
Contents

Preface	xi
Chapter 1. Simulation of Convergent Networks for Intelligent Transport Systems with VSimRTI	1
Robert PROTZMANN, Björn SCHÜNEMANN and Ilja RADUSCH	
1.1. Introduction	1
1.2. Fundamentals of cooperative ITS	2
1.2.1. Message types	2
1.2.2. Application categories	3
1.2.3. Supporting facilities	4
1.3. Overall simulation framework	5
1.4. Simulation of cellular networks	6
1.4.1. Regions and cells	10
1.4.2. Delay models	11
1.4.3. PR-Model and PL-Model	12
1.4.4. Capacity Model	13
1.4.5. Topological and geographical messaging	14
1.5. Simulation study	14
1.5.1. Evaluation metrics	16
1.5.2. Simulation set-up	18
1.5.3. Simulation results	21
1.6. Conclusion	25
1.7. Bibliography	26

Chapter 2. Near-field Wireless Communications and their Role in Next Generation Transport Infrastructures: an Overview of Modelling Techniques	29
Christian PINEDO, Marina AGUADO, Lara RODRIGUEZ, Iñigo ADIN, Jaizki MENDIZABAL and Guillermo BISTUÉ	
2.1. Near-field wireless technologies	30
2.1.1. Near-field versus far-field	30
2.1.2. Near-field-based technologies in transport	33
2.2. Characterization of near-field communications	36
2.2.1. Electrical models	37
2.2.2. Analysis of the mutual inductance of a squared inductive coupling	37
2.2.3. Computer-aided electromagnetic calculation	40
2.3. Discrete event simulators	42
2.3.1. Riverbed Modeler	43
2.3.2. OMNeT++	44
2.3.3. ns-2	45
2.3.4. ns-3	45
2.3.5. Discrete event simulator comparison for near-field communication	46
2.4. Conclusions	47
2.5. Bibliography	48
Chapter 3. Trace Extraction for Mobility in Civil Aeronautical Communication Networks Simulation	51
Fabien GARCIA and Mickaël ROYER	
3.1. Traffic regulations	52
3.1.1. General airspace	52
3.1.2. North Atlantic airspace	53
3.2. Mobility for network simulation	54
3.2.1. Types of mobility models for AANETs	54
3.2.2. Comparison of mobility model types	55
3.3. Example of mobility trace extraction	56
3.3.1. Extraction of information	57
3.3.2. Traces filtering	57
3.3.3. Enhancing traces	58
3.4. Toward cooperative trajectories	60
3.5. Bibliography	60

Chapter 4. Air-Ground Data Link Communications in Air Transport	61
Christophe GUERBER, Alain PIROVANO and José RADZIK	
4.1. Introduction	61
4.1.1. Context.	61
4.1.2. OMNeT++.	63
4.2. Continental air-ground data link communications and VDL mode 2	63
4.2.1. Communication system.	63
4.2.2. Dimensioning parameters and bottlenecks	65
4.2.3. Simulation model	67
4.2.4. Analysis of simulation results	69
4.3. Oceanic air-ground data link communications and AMS(R)S	71
4.3.1. The aeronautical mobile satellite (route) service and Classic Aero	71
4.3.2. Dimensioning parameters and bottlenecks	73
4.3.3. Simulation model	74
4.3.4. Analysis of simulation results	75
4.4. Summary and further work	76
4.5. Bibliography	77
Chapter 5. A Virtual Laboratory as an Assessment Tool for Wireless Technologies in Railway Systems	79
Patrick SONDI, Eric RAMAT and Marion BERBINEAU	
5.1. Introduction	80
5.2. ERTMS subsystems and related test beds	81
5.2.1. The functional subsystem of the ERTMS.	81
5.2.2. The telecommunication subsystem of the ERTMS	84
5.3. A virtual laboratory based on co-simulation for ERTMS evaluation	86
5.3.1. Why a co-simulation approach?	86
5.3.2. Which data and processes must be modeled in each simulator?	87
5.3.3. Overall architecture of the ERTMS–OPNET virtual laboratory.	89
5.3.4. Synchronization modes.	90
5.3.5. Virtual laboratory implementations in the ERTMS simulator	92
5.3.6. Virtual laboratory implementations in OPNET	93
5.3.7. Virtual laboratory implementations in the co-simulation manager.	95

5.4. Effective use of the ERTMS–OPNET virtual laboratory	97
5.4.1. A co-simulation scenario with the ERTMS–OPNET virtual laboratory	97
5.4.2. Efficiency of the co-simulation approach in the evaluation of railway systems	101
5.5. Conclusion	104
5.6. Bibliography	105
Chapter 6. Emulating a Realistic VANET Channel in Ns-3	107
Hervé BOEGLÉN, Benoit HILT and Frédéric DROUHIN	
6.1. Introduction	107
6.2. Influence of the channel propagation model on VANET simulation	107
6.2.1. A realistic IEEE802.11 PHY layer	108
6.2.2. Accurate VANET channel propagation modeling	109
6.3. A way to realistic channel modeling with ns-2	112
6.4. Realistic channel modeling with ns-3	114
6.4.1. The Yans WiFi model	114
6.4.2. The Physim Wi-Fi model emulating OFDM-based transmission	115
6.4.3. Data transmission at ns-3 PHY level	116
6.4.4. The internals of WiFi channel modeling	117
6.5. Case studies: emulation of realistic VANET channel models in ns-3	117
6.5.1. A simplified VANET channel model for an urban environment	118
6.5.2. A normalized VANET channel model for urban environments	121
6.6. Conclusion and discussion	123
6.7. Appendix A: The Abbas et al. Model Implementation	125
6.8. Bibliography	130
Chapter 7. CONVAS: Connected Vehicle Assessment System for Realistic Co-simulation of Traffic and Communications	133
Justinian ROSCA, Ines UGALDE, Praprut SONGCHITRUKSA and Srinivasa SUNKARI	
7.1. Introduction	133
7.2. Related work	135
7.3. CONVAS co-simulation platform	138
7.4. Realistic DSRC channel models	139
7.4.1. CONVAS propagation models	141
7.4.2. Model tuning based on real-world data	142

7.5. Channel model tuning	143
7.5.1. Michigan safety pilot model deployment data	143
7.5.2. Estimation of PDR	144
7.5.3. Model tuning	146
7.6. Connected vehicle applications	149
7.6.1. Intelligent dilemma zone avoidance	149
7.6.2. IDZA implementation in CONVAS	150
7.6.3. IDZA performance criteria	151
7.7. Experimental results	151
7.7.1. CONVAS setup	151
7.7.2. Co-simulation results	152
7.8. Conclusions	159
7.9. Acknowledgments	160
7.10. Bibliography	161
Chapter 8. Highway Road Traffic Modeling for ITS Simulation	165
Marco GRAMAGLIA, Marco FIORE, Maria CALDERON, Oscar TRULLOLS-CRUCES and Diala NABOULSI	
8.1. Introduction	165
8.2. Road traffic models	166
8.2.1. Traffic input feeds	168
8.2.2. Mobility models	169
8.3. Fine-tuned measurement-based model	170
8.4. Comparative analysis of road traffic models	174
8.4.1. Case study scenarios	174
8.4.2. Connectivity metrics	175
8.4.3. Results	176
8.5. Fundamental properties of highway vehicular networks	178
8.6. Discussion and conclusions	181
8.7. Bibliography	182
Chapter 9. F-ETX: A Metric Designed for Vehicular Networks	185
Sébastien BINDEL, Benoit HILT and Serge CHAUMETTE	
9.1. Introduction	185
9.2. Link quality estimators	187
9.2.1. Hardware-based LQE	188
9.2.2. Software-based	189
9.2.3. Discussion	190

9.3. Analysis of legacy estimation techniques	190
9.3.1. Type of window.	191
9.3.2. Window analysis	193
9.4. The F-ETX metric	195
9.4.1. Window management algorithms	195
9.4.2. Multi-assessment approach	197
9.4.3. Routing integration framework	199
9.5. Simulation settings	201
9.5.1. First scenario	202
9.5.2. Second scenario.	202
9.6. Simulation results	202
9.6.1. Performance of the multi-estimators	203
9.6.2. Performance of routing protocols	206
9.7. Conclusion	208
9.8. Bibliography	209
Chapter 10. Autonomic Computing and VANETs: Simulation of a QoS-based Communication Model	211
Nader MBAREK, Wahabou ABDOU and Benoît DARTIES	
10.1. Introduction	211
10.2. Autonomic Computing within VANETs	212
10.2.1. Autonomic Computing	212
10.2.2. Autonomic vehicular communications	213
10.3. Broadcasting protocols for VANETs	213
10.3.1. Deterministic methods	215
10.3.2. Stochastic methods	216
10.4. Autonomic broadcasting within VANETs	218
10.4.1. Optimization of broadcasting protocols in VANETs	218
10.4.2. Self-management architecture	219
10.4.3. QoS-based broadcasting	221
10.5. Simulation of a QoS-based communication model	222
10.5.1. ADM: autonomic dissemination method	222
10.5.2. Simulation environment.	228
10.5.3. Performance evaluation	229
10.6. Conclusion	231
10.7. Bibliography	232
List of Authors	235
Index	239