

Essentials of
**Wireless Mesh
Networking**

CAMBRIDGE WIRELESS ESSENTIALS SERIES

STEVE METHLEY

Contents

<i>Preface</i>	<i>page</i> ix
<i>Acknowledgements</i>	x
1 Mesh overview and terminology	1
1.1 What is a mesh?	2
1.2 The role of mesh in future networks	5
1.3 How do meshes work?	7
1.4 Key mesh issues and the structure of this book	12
2 Attractive mesh attributes and applications	15
2.1 Example applications for mesh	16
2.2 The coverage attribute	21
2.3 Summary	26
Reference	26
3 Fundamentals of mesh technology	27
3.1 Overview	27
3.2 Physical layer	29
3.3 Medium access control	36
3.4 Routing	38
3.5 Transport and applications	40
3.6 Summary	42
4 Mesh capacity, scalability and efficiency – hypothesis testing	43
4.1 Hypothesis 1 – Could customers self-generate capacity in a mesh?	45
4.2 Conclusions – capacity	73
4.3 Hypothesis 2 – Are meshes more efficient?	75
4.4 Conclusions – omni-directional antennas	86
4.5 Hypothesis 3 – Do directional antennas help a mesh?	87

4.6	Conclusions – directional antennas	93
4.7	Hypothesis 4 – Do meshes improve spectrum utilisation?	94
4.8	Conclusions – utilisation	95
4.9	Summary of hypothesis testing	96
	References	97
5	Mesh susceptibility	99
5.1	<i>Interference types</i>	100
5.2	Susceptibility to interference – PHY and MAC	102
5.3	Dedicated mesh routing and transport approaches	121
5.4	Co-existence approaches	129
5.5	Summary of susceptibility and co-existence issues	132
	References	133
6	Mesh services and quality of service	134
6.1	Quality of service and levels required	134
6.2	Quality of service drivers	137
6.3	Improving quality of service by adding network infrastructure	144
6.4	Quality of service summary	148
	References	149
7	Summary of potential mesh pitfalls to avoid	151
7.1	Capacity	151
7.2	Infrastructure	152
7.3	Efficiency	152
7.4	Relay exhaustion	153
7.5	Initial roll-out	153
7.6	Upgradeability	154
7.7	Reliance on user behaviour	154
7.8	Ad hoc versus quality of service	155
7.9	Security and trust	156
7.10	Business case economics	156
7.11	Enduring attractions of mesh	157
	Reference	157

8	Appropriate telecommunications applications for mesh	158
	8.1 User side mesh applications	158
	8.2 Network side or backhaul mesh applications	165
	8.3 Joint user and network side mesh applications	166
	8.4 Time scales	167
	Reference	168
9	Successful mesh implementations	169
	9.1 Wireless cities	169
	9.2 Community Internet	173
	9.3 Vehicular ad hoc network (VANET) applications	175
	9.4 Summary	179
	References	179
10	Wireless sensor networks (WSNs) as mesh networks	180
	10.1 Introduction	181
	10.2 WSN sensors	182
	10.3 WSN power sources	183
	10.4 Wireless sensor technologies and applications	184
	10.5 Differentiating RFID, mesh and sensor networks	186
	10.6 Differentiating 802.15.x, ZigBee and 6LoWPAN	189
	10.7 A suggested taxonomy of WSNs: structure and equality	195
	10.8 System architecture in sensor networks	195
	10.9 Unstructured WSNs	200
	10.10 Structured WSNs	206
	10.11 External routing and transport options	212
	10.12 WSN summary	213
	References	214
	<i>Abbreviations</i>	215
	<i>Selected definitions</i>	219
	<i>Appendix: Mobility models</i>	221
	<i>About the author</i>	225
	<i>Index</i>	226
	<i>Mesh hints and tips (inside back cover)</i>	228