The Construction and Research of Computer Network Laboratory Based on Virtual Simulation Technology

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Abstract. Aiming at a variety of problems about computer networks experiment in institution of higher education, combined with the actual situation in our school, build a computer network laboratory based on virtual simulation technology. In this paper, discusses in detail the construction of laboratory software and hardware, and the set of practice teaching content, this study for the cultivation of application and innovation talents has a great significance.

Introduction

Computer network course is important major course in computer science, it’s very important for the development of the other technical disciplines. At present our country the rapid development of information technology and information industry, are most in need of large number of master computer network and communication technology, it is to cultivate high-quality innovative 21st century computer professionals put forward the urgent request. Building a fully functional computer network laboratory will require a lot of money, the school and students experiment at the same time, it is hard to satisfy large quantities of experiments on rate is low, hardware loss is bigger, is not conducive to the experiment. With the maturity of the virtual simulation software technology and a large number of successful application of virtual simulation software technology can be integrated into the computer network course, the course construction of computer network experiment has played a good role in promoting[1,2].

With the development of computer network technology, the present computer network teaching put forward higher request, the existing experimental teaching only stay in the verification experiment phase, experiment teaching content is not clear and the form loose, students just passively accept the abstract network knowledge. In the experiment teaching link without proper teaching tools and resources to deepen understanding of theoretical knowledge, disconnect between theory and practice of the students resulted a decline in students’ learning interest and passive learning, understanding is not enough for knowledge in depth[3].

The main reason for this phenomenon is that, the first reason is lack of computer network experiment teaching resources to adapt to the characteristics of each school; the second reson is building a professional computer network laboratory required a lot of hardware costs such as the purchase of switches, routers and other hardware devices[4].

The Construction of Virtual Simulation Laboratory

In view of the current computer network experiment teaching in the experimental teaching content is not systematic, lack of experimental hardware equipment and other issues, combined with the actual situation of our laboratory, build a computer network laboratory based on virtual simulation technology. The construction of the laboratory includes virtual simulation laboratory hardware and software, virtual simulation teaching resources and virtual simulation experiment teaching platform.

The Construction of Virtual Simulation Laboratory Hardware and Software

Computer network laboratory in cooperation with CSS and JLU Information Technology Co., Ltd., emulational education system for network protocols is introduced into the computer network experiment teaching, which provides a new teaching method and means.
The part of lab hardware is composed of the master control center platform, the intelligent network equipment and the group control equipment. It is used to build the network environment needed for the experiment, and can realize a variety of network topology, as shown in Figure 1.

Figure 1. The first network structure diagram.

Figure 2. Hardware structure diagram.

The master control center platform is the core of the system hardware, composed of dedicated high-performance servers and central equipment, providing a variety of system services for the experimental environment, ensuring network data traffic, ensuring the integrity of the experimental structure and the effective expansion of the number of experimental users. For the computer network experiments to provide FTP, DNS, DHCP and other services, laboratory management services.
Intelligent network equipment used to build network hardware structure, to provide network topology automation management. By pressing the "Topology" button on the intelligent network equipment, you can switch through all network topologies to effectively avoid the problem of changing the network cable frequently when you change the network structure. At the same time, you can through the control button "Team" to set the control mode of intelligent network equipment, all the lab group network structure can be implemented in the laboratory of one-click switching.

Group control devices are system-specific hardware. Each group control device consists of six shared modules, with intelligent network equipment to achieve a variety of network structure, with data acquisition, dynamic buffer allocation, balanced network load, etc. Each group of control equipment connected to six student experimental machine, the role were defined as A, B, C, D, E, F. According to the experiment, each role has a different division of labor.

At present, the system supports five kinds of network topology, according to the different experimental project content, switch to a different network topology, for example, the first network structure diagram as shown in Figure 2.

The part of lab software consists of protocol emulation editor, protocol analyzer and other tool software. The protocol emulation editor can simulate packets of multiple protocols in the TCP / IP protocol suite. The protocol analyzer can capture the packets sent by the emulation editor and the packets transmitted on the network and visualize the communication process of the common protocol in the form of session diagrams. The other tool software include UDP tools, multicast tools and other auxiliary teaching software.

At present, the laboratory network protocol simulation teaching system has seven groups of control equipment, each group of six machines, which can accommodate 42 students to carry out simulation experiments, each group of students need to cooperate to experiment, to strengthen the exchange of learning communication skills between students, to fully exercise the ability of student teamwork. Network protocol simulation teaching system as an independent curriculum system to experiment mainly, emphasizing the initiative and design ability of students, to broaden the students' ideas, to achieve real teaching interaction. At the same time using Boson NetSim for CCNP and cisco simulator Cisco Packet Tracer simulation experiment teaching software, you can simulate the construction of LAN and WAN operating environment, simulate network experiment in simulation software.

The Construction of Virtual Simulation Teaching Resources

Computer network is a very comprehensive discipline, both hardware and software experiments, both closely, inseparable, first physical theory again after the application of teaching mode, is more advantageous to the understanding of students. The construction of teaching resources should strengthen the experimental teaching links and understanding the core content of the course in depth, develop a detailed experimental plan, select the data link layer, network layer, transport layer and application layer and other knowledge points to design the contents of the experiment. The experiment is divided into operational, design, analytical and innovative types.

The setting and contents of each experimental project are as follows.

No 1. LAN set up, protocol configuration and network diagnosis experiment 2 hours replication experiment. To lead students to visit the network laboratory, to establish the initial concept of computer networks comprehensive experiment, to understand the network which hardware equipment. Master the role of cable in the LAN and the use of twisted pair as a transmission medium to achieve Ethernet connection method. Learn to make two types of RJ45 connectors. Master network configuration and TCP / IP protocol configuration in windows systems. Familiar with the use of ping, ipconfig, tracert and other command tools to test.

No 2. IEEE802 standard and Ethernet simulation experiment 2 hours replication experiment. Students understand the two standards of Ethernet MAC frame format through simulation experiments in the network protocol simulation teaching system environment. Master the ethernet
packet format, the role of MAC address, the role of MAC broadcast address, LLC frame format, the use of simulation editor and protocol analyzer.

No 3. LAN simulation experiment 2 hours replication experiment. Students design and simulation through virtual simulation software to build a LAN operating environment. Master the basic configuration and VLAN (virtual local area network) division of the switch.

No 4. ARP (Address Resolution Protocol) simulation experiment 2 hours replication experiment. Students simulation experiments in the network protocol simulation teaching system environment, through experiments students master the ARP protocol packet format and working principle, understand the role of ARP cache and cache table maintenance process.

No 5. IP (Internet Protocol) simulation experiment 3 hours replication experiment. Students simulation experiments in the network protocol simulation teaching system environment, through experiments enable students to understand the meaning of special IP addresses and IP fragmentation process. Master the IP datagram format, IP checksum calculation method, subnet mask and route forwarding.

No 6. WAN simulation experiment 2 hours comprehensive experiment. Students through the virtual simulation software to design and simulate the construction of a wide area network operating environment. Master the operation characteristics of the wide area network, the configuration method of the router, the working principle and the setting method of the routing protocol, so that students comprehensive learning router operating system IOS operation, routing protocols, routing configuration methods, subnets, supernet construction, network diagnostics and router operation commands and other knowledge.

No 7. TCP (Transmission Control Protocol) simulation experiment 2 hours replication experiment. Students simulation experiments in the network protocol simulation teaching system environment, through the experimental students master the TCP protocol packet format, TCP connection establishment and release process, TCP data transmission number and confirmation process, TCP protocol checksum calculation method, understand the TCP retransmission mechanism.

No 8. Implementation of Experiment on Internet Point - to - Point Communication Based on Socket Support 3 hours comprehensive experiment. Understand the basic concepts and principles of socket. Master the establishment, monitor, connect, send data and receive data of socket. The experiment combines the high-level language programming, point-to-point communication protocol, transport layer principle and Socket programming thought, method and so on[5,6].

After the experiment teaching link, students need a planned curriculum design. After completion of computer network curriculum, curriculum design teaching use the knowledge to complete the comprehensive design subject having a certain degree of difficulty. Through curriculum design training, training and exercise the students' ability of analysis problem, software architecture design, user interface design, program design of the basic skills and techniques.

In the experiment teaching tasks, students can choose according to their own interests do lab opening experiment project. Previous experiments in the Bonson NetSim and Cisco Packet Tracer virtual simulation software environment, you can use switches, routers and other hardware devices to build a network experimental environment for real experiments, to further strengthen the practical operational skills. At the same time, the network protocol simulation teaching system in addition to plan experimental projects, but also provides application layer protocol, network attack and defense, network failure analysis and network application design and other aspects of open experimental projects, from all directions, multi-angle training of students' computer network knowledge and skills, combining theory with practice, greatly improving students' interest in learning, exercising students' ability to think independently, analyze and solve problems.

The Construction of Virtual Simulation Experiment Teaching Platform

Virtual simulation experiment teaching platform relies on network protocol simulation teaching system, platform includes computer network management information system and computer network experimental teaching platform in two parts.
Computer network management information system can help teachers to better experimental teaching management. Through the system, teachers can carry out experimental report management, experimental structure management, experimental information management, experimental program management, laboratory equipment management and experimental bulletin information management.

The experimental teaching platform can assist students in experimenting and provide soft support for experimental operating environment. The platform is a teaching platform to guide students to experiment, assist teachers to teach, it will provide a convenient experimental environment for the learners to improve the learning efficiency by integrating the various auxiliary tools, experimental knowledge points, experimental process guides and experimental thinking problems in the platform.

Management information system installed in the main control center platform, experimental teaching platform installed in the student machine client. Students can download the experimental information and experimental bulletin information arranged in the management information system to the student client to facilitate the students to view the experimental teaching contents.

The Influence of Virtual Simulation Network Laboratory Construction on Theory Teaching

Experiment teaching and theory teaching is parallel and coordinate with each other, mutually reinforcing, and has the equal important position, is to cultivate students' ability to analyze and solve problems. Experiment course is an extension of the theory course, to cultivate students' comprehensive use of knowledge, to solve practical problems, to deepen the understanding of network theory knowledge and application plays a very important role.

First, the virtual simulation network laboratory provides experimental material basis for the operation to the network curriculum, experimental teaching methods to promote students to understand the theoretical knowledge. Computer network courses with other professional courses are different, it needs to master a set of theory, and then practice validation and thinking, usually the theory of knowledge is more obscure, if only theory, no supporting experimental courses for digestion theory, The teaching effect will be very unsatisfactory.

Second, the construction of virtual simulation network laboratory can improve the teaching level of teachers. Contemporary computer network equipment out very fast, but the theoretical basis is unchanged for a long time. If there is no laboratory, teachers can only repeat the teaching theory again and again, do not understand the latest equipment characteristics, knowledge can not be updated in time, teachers ability to grow slowly.

Third, the laboratory construction is beneficial to promote school scientific research ability. Computer network a lot of scientific research is carried out on the basis of the theory innovation experiment, without the lab is unable to verify the theory, the theory of innovation is unconvincing, scientific research ability cannot be improved.

Due to the modern society more and more high demand for talent, not only requires students to have a certain knowledge, but also require students to have a certain ability. Put the theory into the actual ability of teaching, it is a very slow process. Only in the continuous experiments to try and exploration, the students can have keen powers of observation and agile judgment ability.

Summary

Through the construction of computer network virtual simulation laboratory, a highly simulated virtual experiment environment and experimental object has been constructed, the theoretical knowledge of network is realized by software simulation, it has played a very good role in the construction of computer network experiment course. Gradually formed perfect experimental teaching system, put theory into practice, put the knowledge into ability, so as to meet the demand of the society, promote students employment.
References


