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Automated Planning for Open Network Architectures

A dissertation submitted in partial satisfaction
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To my family —

my mother Larisa

my father Oliver

and my sister Marina

Table of Contents

Abstract ……..… xvi

1. Introduction …… 1

1.1 Motivation…… 2

1.1.1 Deployment of new protocols…… 2

1.1.2 Heterogeneous networks…… 3

1.1.3 User application requirements…… 3

1.1.4 Service for legacy applications……..… 3

1.2 Open Network Architectures…… 4

1.2.1 Active networks……. 5

1.2.2 Adaptation of data stream…….. 5

1.3 Planning for Active Networks……. 6

1.4 Implementation of the Planner……..7

1.5 Road Map to the Dissertation……..…. 7

2. Background on Active Networks ……..…... 9

2.1 Active Network Concept ……..…... 9

2.2 Architecture of Active Network Node ……..…. 10

2.3 Panda as an Active Network Middleware……..…..... 12

2.4 Panda Node Architecture…… 13

2.5 Problems of Active Networks……..…... 14

3. Planning Alternatives……17

3.1 The Requirements to Planning…….…... 17

3.1.1 Temporal factor……..… 18

3.1.2 Consistency of adaptations……..…. 19

3.1.3 Ordering of adapters……..19

3.1.4 User preferences as an element of planning…….…..... 20

3.1.5 Efficiency of the plan…….…..…. 21

3.1.6 Extensibility of the system…….…..…. 23

3.1.7 Resource management for planning…….…..…... 24

3.1.8 Other problems…….……..... 24

3.2 Complexity of Planning Problem…… 25

3.2.1 Physical model…….. 25

3.2.2 Observation on planning problem……...…. 26

3.2.3 Estimation of the space of solutions…….…..... 28

3.2.4 NP-completeness……...…… 30

3.2.5 Inefficiency of exhaustive search…….…..... 36

3.3 Naïve Planning……...…. 36

3.4 Template Planning……..… 38

3.5 Heuristic Search…….. 39

3.6 Routing Around Network Resources Planning……..…… 40

3.7 Automated Planning……..…. 41

3.7.1 Incremental planning……..... 42

3.7.2 Central planning……..…….. 45

3.7.3 Distributed planning…….. 46

3.7.4 Where to run central planning……... 47

3.7.5 Reuse of earlier computed plans……... 48

3.7.6 Approach to planning for multicast communication…….……... 48

3.8 Adapter Design……... 51

3.8.1 Classes of adapters…… 52

3.8.2 Adapters with flexible/rigid architecture…….. 54

3.8.3 Two-lever hierarchy of an access to adapters……... 54

3.9 Summary……... 56

4. Planning Protocol…….. 57

4.1 Requirements to the Planning Protocol…….. 57

4.2 Planning Protocol Design……... 59

4.3 Where to Run the Plan Calculation…….…… 60

4.4 Implementation of Planning Protocol in Panda…….. 61

4.5 User Preferences, Data Stream Characteristics, and Planning Data……... 62

4.6 Planning Data Collection…… 64

4.7 Calculation of a Plan……... 65

4.8 Deployment of a Plan…….…. 66

4.9 Incremental Planning Protocol…… 66

4.10 Elements of Resource Management…… 67

4.10.1 Assumptions on resource management……. 67

4.10.2 Detailed description of the resource management implementation…….. 69

4.10.3 Periodic decommissioning of inactive connections…….. 75

4.11 Replanning ……. 76

4.12 User Access to Resources……... 77

4.13 Security in ONA Planning…….. 77

4.13.1 Classification of ONA planning insecurities…… 78

4.13.2 Security of incremental planning protocol…… 80

4.13.3 Untrustworthy ONA node for central planning protocol…….. 82

4.13.4 Secure central planning procedure…… 84

4.13.5 Secure central planning protocol……..… 86

4.13.6 Poor quality and malicious design of adapters……..… 89

4.13.7 Security measures on adapter requests……. 90

4.13.8 Electronic signatures with public key and key distribution…….…. 91

4.14 Summary……. 92

5. Planning Algorithm…….. 93

5.1 Heuristic Search……...94

5.1.1 Adapter selection in two-level adaptation database…….…..95

5.1.2 Adapter description data……...…100

5.1.3 Adapter ordering……..102

5.1.4 Plan optimization ……....110

5.1.5 Resources and temporal constraints……..…...120

5.2 Example of a Plan Calculation……...121

5.2.1 Peer-to-peer communication session……..…..121

5.2.2 Adapter selection…….122

5.2.3 Adapter ordering……..123

5.2.4 Plan optimization…….125

5.3 Using Unary Model for the Plan Calculation Algorithm……..128

5.4 Summary……128

6. The Measuremenst of Performance…….. 130

6.1 Performance of Heuristic Search-based Planning……. 130

6.2 Costs of Incremental versus Central Planning…….. 133

6.3 Planning Process Test……136

6.3.1 The testbed……...…136

6.3.2 The latency of packet delivery and adaptation……....138

6.3.3 Planning procedure latency with the Connector application and null adapters ……...142

6.3.4 Planning procedure latency with real life applications and adaptations .149

6.3.5 Quality of service improvement…….. 165

6.3.6 The discussion on performance……..… 174

7. Related work…… 176

7.1 ONA Implementations for ONA-aware Applications…….…. 176

7.2 ONA Implementation for ONA-unaware Applications…… 179

7.3 AI Planning……... 181

7.4 Planning for ONA……. 184

8. Future work…… 186

8.1 Change of Adapters……....186

8.1.1 Planning fails because no feasible or consistent plan found…….…. .186

8.1.2 Connections failure…….…..... 187

8.2 Planning for Multicast Connection…….….. 188

8.3 ONA Resource Management…….…... 188

8.4 Secure Planning Protocol…….…..… 190

8.5 Alternative Path Planning…….….190

8.6 Other Communication/Distributed Systems that will Benefit from Automated Planning…….191

9. Conclusion……... 192

9.1 Contributions…… 192

9.2 The Discussion……. 195

Appendices…… 202

References……. 218

List of Figures

2.1 Active network node ……... 11

2.2 A Panda-enabled node …… 12

3.1 Two-fold and four-fold data compression…… 21

3.2 A unicast connection …….. 27

3.3 Estimation of solution space …….. 29

3.4 Peer-to-peer connection as a bunch of alternative plans ……. 32

3.5 Alternative plans for three-node connection ……..……. 32

3.6 Examples of naïve solutions …… 37

3.7 Efficiency of planning ……. 44

3.8 Multicast tree planning ……...…… 49

4.1 Planning procedure ……. 60

4.2 Panda planning procedure …… 62

4.3 Resource redistribution among sessions …….……. 70

4.4 Add flow ……..…… 72

4.5 Reject flow …….. 73

4.6 Preemption flow …….. 74

4.7 Replanning of flow if another connection must be added …….……..…..….. 74

4.8 Replan flow if extra resource are released …….……. 75

4.9 Replanning if the network conditions changed …….…….. 76

4.10 Incremental planning procedure …….. 82

4.11 The example of the exemption of an intermediate node(s) in planning data collection via tête-a-tête protocol …… 83

4.12 Central planning procedure with UNC service …… 85

4.13 UNC node does not approve a node as a trustworthy node ……. 86

4.14 The chain of signatures ……...……. 92

5.1 Selection of adapters, ordering of adapters, and location of adapters run sequentially ……..... 94

5.2 Building a local plan ……. 104

5.3 The example of exhaustive search with evaluation ……... 105

5.4 The prototype partial order library plan for adapter ordering ……..... 107

5.5 Resolution of a conflict between preconditions and postconditions ……. 109

5.6 Plan merging failures ……. 114

5.7 Peer-to peer communication through nodes A, B, C, D …… 122

5.8 Adapting partial order plan for link AB ……. 124

5.9 Local plan for link AB ……... 124

5.10 Local plan for link BC and CD …….. 125

5.11 The chain of local plans on node A, B, C, and D …….. 126

5.12 ABC plan after merging AB and BC plans …… 127

5.13 ABCD plan after merging ABC and CD plans …….. 127

6.1 Heuristic to exhaustive search time cost ration …….. 131

6.2 Heuristic search performance by adapters ……. 132

6.3 Heuristic search performance by nodes ……...…. 134

6.4 Incremental versus central planning time cost ……. 135

6.5 Incremental versus central planning efficiency ……. 135

6.6 Panda peer-to-peer connection ……..….. 136

6.7 Packet delivery latency …….. 139

6.8 Adaptation latency ……. 140

6.9 Packet loss …….. 141

6.10 Throughput of Panda associated with packet size ……. 141

6.11 Sample of the distribution of packet latency on packet numbers …….. 142

6.12 Deployment without preloaded adapters ……..…….. 143

6.13 Deployment with preloaded adapters …….……... 144

6.14 Latency of the deployment protocol without adaptations …….. 145

6.15 Incremental planning and deployment latency …….. 146

6.16 Incremental versus central planning latency …….. 147

6.17 The number of packets sent under incremental plan before central plan is calculated and deployed ……. 148

6.18 The latency of pre-planning process …….. 149

6.19 Planning procedure latency for the Connector and WaveVideo applications ... 150

6.20 Plan calculation latency for the Connector and WaveVideo applications ……. 151

6.21 Deployment latency for the Connector and WaveVideo applications ……... 151

6.22 Planning procedure latency on Dell Inspirons ……..…. 152

6.23 Plan calculation latency on Dell Inspirons ……. 152

6.24 Deployment latency on Dell Inspirons …….. 153

6.25 Incremental planning latency on Dell Inspirons …… 154

6.26 Incremental and central planning procedure (Resolution Drop only) on Dell Inspirons connection …….. 154

6.27 The number of packet sent under the incremental plan before the central plan is calculated and deployed ……. 155

6.28 Central replanning process on Dell Inspirons ….……156

6.29 The comparison of adaptation latencies on Dell Inspirons and Hewlett Packard machines connections …… 157

6.30 The planning procedure latency on Dell Inspirons and HPs …….. 158

6.31 The plan calculation latency on Dell Inspirons and HPs ……... 158

6.32 Deployment latency on Dell Inspirons and HPs …… 159

6.33 The planning procedure latency on HPs …… 160

6.34 Plan calculation latency on HPs ……. 160

6.35 Deployment latency on HPs ……..…. 161

6.36 Incremental planning latency for Resolution Drop for HPs …….. 162

6.37 Incremental planning latency for Resolution Drop and Encryption for HPs …. 163

6.38 The number of packets sent under the incremental plan before the central plan was calculated and deployed …….. 163

6.39 Replanning procedure latency on HPs ……..…….. 164

6.40 The plan calculation latency for Rat and VideoWave applications ……... 165

6.41 PSNR (luminance) on Dell Inspirons for 150 Kbps links …….. 166

6.42 PSNR (Cb) on Dell Inspirons connection for 150 Kbps …… 167

6.43 PSNR (luminace) on Dell Inspirons for 5000 Kbps …….… 168

6.44 PSNR (Cb) on Dell Inspirons for 5000 Kbps ……... 168

6.45 PSNR (luminace) on HPs for 150 Kbps …….…...169

6.46 PSNR (Cb) on HPs for 150 Kbps …….…. 169

6.47 PSNR (luminace) on HPs for 5000 Kbps ……..… 170

6.48 PSNR (Cb) on HPs for 5000 Kbps …… 170

6.49 PSNR (luminance) on HPs ……. 171

6.50 The advantage of central planning over incremental planning …….. 173

6.51 PSNR (luminance) for incremental and central plans ……..... 173

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Abstract of the Dissertation

Automated Planning for Open Network Architectures

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Open Network Architectures (ONA) is a relatively new technology for computer systems that allows dynamic deployment of services. The Internet is an obvious area that would benefit from fast deployment of protocols that can appropriately modify or reroute user data streams. ONA systems are meant to use the fast-growing computational resources of modern computer systems to lessen the load on the resources of network communication channels with their often-limited capacity. The balance between communication channels and execution resources depends on user application requirements and network conditions at the moment of the communication. Complex network conditions, in conjunction with temporal constraints, make the automatic choice of necessary measures for improving communications a highly desirable capability. Automatic planning of ONA services should be an important function of ONA.

We propose an approach to the design of a planner for ONA. The approach is focused on the overwhelming number of problems of adaptation planning, such as feasibility and efficiency of a plan, extensibility and composability of adaptations, and temporal limits. The planner automatically calculates properly ordered sequences of

adaptations that modify user data. The purpose of these modifications is to increase throughput, reliability, and safety of communication channels.

The goal of the planner design is to be able to formulate a plan for real-time applications that are very sensitive to the latency of the handshaking phase of the connection. It uses the heuristic search for a plan calculation. The planner is targeted for use by ONA nodes. The actual implementation of this planner was done in Panda, active network middleware that serves adaptation-unaware applications. The latency of the planning algorithm is below 160 milliseconds for realistic cases, which is magnitudes faster than the exhaustive search. The planner was used to calculate plans equally as good as the heuristic search in at least 99% of tested cases. The resulting planning system can be used for adaptation planning in open network architectures, active networks, remote code invocation systems, etc.

This dissertation describes the design, implementation, and performance of the ONA planner.