

# Contents

<b>List of Tables</b>	<b>xi</b>
<b>List of Figures</b>	<b>xiii</b>
<b>Acronyms</b>	<b>xv</b>
<b>1 Introduction</b>	<b>1</b>
1.1 Motivation . . . . .	1
1.2 Problem Statement and Hypothesis . . . . .	2
1.2.1 Problem Statement . . . . .	2
1.2.2 Hypothesis . . . . .	3
1.3 Objectives . . . . .	3
1.4 Methodology . . . . .	4
1.5 Thesis Structure . . . . .	4
<b>2 Background</b>	<b>5</b>
2.1 Wireless Sensor Networks (WSNs) . . . . .	5
2.1.1 Standarization . . . . .	6
2.1.2 Challenges of WSN . . . . .	7
2.2 PHY Layer Attacks . . . . .	8
2.2.1 Eavesdropping . . . . .	9
2.2.2 Jamming Attacks . . . . .	9
<b>3 IEEE 802.15.4 System Description</b>	<b>14</b>
3.1 General Description . . . . .	14
3.2 Components and Topologies . . . . .	14
3.3 PHY Layer . . . . .	15
3.3.1 DSSS transmission . . . . .	15
3.3.2 Clear Channel Assesment (CCA) . . . . .	16
3.3.3 PPDU Format . . . . .	16
3.3.4 Encoding . . . . .	17
3.3.5 Capture Effect . . . . .	17
3.4 MAC layer . . . . .	18
3.4.1 Time Slotted Channel Hopping . . . . .	18
3.4.2 CSMA . . . . .	19
3.4.3 Analytical model . . . . .	20
3.5 Jamming Attacks . . . . .	26

<b>4</b>	<b>Experimental Testbed</b>	<b>32</b>
4.1	Hardware . . . . .	33
4.1.1	Synchronization . . . . .	35
4.1.2	Energy Consumption . . . . .	37
4.2	Software . . . . .	39
<b>5</b>	<b>Results and Discussion</b>	<b>42</b>
5.1	TSCH & Orchestra . . . . .	42
5.2	Unslotted CSMA/CA . . . . .	47
5.2.1	Channel Parameters . . . . .	47
5.2.2	General Procedure . . . . .	49
5.2.3	PDR and Goodput . . . . .	49
5.2.4	Received Signal Strength and Transmission Status . . . . .	54
5.2.5	Energy Consumption . . . . .	57
<b>6</b>	<b>Conclusions and Future Work</b>	<b>59</b>
	<b>Annexes</b>	<b>60</b>
	<b>Bibliography</b>	<b>62</b>