Wireless Networks and Mobile Communications Series

COGNITIVE RADIO NETWORKS

Architectures, Protocols, and Standards

Edited by
Yan Zhang • Jun Zheng • Hsiao-Hwa Chen

CRC Press
Taylor & Francis Group
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藏书章

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CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
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CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

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Printed in the United States of America on acid-free paper
10 9 8 7 6 5 4 3 2 1

International Standard Book Number: 978-1-4200-7775-9 (Hardback)

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Library of Congress Cataloging-in-Publication Data

Cognitive radio networks : architectures, protocols, and standards / editors, Yan Zhang, Jun Zheng, and Hsiao-Hwa Chen.
p. cm.
"A CRC title."
Includes bibliographical references and index.
ISBN 978-1-4200-7775-9 (alk. paper)
1. Cognitive radio networks. I. Zhang, Yan, 1977- II. Zheng, Jun, Ph.D. III. Chen, Hsiao-Hwa. IV. Title.

TK5103.4815.C646 2010
621.384--dc22 2009053747

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Preface

Spectrum is a scarce and precious resource in wireless communication systems and networks. Currently, wireless networks are regulated by a fixed spectrum assignment policy. This strategy partitions the spectrum into a large number of different ranges. Each piece is specified for a particular system. This leads to the undesirable situation that some systems may use only the allocated spectrum to a very limited extent while others have very serious spectrum insufficiency problems. In addition, future-generation broadband wireless networking promises to provide broadband multimedia services under heterogeneous networks coexistence. These challenges and requirements make the problem of scarce spectra even worse, and motivate new technologies to efficiently use spectra and combat the vulnerability of wireless channels.

Cognitive radio is believed to be a high-potential technology to address these issues. It refers to the potentiality that systems are aware of context and are capable of reconfiguring themselves based on the surrounding environments and their own properties with respect to spectrum, traffic load, congestion situation, network topology, and wireless channel propagation. This capability is particularly applicable to resolve heterogeneity, robustness, and openness. However, cognitive wireless networks are still in the very early stages of research and development. There are a number of technical, economical, and regulatory challenges to be addressed. In addition, there are unique complexities in aspects of spectrum sensing, spectrum management, spectrum sharing, and spectrum mobility.

This book systematically introduces and explains cognitive radio wireless networks. It provides a comprehensive technical guide covering introductory concepts, fundamental techniques, recent advances, and open issues in cognitive radio communications and networks. It also contains illustrative figures and allows for complete cross-referencing.

This book is organized into three parts:

- Part I: Physical Layer Issues
- Part II: Protocols and Economic Approaches
- Part III: Applications and Systems

Part I introduces the issues and solutions in the physical layer, including sensing, capacity, and power control. Part II introduces the issues and solutions in the protocol layers. This part also contributes to the applications of economic approaches in cognitive radio networks. Part III explores applications and practical cognitive radio systems.

This book has the following salient features:

- It serves as a comprehensive and essential reference on cognitive radio.
- It covers basics, a broad range of topics, and future development directions.
- It introduces architectures, protocols, security, and applications.
- It assists professionals, engineers, students, and researchers

This book can serve as an essential reference for students, educators, research strategists, scientists, researchers, and engineers in the field of wireless communications and networking. In particular, it will have an instant appeal to students, researchers, developers, and consultants in developing future-generation wireless systems and networks. The content in this book will enable readers to understand the necessary background, concepts, and principles in the framework of cognitive wireless systems. It will also provide readers with a comprehensive technical guidance on cognitive radio, cognitive wireless networks, and dynamic spectrum access. The issues covered include spectrum sensing, medium access control (MAC), cooperation schemes, resource management, mobility, game theoretical approach, and healthcare application.

We would like to acknowledge the time and effort invested by the contributors for their excellent work. All of them were extremely professional and cooperative. Special thanks go to Richard O'Hanley, Stephanie Morkert, and Joette Lynch of Taylor & Francis Group for their patience, support, and professionalism from the beginning until the final stage. We are very grateful to Sathyanarayanamoorthy Sridharan at SPi for his great efforts during the production process. Last but not least, a special thank you to our families and friends for their constant encouragement, patience, and understanding throughout this project.

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He is an associate editor or editorial board member of Wiley's *International Journal of Communication Systems* (*IJCS*); the *International Journal of Communication Networks and Distributed Systems* (*IJCNDS*); Springer's *International Journal of Ambient Intelligence and Humanized Computing* (*JAIHC*); the *International Journal of Adaptive, Resilient and Autonomic Systems* (*IJARAS*); Wiley's *Wireless Communications and Mobile Computing* (*WCMC*); Wiley's *Security and Communication Networks*; the *International Journal of Network Security;* the *International Journal of Ubiquitous Computing*; *Transactions on Internet and Information Systems* (*TIIS*); the *International Journal of Autonomous and Adaptive Communications Systems* (*IJAACS*); the *International Journal of Ultra Wideband Communications and Systems* (*IJUWBCS*); and the *International Journal of Smart Home* (*IJSH*).

He is currently serving as an editor for the book series Wireless Networks and Mobile Communications (Auerbach Publications, CRC Press, Taylor & Francis Group). He serves as a guest coeditor for Wiley's *Wireless Communications and Mobile Computing* (*WCMC*) special issue for best papers in the conference IWCMC 2009; ACM/Springer's *Multimedia Systems Journal* special issue on "wireless multimedia transmission technology and application"; Springer's *Journal of Wireless Personal Communications* special issue on "cognitive radio networks and communications"; Inderscience's *International Journal of Autonomous and Adaptive Communications Systems* (*IJAACS*) special issue on "ubiquitous/pervasive services and applications"; EURASIP's *Journal on Wireless Communications and Networking* (*JWCN*) special issue on "broadband wireless access"; *IEEE Intelligent Systems* special issue on "context-aware middleware and intelligent agents for smart environments"; Wiley's *Security and Communication Networks* special issue on "secure multimedia communication"; Elsevier's *Computer Communications* special issue on "adaptive multicarrier communications and networks"; Inderscience's *International Journal of*

Autonomous and Adaptive Communications Systems (*IJAACS*) special issue on "cognitive radio systems"; the *Journal of Universal Computer Science* (*JUCS*) special issue on "multimedia security in communication"; Springer's *Journal of Cluster Computing* special issue on "algorithm and distributed computing in wireless sensor networks"; EURASIP's *Journal on Wireless Communications and Networking* (*JWCN*) special issue on "OFDMA architectures, protocols, and applications"; and Springer's *Journal of Wireless Personal Communications* special issue on "security and multimodality in pervasive environments."

He is also serving as a coeditor for several books, including *Resource, Mobility and Security Management in Wireless Networks and Mobile Communications*; *Wireless Mesh Networking: Architectures, Protocols and Standards*; *Millimeter-Wave Technology in Wireless PAN, LAN and MAN*; *Distributed Antenna Systems: Open Architecture for Future Wireless Communications*; *Security in Wireless Mesh Networks*; *Mobile WiMAX: Toward Broadband Wireless Metropolitan Area Networks*; *Wireless Quality-of-Service: Techniques, Standards and Applications*; *Broadband Mobile Multimedia: Techniques and Applications*; *Internet of Things: From RFID to the Next-Generation Pervasive Networked Systems*; *Unlicensed Mobile Access Technology: Protocols, Architectures, Security, Standards and Applications*; *Cooperative Wireless Communications*; *WiMAX Network Planning and Optimization*; *RFID Security: Techniques, Protocols and System-on-Chip Design*; *Autonomic Computing and Networking*; *Security in RFID and Sensor Networks*; *Handbook of Research on Wireless Security*; *Handbook of Research on Secure Multimedia Distribution*; *RFID and Sensor Networks*; *Cognitive Radio Networks*; *Wireless Technologies for Intelligent Transportation Systems*; *Vehicular Networks: Techniques, Standards and Applications*; *Orthogonal Frequency Division Multiple Access* (*OFDMA*); *Game Theory for Wireless Communications and Networking*; and *Delay Tolerant Networks: Protocols and Applications.*

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Dr. Zheng has served as general chair of AdHoctNets'09 and AccessNets'07, TPC cochair of AdHocNets'10 and AccessNets'08, and symposium cochair of IEEE GLOBECOM'08, ICC'09, GLOBECOM'10, and ICC'11. He is also serving on the steering committees of AdHocNets and AccessNets, and has served on the technical program committees of a number of international conferences and symposia, including IEEE ICC and GLOBECOM.

Dr. Zheng has conducted extensive research in the field of communication networks. The scope of his research includes design and analysis of network architecture and protocols for efficient and reliable communications, and their applications to different types of communication networks, covering wireless networks and wired

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Hsiao-Hwa Chen is currently a full professor in the Department of Engineering Science, National Cheng Kung University, Tainan, Taiwan. He received a BSc and MSc with the highest honor from Zhejiang University, Hangzhou, China, and a PhD from the University of Oulu, Finland, in 1982, 1985, and 1990, respectively, all in electrical engineering. He worked with the Academy of Finland as a research associate from 1991 to 1993, and with the National University of Singapore as a lecturer and then as a senior lecturer from 1992 to 1997. He joined the Department of Electrical Engineering, National Chung Hsing University, Taichung, Taiwan, as an associate professor in 1997 and was promoted to a full professor in 2000. In 2001, he joined National Sun Yat-Sen University, Kaohsiung, Taiwan, as the founding chair of the Institute of Communications Engineering of the university. Under his strong leadership, the institute was ranked second in the country in terms of SCI journal publications and National Science Council funding per faculty member in 2004. In particular, National Sun Yat-Sen University was ranked first in the world in terms of the number of SCI journal publications in wireless LAN research papers during 2004 to mid-2005, according to a research report released by The Office of Naval Research, United States. He was a visiting professor to the Department of Electrical Engineering, University of Kaiserslautern, Germany, in 1999; the Institute of Applied Physics, Tsukuba University, Japan, in 2000; the Institute of Experimental Mathematics, University of Essen, Germany, in 2002 (under DFG Fellowship); the Chinese University of Hong Kong in 2004; and the City University of Hong Kong in 2007.

His current research interests include wireless networking, MIMO systems, information security, and Beyond 3G wireless communications. He is the inventor of next-generation CDMA technologies. He is also a recipient of numerous research and teaching awards from the National Science Council, the Ministry of Education, and other professional groups in Taiwan. He has authored or coauthored over 200 technical papers in major international journals and conferences, and five books and several book chapters in the area of communications, including *Next Generation Wireless Systems and Networks* and *The Next Generation CDMA Technologies*, both of which were published by Wiley in 2005 and 2007, respectively.

He has been an active volunteer for IEEE for various technical activities for over 15 years. Currently, he is serving as the chair of IEEE Communications Society Radio Communications Committee, and the vice chair of IEEE Communications Society Communications & Information Security Technical Committee. He served or is serving as symposium chair/cochair of many major IEEE conferences, including IEEE VTC 2003 Fall, IEEE ICC 2004, IEEE Globecom 2004, IEEE ICC

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2005, IEEE Globecom 2005, IEEE ICC 2006, IEEE Globecom 2006, IEEE ICC 2007, IEEE WCNC 2007, etc. He served or is serving as an editorial board member and/or guest editor of *IEEE Communications Letters*, *IEEE Communications Magazine*, *IEEE Wireless Communications Magazine*, *IEEE JSAC*, *IEEE Network Magazine*, *IEEE Transactions on Wireless Communications*, and *IEEE Vehicular Technology Magazine*. He is the editor in chief of Wiley's *Security and Communication Networks* journal (www.interscience.wiley.com/journal/security), and the special issue editor in chief of *Hindawi Journal of Computer Systems, Networks, and Communications* (http://www.hindawi.com/journals/jcsnc/). He is also serving as the chief editor (Asia and Pacific) for Wiley's *Wireless Communications and Mobile Computing* (*WCMC*) journal and *International Journal of Communication Systems*. His original work in CDMA wireless networks, digital communications, and radar systems has resulted in five U.S. patents, two Finnish patents, three Taiwanese patents, and two Chinese patents, some of which have been licensed to industry for commercial applications. He is an adjunct professor of Zhejiang University, China, and Shanghai Jiao Tong University, China. Professor Chen is the recipient of the Best Paper Award in IEEE WCNC 2008 and he is also a fellow of IEEE and IET.

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