (Chapters 11 and 12)
- Applications of cognitive radio and SDR (Chapters 13 and 14)

In Chapter 1, a broad coverage of cognitive radio concept along with SDR is provided. A brief history and motivating factors for cognitive radio, including the economic aspects, are given. In Chapter 2, cognitive network concept is introduced and compared with cognitive radio and cross-layer adaptation. Cognitive network design and the related entities are also provided in this chapter. The architecture of an ideal cognitive radio, particularly with respect to the critical machine learning technologies, is described in Chapter 3. The components of the cognitive radio architecture and their functions, the cognition cycle, the inference hierarchy, and how to build cognitive radio architecture on the top of SDR architecture are all explained in detail in this chapter. The software defined radio architectures and relations with cognitive radio are further described in Chapter 4. Ideal and practical SDR architectures are given. The building blocks of SDR architectures are also described in detail. In Chapter 5, communications value-chain is discussed and some ways in which the value-chain can be altered by cognitive radios and cognitive networks are explored. Dynamic spectrum access in cognitive radio is extremely important concept as it enhances the spectrum efficiency greatly. Therefore, Chapter 6 is allocated for the discussion of dynamic spectrum access aspect of cognitive radio from game and coding theoretic perspectives. In Chapter 7, co-existence of different types of cognitive radios is covered, as well as modeling the efficiency of the cognitive radios from the Medium Access Control (MAC) perspectives.

Chapters 8 through 10 discuss the issues related to awareness, sensing, and measurement in cognitive radio systems. General concepts, various cognitive measurements and awareness functions are provided in Chapter 8. In Chapter 9, one of the most important awareness in cognitive radio, which is the spectrum awareness, is discussed in detail. Multi-dimensional spectrum space is explained, methods and challenges to sense the spectrum space are given. Another very important awareness, which is location of users, is given in Chapter 10. Location information management in cognitive wireless network is discussed from various dimensions.

The physical layer aspects of cognitive radio are discussed in Chapters 11 and 12. Orthogonal Frequency Division Multiplexing (OFDM) has proved itself to be the access technology for future generation mobile radio systems. In Chapter 11, the suitability of OFDM technology for cognitive radio is discussed. Another very interesting access technology that could potentially be very useful for cognitive radio for both communication and accurate positioning is ultra wideband (UWB). In Chapter 12, UWB and its suitability for cognitive radio are discussed.

Finally, Chapters 13 and 14 discuss the applications of cognitive radio and SDR. A generic overview and various application scenarios are given in Chapter 13. Chapter 14 focuses on the application of cognitive radio from cross-layer adaptation and optimization perspective.

Audience

This book is intended to be both an introductory technology survey/tutorial for beginners and an advanced technical overview intended for technical professionals in the communications industry, technical managers, and researchers in both academia and industry. We expect that a reader could skip the advanced technical treatments of the topics and still benefit greatly from the book.

A basic background of wireless communications is preferable for a full understanding of the topics covered by the book.

Course Use

The book provides an organic and harmonized coverage of cognitive radio, from radio hardware and digital baseband signal processing, all the way to applications. Within this framework, the book chapters are quite independent from one another. Therefore, different options are possible according to different course structures and lengths, as well as targeted audience background. The topics are covered in both descriptive and technical manners, and can therefore cater to different readers needs. For each chapter we expect that a reader may skip the advanced technical description and still greatly benefit from the book.

The objective of this book is to provide an introduction to the major research issues and challenges in cognitive radio that are currently occupying research attention worldwide. As such, the book is primarily intended to serve as a reference for comprehensive understanding of recent advances in both theory and practical design of cognitive radio and networks.

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Hüseyin Arslan