Development of a Computer Networking Laboratory

by

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Abstract

The department of Engineering Technology at New Mexico State University is currently developing an advanced computer networking laboratory which reflects current technologies and methodologies in use by industry. The department has developed this advanced laboratory with advice from NMSUs Computing and Networking and an ad hoc group of industry advisors. This paper presents findings from the class and the laboratory experiences. The laboratory experiences range from CAT5 installation and testing to punchdown blocks to patch panels, hubs and switches, voice over ethernet telephone service to wireless networking, bridges, and routers to network architecture and Windows NT server administration.

Introduction

The original concept for the networking laboratory was developed in 1994 with the cooperation NMSU's Computing and Networking group. Both the department of Engineering Technology and NMSU's Networking group recognized that the merger of data communications, video, and audio where not just a vision but would soon be a reality. This development would change communications. It was necessary for the department to develop a plan to prepare the department's networking laboratory for network communications in the 21st century. Figure 1 graphically summarizes the plan or vision for the networking laboratory.

Making the Laboratory a Reality

In the fall of 1998, the department of Engineering Technology received funding for the development of a Security Technology program at New Mexico State University. The funding, provided through the Federal Bureau of Investigation, included support for the department to develop a Computer Networking Laboratory to support the program's Information Security Technology program. Specifically, the funding for the networking lab was earmarked to provide the following:

- Computer Equipment Support
- Networking Test Equipment
- Networking Hardware and Supplies
- Supporting Software
- Construction of Networking Laboratory space
- Academic Module Development

Figure 1 A bock diagram view of the proposed computer networking lab.

Defining the Curriculum Objectives of the Laboratory

An ad hoc group of industrial advisors helped to further plan the development of the laboratory facility. Informal discussions with the advisors helped the department to identify essential technologies and knowledge needed by graduates of our program to succeed in completing for high-tech jobs and continued growth and success on the job. The ad hoc advisors identified the following:

1. The lecture material must reflect industry practices and methodologies
2. The students must learn the capabilities and limitations of existing technologies in a laboratory setting not a textbook.
3. Students must apply their knowledge in a manner which reflects industry methodologies
4. Students must develop a strong theoretical base so that he/she can easily adapt to new innovations in computer networking

Responding to the Defined Curriculum Objectives

The following is a discussion over the current curriculum being used in the computer networking class and laboratory. Each of the recommendations by the ad hoc advisory group have been addressed in either the lecture or the laboratory. The response to each recommendation is discussed.

1. The lecture material must reflect industry practices and methodologies

In 1998, the textbook for the course was changed to **MCSE Networking Essentials**, a study guide for the Microsoft Certified Systems Engineer examination. In 2000, the

course material will be changed to **Cisco's Networking Academies** training. The Cisco training to be used is the first step in the process for a graduate to become a **CNE (Cisco Network Engineer)** which is considered to be the best networking certification. The use of conventional networking textbooks was abandoned due to the problems with outdated methodologies.

2. **The students must learn the capabilities and limitations of existing technologies in a laboratory setting not a textbook.** The students are required to build a computer network from the ground up. This includes the following laboratory exercises:

    - installing the CAT5 cables, RJ-45 connectors and faceplates followed by testing the cable installation using industry accepted test equipment and procedures
    - wiring the connections in a networking closet, including the patch panel.
    - installation of the Hubs and Switches
    - setting the protocol switches and configuration switches on the computers
    - experiment with verifying the network installation using Ping and other network troubleshooting techniques
    - experiment with set-up and administration of a wireless computer network
    - experiment with a Voice over IP telephony system
    - install an NT server based network

2. Students must apply their knowledge in a manner which reflects industry methodologies

The students are expected develop a full understanding of each technology they experiment with. This includes the requirement that each student set-up a network installation. In addition, the student is required to provide a weekly report on the current state of their network. In some instances, the students were given a new technology, such as a wireless network or a ethernet telephone system, and were asked to report on its capabilities and limitations. The report was prepared in a memo form to a boss that might or might not have a good technical understanding. The report also had to be short, to the point, and accurate. The students had to keep the "boss" advised to the status of their progress. The course included presentations by industry experts over advanced networking concepts

3. Students must develop a strong theoretical base so that he/she can easily adapt to new innovations

The lecture material was designed to provide the student with a solid understanding of the

theory behind the networking technologies. The OSI 7-layer model, the foundation for exchanging information via computer networks, was explored. The Physical, Data Link, Network, and Transport layers were examined in great detail. The students developed a good understanding of Ethernet and TCP/IP and found that they could easily understanding alternative protocols such as ATM, UDP, IPX, and others

Assessing the Success

Assessment of the classes progress was provided via verbal questions asked of the students in an interview manner. Many of the questions were provided by the industry ad hoc advisors. An informal measure of accurate response was used to determine the student's current understanding. A summary of the results of the assessment is provided in Table 1.

WEEK	Positive Responses to Question
1	≈ 20% (4 students)
9	≈ 50% (9 students)
15	≈ 77% (14 students)

Population size = 18

In week 1 only four students had a good base understanding of computer networking. By week 9, approximately 9 students were gaining a good understanding. At the end of the semester (week 15) about 14 students understood the basic and advanced concepts of computer networking.

The laboratory exercises and the student installed computer networks were reviewed by computer networking experts and the results were favorable. Several of the ad hoc advisors stated that they wished they had a class like this when they were learning computer networking.

Conclusion

The Fall 1999 semester for the ET 377 Computer Networking class was a success. The students constructed a computer network that demonstrated an excellent understanding of networking technologies. They were able to successfully interface with state of the art networking technologies and report their progress in an intelligent manner. The final exam included several "What are the issues" type questions which the students were able to answer very well. The response from industry has been favorable and should enable us to continue improving the laboratory and class.