Abstraction Technology for a Proof Environment of Large-Scale Network

Akashi Kunio (0810002)

School of Information Science,
Japan Advanced Institute of Science and Technology

February 9, 2010

Keywords: network emulation, testbed, large-scale network.

The Internet is an important infrastructure. Many users are using a lot of services in the Internet. More and more technologies that leverage the Internet tend to be deployed. There is a possibility that new technologies which are not sufficiently verified affect other users and services. New technologies should sufficiently be verified before being deployed to the Internet. It needs that the quality of implementations are improved before deployment to the Internet.

There are testbeds to verify network technology. Among them, there are testbeds targeting to applications and products that utilize network. In this research project, such testbeds are called the proof environments.

There are two types of the proof environments. One is the proof environment using the Internet. Another one is the proof environment isolated from the Internet. In using the proof environment isolated from the Internet, conductors of experiment can verify networking technologies without considering effects to and from other users and services. However, there are characteristics of the Internet, such as delay and bandwidth, that should be considered. Conductors of experiment cannot verify networking technologies with considering characteristics of the Internet in isolated proof environment. So, I propose functions to emulate characteristics of the Internet in the isolated proof environment.

I propose a software-based method to emulate characteristics of the Internet. In this research project, the software emulating characteristics of the Internet is called Network Characteristics Emulators(NCEs). By using NCEs, in the proof environment isolated from the Internet, it is possible to build experiment network considering characteristics of the Internet. However, the existing proof environments isolated from the Internet do not support functions that automatically builds experiment network emulating characteristics of the Internet. Thus, when conductors of experiment want to consider characteristics of the Internet, conductors require to manually configure softwares that emulate characteristics of the Internet.

NCEs consume resources of node such as CPU and memory in emulating characteristics of the Internet. A proof environment limits scale of experiment network because the number of available nodes are limited. I propose a method to build experiment network as large as possible using available resources on the proof environment isolated from the Internet.

This research project proposes methods to build large-scale experiment network under limited resources. If a single node emulates many characteristics, it is possible to build a large-scale experiment network under limited number of nodes. NCEs calculate the amount of required resources when they emulate characteristics of the Internet under limited resources. NCEs are multiplexed without exceeding resources limited by physical nodes. Because multiplexing allows to emulate multiple links on a single node, building larger-scale experiment network becomes possible.

In this research project, I define five network characteristics. NCEs emulate delay, jitter, bandwidth, packet loss and IP routing. NCEs are placed between nodes. NCEs which use five parameters when forwarding packets emulate physical distance between nodes, unstable connection and unstable bandwidth. However general NCEs forward packets basically by IP routing. If applications and experiment network support IP routing independently, applications might not properly work. So the instead of packet forwarding, bridging is used in this research project. In this way, applications that support IP routing can be verified because the experiment network does not forward packets. Conductors of experiment can select either supporting or not supporting IP routing topology. In this way, a variety of applications can be verified. The experiment network can be

built to emulate only necessary parameters according to verification.

In this research project, I conducted an experiment by building the experiment network that emulates characteristics of the Internet. Then, I compared manually configured experiment network with my emulated experiment network. I confirmed that my proposed system makes building experiment networks easier and faster. Additionally, I also compared to related works that are SpringOS and Modelnet. Proposed system more scalable than related works. Consequently, my proposed system makes allows to build flexible large-scale experiment network.