

A Case Teaching Method about Network Planning and Design

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Abstract. A Case Teaching Method is put forward for Network Planning and Design course. Case Teaching Method is described by introducing Spanning Tree Protocol and VLAN technology. This method can help students understand and master the course knowledge conveniently. Network scheme designs are arranged after class in order to improve their design capability and ability of analyzing system. Discussing and modifying their designs in class, students will learn an effective method to design network. An inspiring result was achieved in the process of the Case Teaching Method in the past few years.

Keywords: Network Planning and Design; Case Teaching Method; STP; VLAN

1. Introduction

Network planning and design is a network professional course in Computer College. The aim of this course is to let students understand the basic principle of computer network design and construction, master the general methods of designing computer network, know well about the task and goal of network engineering. After lessons, students can not only master the design principle and method skillfully, but also learn to design network in practice. More and more schools regard this subject as professional course for the students of computer network engineering.

From 2008, network planning and design was carried out in school of computer science and technology, Shandong Jianzhu University. Moreover, at the end of this course, the course design is added to consolidate the students' study effect.

Network planning and design is a subsequent course following Computer Network and Network Equipments. The emphasis of this course is guiding students to be familiar with the method of network design on the basis of computer network, network equipment, cabling system. As the focus of this course is the engineering and practice, we will put emphasis on practice teaching and avoid tedious theory.

2. The Arrangement of the Course

Computer network design is a very vital link in the network construction. During the design of computer network, it is necessary to analyze the requirements. To satisfy the need of business, the network plan should abide by network standard. The excellent design will construct the network easily and effectively, achieve the satisfactory result.

This course mainly consists of the following contents, the basis of network design, network analysis and design, analysis of network requirement, design of logical network, design of physical network, network test, operation and maintain of the network, treatment of network fault, wireless network, and so on. We will combine the basic theory and specific design to result in scientific design. In the process of this course, we will bring up students the ability of self-study and resolving practical problems [1].

This course has 40 school hours. The time in class is limited, so we encourage students to do some network design after class. The homework would be a reference of the course result.

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In order to keep up with the practice, we refer to the technology document and training material in Network Company such as Cisco, Huawei. And the textbook we choose is Network Design Course which is edited by Chen Ming and published by Tsinghua University Press.

3. Case Teaching Method

If there are only pure theories in classroom, students will feel tolerant and dislike this course; furthermore, they may feel helpless when they face with the practical projects in their career. So we will analyze some special and typical case to help students understand the theory deeply and master the skill of network design. At the same time, we will arrange students to complete some small size of network design work.

3.1. STP Case Study

Students have learned about STP (spanning tree protocol) formerly. In Network Planning and Design, STP is the emphasis. In the teaching process, we review these knowledge points first and help students recall the related theory. We not only introduce the theory to students, but also analyze one vivid case about this theory deeply [2].

In the switching network, there are 3 steps to build up STP. Firstly, the root bridge is elected, and then root port is selected in Non-root Bridge, at last the designate port is chosen in each segment.

Now, referring to figure 1, the mechanism, operating process, and security of STP are described.

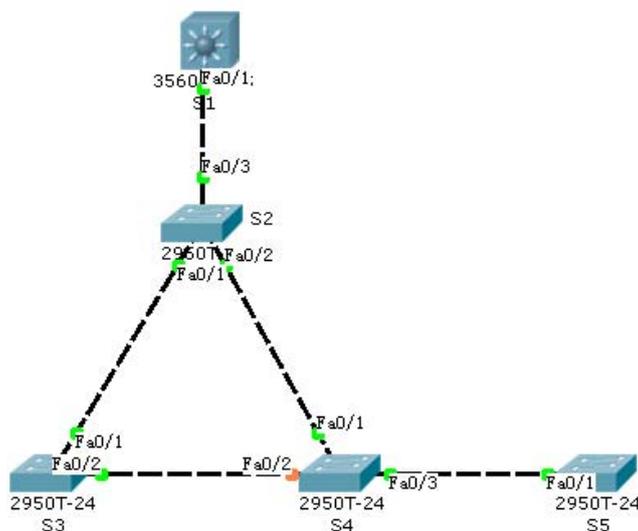


Figure 1. Topology of STP Case

In figure 1, S1, S2, S3, S4 belong to core network and they are settled in center machine room. There are downlink switching network below S3, S4. S5 is a part of distributed network, and there are sub-class switches connecting to it. S1 is a high performance multi-layer switch and it connects to Internet and network servers. Except S1, all the switches in the topology are 2-layer switches. Taking into account either the equipment performance or network topology, S1 is the most suitable root bridge.

It is BPDU packets that decide which switch is elected as Root Bridge. There are both priority information and MAC address in BPDU packet and the default priority of a switch is 32768. To be a root bridge in switching network, a switch should have a priority or a MAC address less than others. MAC address is a stable value and cannot be modified. So we can lower the priority. The commands are showed below.

```
S1(config)#spanning-tree vlan 1-1001 priority 4096
```

After this, the priority of S1 is changed to 4096, and S1 will be the root bridge in VLAN 1-1001. It should be noted that the priority must be multiple of 4096 and the scope of VLAN can be set as needed.

We can use following command also.

```
S1(config)#spanning-tree vlan 1-1001 root primary
```

After the configuration, S1 become the root bridge and Fa0/2 in S4 becomes blocking. Then the loop in switching network disappears, and broadcast storm can be avoided.

A switch will be root in switching network if we operate as above, so S5 or other lower switch can be root too. Once they become root in switching network, the ports status will be changed. In this topology, Fa0/1 in S2 will be blocking. If there is outgoing data from LAN attached to S3 cannot be sent via S2 to S1. The data will be sent to S4 first, then via S2, finally S1. The chosen path violates the design of the designer. The transmission efficiency is cut down and there will be hidden danger in the network.

To avoid configuring switches in network at will, we can strengthen the configuration management of the switches, and on the other hand, we can configure security settings in the core switches.

From the topology in Fig 1, we can configure S4 as follow.

```
S4(config)# interface fa 0/3
```

```
S4(config-if)#spanning-tree guard root
```

If there are other BPDU packets that have lower priority than S1 reaching fa0/3 of S4, S4 will block fa0/3. The state of fa0/3 will not change until there are no similar packets.

By this way, the chaos state of STP will not come to true.

3.2. VLAN Case Study

VLAN (Virtual LAN) is widely used in LAN, and it is also a link which easily gets into trouble in network design and planning.

Topology showed in figure 2 is to be discussed below.

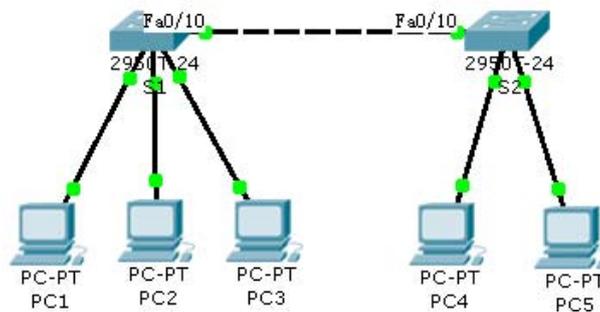


Figure 2. Topology of VLAN Case

The connection is shown in figure 2. The configuration is under the static VLAN configuration, dividing VLAN based on switch ports. Fa0/10 in both S1 and S2 are trunk ports and other ports are access ports. PC1, PC2, PC4 are in VLAN1, and PC3, PC5 are in VLAN2. Fa0/10 is configured as below.

```
S1(config)#interface fa 0/10
```

```
S1(config-if)#switchport mode trunk
```

PC1 can access PC4 because they belong to the same VLAN.

Now let's change the configuration. Fa0/10 in S1 accesses VLAN 1 and Fa0/10 in S2 accesses VLAN 2. The five PCs are set into the same network. Their IP addresses have the same network number.

After these changes, we will find that PC1 can access PC5, while it cannot access PC4 any longer.

Why two PCs with different VLAN can access each other in 2-layer switching network?

When the packets from PC1 enter S1, VLAN tag will be added. These packets will be transferred among VLAN1. Fa0/10 is a port of VLAN 1, so the packets can be sent out from this port. When these packets enter S2, as Fa0/10 in S2 is a port of VLAN 2, the packets will be tagged with the market of VLAN 2. So the packets can be sent to other S2 ports in VLAN 2.

The analysis above indicates that, when the packets enter switch the VLAN tags will be added; when the packets come out of switch, if the exit port is in access mode, the VLAN tags will be removed; else, if the

exit port is in trunk mode, the VLAN tags will be carried continuously. This is a difference between access port and trunk port.

After analyzing VLAN case, students will master the VLAN knowledge point firmly.

3.3. Course Design Job

In order to enrich the students study and consolidate the knowledge points taught in class, we arrange a series of course design jobs, including individual design and entire design.

After finishing a knowledge point, a design job will be assigned to students. Such as design of middle-size LAN, design of network servers, design of WLAN, design of network firewall. Each design job is divided into some sub-jobs. For example, the design of middle-size LAN can be disintegrated into design of Internet café, design of middle-size corporation network, design of computer room, design of school network center.

At the end of the course, students are requested to complete a large-size network planning. This design contains almost all of the knowledge points of this course. As this design job is large so students can be divided into different groups. Each team completes one design work. Referring to the total design of the campus, we should consider all kinds of technology, such as LAN, WAN, Wireless Network, security, and so on. The whole job is completed as the following steps, proposing the plan, designing the topology, choosing equipments, quoting price of the whole network, designing the process of construction, and so on. By this way students can understand the design methods, design tools, network devices, network plan deeply and clearly.

The final design job is required to be finished in spare time. Students are encouraged to use the new knowledge. They can consult documents widely and discuss the problems with each other. After the job, students will share their design and review others' work. They can enhance themselves in the mutual study.

In order to let the students attach importance to the design job, we regard the completion of the design as an important reference in final result.

4. Effect of This Teaching Method

The case teaching method in Network Planning and Design is the result of group discuss among the colleagues in Network Teaching Group.

In the teaching process, we have changed the pattern of referring to book entirely. And we carry out the teaching work with the help of network cases. Students are encouraged to discuss and release their viewpoint freely. They find that this method can inspire their study interests and improve efficiency highly in classroom. Students are interesting in the design job since then. The students' practical ability is also enhanced obviously [3].

The test in the final term is also modified. The subjects about network planning and network analysis are added, while the concept subjects are cut down.

In despite of the large scale and fussy knowledge in this course, students can arrange their study systematically and they are willing to express themselves and share their thought.

After several terms of practice, students' ability of design, analysis, resolving problems are improved highly. They also have a high level view in network planning and design. They have achieved favorable result in this course. Quite a few students engage in network design after school, and they can deal with complex work freely and keep ahead in their career.

5. Conclusion

Nowadays, computers and related technology have developed quickly and network becomes more and more important. The excellent network application must base on first-class network, and excellent network platform depends on outstanding network design.

The performance of network design decides the performance and reliability of the network platform. Network Planning and Design has a vital station in the course system of computer network engineering. The

start and innovation of this course are both aimed to bring up experts in network design and planning. They are not only armed with abundant theory, but also skillful in network construction. They can master the whole methods and skills about design and construction and they will be skillful network engineers one day [4].

6.Acknowledgments

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7.References

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