

Contents

1	New Types of Air Interface Based on Filter Banks for Spectrum Sharing and Coexistence	1
	Yahia Medjahdi, Didier Le Ruyet, Daniel Roviras, and Michel Terré	
1.1	The Concept of Multicarrier Transmission.....	2
1.1.1	Gabor Analysis of Multicarrier Systems	2
1.1.2	Orthogonal and Biorthogonal Multicarrier Systems	3
1.2	Orthogonal Frequency Division Multiplexing (OFDM): Advantages and Drawbacks	4
1.3	Filter Bank Based Multicarrier Systems	4
1.3.1	Classes of FBMC	5
1.3.2	Filter Bank Transceivers	6
1.3.3	Equalization Techniques in FBMC	12
1.3.4	Polyphase Implementation of Filter Bank for Multicarrier Transmission	15
1.3.5	Review of Prototype Filter Design.....	21
1.4	Spectrum Sharing and Coexistence: FBMC Application.....	27
1.5	Conclusion	32
	References.....	32
2	Cognitive Interference Alignment for Spectral Coexistence	37
	Shree Krishna Sharma, Symeon Chatzinotas, and Björn Ottersten	
2.1	Introduction	38
2.1.1	Notation	39
2.2	Interference Alignment (IA) Fundamentals.....	39
2.2.1	Degrees of Freedom (DoF).....	40
2.2.2	IA Principle	41
2.2.3	Classification of IA Techniques.....	43
2.3	IA in Cognitive Radio Networks	48

2.4	Spectral Coexistence	50
2.4.1	Generic System Model	50
2.4.2	IA Precoding and Filtering	52
2.5	Practical Scenarios	54
2.5.1	Macrocell-Femtocell Coexistence in Spatial Domain	54
2.5.2	Multibeam-Monobeam Satellite Coexistence in Frequency Domain.....	55
2.6	Practical Challenges of IA	60
2.7	Chapter Summary	61
	References.....	61
3	Cooperative Spectrum Sensing.....	67
	H. Birkan Yilmaz, Salim Eryigit, and Tuna Tugcu	
3.1	Introduction.....	68
3.2	Spectrum Sensing Preliminaries	69
3.2.1	Spectrum Sensing in AWGN Channel.....	70
3.2.2	Spectrum Sensing in Rayleigh Channel	71
3.2.3	Spectrum Sensing in Nakagami-m Fading Channel	71
3.3	Cooperation and Fusion Strategies	72
3.3.1	Hard Fusion Strategies	73
3.3.2	Soft Fusion Strategies	73
3.4	Quantization Enhancements	74
3.4.1	Incentives for Utilizing Quantization	74
3.4.2	Local Quantization	74
3.4.3	Fusion Strategies.....	76
3.5	Effects of Imperfect Reporting Channel	78
3.6	Optimizing Detector That Uses Quantization.....	80
3.6.1	Threshold Optimization	80
3.6.2	Improving Weights and Threshold Optimization	81
3.6.3	Results	81
3.7	Cooperative Sensing Scheduling	82
3.7.1	Introduction	83
3.7.2	System Model.....	83
3.7.3	Problem Formulation	85
3.7.4	Performance Evaluation	90
3.8	Utilizing Sensing Results for REM Construction.....	92
3.8.1	REM Architecture	94
3.8.2	REM Quality Metrics.....	96
3.8.3	RSS Measurements in Fading Channels	97
3.8.4	REM Construction Techniques	99
3.8.5	Spatial Statistics Based Methods	100
3.8.6	Transmitter Location Determination Based Methods.....	103
3.9	Conclusion	104
	References.....	104

4	Medium Access Control Protocols in Cognitive Radio Networks	109
	Liljana Gavrilovska, Daniel Denkovski, Valentin Rakovic, and Marko Angjelicinoski	
4.1	Introduction	110
4.2	C-MAC Protocol Classification and Systematization	112
4.3	Generic C-MAC Protocols Layout: The C-MAC Cycle	113
4.4	Overview of the Generic C-MAC Functionalities	115
	4.4.1 Spectrum Sensing Strategies	115
	4.4.2 Spectrum Sharing Strategies	119
	4.4.3 Control Channel Management Strategies	123
4.5	C-MAC Cycle Use Cases	126
	4.5.1 Cooperative Spectrum Sensing Based on Estimated Noise Power	126
	4.5.2 Coordinated Beamforming for Spectrum Sharing	132
	4.5.3 Asynchronous Rendezvous for Control Channel Management	138
4.6	Concluding Remarks	145
	References	146
5	Dynamic Channel Selection for Cognitive Femtocells	151
	Gustavo Wagner Oliveira da Costa, Andrea Fabio Cattoni, Preben E. Mogensen, and Luiz A. da Silva	
5.1	Introduction	152
5.2	Overview of Femtocells and Challenges	153
5.3	System Model and Assumptions	154
5.4	Simulation Scenario	156
5.5	Potential Link Capacity Gain	159
5.6	Game Theoretic Analysis	160
5.7	Graph Theoretic Analysis	164
5.8	Distributed Methods for Channel Allocation	168
	5.8.1 Dynamic Channel Allocation	168
	5.8.2 Dynamic Reuse Selection	169
	5.8.3 Negotiated Reuse Selection	171
5.9	Results and Discussions	172
5.10	Concluding Remarks and Further References	178
	References	179
6	Towards Cognitive Internet: An Evolutionary Vision	181
	Fabrizio Granelli, Dzmitry Kliazovich, and Neumar Malheiros	
6.1	Introduction	182
6.2	Historical Perspective	182
	6.2.1 Legacy TCP/IP	182
	6.2.2 Motivation for Adaptation	183

- 6.3 Adaptive TCP/IP: Enabling Technologies 184
 - 6.3.1 Cross-Layer Design 184
 - 6.3.2 Distributed and Agent-Based Solutions 188
 - 6.3.3 AI-Based Reasoning and Learning 191
 - 6.3.4 Architectures to Support Adaptive Protocols..... 192
 - 6.3.5 Discussion 192
- 6.4 The Evolution to Cognitive Protocols 193
- 6.5 Conclusion 197
- References..... 198
- 7 Automatic Best Wireless Network Selection Based on Key Performance Indicators 201**

Stefano Boldrini, Maria-Gabriella Di Benedetto, Alessandro Tosti, and Jocelyn Fiorina

 - 7.1 Introduction..... 202
 - 7.2 Quality of Experience and KPIs 203
 - 7.2.1 VoIP Case 204
 - 7.3 Cognitive Engine 206
 - 7.4 Model Structure 206
 - 7.5 Experimentation 209
 - 7.5.1 Experimental Set-Up 209
 - 7.5.2 Experimental Data 210
 - 7.6 Conclusions and Future Work 212
 - References..... 213
- 8 Localization in Cognitive Radio Networks..... 215**

Ioannis P. Chochliouros, Ioanna Papafili, George S. Agapiou, Anastasia S. Spiliopoulou, Stelios Agapiou, Ronald Raulefs, and Siwei Zhang

 - 8.1 Cognitive Radio: An “Enabler” for Future Evolution of Communications Systems 216
 - 8.1.1 Realization of a More Efficient Use of Spectrum 217
 - 8.1.2 Enhancement of Users’ Experience..... 218
 - 8.1.3 Optimization of Networks..... 219
 - 8.1.4 Technical Requirements on Current CR Systems, as Identified by Actual Standardization Works 221
 - 8.1.5 CRNs for Further Network Deployment 222
 - 8.1.6 Conclusion 223
 - 8.2 Indoor Positioning and Horizontal Handover Employing RSSI Fingerprinting in OTE Labs 224
 - 8.2.1 Positioning Technique 225
 - 8.2.2 Experimental Setup 227
 - 8.2.3 Indoor Positioning Application 228
 - 8.2.4 Status and Finger Operations 228
 - 8.2.5 Find Operation 228

8.2.6	Accuracy of Indoor Positioning	232
8.2.7	Conclusion	233
8.3	Cognitive Cooperative Positioning	233
8.3.1	Geo-Localization	234
8.3.2	WHERE2 Project	235
8.3.3	Multi-user Positioning	238
8.3.4	Conclusions	240
	References	241
9	Challenges Towards a Cloud-RAN Realization	245
	Andreas Georgakopoulos, Dimitrios Karvounas, Vera Stavroulaki, Kostas Tsagkaris, and Panagiotis Demestichas	
9.1	Introduction	245
9.2	Related Work	247
9.3	Intelligence and Cognition in Cloud-RANs	248
9.3.1	Elements of the Approach	248
9.3.2	Benefits from the Cloud-RAN	250
9.4	Future Considerations	253
9.5	Conclusions	254
	References	255
10	A Regulatory Perspective on Cognitive Radio and Spectrum Sharing	257
	Linda Doyle and Tim Forde	
10.1	Introduction	257
10.2	A Means of Contextualising the Regulatory Perspective	259
10.2.1	The Makers of the Rules	261
10.3	The Supposedly Low Hanging Fruit: The TV White Spaces	263
10.3.1	TV White Space Regulations in General	264
10.3.2	A Global Summary of the State of Play	266
10.3.3	The Outlook	269
10.4	The Sharing Economy	270
10.4.1	International Moves: PCAST, LSA and BSOs	271
10.4.2	The 3.5 GHz Sharing Opportunity	277
10.4.3	The 2.3 GHz Sharing Opportunity	279
10.4.4	The Outlook	282
10.5	Other Work of the IEEE	282
10.5.1	IEEE DySPAN-SC	283
10.6	Some Perspectives for the Future	284
10.6.1	Systematising of Sharing and Cognitive Technologies	284
10.6.2	Sharing Is Clearing	286
10.7	Conclusion	287
	References	287

11	Simulation of Cognitive Radio Networks in OMNeT++	291
	Giuseppe Caso, Luca De Nardis, and Oliver Holland	
11.1	Introduction.....	291
11.2	System Model.....	293
11.2.1	Operating Mode 1: Constant False Alarm Rate (CFAR).....	295
11.2.2	Operating Mode 2: Constant Detection Rate (CDR).....	296
11.3	OMNeT++: Objective Modular Network Testbed in C++.....	299
11.4	MiXiM: The Mixed Simulator.....	300
11.4.1	From a MiXiM-Based to a Cognitive Radio Scenario....	302
11.5	Application of the CR Simulator to Open Research Issues.....	304
11.5.1	Cooperative Spectrum Sensing Based on Hard Decision Fusion Rules Under CFAR and CDR Constraints.....	305
11.5.2	Impact of Spatio-Temporal Correlation in Cooperative Spectrum Sensing for Mobile Cognitive Radio Networks.....	308
11.6	CR Simulator: Availability and Possible Collaborations.....	312
	References.....	312
12	Designing a CR Test Bed: Practical Issues	315
	Andrea Fabio Cattoni, Jakob Lindholm Buthler, Oscar Tonelli, Luiz A. da Silva, João Paulo Miranda, Paul Sutton, Floriana L. Crespi, Sergio Benco, Alberto Perotti, and Daniel Riviello	
12.1	Introduction.....	316
12.2	Evolution of Test Bed Research.....	317
12.2.1	Trends in Implementation-Based CR Research.....	317
12.2.2	Review of the State of the Art.....	319
12.2.3	Experimentation Methodology and Benchmarking.....	321
12.3	Practical Research Activities with a Test Bed.....	325
12.3.1	Understanding the Requirements of Your Own Research Application.....	326
12.3.2	Choice of the Hardware.....	327
12.3.3	Practical Test Bed Issues.....	328
12.3.4	Dealing with the HW.....	330
12.4	SW Platforms.....	332
12.4.1	Writing an Application.....	332
12.4.2	Running Experiments: Best Practices.....	349
12.5	Conclusion.....	358
	References.....	358

13 Low-Cost Testbed Development and Its Applications in Cognitive Radio Prototyping 361
 Tomaž Šolc, Carolina Fortuna, and Mihael Mohorčič

13.1 Introduction 361

13.2 Radio Front-Ends for Embedded Testbeds 363

 13.2.1 VESNA with the SNE-ISMTV Expansion 364

 13.2.2 Reconfigurable Integrated Transceivers 365

 13.2.3 Getting Closer to SDR with Custom Hardware 372

 13.2.4 Summary 373

13.3 Testbed Infrastructure 374

 13.3.1 LOG-a-TEC Testbed Deployment 374

 13.3.2 Network Design Constraints 378

 13.3.3 Performance Evaluation of the Management Network ... 380

 13.3.4 Measurements in Logatec 382

 13.3.5 LOG-a-TEC Testbed Access, Control and Reconfiguration 387

 13.3.6 Summary 388

13.4 Signal Generation Use Case 389

 13.4.1 Summary 393

13.5 An Interference Mitigation Use Case 393

 13.5.1 Summary of the PAPU Algorithm 394

 13.5.2 Experimental Set-Up 395

 13.5.3 The Adaptation of the Theoretical Framework..... 396

 13.5.4 Empirical Parameter Determination 398

 13.5.5 Experimental Results 400

 13.5.6 Summary 403

13.6 Summary of the Chapter 403

References 404



<http://www.springer.com/978-3-319-01717-4>

Cognitive Radio and Networking for Heterogeneous
Wireless Networks

Recent Advances and Visions for the Future

Di Benedetto, M.-G.; Fabio Cattoni, A.; Fiorina, J.; Bader,
F.; De Nardis, L. (Eds.)

2015, XXV, 405 p. 172 illus., Hardcover

ISBN: 978-3-319-01717-4