An Integrated Environment for Open-Source Network Softwarization

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ABSTRACT

Network softwarization drives innovation both in software and hardware. This demo introduces a highly integrated environment that enables open source solutions for software defined network (SDN) in both hardware and software. This environment is built upon the NetFPGA platform for rapid prototyping of networking devices. It showcases tools (OSNT and OFLOPS) for evaluating the performance of networking devices, and demonstrates them using a pipelined multi-table OpenFlow enabled switch application. An open-source environment integrating both software and hardware that fully inter-operate, as demonstrated here, is essential for high-quality software defined networking solutions.

1. INTRODUCTION

The introduction of solutions for SDN is an assembly of efforts: from the development of new applications, through their evaluation and deployment. The congregation of resources required for such an effort is large, and they rarely interoperate seamlessly. The introduced hardware and software integrated environment is composed from the following building blocks: the NetFPGA platform [1], an Open Source Network Tester (OSNT) [2], and OFLOPS-Turbo [3] - an open modular platform for network experiments, and a pipelined multi-table OpenFlow enabled switch prototype.

2. OPEN SOURCE APPLICATIONS

2.1 NetFPGA

NetFPGA is an open platform enabling researchers and instructors to build high-speed, hardware-accelerated networking systems. The most prominent NetFPGA success is OpenFlow [4], which in turn has reignited the Software Defined Networking movement. NetFPGA enabled OpenFlow by providing a widely available open-source development platform capable of full line-rate and was, until its commercial uptake, the reference platform for OpenFlow.

NetFPGA offers several low-cost, PCIe host adapter cards, for 1Gbps through 100Gbps applications. In this demo we will be showcasing the NetFPGA-10G board and the recent NetFPGA-SUME board [5] shown in Figure 1.

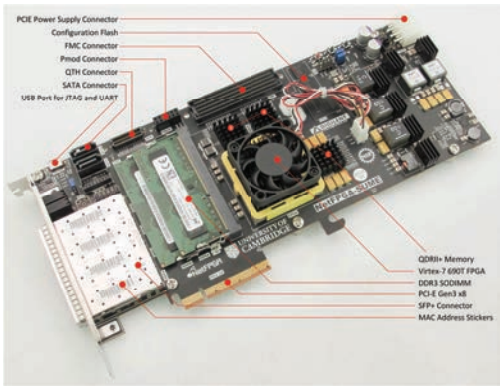

Figure 1: NetFPGA-SUME board: An open-source, low cost PCIe host adapter card for rapid prototyping of high performance networking devices.

2.2 Open Source Network Tester

OSNT is a 40Gbps Open Source Network Tester, developed on the NetFPGA platform. It is designed to combine both hardware and software into a single complete network testing solutions. OSNT consists of a software driver supporting command-line and graphic-user interfaces (CLI and GUI), traffic generators and monitors modules. Users can generate (configurable) rate limited traffic, with up to 10Gbps per port, and capture high-resolution timestamped packets to evaluate system and device under test in terms of bandwidth and latency.

2.3 OFLOPS-Turbo

OFLOPS-Turbo is an holistic measurement platform which enables the development of custom OpenFlow-based experiments. The platform provides a unified API that allows developers to control and extract information from the data and control channels, as well as, SNMP switch-state information. The OFLOPS-Turbo architecture consists of a software and a hardware subsystem. The software subsystem runs the core OFLOPS-Turbo functionality, along with the measurement module of the user. The hardware subsystem is using OSNT. The user can interconnect the OFLOPS-Turbo host with one or more switches in arbitrary topologies and mea-

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sure with high precision specific aspects of the network architecture, both on the data and control plane.

2.4 Multi-Table OpenFlow-Enabled Switch

A pipelined multi-table switch described in the OpenFlow Switch specification [6] is a primitive device of the infrastructure for building SDN in OpenFlow protocol. We present a pipelined multi-table OpenFlow-enabled switch [7] that supports a transactional configuration mechanism, providing packet consistent configuration. A software driver interacting between the switch hardware and agent enables modification and insertion of rules in the table, allowing to install new policies in the switch. It can also read statistics from the switch, observing the forwarding behavior.

3. DEMO SYSTEM CONFIGURATION

The proposed environment allows users to build low cost network testbeds (such as the simple example shown in 2a) to study software defined networking. In this demonstration we introduce this integrated environment. The device under test, the multi-table OpenFlow switch, is prototyped over a NetFPGA platform. We demonstrate how it is being evaluated using OFLOPS-Turbo.

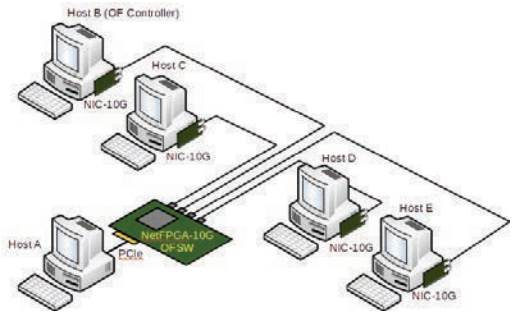
3.1 Detailed List of Demonstrated Items

Beyond a live demonstration of the integrated environment, as described below, we show the development environment, the open-source code repository and presentations explaining the various components. The demonstrated environment includes:

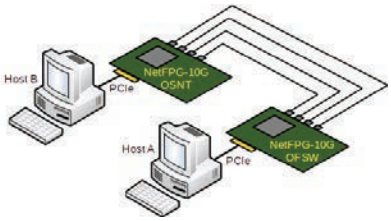
1. NetFPGA-SUME and NetFPGA-10G cards.
2. OSNT platform.
3. OFLOPS-Turbo platform.
4. Multi-table OpenFlow Switch application.

3.2 Importance and timeliness of the Demonstration

Network softwarization is driven, amongst others, by the need for innovation and reduced complexity in networking design and research. While most efforts focus on the software aspects of these, providing hardware platforms that support this work is essential. The environment proposed in this demonstration answers these needs. From the NetFPGA platform for rapid prototyping of new networking devices, through OSNT, to OFLOPS-Turbo as an ideal platform for planning and conducting the evaluation of OpenFlow switches. This highly integrated environment can not be properly demonstrated, unless a real OpenFlow switch is under test. Furthermore, such a switch needs to have innovative characteristics in order to present the timeliness of this system and the full set of environment's capabilities. The introduced multi-table OpenFlow switch thus answers these requirements.



(a) Network systems configured with the NetFPGA platform.



(b) OpenFlow switch evaluation using OSNT.

Figure 2: Network system testbed configurations.

3.3 Demo Experimental Setup

To demonstrate the OpenFlow-enabled switch prototype implementation, we configure two-node topology depicted in Figure 2b. Both nodes are equipped with a NetFPGA card, a quad-core Intel E5-2687W CPU, and 64GB of RAM. The NetFPGA card on Host-A is programmed with the OpenFlow-enabled switch implementation, while the NetFPGA card on Host-B is used to run with the OSNT hardware. To configure the new rules in the switch, an agent running on Host-A is triggered by data-plane packets in the traffic generated by OSNT. The demo shows the packet forwarding behavior in the switch as it installs new rules. We also show how we compute the forwarding latency using OSNT's packet timestamping method. OFLOPS-Turbo is used as the software experimentation platform.

4. REFERENCES

[1] NetFPGA. http://www.netfpga.org.

[2] ANTICHI, G., ET AL. OSNT: Open Source Network Tester. *IEEE Network Magazine* (2014).

[3] ROTSOS, C., ET AL. OFLOPS-Turbo: Testing the Next-Generation OpenFlow Switch. *International Conference on Communications* (2015).

[4] MCKEOWN, N., ET AL. Openflow: enabling innovation in campus networks. *ACM SIGCOMM CCR 38*, 2 (2008), 69–74.

[5] ZILBERMAN, N., ET AL. NetFPGA SUME: Toward 100 Gbps as Research Commodity. *IEEE Micro*, 5 (2014), 32–41.

[6] OpenFlow. https://archive.openflow.org.

[7] HAN, J. H., ET AL. Blueswitch: Enabling provably consistent configuration of network switches. In *ANCS* (2015).