

Contents

Part I Introduction

1	Origins and Characteristics	3
1.1	Delay Tolerant Networks	4
1.1.1	Evolution	5
1.1.2	Characteristics and Challenges	6
1.2	Mission-Oriented Opportunistic Networks	8
1.3	Research Areas in OMNs	9
1.3.1	Cooperation	11
1.3.2	Human Mobility	13
1.3.3	Privacy and Anonymity	15
1.3.4	Congestion	17
1.4	Network Simulation	18
1.5	Summary	19
1.6	Review Terms	20
1.7	Exercises	20
1.8	Programming Exercises	21
2	Delay Tolerant Routing and Applications	23
2.1	Routing Protocols	24
2.1.1	Epidemic	25
2.1.2	Spray and Wait	27
2.1.3	PRoPHET	30
2.1.4	RAPID	32
2.1.5	Bubble Rap	34
2.2	Routing Based on Encounter Statistics	35
2.2.1	Encounter-Based Routing	36
2.2.2	Contact-Based Routing in DTNs	36
2.2.3	Delegation Forwarding	37

- 2.3 Performance Indicators and Key Insights 40
 - 2.3.1 Performance Evaluation Metrics 40
 - 2.3.2 General Insights into Routing 41
- 2.4 Real-Life Traces 44
- 2.5 Applications 47
 - 2.5.1 DakNet 47
 - 2.5.2 Bytewalla 48
 - 2.5.3 DTWiki 48
 - 2.5.4 DT-Talkie 48
 - 2.5.5 ZebraNet 49
- 2.6 Summary 49
- 2.7 Review Terms 50
- 2.8 Exercises 50
- 2.9 Programming Exercises 51
- 3 A Developer’s Guide to the ONE Simulator 53**
 - 3.1 Development with NetBeans 53
 - 3.1.1 Setting Up a Project 54
 - 3.1.2 Using Real-Life Traces in Simulations 56
 - 3.1.3 Debugging with NetBeans 58
 - 3.2 Developing a New Routing Protocol 60
 - 3.2.1 The Roadmap 61
 - 3.2.2 Implementation Details 62
 - 3.3 Version Control 66
 - 3.4 Testing Protocol Development 71
 - 3.4.1 An Overview of JUnit 72
 - 3.4.2 Testing with ONE 74
 - 3.5 Best Practices 85
 - 3.6 Summary 86
 - 3.7 Review Terms 87
 - 3.8 Exercises 87
 - 3.9 Programming Exercises 87

Part II Human Aspects in Opportunistic Mobile Networks

- 4 Emerging Sensing Paradigms and Intelligence in Networks 91**
 - 4.1 Emerging Paradigms of Sensor Networks 92
 - 4.1.1 Human-Centric Sensing 92
 - 4.1.2 Mission-Oriented Sensor Networks 93
 - 4.2 Disaster Scenarios and Their Aftermath 94
 - 4.2.1 Sensor Networks for Environmental and Disaster Monitoring 95
 - 4.2.2 Post-disaster Mobility Models 101
 - 4.2.3 Communication Aspects 104

- 4.3 The Notion of Intelligence 107
 - 4.3.1 Agent-Based Systems 108
 - 4.3.2 Situation Awareness 112
- 4.4 Intelligence-Induced Movement in MOONs 115
 - 4.4.1 Representation of MOONs. 116
 - 4.4.2 Opportunistic Communications with Intelligence. 117
 - 4.4.3 Comparative Study 120
- 4.5 Summary. 124
- 4.6 Review Terms 125
- 4.7 Exercises 125
- 4.8 Programming Exercises 126
- 5 Aspects of Human Emotions and Networks 127**
 - 5.1 Models of Human Emotions 128
 - 5.1.1 Emotions and Facial Expressions 128
 - 5.1.2 Plutchik’s Circumplex Model 129
 - 5.1.3 Pleasure-Arousal-Dominance Model 130
 - 5.2 Computational Models of Emotions 131
 - 5.2.1 Computational Model Based on Plutchik’s Theory 131
 - 5.2.2 Markovian Model of Emotions. 132
 - 5.2.3 Emotion and Adaptation 133
 - 5.3 Emotion Detection 134
 - 5.3.1 Overview and Applications 134
 - 5.3.2 Smartphone-Based Emotion Detection 136
 - 5.3.3 Emotion Detection in Online Social Networks 137
 - 5.3.4 Emotional Response of Human Beings 139
 - 5.4 Effects of Emotion in MOONs. 140
 - 5.4.1 Relevance in MOONs. 141
 - 5.4.2 Terminologies 141
 - 5.4.3 Influence on Network Dynamics. 142
 - 5.5 Application Scenario. 145
 - 5.5.1 Variation in Emotion. 145
 - 5.5.2 Variation in Traffic Load 146
 - 5.5.3 Changes in User Cooperation. 148
 - 5.6 Practical Implications 149
 - 5.7 Summary. 158
 - 5.8 Review Terms 159
 - 5.9 Exercises 159
 - 5.10 Programming Exercises 160

Part III Cooperation in Opportunistic Mobile Networks

- 6 Evolutionary Game in Wireless Networks 163**
 - 6.1 Overview of Game Theory 164
 - 6.1.1 Classical Game Theory 164
 - 6.1.2 Evolutionary Game Theory 169
 - 6.2 Applications of EGT. 172
 - 6.2.1 Biology and Economics. 172
 - 6.2.2 Vehicular Ad Hoc Networks 173
 - 6.2.3 Other Wireless Networks. 175
 - 6.3 RSP Game in OMNs 177
 - 6.3.1 Action of the Nodes 180
 - 6.3.2 Analysis of Cooperation Strategies 183
 - 6.3.3 Relationship Among the Strategies 185
 - 6.4 Summary. 188
 - 6.5 Review Terms 188
 - 6.6 Exercises 189

- 7 Enforcing Cooperation in OMNs 191**
 - 7.1 Cooperation Enforcement Schemes 192
 - 7.1.1 Incentive-Based Schemes. 192
 - 7.1.2 Game Theory-Based Schemes 196
 - 7.1.3 Other Approaches of Cooperation. 198
 - 7.2 Distributed Cooperation Enforcement 199
 - 7.3 A Detailed Look at DISCUSS 201
 - 7.3.1 Information Acquisition. 202
 - 7.3.2 Strategy Adaptation. 205
 - 7.4 Characteristics of DISCUSS. 207
 - 7.4.1 Theoretical Analysis 207
 - 7.4.2 Complexity Analysis. 210
 - 7.5 Performance Insights. 212
 - 7.5.1 DISCUSS with Global Knowledge 213
 - 7.5.2 Effects of Generation Interval. 213
 - 7.5.3 Similarity Measurement. 213
 - 7.5.4 Variation in Group Composition. 215
 - 7.5.5 Delivery of Messages 217
 - 7.6 Summary. 220
 - 7.7 Review Terms 220
 - 7.8 Exercises 221
 - 7.9 Programming Exercises 221

Part IV Advanced Topics

8 Heterogeneity in OMNs 225

8.1 Heterogeneity in Communication Networks 226

8.1.1 Overview of Heterogeneity 226

8.1.2 Heterogeneity at Link Layer. 228

8.1.3 Heterogeneity at Network Layer 229

8.1.4 Heterogeneous Contact Patterns 231

8.2 Aspects of Heterogeneity in OMNs. 233

8.2.1 Heterogeneity in Connection Dynamics 234

8.2.2 Diverse Hardware of the Devices 235

8.2.3 (In)Compatibility of Routing Protocols in OMNs 237

8.2.4 Effects of Incompatibilities. 238

8.3 OMNs as Graphs 239

8.3.1 Temporal Graphs 239

8.3.2 Time-Varying Graphs 243

8.3.3 Representation of Heterogeneous OMNs 244

8.4 Overcoming the Adverse Effects of Heterogeneity 246

8.4.1 Hardware Incompatibility. 246

8.4.2 Protocol Translation Units 246

8.5 Key Insights 249

8.5.1 Heterogeneous Connection Events 251

8.5.2 Incompatible Networking Devices. 251

8.5.3 Heterogeneous Routing Protocols 253

8.6 Observations 254

8.7 Summary. 255

8.8 Review Terms 256

8.9 Exercises 256

8.10 Programming Exercises 257

9 Opportunistic Mobile Networks: Toward Reality 259

9.1 Comprehensive Statistics 259

9.2 A Look at the Standards 262

9.2.1 Request for Comments 262

9.2.2 Patents 264

9.3 Promising Avenues. 267

9.3.1 Opportunistic Computing. 267

9.3.2 Remote Healthcare 267

9.3.3 5G and OMNs 268

9.3.4 Traffic Off-Loading. 269

9.3.5 OMNs and the Internet of Things 269

9.4 Prospective Project Topics 270

9.5 Summary. 271

9.6 Review Terms 272

9.7 Exercises 272

10 The Big Picture 273

 10.1 Challenges and Applications 273

 10.2 Human Aspects and Heterogeneity 274

 10.3 Issues of Cooperation 275

Author Biographies 277

References 281

Index 299



<http://www.springer.com/978-3-319-29029-4>

Opportunistic Mobile Networks

Advances and Applications

Misra, S.; Saha, B.K.; Pal, S.

2016, XXXII, 303 p. 66 illus., 3 illus. in color., Hardcover

ISBN: 978-3-319-29029-4