Proceedings of the Asia-Pacific Advanced Network **2013** *v. 36, p. 17-22.*
http://dx.doi.org/10.7125/APAN.36.3
ISSN 2227-3026

OF@TEIN: An OpenFlow-enabled SDN Testbed over International SmartX Rack Sites

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Abstract: In this paper, we will discuss our on-going effort for OF@TEIN SDN (Software-Defined Networking) testbed, which currently spans over Korea and five South-East Asian (SEA) collaborators with internationally deployed OpenFlow-enabled SmartX Racks.

Keywords: Software-Defined Networking; OpenFlow; SmartX Racks; and Future Internet testbed.

1. Introduction

For the successful verification of Future Internet research ideas, the construction and federated operation of testbeds over international research & engineering networks is highly important. In this context, starting from 2008, various projects on Future Internet testbeds, such as US GENI (Global Environment for Network Innovations), EU FIRE (Future Internet Research & Experimentation), and Japan NWGN (New-Generation Network), have been initiated along with the wide adoption for OpenFlow-enabled SDN (Software-Defined Networking) technology

[1]. Especially, GENI has been deploying GENI Racks to promote the easy construction and wide expansion of SDN-enabled testbeds in US national scale.

Similarly in OF@TEIN project, launched in July 2012 as one of e-TEIN projects sponsored by Korean Government via NIA (National Information Society Agency), we target to gradually build and operate an OpenFlow-enabled SDN testbed over TEIN4 (Trans-Eurasia Information Network 4). This OF@TEIN collaboration project is being carried out by a consortium of Korean universities and international collaboration sites, led by GIST (Gwangju Institute of Science & Technology), Korea. More specifically, unique SmartX Racks are deployed to promote the international collaboration with TEIN NRENs (National Research & Education Networks), resulting in an OpenFlow-enabled SDN testbed over 7 international sites. Thus, in this paper, we will review and discuss the development and deployment of on-going progress

2. OF@TEIN: Initial Phase Tasks

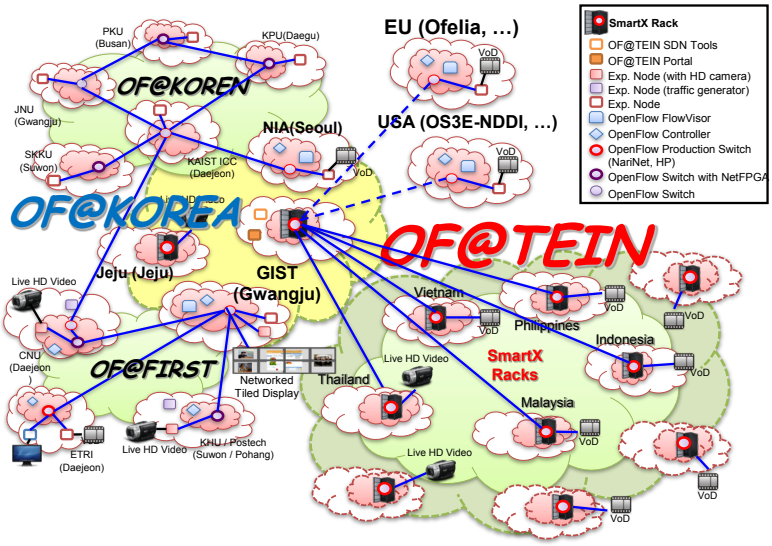

Fig. 1. OF@TEIN OpenFlow-enabled SDN testbed (planned concepts).

In year 2012, the main target of OF@TEIN was to initiate the deployment for an OpenFlow-enabled SDN testbed for Korean and South-East Asian (SEA) collaborators over TEIN4. The five collaborators from SEA are HUST @Hanoi, Vietnam; ASTI @Manila, Philippines; Chulalongkorn University @Bangkok, Thailand; ITB @Bandung, Indonesia; and University of Malaya @Kuala Lumpur, Malaysia. The overview diagram for initially planned OF@TEIN infrastructure is presented in Fig. 1, where the dotted SmartX Rack clouds and dotted links represent the portion of future expansion.

In this initial phase of OF@TEIN project, we are currently focusing on following three tasks to prepare the resources and tools for the experiments:

- Design and prototype verification of SmartX Racks: We first design unique SmartX Racks with OpenFlow switching and remote management capabilities. We then verify our design by prototyping two types of SmartX Racks (Type A and Type B) to match different needs of participating sites [2, 5].
- Site installation and network connection of OF@TEIN system/network: As part of OF@TEIN installation, we install SmartX Racks at participating sites. Also, we connect them to TEIN via the support of NRENs while deploying the system and network monitoring tools to assist the persistent operation of OF@TEIN [3].
- Design and development of OF@TEIN SDN tools: To enable OpenFlow-enabled SDN experiments, we design and develop several OF@TEIN SDN tools to assist both experimenters and managers [4, 5].

3. OF@TEIN: Task Details and Progress for Initial Phase

3.1. Design and verification of SmartX Rack

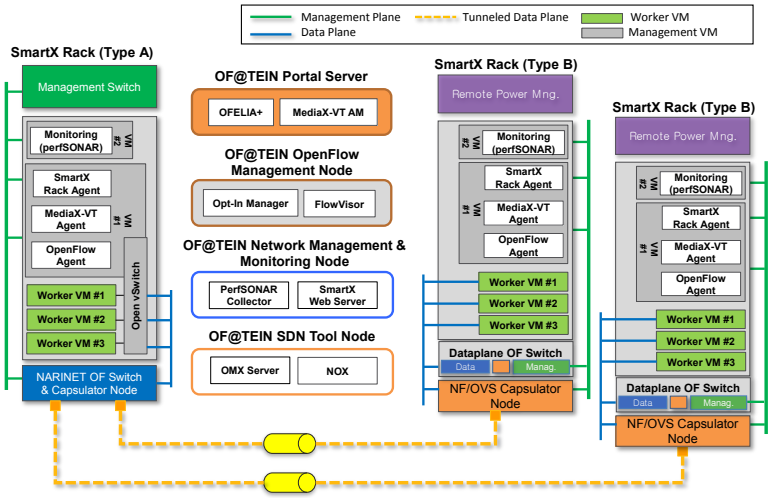

Fig. 2. OF@TEIN testbed: SmartX Racks and Server Nodes.

As shown in Fig. 2, we utilize SmartX Racks and Server Nodes to simultaneously support computing/networking resources. We design two types (Type A / Type B) of SmartX Racks to provide varying combinations of computing/networking resources. Each SmartX Rack (Type B) consists of four devices such as Management & Worker node, Capsulator node, OpenFlow switch, and Power management device. Especially, as shown in Fig. 3, OpenFlow switching with

tunneling is adopted to enable the multi-international connections among SmartX Racks. That is, OpenFlow switches (that connects the experimenter VMs (virtual machines)) are linked by the L2-GRE tunneling of Narinet/NF/OVS Capsulators. We also verify the functionalities of SmartX Racks by checking their SDN capability as well as remote management support.

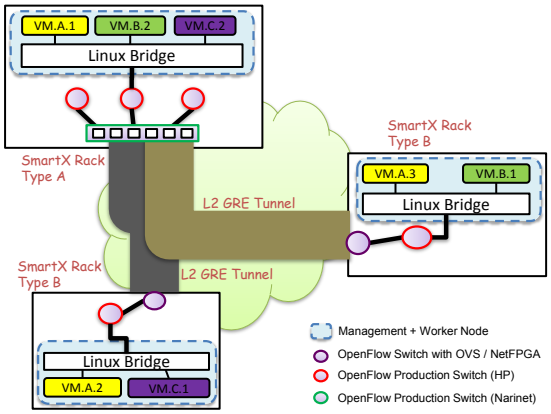

Fig. 3. Connecting VMs with OpenFlow-aware Capsulators (via GRE tunneling).

3.2. Site installation and network connection of OF@TEIN system/network

The initial version of OF@TEIN system/network was constructed by installing SmartX Racks (Type B), as depicted in Fig. 4. We also deployed several monitoring tools (based on perfSONAR, catti, and others) to check the operation status of OF@TEIN system/network.

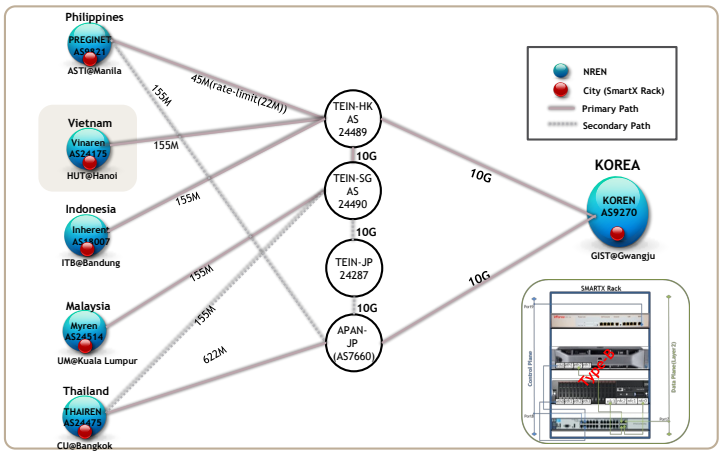

Fig. 4. OF@TEIN network connections and SmartX Rack site installation.

3.3. Design and development of OF@TEIN SDN tools

We design and develop several tools for OF@TEIN management and experiments, as shown in Fig. 5. It allows us to conveniently manage the computing/networking/FlowSpace resources for SDN experiments. Based on OCF (OFELIA Control Framework), we develop OF@TEIN

Portal to provide UIs for administrators and experimenters. We also offer SDN Experiment UI to support smooth service creation by interactively monitoring experiment status.

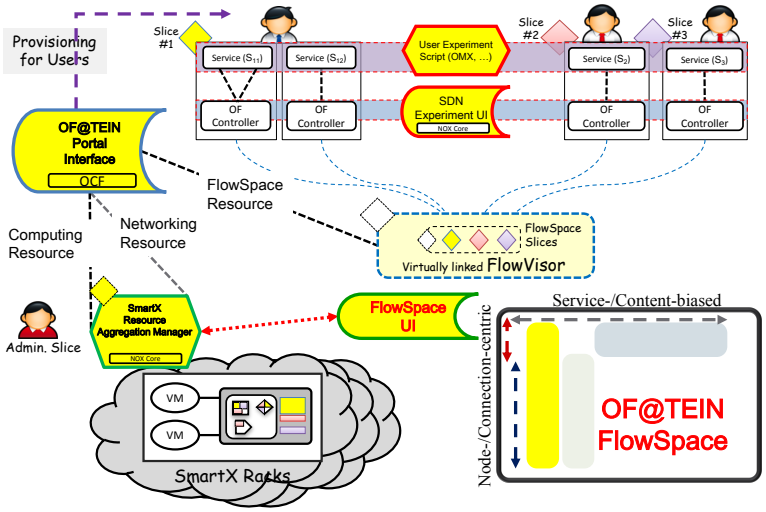

Fig. 5. OF@TEIN SDN Tools to support experimenters.

4. OF@TEIN: Preliminary Verification

After completing the initial installation, we verified its operation by performing a pilot experiment as shown in Fig. 6. Since then, OF@TEIN has been undergoing beta testing to fix issues, mostly tied with stabilized operation for simultaneous experimenters. Also, OF@TEIN training workshop was successfully held in Feb. 2013 at MYREN NOC with international collaborators to promote their understanding and utilization of OF@TEIN.

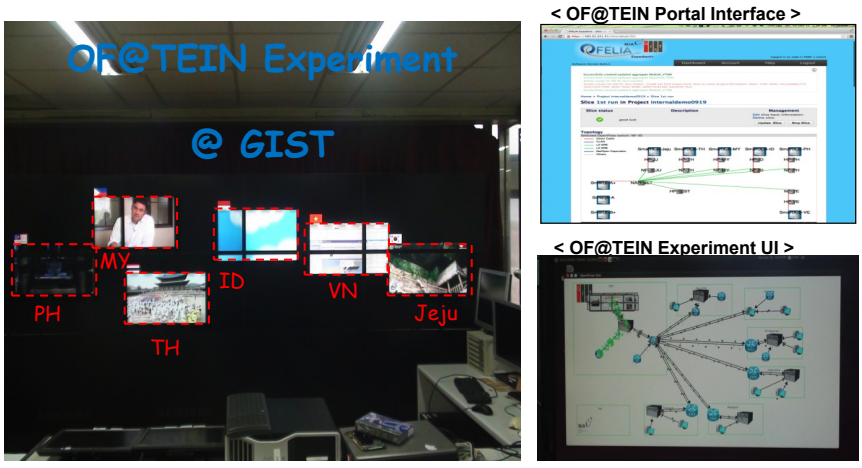

Fig. 6. OF@TEIN experiment @ GIST with related UIs.

5. Conclusions

The on-going effort for OF@TEIN SDN (Software-Defined Networking) testbed has been successfully launched in 2012 with internationally deployed OpenFlow-enabled SmartX Racks. In coming years, we hope to gradually extend and upgrade OF@TEIN so that we can facilitate the realistic Future Internet research collaboration of all Asian countries.

Acknowledgements

We would like to appreciate all OF@TEIN international partners for their sincere collaboration (including SmartX Rack hosting and OF@TEIN utilization). Also special thanks go for GIST students (Namgon Kim and Jaeyong Yoo) who significantly contributed in the initial setup stage. Finally, we appreciate the effort of KTNetworks staffs (Jaesoo Park, Yongjin Kim, and Boshik Shin) in SmartX Rack site installations.

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