

Contents

1	Introduction	1
1.1	Cognitive Radio	2
1.1.1	Cognitive Radio Network Architecture	3
1.1.2	Cognitive Radio Functionalities	5
1.1.3	Cognitive Radio Access Paradigm	5
1.2	Cooperative Spectrum Sharing in Cognitive Radio Networks	7
1.2.1	Resource Compensation based CSS	8
1.2.2	Energy Harvesting in CSS using SWIPT technology	9
1.3	Issues and Challenges in modelling Cooperative Spectrum Sharing	10
1.4	Motivation of the Research	11
1.5	Research Objective	12
1.6	Thesis Contributions	13
1.6.1	A utility driven bandwidth and time allocation CSS scheme for single-PU, multi-SUs overlay CRNs	13
1.6.2	A one-to-one mapping for multiple resource allocation CSS scheme in multi-PU, multi-SUs overlay CRNs	14
1.6.3	A many-to-one mapping for multiple resource allocation CSS scheme in multi-PU, multi-SUs overlay CRNs	14

1.6.4	A joint power-and-time allocation CSS scheme for energy harvesting multi-PUs, multi-SUs overlay CRNs	15
1.7	Thesis Organization	16
2	Literature Survey	18
2.1	Introduction	18
2.2	Spectrum Sharing in CRN	19
2.3	Relay-aided cooperative spectrum sharing in CRN	21
2.3.1	Relay-aided CSS in single-PU multi-SUs CRNs	24
2.3.2	Relay-aided CSS in multi-PUs multi-SUs CRNs	25
2.3.3	Summary	30
2.4	Energy harvesting for energy efficient communication during CSS .	30
2.4.1	SWIPT technology in CRN	31
2.5	Conclusion	34
3	A utility driven bandwidth and time allocation CSS scheme for single-PU, multi-SUs overlay CRNs	35
3.1	Introduction	35
3.2	Problem Statement	37
3.2.1	Assumptions	37
3.2.2	Notations and Symbols Used	38
3.3	System Model	40
3.3.1	Case 1	42
3.3.2	Case 2	44
3.4	Problem Formulation	46

3.4.1	Allocation of W_A	47
3.4.2	Allocation of T_A	47
3.4.3	Nature of the Problem	48
3.5	Proposed scheme	49
3.5.1	Bandwidth Sharing	50
3.5.2	For Time Sharing	51
3.5.3	Algorithm 3:	52
3.6	Case analysis and Results discussions	55
3.6.1	Simulation setup	57
3.6.2	Performance Metrics	58
3.6.3	Experiment on PU_{ch1}	60
3.6.4	Experiment on PU_{Ch2}	62
3.6.5	Delay analysis for the proposed resource sharing models . . .	65
3.6.6	Performance Comparison with existing methods	68
3.7	Conclusion	70
4	A one-to-one mapping for multiple resource allocation CSS scheme in multi-PUs, multi-SUs overlay CRNs	72
4.1	Introduction	72
4.2	Problem Statement	74
4.2.1	Assumptions	74
4.2.2	Notations and Symbols Used	75
4.3	System Model	76
4.3.1	Optimal allocation of α and β	81

4.4	Proposed one-to-one mapping model among PUs and SUs	86
4.4.1	Matching Theory	86
4.5	Simulations results and performance analysis	90
4.5.1	Performance Metrics	91
4.5.2	Performance analysis of proposed optimization scheme	91
4.5.3	Performance analysis of average utility of PUs and SUs	93
4.5.4	Performance analysis of average utility of SUs for varying network size	94
4.5.5	Performance analysis of avg. satisfaction of SUs for varying network size	95
4.5.6	Performance analysis of proposed approach vs. conventional approaches	96
4.6	Conclusion	97
5	A many-to-one mapping for multiple resource allocation CSS scheme in multi-PUs, multi-SUs overlay CRNs	99
5.1	Introduction	99
5.2	Problem Statement	101
5.2.1	Assumptions	101
5.2.2	Notations and Symbols Used	102
5.3	System Model	103
5.4	Proposed Cooperative Communication Framework	105
5.4.1	Analysis of matching theory for the proposed cooperative scheme	107
5.4.2	Proposed cooperative strategy among SUs based on Matching Theory	111

5.5	Simulations Results and Discussion	117
5.5.1	Performance Metrics	118
5.5.2	PU utility analysis for proposed scheme vs. existing schemes	118
5.5.3	SU's utility analysis for proposed scheme vs. existing schemes	120
5.5.4	SU's satisfaction analysis for proposed scheme vs. existing schemes	122
5.5.5	SU's participation analysis for proposed scheme vs. existing schemes	124
5.5.6	SU's throughput fairness index analysis for proposed scheme vs. existing schemes	125
5.6	Conclusion	127
6	A joint power-and-time allocation CSS scheme for energy harvesting multi-PUs, multi-SUs overlay CRNs	129
6.1	Problem Statement	131
6.1.1	Assumptions	131
6.1.2	Notations and Symbols Used	132
6.2	System Model	133
6.3	Problem Formulation	140
6.3.1	Performance metrics	140
6.3.2	Formulation of Optimization Problems	141
6.3.3	Nature of Optimization Problems	142
6.3.4	Performance analysis with Optimal results	145
6.3.5	Performance analysis with Optimal results	151
6.4	Proposed cooperative communication framework for PUs and SUs .	154
6.4.1	Hedonic coalition formation game	155

6.4.2	A Working Example	158
6.4.3	Theoretical analysis of Algorithm 3 based on Hedonic Game concept	161
6.5	Numerical Results and Comparison Analysis	163
6.5.1	Performance Metrics	164
6.5.2	Utility of SUs in proposed cooperation scheme vs. non- cooperation scheme	165
6.5.3	Satisfaction of SUs in proposed cooperation scheme vs. non- cooperation scheme	166
6.5.4	Participation of SUs in proposed cooperation scheme vs. non-cooperation scheme	168
6.5.5	Utility of PUs with varying size of networks	169
6.6	Conclusion	170
7	Conclusion and Future Direction	172
7.1	Conclusion	172
7.2	Future Directions	174
	Publications based on the Thesis Works	188