ATLANTIS PRESS

Advances in Social Science, Education and Humanities Research, volume 336

5th International Conference on Social Science and Higher Education (ICSSHE 19)

Construction of Network Comprehensive Experimental Platform Based on Virtual Simulation

Hui Wang
School of Computer Science and Engineering
Xi'an Technological University
Xi'an, China
277019826@qq.com

Juchao Lei
School of Computer Science and Engineering
Xi'an Technological University
Xi'an, China
274766943@qq.com

***Abstract*—In order to solve the problems of large equipment investment, imperfect experimental content and difficult construction of experimental environment in the construction of network comprehensive experiment, the paper studies how to build a network comprehensive experimental platform based on virtual simulation technology in the context of the new engineering. By integrating network management software with network simulation software, a comprehensive network practice and experiment platform is built, which aims to realize network application and maintenance, network equipment configuration, network management, network engineering design and so on. Therefore, the comprehensive practice of online course teaching can be carried out by using this platform. Through this comprehensive experimental platform proposed in this paper, the teaching effect is improved while reducing the maintenance cost of the laboratory. At last, the purpose of practical teaching is realized well.**

Keywords—virtual simulation technology; network comprehensive experiment; experimental platform; network simulation software

I. INTRODUCTION

Under the background of new engineering, engineering education should be closely connected with industrial development and industrial needs to cultivate diversified and innovative engineering and technical talents. Moreover, the teaching process should be closely integrated with the latest development of industry and technology and the latest demand for talents in the industry[1-3]. Therefore, in order to meet the requirements for talent training under the background of new engineering, it is necessary to introduce engineering practice projects into the classroom to improve students' engineering practice ability. The paper introduces the teaching method of reforming and innovative engineering practice based on virtual simulation technology and introduces the network engineering practice project into teaching flexibly[4-5].

II. CURRENT SITUATION AND PROBLEMS

A. Current Situation

Because the courses of network engineering are related to each other, in practice, the practical teaching of the curriculum cannot exist in a single and isolated way. If we only rely on a single curriculum or a single knowledge point to build a practical teaching system, the practical teaching activities will be independent of each other, and it is difficult to form a unified organic whole[6].

The network comprehensive experiment of each course in the network engineering professional course group is arranged together reasonably, so as to form an organic whole. Therefore, the network comprehensive experiment is not the sum of all the experiments in the course group. Instead, it analyzes and compares these experiments in each course, streamlines the same experiment, eliminates the difficult to implement experiments, and then combines these experiments to optimize the resources and increase the sharing[7-8]. They are concentrated in an experimental environment to form a new comprehensive experimental system, which makes it more in line with the actual situation of college students.

Through comprehensive experiments, students can complete a series of experimental tasks throughout the entire process of network engineering under the premise of mastering the theoretical knowledge and practical knowledge of network engineering. Specifically, these experimental tasks include the selection, configuration, design, construction, and construction of network equipment to testing, management, maintenance, application, and development[9].

B. Existing Problems of Computer Network Experiment

With the continuous opening of the new technology curriculum and the upgrading of the experimental phase, the nature of the experiment has gradually changed, from a confirmatory experiment to a comprehensive experiment. Moreover, experiments have also evolved from simple to complex, from a single course experiment to a collection of multiple course experiments. However, the ensuing problems are that the traditional computer room management mode is rigid, the computer performance is solidified, and the experimental requirements are difficult to personalize[10]. In addition, problems such as difficulty in expanding the experimental site have been highlighted, which has affected the high-quality development of some course experiments. The existing experimental environment makes it difficult to achieve true "integration" in network integrated experiments. Therefore, in order to enable students to fully grasp the content of network construction and application, the experimental content needs to involve the network, network equipment configuration, operating system and application

deployment, and also need to monitor and manage the network. At present, it can only support the experimental implementation of a single network course, but if we want to realize the comprehensive practice of multiple network courses, we will not be able to do so. The problems are reflected in the following aspects:

C. Lack of experimental equipment, construction needs further improvement

The content of network engineering professional courses involves a lot of knowledge, and the number of experiments related to knowledge points is also numerous, requiring a lot of equipment, such as switches, routers, firewalls, etc. The same type of equipment has different models, and the number of devices is large. It takes a lot of money to purchase network equipment. At present, the network equipment brands equipped in the laboratory are relatively single. Students can only master a certain series of product configuration and usage methods, which have certain limitations and the teaching effect is not satisfactory.

D. The form of the experiment is simple, and the final result of the experiment is not good

The experimental autonomy and experimental weight of the network engineering course are low, lacking design and comprehensive experiments. At present, most of the experiments are confirmatory experiments, and students complete the experiments according to the experimental requirements. Since the experimental steps are all scheduled in advance, the experimental process and results are singular. The subjective initiative of the students is not played, and the working principle of some equipment is not well understood.

E. The experimental environment cannot meet the comprehensive experimental requirements

Because multiple labs share a single host, the experimental environment is prone to conflict. In order to prevent conflicts in multiple course lab environments, it is possible to install desktop virtualization software, create virtual machines on the experimental host, and then deploy their own experimental environment in the virtual machine. This reduces the chance of system failure in the lab PC. Because this desktop virtualization software needs to allocate the CPU and memory resources of the machine to the virtual machine, the performance of the virtualized system is obviously insufficient when the performance of the experimental host itself is not high.

When implementing network engineering experiments and using the test bench for networking experiments, it is necessary to frequently plug and unplug the jumpers, which will damage the interfaces and network cables on the patch panels, and the resulting faults will affect the expected results of the experiment. After installing the simulators eNsp and GNS3 on the PC in the lab, you will find that the PC is running slowly and the number of network devices that can be turned on in the simulator is limited. The reason is that the simulation software has higher requirements on the performance of the computer. The lower hardware configuration of the PC limits the number of network devices in the simulator, and thus cannot complete large-scale networking experiments.

III. Design of the Network Comprehensive Experimental Teaching Platform

In order to solve these problems, according to the requirements of the experiment content in the network engineering professional course, we can use the simulation software Cisco Packet Tracer, NetRiver, NS3 (Network Simulator) and virtualization technology to build a network comprehensive experimental teaching platform based on the existing experimental environment. The experimental platform can support a variety of operating systems, flexible performance expansion, host-on-demand virtualized experimental teaching platform, and developed a supporting virtualization platform management system.

On the basis of students' understanding and proficiency in real network equipment, the experimental platform provides downloads of various network simulation software. With the network simulation platform, students can build and learn complex networks. The task requirements of the experiment are different, and the solution is different. Reflected in the network topology diagram, the device selection and line configuration are also different. Students can design their own implementation plans according to their own interests or specialties, and simulate the real network environment on the simulation software to complete the equipment selection, configuration, testing and other operations, which helps students to develop practical problems. After two years of operation, the experimental platform solved the above problems, and it was running well and received good teaching results.

A. Design of network comprehensive experimental platform

In view of the current status of laboratory equipment, the virtualization technology is combined with the simulation software to build a network comprehensive experimental platform to realize the network comprehensive practice teaching. Extend and enhance experimental capabilities by building experimental platforms using hardware from the existing labs. Run virtual machines on the server cluster, and install experimental applications and simulators on each virtual machine. As long as the resources of the physical server are sufficient, the virtual machine can be provided with an operating environment that satisfies various applications.

B. Application of simulation software

On the one hand, the simulation software can make up for the damage caused by the frequent insertion and removal of the patch panel interface, thus affecting the experimental effect; on the other hand, the network equipment provided in the simulator can fill the shortage of network equipment, and each student can skillfully configure the network equipment.

Most network simulation software is simulation network equipment. Common simulation software include Boson NetSim, Cisco Packet Tracert, GNS3, eNSP, and so on. The first two simulation software are analog device commands to facilitate the learning of device operation instructions; the

latter two are virtual network devices in the computer and install the corresponding operating system to simulate the behavior of network devices such as real routers and switches.

In the early days of conducting network engineering course experiments, the simulator used was Packet Trace software developed by CISCO. In the experimental teaching, the software can directly establish the network topology by using the drag and drop method on the graphical user interface, and can observe the running process of the network according to the progress and processing of the data packets in the network. This kind of software has a good teaching effect in network experiment teaching, but it also has limitations. Compared with Packet Trace, the advantages of GNS3 and eNSP are as follows.

- GNS3 and eNSP support more parameters and commands in virtual network devices. Packet Trace software covers all of the various network devices associated with Cisco Certified CCNA. Therefore, it is difficult to implement all the functions of a real device, so that it cannot support some parameters and commands by itself.
- GNS3 and eNSP can be associated with real networks. When using Packet Trace, users use related virtual devices and network protocols in a closed environment and are not associated with the real-world environment.

C. Planning of comprehensive experimental content

The main features of network-integrated practice are as follows: (1) Practicality, students can master the theoretical knowledge through practice; (2) Comprehensive, the comprehensive practice includes knowledge content such as network management, structured cabling, network security, and web applications.

Network professional practice teaching mode includes three parts, which is shown in Fig.1. Security configuration throughout from the network design planning, the device configuration to the network management and application.

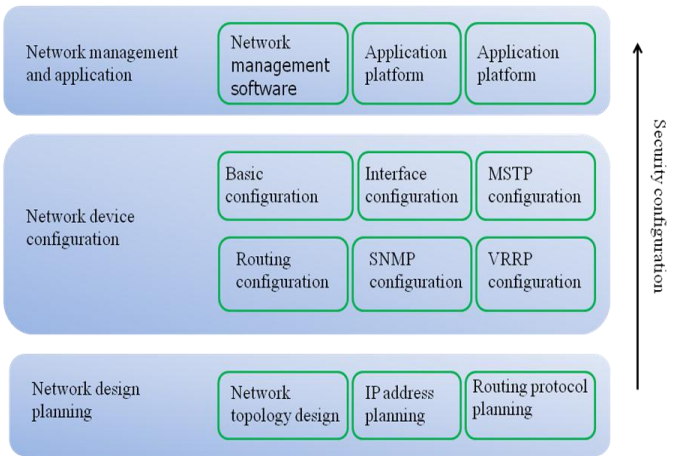

Fig. 1. Network professional practice teaching mode.

Through the network comprehensive experimental method, students can have a comprehensive understanding and understanding of the network. Students can move from the network design planning stage to the network equipment configuration stage to implement the network construction. After completing the networking, network application experiments can be launched through the network management software or application. During this process, the security configuration runs through.

Comprehensive practice focuses on the flexible combination of experimental content and experimental environment. Emphasis is placed on combining the three experiments to strengthen the weight of independent experiments, which is hierarchical, structural and connected in the practice links. Gradient teaching mode of practice teaching in network engineering specialty is shown in Fig.2.

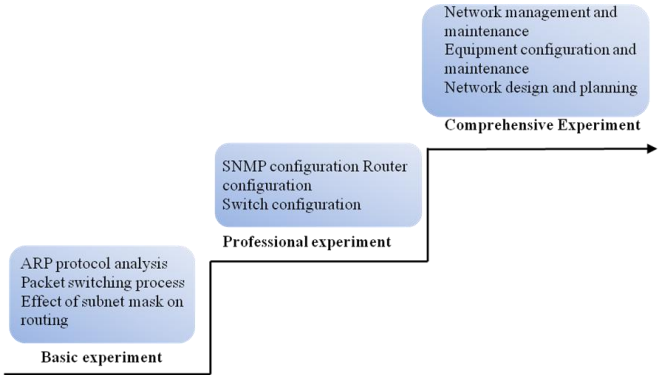

Fig. 2. Gradient teaching mode of practice teaching in the network engineering specialty.

In the experimental phase of the network design planning, the drawing and annotation tools in the simulator are used to visually present the structure of the created network topology. It can complete the network practice of IP address planning, routing protocol planning and so on. The eNSP and GNS3 software have the highest simulation capability to perform many experiments related to router switch configuration using the operating system in real devices. In the network equipment configuration and maintenance phase, the simulators eNSP and GNS3 provide a large number of network devices with a large number of types, which can complete large-scale networking requirements in the simulator. It can also perform network security experiment practices such as firewall configuration and testing, and access control design.

Interconnection between network devices of different vendors can be realized by configuring in the simulator. First, routers and cloud devices would be added in GNS3 and connect to the virtual NIC. Then, connect the two devices with cable. Similar operations were used to add switches and cloud devices in eNSP and connect to virtual network cards. Connect the two devices with cable and bind the switch interface to the virtual NIC interface through the configuration option on the switch.

GNS3 and eNSP have been connected with the above configuration. In this environment, it is possible to simulate network scenarios where devices of different network vendors

coexist, creating a more realistic and ideal analog network environment. Through the configuration of Huawei or Cisco network equipment, the guiding ideology of network equipment configuration of different network vendors in the network is compared, and the students' practical resilience is cultivated to meet the deeper requirements of network technology learning.

It is also possible to interconnect the virtual device with the actual network by bridging with the local network card, and the connected software device function can be applied to the simulator network. Configure the network device on the eNsp, set up the network, and enable the eSight network management software on the local host to perform SNMP configuration on the network devices in the simulator. The network device in the simulator can be used as a network element device to monitor network element devices, and at the same time, manage and maintain the network.

IV. CONCLUSION

By introducing virtualization technology and simulation software into the experimental teaching of network courses, on the one hand, the resources needed for ordinary simulation experiments are saved, and the limitations of hardware are removed. The reliability and flexibility of the experimental environment are improved. On the other hand, the experimental platform based on this scheme expands the experimental environment and improves the teaching effect finally.

ACKNOWLEDGMENT

The authors acknowledge the financial support from Research project on teaching reform of education in Shaanxi province (Grant No. 17JY015); Characteristic disciplines in Education department of Shaanxi province(Grant No. 080901); Research project on teaching reform of Xi 'an Technological University(Grant No. 18JGZ01); Research project on teaching reform of Xi 'an Technological University(Grant No. 18JGZ03) ; The Industrial research project of Science and Technology Department of Shaanxi Province(Grant No. 2016KTZDGY4-09); Laboratory fund of Xi 'an Technological University (GSYSJ2017007)

REFERENCES

[1] Wang Zhen, Chen Weiwei, Wu Yongfen, "Design and Implementation of the Computer Experimental Teaching Platform Based on Virtualization Technology," Software Engineering, 2017, 20(07):5-8.

[2] Shi Yan, "Application of GNS3 Research in Computer Network Technology," Digital Technology and Application, 2015(7):92.

[3] Yan Ge, "A Network Architecture of Laboratory based on Cloud Computing, " Journal of Zhangzhou Normal University(Natural Science), 2011, 24(3):25-29.

[4] Zhou Weilin, Yang Yuan, Xu Mingwei, "Network Function Virtualization Technology Research," Journal of Computer Research and Development,2018,55(04):675-688.

[5] Zhu Licai, Geng Zhen, Huang Jinjin, "Design and implementation of computer network experimental teaching in a network engineering specialty," Experimental Technology and Management, 2017,34(5):161-164.

[6] Bian Shengqin, Wang Jianping, Cui Xiaolong, "Construction of Computer Network Laboratory and Reform of Experimental Teaching," Research and Exploration in Laboratory, 2017, 36(2):259-262.

[7] Guo Qing, Hai Ying, Zhao Zhonghua, "Exploration on the Reform of the Experimental Teaching Evaluation Model Based on the Cultivation of Innovative Practice Ability," Research and Exploration in Laboratory, 2017,36(7):175-177.

[8] Liu Laiyu, Chen Chen, Dong Yan, "Exploration and Practice on Virtual Simulation Experimental Teaching to Boost Innovation and Entrepreneurship Education," Experimental Technology and Management, 2017,34(12):128-131.

[9] Liu Huaying, "On the Construction of Virtual Simulation Experiment Teaching Center, " Experiment Science and Technology, 2018(03).

[10] Yin Long, Zhang Li, Zhao Li, Lu Xiaojun, "Study on the deep integration of virtual simulation technology with innovative and entrepreneurial education," Experimental Technology and Management, 2018(04)