CAMBRIDGE

Cambridge University Press & Assessment
978-0-521-19874-5 — Unlocking the Power of OPNET Modeler
Zheng Lu , Hongji Yang
Table of Contents
More Information

Contents

Preface xi
List of abbreviations xiii

Part I Preparation for OPNET Modeling 1

1 Introduction **3**

1.1 Network modeling and simulation 3
1.2 Introduction to OPNET 4
1.3 OPNET Modeler 5
1.4 Summary 6
1.5 Theoretical background 6
1.5.1 Simulation and principles of simulator 6
1.5.2 Hybrid simulation 9

2 Installation of OPNET Modeler and setting up environments **11**

2.1 System requirements for using OPNET Modeler 11
2.2 Installation on Windows 11
2.2.1 Installation of OPNET Modeler 12
2.2.2 Installation and configuration of Microsoft Visual C++ 15
2.2.3 OPNET Modeler preferences for C/C++ compiler 17
2.2.4 Licensing 19
2.3 Installation on Linux 20
2.3.1 Installation of OPNET Modeler 20
2.3.2 Installation and configuration of GCC compiler 21
2.3.3 OPNET Modeler preferences for GCC compiler 21
2.3.4 Licensing 22
2.4 Theoretical background 23
2.4.1 Compilation and linking options 23
2.4.2 Simulation models compilation and linking 23

© in this web service Cambridge University Press & Assessment www.cambridge.org

CAMBRIDGE

Cambridge University Press & Assessment
978-0-521-19874-5 — Unlocking the Power of OPNET Modeler
Zheng Lu , Hongji Yang
Table of Contents
More Information

3 OPNET Modeler user interface 24

3.1 Project management 24
3.2 Modeler preferences 26
3.3 OPNET editors 29
3.3.1 Project Editor 29
3.3.2 Node Editor 31
3.3.3 Process Editor 31
3.3.4 Link Editor 32
3.3.5 Packet Format Editor 32
3.3.6 ICI Editor 34
3.3.7 PDF Editor 35
3.3.8 Probe Editor 35
3.4 Simulation Results Browser 37
3.5 Animation Viewer 37
3.6 Using OPNET documentation 39

Part II Modeling Custom Networks and Protocols 41

4 OPNET programming interfaces 43

4.1 Introduction to OPNET programming 43
4.2 OPNET API categorization 44
4.3 Kernel APIs/Kernel Procedures (KPs) 45
4.3.1 Distribution Package 46
4.3.2 Packet Package 49
4.3.3 Queue Package and Subqueue Package 51
4.3.4 Statistic Package 51
4.3.5 Segmentation and reassembly package 52
4.3.6 Topology package 52
4.3.7 Programming Support APIs 54
4.4 Theoretical background 54
4.4.1 Proto-C specifications 54
4.4.2 Process model and external model access (EMA) program 56
4.4.3 OPNET Modeler model programming external interfaces: co-simulation, external tool support (ETS) and OPNET Development Kit (ODK) 56

5 Creating and simulating custom models using OPNET APIs 58

5.1 General procedure for creating and simulating custom models 58
5.2 Custom models 59
5.2.1 Case 1 59
5.2.2 Case 2 68
5.2.3 Case 3 70

© in this web service Cambridge University Press & Assessment www.cambridge.org

CAMBRIDGE

Cambridge University Press & Assessment
978-0-521-19874-5 — Unlocking the Power of OPNET Modeler
Zheng Lu , Hongji Yang
Table of Contents
More Information

5.2.4 Case 4 74
5.2.5 Case 5 79
5.2.6 Case 6 83
5.2.7 Case 7 95
5.3 Model optimization and validation 96

6 High-level wrapper APIs 100

6.1 Why and how to use wrapper APIs 100
6.2 Wrapper APIs provided with the book 101
6.2.1 Geo_Topo wrapper APIs 102
6.2.2 Routing wrapper APIs 104
6.2.3 Flow wrapper APIs 106
6.3 How to write your own wrapper API 107

7 Modeling with high-level wrapper APIs 110

7.1 Revisit of previous case 110
7.2 Creating connection-oriented communications 112
7.2.1 Single flow 114
7.2.2 Trunk of flows 119

Part III Modeling and Modifying Standard Networks and Protocols 123

8 Modeling wired networks with standard models 125

8.1 Client/server structure 125
8.1.1 Creating a network model 125
8.1.2 Task, application, and profile configurations 127
8.1.3 Choosing and viewing statistic results 131
8.2 Local area network 132
8.3 Wide area IP network 132
8.4 Automatic network deployment 134
8.5 Summary 135

9 Modeling wireless networks with standard models 137

9.1 Basics of wireless modeling 137
9.2 Wireless local area networks (WLANs) 138
9.2.1 Communication within WLANs 138
9.3 Communication between WLANs 140
9.4 Wireless mobile networks 143
9.4.1 Movement via trajectories 143
9.4.2 Facilities for random mobility 146
9.4.3 Movement via programming interfaces 148
9.5 Automatic network deployment 148

© in this web service Cambridge University Press & Assessment www.cambridge.org

CAMBRIDGE

Cambridge University Press & Assessment
978-0-521-19874-5 — Unlocking the Power of OPNET Modeler
Zheng Lu , Hongji Yang
Table of Contents
More Information

10 Modifying standard models 151

10.1 Introduction 151
10.2 Case study 151

Part IV OPNET Modeling Facilities 165

11 Debugging simulation 167

11.1 Debugging facilities in OPNET Modeler 167
11.1.1 Prerequisites for debugging 168
11.1.2 Preparing simulation scenario 168
11.1.3 Debugging with ODB 169
11.1.4 Debugging with CDB/GDB 175
11.1.5 Debugging with Microsoft Visual C++ Debugger 177
11.1.6 Debugging with animation 179

12 OPNET programming in C++ 182

12.1 Proto-C, C, and C++: language and library differences 182
12.2 Memory management differences between Proto-C APIs and C/C++ standard library functions 182
12.3 Proto-C data structures and algorithms packages, C++ standard template libraries (STL) and Boost C++ libraries 184
12.4 Environment configurations for C++ programming in OPNET 185
12.5 Case study on programming OPNET models in C++ 187

13 Traffic in OPNET simulation 194

13.1 Introduction 194
13.2 Explicit traffic 194
13.2.1 Explicit traffic based on application 195
13.2.2 Explicit traffic based on traffic generation parameters 196
13.2.3 Explicit self-similar traffic based on raw packet generator (RPG) model 197
13.3 Background traffic and hybrid simulation 200
13.3.1 Background traffic based on baseline load 201
13.3.2 Background traffic based on traffic flow 202

14 External model access (EMA) 207

14.1 What EMA is and reasons to use it 207
14.2 EMA case study 208

15 OPNET co-simulation with third-party programs 215

15.1 Co-simulation with external programs 215

© in this web service Cambridge University Press & Assessment www.cambridge.org

CAMBRIDGE

Cambridge University Press & Assessment
978-0-521-19874-5 — Unlocking the Power of OPNET Modeler
Zheng Lu , Hongji Yang
Table of Contents
More Information

15.1.1 Introduction 215
15.1.2 Co-simulation with an external C program 216
15.1.3 Creating simulation models 217
15.1.4 Creating an external C co-simulation controller program 221
15.1.5 Running co-simulation 224
15.1.6 Co-simulation with other systems 225
15.2 Co-simulation with MATLAB 225
15.2.1 Setup of environment variables 226
15.2.2 Modifying OPNET models and external code 226

16 Model authoring and security 232

16.1 Introduction 232
16.2 Protecting a model 232
16.3 Making a demo model 234
16.4 Licensing a model 234

References 236
Index 237

© in this web service Cambridge University Press & Assessment www.cambridge.org