Forwarding on Gates: A clean-slate Future Internet Approach within the G-Lab project

Florian Liers, Thomas Volkert, Andreas Mitschele-Thiel
{ florian.liers | thomas.volkert | mitsch }@tu-ilmenau.de
Technische Universität Ilmenau

1. Introduction

Today's Internet suffers from an increasing complexity. Each new extension or new management protocol adds additional overhead and management dependencies. New approaches for complexity reduction have to find a common mechanism to integrate features like security, intermediate devices (e.g. NAT and firewalls), mobility and multi-homing. However, the Internet architecture does not provide such a mechanism. In general, it provides only limited manageability. Integration of new features requires mostly a creative usage of IP addresses, like a reserved address space for multicast. The result is an overloaded semantic of the IP address concept, resulting in even higher system complexity. In other cases it is even necessary to include higher layer identifiers, like port numbers for NAT traversal. This violates not only the end-to-end principles but also the layering introduced by the ISO/OSI model. Especially, the latter adds complexity to an implementation and hampers the extendibility of the system.

2. Forwarding on Gates

We propose a new architecture for a Future Internet, allowing a better integration of today's features and upcoming new features. It provides a uniform feature interaction mechanism and a common method to combine features. In summary, the management complexity is reduced and the extendibility of inter-network systems is restored.

Our architecture includes an index-based forwarding approach. Hence, it uses a lightweight forwarding plane, which forwards packets, based on an explicitly given route. In contrast to usual source routing based approaches, our system derives the routes in an incremental way. Depending on the implementation of the architecture, this process can degenerate either to hop-by-hop routing or to a virtual circuit switching. In practice, we expect it is a mixture of both. The forwarding plane includes not only the hops between hosts and routers. It can include any functional block using packets as input. Such a functional block, which we call "gate", is an abstraction of the simple forwarding used in common index-based forwarding systems. The forwarding plane transfers packets from one gate to the next one until the target node is reached. Therefore, we call the approach "forwarding on gates" (FoG).

3. Validation within G-Lab

In theory, FoG can operate as overlay network. However, by using IP underneath, FoG wouldn't reduce the complexity and further it wouldn't show its full potential. Therefore, it needs an environment where FoG can completely replace IP. But international large scale test beds like PlanetLab do not support other layer 3 protocols than IP. Opposite to this, the G-Lab test bed allows direct access to layer 2. Hence, we decided to propose the integration of our concept in the second phase of the G-Lab project.

The for the integration needed FoG software should include a small patch for the Linux kernel 2.6.x. This should implement the basic forwarding function and further it should be included in a proprietary boot image for the G-Lab network nodes. Most of the management and signaling logic should be implemented as user space applications. Hence, they could be easily deployed via the standard PlanetLab software used in G-Lab. Caused by the replacement of IP, the network nodes have to be able to communicate within the distributed G-Lab network as if they were participating nodes within a single Ethernet based network. For this purpose, the G-Lab project includes support for GRE tunnels which allow the bypass the common IP based forwarding and routing mechanism without any protocol conflicts. This tunneling abstracts all G-Lab network parts, distributed over Germany, to one Ethernet based network. The resulting network abstraction is shown in Figure 1.

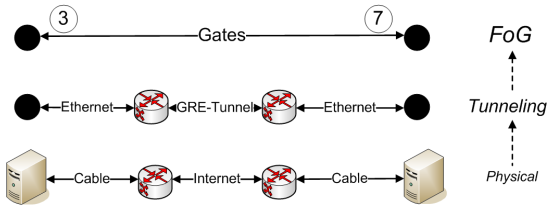

Figure 1: Resulting network abstraction for FoG within the G-Lab project

From the tests in G-Lab, we expect new insights into the average state distribution in a large-scale FoG based network. Furthermore, the tests will show the ability to handle high dynamic network changes and the possibilities to recover from link failures in large networks.