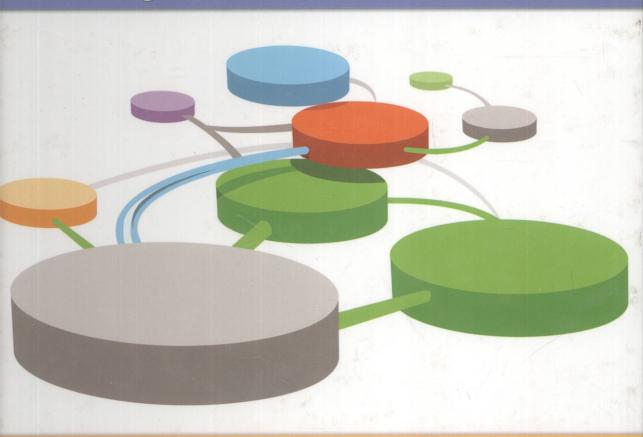
Wireless Networks and Mobile Communications Series

# COOPERATIVE WIRELESS COMMUNICATIONS

Edited by

Yan Zhang • Hsiao-Hwa Chen • Mohsen Guizani



TN92 C778.2

## COOPERATIVE WIRELESS COMMUNICATIONS



Edited by
Yan Zhang
Hsiao-Hwa Chen
Mohsen Guizani





CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the Taylor & Francis Group, an **Informa** business AN AUERBACH BOOK

Auerbach Publications Taylor & Francis Group 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742

© 2009 by Taylor & Francis Group, LLC Auerbach is an imprint of Taylor & Francis Group, an Informa business

No claim to original U.S. Government works Printed in the United States of America on acid-free paper 10987654321

International Standard Book Number-13: 978-1-4200-6469-8 (Hardcover)

This book contains information obtained from authentic and highly regarded sources. Reasonable efforts have been made to publish reliable data and information, but the author and publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The authors and publishers have attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged please write and let us know so we may rectify in any future reprint.

Except as permitted under U.S. Copyright Law, no part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, please access www.copyright.com (http:// www.copyright.com/) or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. CCC is a not-for-profit organization that provides licenses and registration for a variety of users. For organizations that have been granted a photocopy license by the CCC, a separate system of payment has been arranged.

Trademark Notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

#### Library of Congress Cataloging-in-Publication Data

Zhang, Yan, 1977-

Cooperative wireless communications / Yan Zhang, Hsiao-Hwa Chen, and Mohsen Guizani.

p. cm. -- (Wireless networks and mobile communications)

Includes bibliographical references and index.

ISBN 978-1-4200-6469-8 (alk. paper)

1. Wireless communication systems. I. Chen, Hsiao-Hwa. II. Guizani, Mohsen. III. Title.

TK5103.2.Z525 2009 621.384--dc22

2008037931

Visit the Taylor & Francis Web site at http://www.taylorandfrancis.com

and the Auerbach Web site at http://www.auerbach-publications.com

## COOPERATIVE WIRELESS COMMUNICATIONS

## WIRELESS NETWORKS AND MOBILE COMMUNICATIONS

Dr. Yan Zhang, Series Editor Simula Research Laboratory, Norway E-mail: yanzhang@ieee.org

#### **Cooperative Wireless Communications**

Yan Zhang, Hsiao-Hwa Chen and Mohsen Guizani

ISBN: 1-4200-6469-X

## Unlicensed Mobile Access Technology: Protocols, Architectures, Security, Standards and Applications

Yan Zhang, Laurence T. Yang and Jianhua Ma

ISBN: 1-4200-5537-2

#### Wireless Quality-of-Service: Techniques, Standards and Applications

Maode Ma, Mieso K. Denko and Yan Zhang

ISBN: 1-4200-5130-X

#### **Broadband Mobile Multimedia: Techniques and Applications**

Yan Zhang, Shiwen Mao, Laurence T. Yang and Thomas M Chen

ISBN: 1-4200-5184-9

## The Internet of Things: From RFID to the Next-Generation Pervasive Networked Systems

Lu Yan, Yan Zhang, Laurence T. Yang and Huansheng Ning

ISBN: 1-4200-5281-0

#### Millimeter Wave Technology in Wireless PAN, LAN and MAN

Shao-Qiu Xiao, Ming-Tuo Zhou and Yan Zhang

ISBN: 0-8493-8227-0

#### **Security in Wireless Mesh Networks**

Yan Zhang, Jun Zheng and Honglin Hu

ISBN: 0-8493-8250-5

### Resource, Mobility and Security Management in Wireless Networks and Mobile Communications

Yan Zhang, Honglin Hu, and Masayuki Fujise

ISBN: 0-8493-8036-7

#### Wireless Mesh Networking: Architectures, Protocols and Standards

Yan Zhang, Jijun Luo and Honglin Hu

ISBN: 0-8493-7399-9

#### Mobile WIMAX: Toward Broadband Wireless Metropolitan Area Networks

Yan Zhang and Hsiao-Hwa Chen

ISBN: 0-8493-2624-9

#### **AUERBACH PUBLICATIONS**

www.auerbach-publications.com
To Order Call: 1-800-272-7737 • Fax: 1-800-374-3401
E-mail: orders@crcpress.com

### **Editors**

Yan Zhang received his BS in communication engineering from Nanjing University of Post and Telecommunications, China; his MS in electrical engineering from Beijing University of Aeronautics and Astronautics, China; and his PhD from the School of Electrical & Electronics Engineering, Nanyang Technological University, Singapore. He is an associate editor on the editorial board of Wiley Wireless Communications and Mobile Computing (WCMC), Security and Communication Networks (Wiley); International Journal of Network Security; International Journal of Ubiquitous Computing; Transactions on Internet and Information Systems (TIIS); International Journal of Autonomous and Adaptive Communications Systems (IJAACS); International Journal of Ultra Wideband Communications and Systems (IJUWBCS); and International Journal of Smart Home (IJSH). He is currently serving as the book series editor for Wireless Networks and Mobile Communications book series (Auerbach Publications, CRC Press, Taylor & Francis Group). He serves as guest coeditor for the following: IEEE Intelligent Systems, special issue on "Context-Aware Middleware and Intelligent Agents for Smart Environments"; Wiley Security and Communication Networks special issue on "Secure Multimedia Communication"; Springer Wireless Personal Communications special issue on selected papers from ISWCS 2007; Elsevier Computer Communications special issue on "Adaptive Multicarrier Communications and Networks"; Inderscience 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 Journal of Cluster Computing special issue on "Algorithm and Distributed Computing in Wireless Sensor Networks"; EURASIP Journal on Wireless Communications and Networking (JWCN) special issue on "OFDMA Architectures, Protocols, and Applications"; and Springer Journal of Wireless Personal Communications special issue on "Security and Multimodality in Pervasive Environments."

He is serving as coeditor for several books: 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.

Dr. Zhang serves as symposium cochair for ChinaCom 2009; program cochair for BROAD-NETS 2009; program cochair for IWCMC 2009; workshop cochair for ADHOCNETS 2009; general cochair for COGCOM 2009; program cochair for UC-Sec 2009; journal liasion chair for IEEE BWA 2009; track cochair for ITNG 2009; publicity cochair for SMPE 2009; publicity cochair for COMSWARE 2009; publicity cochair for ISA 2009; general cochair for WAMSNet 2008; publicity cochair for TrustCom 2008; general cochair for COGCOM 2008; workshop cochair for IEEE APSCC 2008; general cochair for WITS-08; program cochair for PCAC 2008; general cochair for SecTech 2008; workshop chair for SEA 2008;

workshop co-organizer for MUSIC'08; workshop co-organizer for 4G-WiMAX 2008; publicity cochair for SMPE-08; international journals coordinating cochair for FGCN-08; publicity cochair for ICCCAS 2008; workshop chair for ISA 2008; symposium cochair for ChinaCom 2008; industrial cochair for MobiHoc 2008; program cochair for UIC-08; general cochair for CoNET 2007; general cochair for WAMSNet 2007; workshop cochair FGCN 2007; program vice-cochair for IEEE ISM 2007; publicity cochair for UIC-07; publication chair for IEEE ISWCS 2007; program cochair for IEEE PCAC'07; special track cochair for "Mobility and Resource Management in Wireless/Mobile Networks" in ITNG 2007; special session co-organizer for "Wireless Mesh Networks" in PDCS 2006; and a member of technical program committee for numerous international conference, including ICC, GLOBECOM, WCNC, PIMRC, VTC, CCNC, AINA, and ISWCS. He received the Best Paper Award at the IEEE 21st International Conference on Advanced Information Networking and Applications (AINA-07).

From August 2006, Dr. Zhang has been working with Simula Research Laboratory, Norway (http://www.simula.no/). His research interests include resource, mobility, spectrum, data, energy, and security management in wireless networks and mobile computing. He is a member of IEEE and IEEE ComSoc.

Hsiao-Hwa Chen is currently a full professor in the Department of Engineering Science, National Cheng Kung University, Taiwan. He received his BSc and MSc with the highest honor from Zhejiang University, China, and his PhD from the University of Oulu, Finland, in 1982, 1985, and 1990, respectively, all in electrical engineering. He worked as a research associate at the Academy of Finland from 1991 to 1993, and as a lecturer and then a senior lecturer at the National University of Singapore from 1992 to 1997. He joined the Department of Electrical Engineering, National Chung Hsing University, 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, Taiwan, as the founding chair of the Institute of Communications Engineering of the University. Under his strong leadership the institute was ranked the 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 LANs research papers during 2004 to mid-2005, according to a research report released by the Office of Naval Research, Arlington. 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.

Dr. Chen's current research interests include wireless networking, MIMO systems, information security, and Beyond 3G wireless communications. He is the inventor of next generation CDMA technologies and is 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, 5 books, and several book chapters in the area of communications, including the book titled *Next Generation Wireless Systems and Networks* (512 pages) and *The Next Generation CDMA Technologies* (468 pages), both by Wiley in 2005 and 2007, respectively. He has been an active volunteer for IEEE's 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 2005, IEEE Globecom 2005, IEEE ICC 2006, IEEE Globecom 2006, IEEE ICC 2007, and IEEE WCNC 2007.

Editors ix

Dr. Chen served or is serving as 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* journal and Wiley's *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 a recipient of the Best Paper Award in IEEE WCNC 2008.

Mohsen Guizani is currently a full professor and the chair of the Computer Science Department at Western Michigan University since 2003. Previously, he served as the chair of the Computer Science Department at the University of West Florida from 1999 to 2003. He was an associate professor of electrical and computer engineering and the director of graduate studies at the University of Missouri-Columbia from 1997 to 1999. Prior to joining the University of Missouri, he was a research fellow at the University of Colorado-Boulder. From 1989 to 1996, he held academic positions at the Computer Engineering Department at the University of Petroleum and Minerals, Dhahran, Saudi Arabia. He was also a visiting professor in the Electrical and Computer Engineering Department at Syracuse University, Syracuse, New York during the academic year 1988–1989. He received his BS (with distinction) and MS in electrical engineering; MS and PhD in computer engineering in 1984, 1986, 1987, and 1990, respectively, all from Syracuse University, Syracuse, New York.

Dr. Guizani's research interests include wireless communications and computing, computer networks, design and analysis of computer systems, and optical networking. He served or is serving on the editorial boards of more than 20 national and international journals, such as the IEEE Transaction on Wireless Communications (TWireless); IEEE Transaction on Vehicular Technology (TVT); IEEE Communications Magazine; the Journal of Parallel and Distributed Systems and Networks; and the International Journal of Computer Research. He served as a guest editor in the IEEE Communication Magazine; IEEE Journal on Selected Areas in Communications; IEEE Network Magazine; Journal of Communications and Networks; The Simulation Transaction; International Journal of Computer Systems and Networks; International Journal of Communication Systems; International Journal of Computing Research; and Journal of Cluster Computing. Dr. Guizani is the founder and editor-in-chief of the Wireless Communications and Mobile Computing journal published by Wiley (http://www.interscience.wiley.com/jpages/1530-8669/). He is also the founder and general chair of the two international conferences: International Wireless Conference on Wireless Communications and Mobile Computing (ACM IWCMC); and Wireless Networks, Communications, and Mobile Computing (IEEE WirelessCom). He is the author/coauthor of six books and more than 180 articles in refereed journals and conferences in the areas of high-speed networking, wireless networking and communications, mobile computing, and optical networking and network security. He has served as a keynote speaker for many international conferences as well as presented a number of tutorials and workshops. He served as the general chair for the Parallel and Distributed Computer Systems (PDCS 2002); IEEE Vehicular Technology Conference 2003 (VTC'03); PDCS 2003; IEEE WirelessCom 2005; ACS/IEEE AICCSA 2006; and IEEE IWCMC 2006. He also served as the program and symposia chair for many conferences and symposia in IEEE Globecom and IEEE ICC.

Dr. Guizani is the chair of the IEEE Communications Society Technical Committee on Transmissions, Access, and Optical Systems (IEEE TAOS), the vice-chair of the IEEE Communications Society of Personal Communications (IEEE TCPC), and a member of other IEEE ComSoc technical committees. He was the IEEE Computer Society Distinguished National Speaker from 2003 to

X Editors

2005. He is also ABET Accreditation Evaluator for Computer Science and Information Technology Programs.

Dr. Guizani received both the Best Teaching Award and the Excellence in Research Award from the University of Missouri-Columbia in 1999 (a college-wide competition). He won the best Research Award from KFUPM in 1995 (a university-wide competition). He was selected as the Best Teaching Assistant for two consecutive years at Syracuse University in 1988 and 1989.

Dr. Guizani is a senior member of IEEE, and a member of IEEE Communication Society, IEEE Computer Society, ASEE, and ACM.

For more details, please visit: http://www.cs.wmich.edu/ mguizani/

## Contributors

#### Baher Abdulhai

Civil Engineering Department University of Toronto Toronto, Ontario, Canada

#### Raviraj S. Adve

Department of Electrical and Computer Engineering University of Toronto Toronto, Ontario, Canada

#### **Hazim Ahmed**

Software Systems Engineering Department University of Regina Regina, Saskatchewan, Canada

#### Almudena Alcaide

Computer Science Department Carlos III University of Madrid Madrid, Spain

#### Y. Bar-Ness

Center for Wireless Communications and Signal Processing Research ECE Department New Jersey Institute of Technology Newark, New Jersey

#### Elena-Veronica Belmega

Université Paris-Sud XI SUPELEC, Signals and Systems Laboratory Gif-sur-Yvette, France

#### **Aggelos Bletsas**

Department of Physics Radio Communications Laboratory Aristotle University of Thessaloniki Thessaloniki, Greece

and

Electronic and Computer Engineering
Department
Technical University of Crete
Crete, Greece

#### Lin Cai

Department of Electrical and Computer Engineering University of Victoria Victoria, British Columbia, Canada

#### Symeon Chatzinotas

Centre for Communication System Research University of Surrey Guildford, United Kingdom

#### **Yifan Chen**

School of Engineering University of Greenwich Greenwich, United Kingdom

#### Yuanzhu Peter Chen

Department of Computer Science Memorial University of Newfoundland Saint John's, Newfoundland, Canada

#### Josephine P. K. Chu

Department of Electrical and Computer Engineering University of Toronto Toronto, Ontario, Canada

#### **Zaher Dawy**

Electrical and Computer Engineering Department American University of Beirut Beirut, Lebanon

#### Mérouane Debbah

SUPELEC, Alcatel-Lucent Chair on Flexible Radio Gif-sur-Yvette, France

#### Nikos Dimokas

Department of Informatics Aristotle University of Thessaloniki Thessaloniki, Greece

#### Andrew W. Eckford

Department of Computer Science and Engineering York University Toronto, Ontario, Canada xii Contributors

#### **Mohamed El-Darieby**

Software Systems Engineering Department University of Regina Regina, Saskatchewan, Canada

#### David Fusté-Vilella

Computer Architecture Department Technical University of Catalonia Barcelona, Spain

#### Jorge García-Vidal

Computer Architecture Department Technical University of Catalonia Barcelona, Spain

#### Zhu Han

Electrical and Computer Engineering
Department
University of Houston
Houston, Texas

#### Julio C. Hernández-Castro

Computer Science Department Carlos III University of Madrid Madrid, Spain

#### Luoquan Hu

Suzhou Testing Center for Information Technology Products Suzhou Entry-Exit Inspection and Quarantine Bureau People's Republic of China Suzhou, Jiangsu

and

School of Electronics and Information Soochow University People's Republic of China Suzhou, Jiangsu

#### Muhammad Ali Imran

Centre for Communication System Research University of Surrey Guildford, United Kingdom

#### **Alexandros Kaloxylos**

Department of Telecommunications Science and Technology University of Peloponnese Tripoli, Greece

#### **Vasileios Karyotis**

School of Electrical and Computer Engineering National Technical University of Athens Athens, Greece

#### **Dimitrios Katsaros**

Department of Computer and Communication Engineering University of Thessaly Thessaly, Greece

#### Samson Lasaulce

**CNRS** 

SUPELEC, Signals and Systems Laboratory Gif-sur-Yvette, France

#### Jijun Luo

Radio Access LTE System Product Management Nokia Siemens Networks Munich, Germany

#### Veluppillai Mahinthan

Centre for Wireless Communications
Department of Electrical and Computer
Engineering
University of Waterloo
Waterloo, Ontario, Canada

#### Yannis Manolopoulos

Department of Informatics
Aristotle University of Thessaloniki
Thessaloniki, Greece

#### Jon W. Mark

Centre for Wireless Communications Department of Electrical and Computer Engineering University of Waterloo Waterloo, Ontario, Canada

#### Albena Mihovska

Center for TeleInfrastruktur Aalborg University Aalborg, Denmark

#### **Emilio Mino**

Radio Access Networks Telefonica I+D Madrid, Spain Contributors

#### **Nelson Moniz**

Department of Computer Science and Engineering York University Toronto, Ontario, Canada

#### Yasser Morgan

Software Systems Engineering Department University of Regina Regina, Saskatchewan, Canada

#### Julián Morillo-Pozo

Computer Architecture Department Technical University of Catalonia Barcelona, Spain

#### **Esther Palomar**

Computer Science Department Carlos III University of Madrid Madrid, Spain

#### Symeon Papavassiliou

School of Electrical and Computer Engineering National Technical University of Athens Athens, Greece

#### Nikos Passas

Department of Informatics and Telecommunications University of Athens Athens, Greece

#### Vincent H. Poor

Electrical Engineering Department Princeton University Princeton, New Jersey

#### **Michael Portnoy**

Department of Computer Science and Engineering York University Toronto, Ontario, Canada

#### **Predrag Rapajic**

School of Engineering University of Greenwich Greenwich, United Kingdom

#### Arturo Ribagorda

Computer Science Department Carlos III University of Madrid Madrid, Spain

#### Erica Cecilia Ruiz-Ibarra

Department of Electrical and Electronics Engineering Instituto Tecnologico de Sonora Sonora, Mexico

#### Xuemin (Sherman) Shen

Centre for Wireless Communications
Department of Electrical and Computer
Engineering
University of Waterloo
Waterloo, Ontario, Canada

#### O. Simeone

Center for Wireless Communications and Signal Processing Research ECE Department New Jersey Institute of Technology Newark, New Jersey

#### U. Spagnolini

Dipartimento di Elettronica e Informazione Politecnico di Milano Milano, Italy

#### Juan M. E. Tapiador

Computer Science Department Carlos III University of Madrid Madrid, Spain

#### **Kamel Tourki**

Electrical and Computer Engineering Department Texas A&M University at Qatar Doha, Qatar

#### Elias Tragos

Computer Networks Laboratory Institute of Communication and Computer Systems (ICCS) National Technical University of Athens Athens, Greece

#### Dionysia Triantafyllopoulou

Department of Informatics and Telecommunications University of Athens Athens, Greece

#### **Costas Tzaras**

xiv

Centre for Communication System Research University of Surrey Guildford, United Kingdom

#### Luis Armando Villasenor-Gonzalez

Department of Electronics and Telecommunications Centro de Investigacion Cientifica y de Educacion Superior de Ensenada Ensenada, Baja California, Mexico

#### Natalija Vlajic

Department of Computer Science and Engineering York University Toronto, Ontario, Canada

#### Yong Wang

Department of Computer Science University of Northern British Columbia Prince George, British Columbia, Canada

#### Chau Yuen

Modulation and Coding Department Institute for Infocomm Research Singapore

#### Yan Zhang

Networks and Distributed Systems Department Simula Research Laboratory Oslo, Norway

#### **Zhenrong Zhang**

School of Computer, Electronic, and Information Guangxi University Guangxi, People's Republic of China

## Contents

Editors vii Contributors xi	
PART I	Fundamentals
Chapter 1	Capacity of Cooperative Channels: Three Terminal Case Study
Chapter 2	Capacity Limits in Cooperative Cellular Systems
Chapter 3	Low-Complexity Strategies for Cooperative Communications
Chapter 4	Orthogonal Opportunistic Relaying for Cooperative Wireless Communications 73  Aggelos Bletsas
Chapter 5	Cross-Layer Design for Cooperative Wireless Communication
Chapter 6	Power Allocation in Cooperative Wireless Networks
Chapter 7	Joint Power Allocation and Partner Selection in CD Systems
Chapter 8	Topology Control in Cooperative Wireless Ad Hoc Networks
Chapter 9	Game Theory and Cooperation Analysis
Chapter 10	Cooperative Cognitive Radio

vi

PART II	Techniques
Chapter 11	Cooperative Diversity of Generalized Distributed Antenna Systems
	Yifan Chen, Luoquan Hu, Chau Yuen, Yan Zhang, Zhenrong Zhang, and Predrag Rapajic
Chapter 12	Cooperative ARQ Protocols
	Julián Morillo-Pozo, David Fusté-Vilella, and Jorge García-Vidal
Chapter 13	Impact of Cooperative Transmission on Network Routing
	Zhu Han and Vincent H. Poor
Chapter 14	Cooperative Relaying in Multihop Cellular Networks
	Zaher Dawy
Chapter 15	Cooperative Radio Resource Management for Heterogeneous Networks 339
	Albena Mihovska, Elias Tragos, Jijun Luo, and Emilio Mino
Chapter 16	Cooperative Caching in Wireless Multimedia Sensor Networks
	Nikos Dimokas, Dimitrios Katsaros, and Yannis Manolopoulos
Chapter 17	Cooperative Security in Peer-to-Peer and Mobile Ad Hoc Networks
	Esther Palomar, Juan M. E. Tapiador, Julio C. Hernández-Castro, and Arturo Ribagorda
Chapter 18	Application Cooperation in Wireless Mesh Networks
	Mohamed El-Darieby, Hazim Ahmed, Baher Abdulhai, and Yasser Morgan
Chapter 19	Cooperation and Interference in Wireless Mesh Networks
	Yuanzhu Peter Chen and Yong Wang
Chapter 20	Cooperation in Wireless Sensor and Actor Networks
	Erica Cecilia Ruiz-Ibarra and Luis Armando Villasenor-Gonzalez
Chapter 21	Self-Healing Wireless Sensor Networks
	Natalija Vlajic, Nelson Moniz, and Michael Portnoy
Index	

## Part I

**Fundamentals** 

试读结束: 需要全本请在线购买: www.ertongbook.com