

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Coexistence Problems in Wireless Networks	1
1.2	Medium Access Control Problems for Coexistence of CR Networks	2
1.2.1	Rendezvous (Control Channel) Establishment	2
1.2.2	Spectrum Sharing	3
1.2.3	Frequency Reuse of a Single Channel	4
1.2.4	Channel Assignment in Multi-hop Cognitive Radio Networks	5
1.2.5	Coexistence of Heterogeneous Cognitive Radio Networks	6
<b>2</b>	<b>Taxonomy of Coexistence Mechanisms</b>	<b>7</b>
2.1	Classification by Coexistence Mechanism's Architecture (A)	8
2.2	Classification by Coexistence Mechanism's Control Channel (B)	11
2.3	Classification by Coexistence Cycle State (C)	13
2.4	Classification by Placement in the Protocol Stack (D)	14
2.5	Classification by Coexistence Mechanism's Synchronicity (E)	16
2.6	Classification by Coexistence Mechanism's Memory Usage (F)	16
<b>3</b>	<b>Rendezvous of Cognitive Radios</b>	<b>19</b>
3.1	Rendezvous-Enabling Techniques	20
3.1.1	Common Control Channel Based Rendezvous	20
3.1.2	Channel Hopping Based Rendezvous	21
3.2	Quorum Systems	22
3.3	Network Model	23

3.4	The Quorum-Based Channel Hopping System. . . . .	25
3.4.1	Metrics for Evaluating Channel Hopping Systems. . . . .	27
3.5	Optimal Synchronous Quorum-Based Channel Hopping Systems. . . . .	29
3.5.1	Minimizing the Maximum Time-to-Rendezvous . . . . .	29
3.5.2	Minimizing the Load. . . . .	30
3.5.3	Performance Evaluation. . . . .	32
3.6	Asynchronous Channel Hopping System . . . . .	35
3.6.1	The Asynchronous Channel Hopping System with a Degree of Overlapping $m = 2$ . . . . .	39
3.6.2	The Asynchronous Channel Hopping System with Maximum Degree of Overlapping . . . . .	41
3.6.3	Optimal Asynchronous Channel Hopping Systems . . . . .	46
3.6.4	Asymmetric Optimal Asynchronous Channel Hopping Systems . . . . .	48
3.6.5	Symmetric Optimal Asynchronous Channel Hopping Systems . . . . .	48
3.6.6	Comparisons. . . . .	55
3.6.7	Performance Evaluation. . . . .	55
3.7	Summary . . . . .	59
<b>4</b>	<b>Coexistence-Aware Spectrum Sharing for Homogeneous Cognitive Radio Networks . . . . .</b>	<b>61</b>
4.1	Homogeneous Coexistence Mechanisms in IEEE 802.22 Networks. . . . .	61
4.1.1	PHY-Layer Support and MAC-Layer Control Messages in IEEE 802.22 . . . . .	61
4.1.2	Non-exclusive Spectrum Sharing: Resource Renting . . . . .	62
4.1.3	Exclusive Spectrum Sharing. . . . .	63
4.1.4	Other Related Work . . . . .	64
4.2	Protocol Descriptions. . . . .	64
4.2.1	Basic Assumptions . . . . .	64
4.2.2	Dynamic Switching Between the Two Spectrum Sharing Modes . . . . .	65
4.2.3	The Channel Selection Mechanism . . . . .	68
4.2.4	The Channel Contention Procedure . . . . .	69
4.3	Performance Evaluation . . . . .	71
4.3.1	The 3-BS Scenario . . . . .	72
4.3.2	The 9-BS Scenario . . . . .	73
4.4	Summary . . . . .	75

<b>5</b>	<b>Frequency Reuse over a Single TV White Space Channel . . . . .</b>	<b>77</b>
5.1	System Model . . . . .	77
5.1.1	Uplink Soft Frequency Reuse . . . . .	77
5.1.2	Uplink Resource Allocation Problem . . . . .	78
5.1.3	A Game-Theoretic Framework . . . . .	81
5.2	Game of Transmit Power Control . . . . .	81
5.2.1	Transmit Power Control Subproblem . . . . .	82
5.2.2	Multi-cell Transmit Power Control as Non-cooperative Game . . . . .	84
5.3	Game of Subchannel Allocation . . . . .	85
5.3.1	Subchannel Allocation Subproblem . . . . .	85
5.3.2	Multi-cell SCA as Non-cooperative Game . . . . .	86
5.4	A Two-Level Game-Theoretic Approach . . . . .	87
5.4.1	Local Uplink Resource Allocation Algorithm . . . . .	87
5.4.2	Two-Level Game-Theoretic Algorithm . . . . .	88
5.4.3	Implementation Variants . . . . .	92
5.5	Simulation Results . . . . .	94
5.6	Summary . . . . .	100
<b>6</b>	<b>Channel Assignment for Multi-hop Cognitive Radio Networks. . .</b>	<b>101</b>
6.1	Channel Assignment Strategies . . . . .	102
6.1.1	Link-Based Channel Assignment . . . . .	102
6.1.2	Flow/Component-Based Channel Assignment . . . . .	102
6.2	Motivation for Segment-Based Channel Assignment . . . . .	103
6.2.1	Segment-Based Channel Assignment . . . . .	103
6.2.2	Performance Considerations . . . . .	105
6.3	Segment-Based Channel Assignment . . . . .	108
6.3.1	Initial Handshake . . . . .	108
6.3.2	Channel Assignment . . . . .	109
6.3.3	Segment Maintenance . . . . .	111
6.4	Performance Evaluation . . . . .	114
6.4.1	Simulation Setup . . . . .	114
6.4.2	Simulation Results . . . . .	114
6.5	Summary . . . . .	116
<b>7</b>	<b>Ecology-Inspired Coexistence of Heterogeneous Cognitive Radio Networks . . . . .</b>	<b>117</b>
7.1	Heterogeneous Coexistence Scenarios . . . . .	118
7.2	Technical Background . . . . .	119
7.2.1	The Mediator System . . . . .	119
7.2.2	Interspecific Competition in Ecology . . . . .	120
7.3	Overview of the Protocol . . . . .	120
7.3.1	System Model . . . . .	121
7.3.2	Ecology-Inspired Spectrum Allocation . . . . .	121
7.3.3	Problem Formulation . . . . .	122

7.4	An Ecology-Inspired Spectrum Share Allocation Algorithm . . . .	123
7.4.1	A Weighted-Fair Spectrum Competition Model . . . . .	123
7.4.2	Characteristics of the Stable Equilibrium . . . . .	125
7.5	Performance Evaluation . . . . .	128
7.5.1	The Stable Equilibrium . . . . .	128
7.5.2	Weighted Fairness. . . . .	128
7.5.3	System Satisfaction . . . . .	129
7.6	Summary . . . . .	131
<b>Bibliography . . . . .</b>		<b>133</b>
<b>Index . . . . .</b>		<b>139</b>

Cognitive Radio Networks

Medium Access Control for Coexistence of Wireless  
Systems

Bian, K.; Park, J.-M.; Gao, B.

2014, XII, 141 p. 50 illus., 24 illus. in color., Hardcover

ISBN: 978-3-319-07328-6