

Contents

1	Introduction	1
1.1	Seismic Survey	1
1.1.1	Seismic Wave Fundamentals	3
1.1.2	Survey Equipment	4
1.1.3	Seismic Signal Recording	8
1.1.4	Survey Planning	9
1.2	Wireless Seismic Data Acquisition (WSDA)	10
1.2.1	Historical perspective	11
1.2.2	Network Coverage and Deployment	12
1.2.3	Data Generation and Transmission	14
1.2.4	Energy Consumption	14
1.3	Problem Statement	15
1.4	Contributions	20
1.5	Thesis Organization	21
2	Related Work	23
2.1	Recent Advancement in WSDA Devices and Systems	23
2.1.1	Blind Nodes	23
2.1.2	Quality Control (QC) Capable Nodes	24
2.1.3	Real or Near Real-Time Systems	24
2.2	WSDA Methods	24
2.2.1	Blind Acquisition Method	25
2.2.2	Real-time Acquisition Method	26
2.2.3	Multi-vibroseis Acquisition Technique	26
2.3	Network Architectures for WSDA	28
2.4	Technologies for WSDA	31
2.5	IEEE 802.11-Based Technology Solutions	35
2.5.1	PHY and MAC Sub-layer	37
2.5.2	802.11 Ad Hoc Networking	43

2.5.3	Energy Consumption	44
2.5.4	IEEE 802.11 Challenges	46
2.5.5	Proposed IEEE 802.11 Standards	48
2.6	Routing Protocols for WSDA	52
2.6.1	Routing Based on Network Structure	52
2.6.2	Routing Based on Path Discovery Process	60
2.6.3	Proposed Routing Approach	62
2.7	Conclusion	63
3	Proposed WSDA Architecture, Methodology, and Scenarios	65
3.1	Introduction	65
3.2	WSDA Proposed Architecture	65
3.2.1	Geophone Domain	66
3.2.2	Gateway Domain	67
3.3	Geophone Data Traffic Model	69
3.4	Research Questions	71
3.5	Methodology and Scenarios	73
3.5.1	Scenario 1	74
3.5.2	Scenario 2	75
3.5.3	Scenario 3	76
3.6	OMNeT++ Simulator	78
3.7	Conclusion	79
4	MAC Modeling for WSDA Networks	81
4.1	Single-hop Modeling and Analysis of the DCF	81
4.1.1	Markov Model for a Geophone Node	84
4.1.2	Stationary Transmission Probability	89
4.1.3	System Throughput	91
4.1.4	Channel State Markov Model	93
4.1.5	Average Packet Delay	97
4.1.6	Model Validation	98
4.2	Evaluation of Recording Period Acquisition (RPA) Traffic Model	105
4.2.1	Key Performance Indicators (KPIs)	107
4.2.2	Results	109
4.3	Conclusion	112

5	RPL for WSDA Networks	113
5.1	Introduction	113
5.2	RPL Overview for WSDA Networks	113
5.2.1	Control Messages	114
5.2.2	RPL Topology construction	115
5.2.3	Trickle Algorithm	118
5.2.4	RPL Routing Metrics	119
5.3	RPL Topology as Applied to the Proposed WSDA Architecture	121
5.4	Evaluation of RPL in WSDA Subnetwork	122
5.4.1	Simulation model	124
5.4.2	Traffic generation	124
5.4.3	Result analysis	125
5.5	Modeling Geophone Hop Count Distribution in Relation to RPL	127
5.6	Conclusion	132
6	WSDA Network Performance Evaluation	135
6.1	Introduction	135
6.2	Performance Metrics	135
6.3	Performance Evaluation in the 2.4 and 5 GHz Band	138
6.3.1	Interference Effect	140
6.3.2	Simulations	141
6.3.3	Results	145
6.3.4	Discussions	151
6.4	Energy Consumption	152
6.4.1	Simulation Setup	154
6.4.2	Results	155
6.5	Energy Consumption Modeling for WSDA	158
6.6	Conclusion	164
7	Conclusion	165
7.1	Future Work	169
7.2	Other Areas of Application	169
	Acronyms	176
	List of Figures	180

List of Tables	181
Bibliography	183