Learning and Teaching the Communication Between VLANs with Three Layer Switch

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Abstract. There are a lot of communication technologies between VLANs, such as with the Single Arm Routing Method and Three Layer Switch. The communication technology between VLANs is a very important point in study network. With Packet Tracer as one education simulation technology, researchers simulate a network topology to learning and teaching the communication between VLANs with Three Layer Switch in this paper. The simulate results show that researchers can more easily and efficiently configure network topology for learning and teaching the communication technology between VLANs with Three Layer Switch in Packet Tracer than in actual network equipments.

Introduction

The most important technology of computer network is the connection technology. More and more colleges and universities make training network technology talented person as an important strategic task [1], and have the classes for learning and teaching the various communication technologies such as between VLANs [2]. To learning and teaching the communication technology between VLANs needs many actual network equipments such as Switch and Router. However, many colleges and universities have not enough actual network equipments for the network experiment.

In this paper, researchers study Packet Tracer as an education simulation technology, and conduct the simulation network experiment. In the simulation network topology, researchers simulate the communication technology between VLANs with Three Layer Switch [3]. Then, researchers analyze the simulation result and compare the advantage of education simulation technology with actual network equipments.

Education Simulation Technology

There are many simulation technologies for education and research such as Packet Tracer [4], GNS3 [5], OPNET [6], NS2 [7], etc. But, for Packet Tracer is one of the most popular and the easiest simulation tools for Cisco Systems, Inc. many teachers of colleges and universities teach network technology with it. Packet Tracer supplements physical equipment in the classroom by allowing students to create a network with an almost unlimited number of devices, encouraging practice, discovery, and troubleshooting. The simulation-based learning environment helps students develop 21st century skills such as decision making, creative and critical thinking, and problem solving.

The Communication between VLANs

The Communication Technology Types. VLAN is virtual local area network or virtual LAN. VLAN Trunk [8] is the key and difficult points in VLAN. There are two standards for VLAN Trunk: ISL and IEEE 802.1Q [9]. In computer network, only Routers in VLAN topologies provide broadcast filtering, security, address summarization, and traffic-flow management. By definition, Switches may not bridge IP traffic between VLANs. There need Routers to provide communication.

There are two communication technologies between VLANs. The first one is the traditional method. In this method, there are some access links between Switch and Router, and the amount of access links is the same as that of VLANs. The second one is the single arm routing method. In this method, there is only one trunk link between Switch and Router for more VLANs. Then, researchers can also communication between VLANs with Three Layer Switch. This communication technology is different with the traditional method and the single arm routing method.

ISL and IEEE 802.1Q are two standards for VLAN Trunk. ISL is a Cisco proprietary technology, and IEEE 802.1Q is the international standard by IEEE. In addition to Cisco both support, other vendors only support IEEE 802.1Q. IEEE 802.1Q uses an internal tagging mechanism which inserts a 4-byte tag field in the original Ethernet frame. The Ethernet frame structure with IEEE 802.1Q frame tagging is shown as Fig. 1, and the detailed descriptions of IEEE 802.1Q frame tagging structure is shown in Fig. 2.

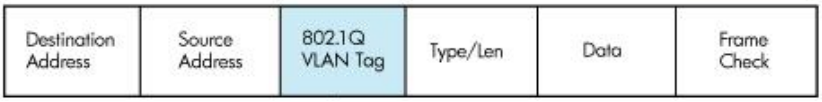

Fig. 1 the Ethernet Frame Structure with IEEE 802.1Q Frame Tagging

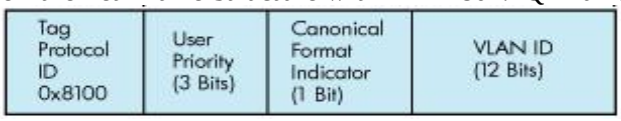

Fig. 2 IEEE 802.1Q Frame Tagging Structure

Tag Protocol Identifier (TPID) field is 16 bits, and it is set to a value of 0x8100, in order to identify the frame as an IEEE 802.1Q tagged frame. After TPID field is Tag Control Information (TCI) field, and TCI is further divided into User Priority, DEI, and VID fields. User Priority field is 3 bits, and refers to the IEEE 802.1Q priority. The field indicates the frame priority level which can be used for the prioritization of traffic and can represent 8 levels from 0 to 7. Canonical Format Indicator (DFI) field is 1 bit. If the value of this field is 1, the MAC address is in no canonical format. If the value is 0, the MAC address is in canonical format. VLAN Identifier (VID) field is 12 bits.

Simulation Network Experiment

Simulation Topology. In Packet Tracer, researchers simulate a network topology includes two PCs, one Three Layer Switch as in Fig. 3. Then, researchers configure the simulation topology as Table 1.

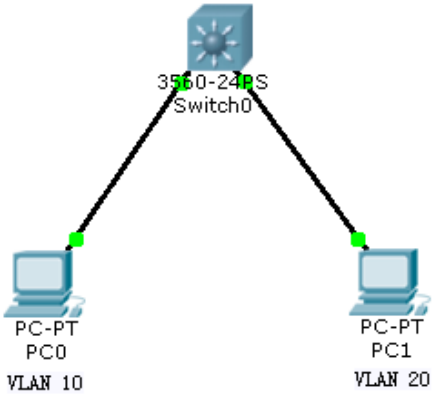

Fig. 3 The Simulation Topology

Table 1 The IP Address of Network Topology

Device	Interface	IP address	Subnet Mask	Default Gatway
PC0	NIC	192.168.10.1	255.255.255.0	192.168.10.254
PC1	NIC	192.168.20.1	255.255.255.0	192.168.20.254
Switch0	Fa0/10	N/A	N/A	N/A
	Fa0/20	N/A	N/A	N/A
	VLAN 10	192.168.10.254	255.255.255.0	N/A
	VLAN 20	192.168.20.254	255.255.255.0	N/A

Researchers configure IP address for PC1, PC2 with Table1, and configure two VLANs such as VLAN 10 and VLAN 20. Researchers make Fa0/10 in VLAN 10 and Fa0/20 in VLAN 20 with access mode in Switch0. The command on Switch0 is as following:

```
Switch0#vlan database
Switch0 (vlan)#vlan 10 name v10
VLAN 10 added:
  Name: v10
Switch0 (vlan)#vlan 20 name v20
VLAN 20 added:
  Name: v20
Switch0 (vlan)#exit
APPLY completed.
Exiting....
Switch0#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch0 (config)#interface vlan 10
Switch0 (config-if)#
Switch0 (config-if)#ip address 192.168.10.254 255.255.255.0
Switch0 (config-if)#interface vlan 20
Switch0 (config-if)#ip address 192.168.20.254 255.255.255.0
Switch0 (config-if)#exit
Switch0 (config)#interface fastEthernet 0/10
Switch0 (config-if)#switchport access vlan 10
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan10, changed state to up
Switch0 (config-if)#interface fastEthernet 0/20
Switch0 (config-if)#switchport access vlan 20
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan20, changed state to up
Switch0 (config-if)#end
```

After the above configuration, researchers make Fa0/10 in VLAN 10 and Fa0/20 in VLAN 20 with access mode in Switch0. However, For Fa0/10, Fa0/20 of Switch0 are in different VLANs, PC1 cannot communicate with PC0 such as *ping* command. The results are shown in Fig. 4.

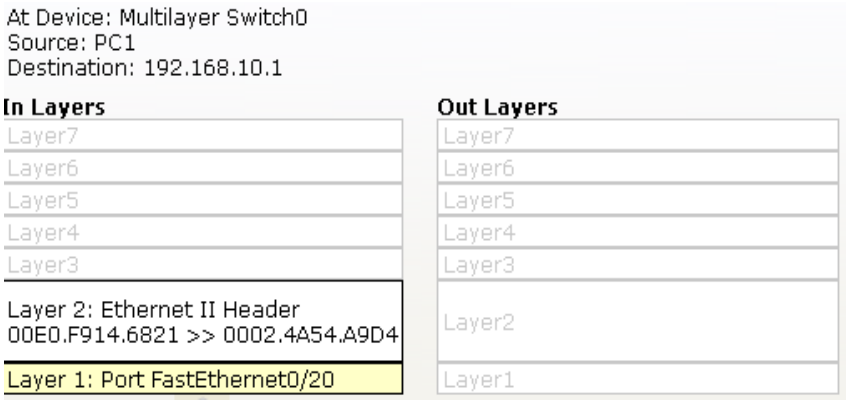

Fig. 4 Not Communicate between PC0 and PC1

However, Switch0 is a Three Layer Swith and have the routing funcation. Researchers can start the routing function of Three Layer Switch with *ip routing* command. The reason is that Switch0 can look up the PC0 (destination IP) address in the CEF table after starting the routing function of Three Layer Switch. Switch0 can transform the ICMP message from PC1 to PC0. Then, PC1 can communicate with PC0. The result is show in Fig. 3. in Smulation Mode of Packet Tracer.

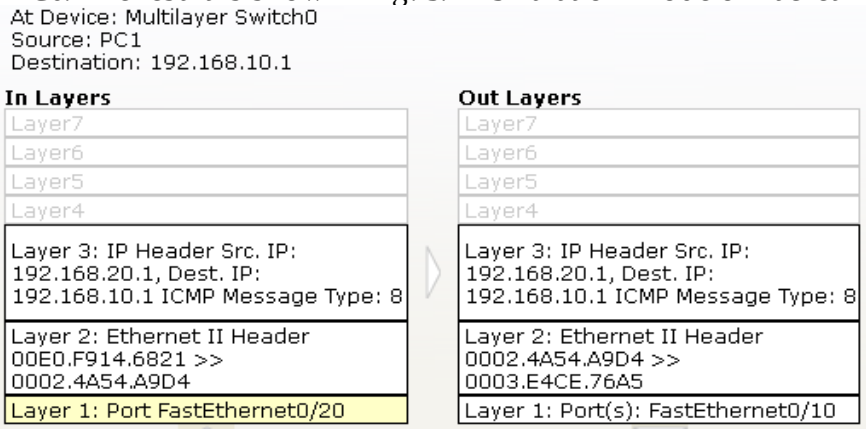

Fig. 5 Communicate between PC0 and PC1

Summary

When teaching the various communication technologies, colleges and universities meet some difficulties, such as having not enough actual network equipments for the network experiment. In this paper, researchers study Packet Tracer as an education simulation technology, and learn the communication technology between VLANs with Three Layer Switch with Packet Tracer. The simulation results show researchers can achieve the same function with Packet Tracer as with the actual network equipments, and can more easily and efficiently configure network topology for learning and teaching. With comparison and analysis in this paper, researchers can see that the education simulation technology can approve more easily and efficiently method for learning and teaching than the actual network equipments.

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