Design and Building of P4 Programmable Network Testbed and Reservation System on TWAREN

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***Abstract*—This paper introduces the P4 programmable testbed built by TWAREN. In this testbed, you can define how the P4 switch handles packets by writing P4 language code, providing more customization than the SDN network. However, hardware P4 switches are expensive, and many users often use BMv2 for research due to financial reasons. Therefore, we have selected several nodes on the TWAREN network to build multiple physical P4 switches and connected them via VPLS to form a large remote P4 programmable testbed. With P4 programmable testbed, users can verify their mechanism on a large-scale physical network.**

Keywords—P4, programmable network, TWAREN

I. INTRODUCTION

Big Data and Cloud Computing are hot technology, and they use the network to transmit data, so optimization of network transmission is a benefit for them.

To improve network transmission, network measurement tools are necessary. However, most of the measurement tools in traditional networks have disadvantages, such as insufficient monitoring range, large bandwidth consumption, or the requirement of many devices. In addition, traditional network devices have customization limitations, so many researchers consider having an open network architecture to meet the desires of individual experiments. Therefore, Software Defined Network (SDN) [1] technology has emerged, which separates the control plane from the data plane in the network. Developers can develop the desired functions on the control plane and let both the control plane and the data plane follow the same SDN protocol so that the controller to control the switch smoothly to achieve the developed functions. Such capacity in the control plane also makes SDN have customizable features.

While the control plane of SDN is open, the data plane is closed than the control plan to customization. To further have a customization feature on the data plane, P4.org create the P4 language[2][3].

A P4 switch (Programmable Protocol-independent Packet Processor, P4) is a programmable switch. By writing the P4 language, developers can create switch that meets their needs. The P4-enabled switches are the software switch bmv2, which is free, and the hardware switch Intel Tofino P4, which is a hardware switch with a Tofino chip that costs more and allows users to choose which version to use depending on their budget.

The software version and the hardware version still have some differences in P4 language coding, and the performance of the software version is not good enough to reflect the time of data transmission in the realistic network when the network performance is measured. However, the hardware version is more expensive, and not all users can afford it. Based on this motivation, we intend to build a P4 programmable network testbed based on Taiwan Advanced Research and Education Network (TWAREN) with the Intel Tofino P4, so that research institutes with an insufficient budget and researchers in networks, Big Data or Cloud Computing can also have the opportunity to operate a hardware-based P4 switch to transmission data.

even research institutions with an insufficient budget can have the opportunity to operate the hardware P4 switch.

TWAREN is a broadband network that connects multiple academic and research institutions in Taiwan and abroad. Based on our previous experience in building a large-scale SDN testbed on TWAREN [4][5], we plan to deploy hardware P4 switches in a few selected TWAREN backbone nodes and LAN nodes to provide a large-scale P4 testbed in Taiwan.

The contents of this paper are as follows. Section II will explain the architecture of the P4 programmable testbed on TWAREN that we have built this year. In Section III, the Testbed reservation system will be shown and planned to provide for the domestic research community. The last section will be the conclusion and future work.

II. TWAREN PROGRAMMABLE TESTBED ARCHITECTURE

This section describes the architecture of the TWAREN programmable network testbed. As shown in Fig. 1, we deployed one P4 switch and one server at each node in the Hsinchu headquarters, Tainan branch, National Cheng Kung University (NCKU), National Yang Ming Chiao Tung University (NYCU), and National Chung Hsing University (NCHU). The server deployed on each node can be regarded as a client of the P4 switch.

Between the nodes, we use VPLS connections provided by TWAREN for interconnection. These connections are data paths between the P4 switches. As shown in Fig. 1, our TWAREN P4 programmable network testbed is based on the core of the Hsinchu headquarters and Tainan branches and is directly connected with the TWAREN VPLS by NCKU, NYCU, and NCHU. However, TWAREN equipment is a 10G interface and the hardware P4 switch only has a 100G/40G interface, so we use a breakout to output a 40G signal into 4*10G lines to interface with TWAREN equipment. In addition, to reduce network attacks from the external Internet, we deployed two

physical SSL VPNs to provide user authentication and obtain private IP addresses on the client. TABLE I shows the link type of interface in all equipment connected to TWAREN.

To offer a service to research institutions in Taiwan for P4 testbed reservations in the future. We have also implemented a beta version of the reservation system for this testbed after completing the construction of the P4 programmable network testbed.

III. P4 Testbed Reservation System

This section shows the beta reservation system for the P4 programmable network testbed. Since the number of our P4 switch pipelines is only 2, which allows at most 2 people to access them at the same time, but to avoid interfering with each other, we decided to open only 1 person who can make a reservation to access the testbed at the same time. If domestic research institutions need to use the this testbed, they need to make a reservation through this beta reservation system.

The reservation process is divided into the following steps. Step 1: Users apply for accessing P4 Testbed. Step 2: System Sending Notification: The system sends an E-mail informing that the application request has been received and is waiting to be processed. Step 3: Reviewed by our teams. Step 4: Sends notification: SSLVPN program (or connection key), user account/password, IP address information, etc.

TABLE I. LINK TYPE OF DEVICE INTERFACE

Number	Source	Destination	LinkType
1	Tainan	NCKU	10G SR
2	Tainan	NYCU	10G SR
3	Hsinchu	Tainan	10G SR
4	Hsinchu	NYCU	10G SR
5	Hsinchu	NCHU	10G SR
6	Hsinchu	NCKU	10G SR
7	Tainan	NCHU	10G SR

Number	Source	Destination	LinkType
8	Tainan	SSL VPN	1G RJ-45
9	NYCU	SSL VPN	1G RJ-45
10	NCKU	SSL VPN	1G RJ-45
11	Hsinchu	SSL VPN	1G RJ-45
12	NCHU	SSL VPN	1G RJ-45
13	All Servers	SSL VPN	1G RJ-45

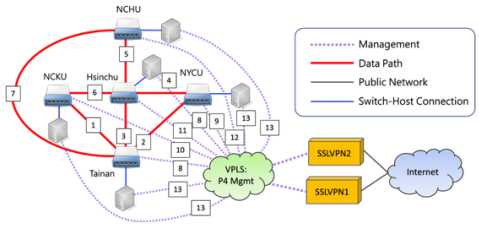
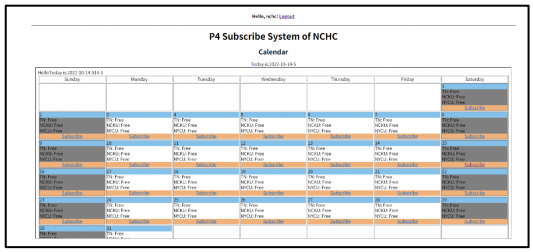


Fig. 1. P4 programmable switch network testbed



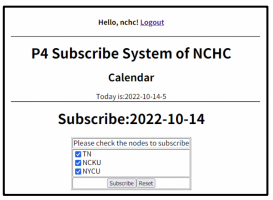


Fig. 2. The Portal and avalable reserveration calendar page

Fig 2 shows the beta reservation system we have developed. After receiving a notification from our team, user will receive a user account and password to log into the beta reservation system from the portal. After successfully logging into the system, the available dates for the testbed will be displayed on the monthly calendar. Users can select an available time to submit a reservation request. After the user submits the reservation request successfully, the system will ensure user who reserve at this time can access the P4 testbed. When the reservation time using the P4 testbed expires, the recovery mechanism will kick in, restoring the testbed environment to its default state so that the next reserved user can use it.

IV. Conclustions and Future Work

Previously, our team surveyed international P4 testbeds and reservation services. We found that these testbeds, such as GEANT P4, NICT, FABRIC, etc., often have many restrictions on the applying process and there is no similar testbed and service in Taiwan, therefore, our team propose to construct a P4 testbed and reservation system in Taiwan.

This paper introduced the P4 programmable network testbed built on TWAREN this year. At this stage, we selected the Hsinchu Headquarters, Tainan branch, NCKU, NYCU, and NCHU. Through the VPLS service provided by TWAREN, we can link the P4 switches at each node to create a physical network testbed.

In the future, we will open this P4 programmable network testbed for the research community or researchers in Big Data and Cloud Computing to apply for leasing, hoping to use this testbed to benefit the domestic research community.

References

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