

Experiments with the Emulated NDN Testbed in ONL

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ABSTRACT

Named Data Networking (NDN) is a recently proposed information-centric network architecture. The NDN Testbed is a global infrastructure that enables real-world NDN demonstrations. However, deploying new applications directly on the NDN Testbed requires considerable operational support and may introduce instability to shared testbed infrastructure. What's more, network performance parameters cannot be easily modified on the NDN Testbed to study application behaviors. As a result, an emulated NDN testbed, and one over which developers have full control, can benefit testing, debugging, and evaluating new NDN applications and services as a complement and precursor to testbed deployment.

In this demonstration, we present the emulated NDN testbed that runs in the Open Network Laboratory (ONL). The emulated testbed runs on real servers (there is no simulation) and uses the same NDN forwarding daemon, NFD, and the same routing software, NLSR, that are used in the NDN Testbed; this minimizes the efforts required of developers to evaluate their applications. We show how the flexibility of ONL enables the study of application behaviors in varying network environments and conditions. We also use a data collection application to demonstrate the effectiveness of using the emulated testbed to support application development.

Categories and Subject Descriptors

C.2.1 [Network Architecture and Design]: Network communications

Keywords

Named Data Networking; NDN Testbed; Open Network Laboratory

1. INTRODUCTION

Real-world demonstrations have been regularly performed to show the advantages of the NDN architecture and pro-

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vide feedback for NDN development. The NDN Testbed [1], a network of 26 sites around the world as of August 2015 (Figure 1), is a key building block that enables large-scale demonstrations. The NDN Testbed is remotely managed by an administrator, and each site has an operator taking care of events that require physical access, such as power cycling. To reduce the operational overhead of deploying new applications on the NDN Testbed, an emulated testbed is needed.

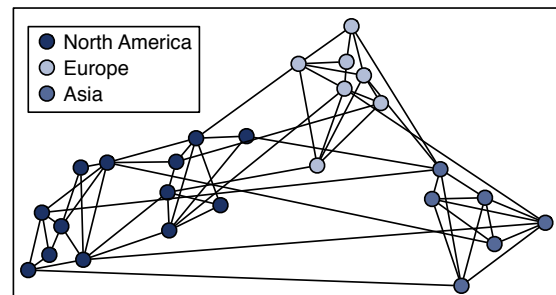


Figure 1: The NDN Testbed

In previous work, we have manually configured an NDN Testbed topology in ONL, which provides an isolated and user-controlled network environment for experiments [2], to debug and evaluate NLSR and NFD [3]. Based on our experience, we believe it would be beneficial to automate the emulated NDN testbed configuration and make it available to developers.

2. EMULATED NDN TESTBED

The emulated testbed operates as an IP overlay that requires configuring both the IP and NDN networks.

2.1 IP Topology Configuration

The underlying IP network is configured using the Remote Laboratory Interface (RLI) provided by ONL. Figure 2 shows the emulated testbed topology, where each host represents an NDN gateway router. The IP software routers (SWRs), shown as large circles, connect gateway routers. The SWRs also provide flexibility in modifying link delays, so that developers can vary network conditions to fully examine application behaviors. Our demonstration also includes NDN endhosts, which use virtual machines (VMs), shown as small circles in Figure 2. VMs require less hard-

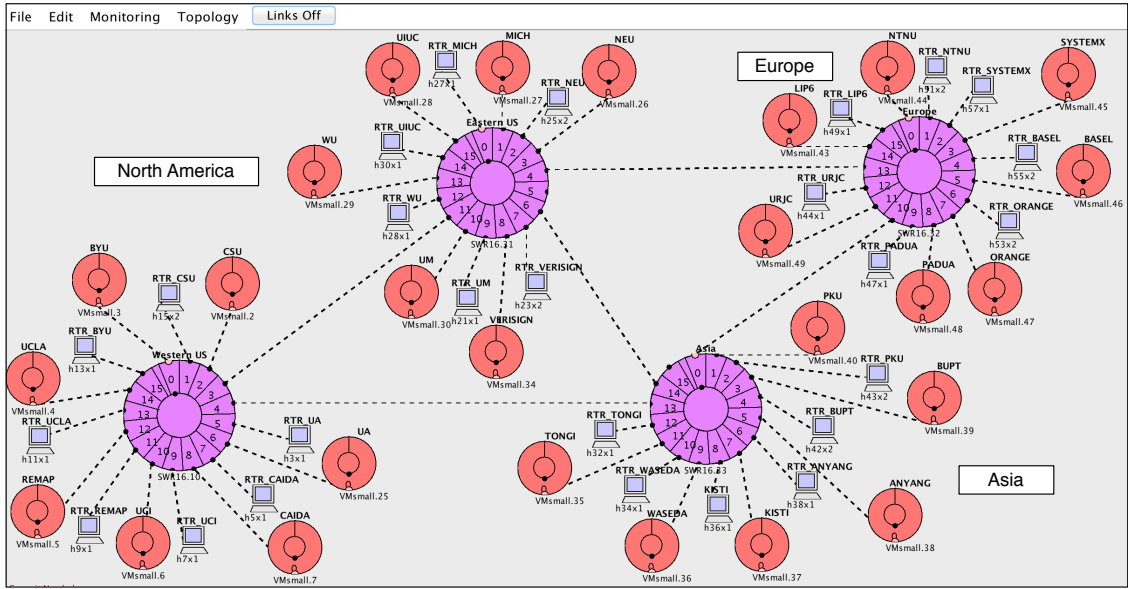


Figure 2: Emulated NDN Testbed in ONL

ware and provide developers greater flexibility, allowing for larger and more complex experiments.

2.2 NDN Topology Configuration

The NDN network requires installing forwarding entries on each node based on the NDN topology described using configuration files. NDN forwarding entries between gateway routers are configured by NLSR. The configuration files required by NLSR are generated using a flexible template program. A developer can easily set a master configuration file and automatically spawn configurations for each router. These configuration files are processed by the appropriate routers and describe the status of the network on the routing layer. The NFD links between endhosts and routers are stored as a one-to-many list. When NFD is initialized, each endhost and router creates a face and registers a next-hop for the applicable prefixes. NFD and NLSR are launched using the scripts we have developed.

3. DATA COLLECTION APPLICATION

The current data collection application collects bandwidth usage on testbed links, and it has been deployed on the NDN Testbed [1]. The application consists of a consumer (the testbed server) and multiple producers (the testbed nodes). Periodically, the consumer sends an Interest packet requesting the tx/rx counters of the producer's links. The producer replies by fetching the statistics of its faces from the NFD, and then filtering the counters of the relevant links.

We have been working on extending the application to provide a framework for users to specify the data to be collected, such as NFD process IDs and link RTTs. The ongoing development has been using the emulated testbed for testing and debugging. Eventually, the extended application will be deployed on the NDN Testbed, and we expect a smooth deployment.

4. DEMONSTRATION

This demonstration presents the emulated testbed and shows its effectiveness in supporting NDN research.

First, we show how the emulated NDN testbed is configured and launched in ONL. To demonstrate the benefits of having full control over the testbed, we show how link costs can be modified so that NLSR and NFD take action and switch to lower-cost forwarding paths.

Next, we demonstrate the flexibility of modifying network performance parameters. The extended data collection application will be deployed to monitor the link RTTs. Network performance parameters, such as link delays and packet loss rates, are modified by configuring the SWRs, and we show how the data collected by the application reflects those changes.

Lastly, an emulated testbed with link delays configured the same as the ones of the NDN Testbed is demonstrated. We collect the link delays to show the network performance is comparable to the NDN Testbed. Thus, developers could evaluate end-to-end application performance before evaluating it in the NDN Testbed.

The source code for the demo is available at https://github.com/WU-ARL/Emulated_NDN_Testbed_in_ONL.

Acknowledgment

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5. REFERENCES

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