Automated Planning for Open Network Architectures

A dissertation submitted in partial satisfaction
of the requirements for the degree
Doctor of Philosophy in Computer Science

by

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University of California, Los Angeles
2002
To my family—
my mother Larisa
my father Oliver
and my sister Marina
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Abstract of the Dissertation

Automated Planning for Open Network Architectures

by

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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.