TUNOS: Towards Network Operating System for Software Defined Networking

Prof. Jun Bi, et.al.
Tsinghua University, Beijing China
junbi@tsinghua.edu.cn

Currently, the emergence of Software Defined Networking (SDN) enables continuous network innovation. SDN is a network architecture which decouples the control plane from the forwarding plane [1]. From the perspective of SDN, the forwarding plane consists of high-performance commodity switches while the control plane is refactored to an open and centralized control platform for the deployment and co-existence of multiple control protocols to control packets forwarding through a standard forwarding abstract interface (e.g. the OpenFlow protocol).

1. TUNOS Vision

Current SDN controllers are considered as a kind of middleware that builds channels between APPs and devices, not a network operating system (NOS) which truly de-couples APPs and network infrastructure from the view of resource management. OS is derived from the management of computing and storing resource and the provision of common services for programs in a COMPUTER [2]. In our opinion, the effective allocation and the global optimization of forwarding resource for co-existence of multiple control protocols is a necessary feature of NOS. Furthermore, the openness of SDN puts the management of forwarding resource on the same level of the management of computation and storage resources so that NOS can control, integrate and optimize forwarding, computing and storing resource in a NETWORK.

2. TUNOS Architecture

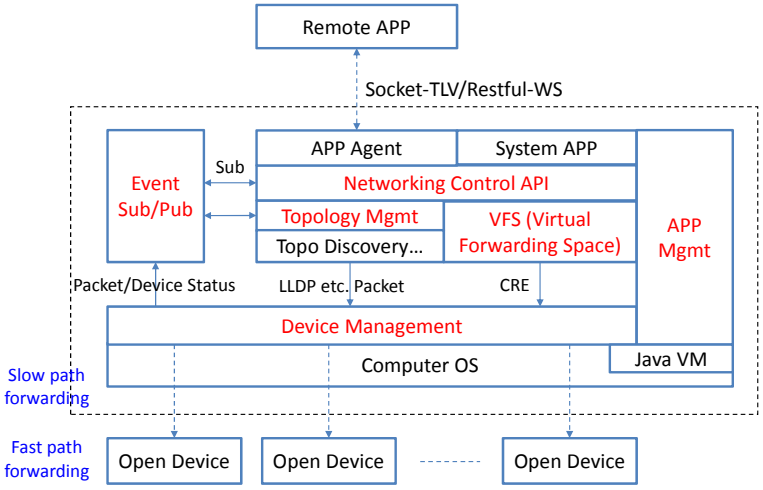

Fig.1 TUNOS Architecture

We developed a prototype of network operating system named TUNOS [3] in the FINE project which is supported by “863” high-tech program in China, as shown in Figure 1. The main features of

TUNOS include device management, event subscription and publication, topology discovery and view, virtual forwarding space and control application management. TUNOS also provides high-level APIs and well-defined module blocks for APPs to support protocol design by hiding hardware details.

At the current stage, the design and implementation of TUNOS focus on effective and fair forwarding resource scheduling for multiple APPs to share the common physical resources in open devices. In TUNOS, we designed Virtual Forwarding Space (VFS), which is the unified management and control to all of forwarding resource in the whole networking, shown as Figure 2. For example, flow tables are actually created and stored in VFS, and swapped between TUNOS and devices with an effective and fair policy. This makes the flow table more scale, and also improve the reliability when APP or device failure happens. We will show the actual result of flow table management as an example.

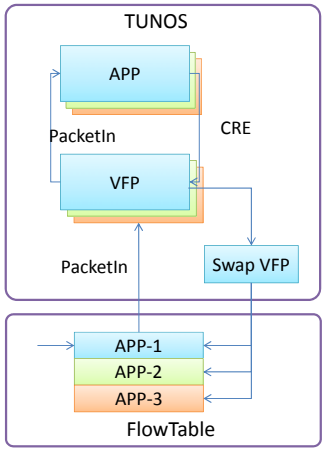

Fig.2 Virtual Forwarding Space

3. Demo of TUNOS

In this demo, we use MININET to mimic a Tsinghua campus network topology with 25 nodes. TUNOS running in an outside server connects with every node by OpenFlow protocol. We base our demo on traffic traces from the real network of Tsinghua campus. These traffic traces can be introduced into MININET through a packet generator. We limit FlowTable capacity at 1000 entries by counting control rule entities (CREs) with a capacity parameter in TUNOS.

To validate TUNOS, A routing application and a secruity application will generate CREs and write them into VFS by means of the proactive trigger from unmatched packets and the active pre-configuration by policy. TUNOS will schedule control rules into FlowTable with a swap policy according to a traffic classification and a global control rule view in the case of limited FlowTable capacity. TUNOS will choose control rules for heavy hitters to download FlowTable while control flow (e.g. ICMP packet) will be processed by TUNOS. Thus, control applications can generate control rules according to control requirement rather than hardware capacity through forwarding resource management in TUNOS.

Reference

[1] Software-Defined Networking: The New Norm for Networks, ONF White Paper, 2012

[2] A. Silberschatz, P. B. Galvin, G. Gagne, Operating System Concepts the 8th edition, 2009

[3] T. Feng, J. Bi, H. Hu, TUNOS: A Novel SDN-oriented Networking Operating System, ICNP12, poster, Austin, USA, 2012