AC 2009-2359: IMPLEMENTATION OF A NEW COMMUNICATION LABORATORY

Shuju Wu, Southeast Missouri State University

Xiaobing Hou, Southeast Missouri State University

Ragu Athinarayanan, Southeast Missouri State University

Charlie Wallgren, Southeast Missouri State University

© American Society for Engineering Education, 2009

Implementation of an Integrated Undergraduate Telecommunications Laboratory

Abstract

This paper focuses on the implementation of the integrated laboratory using identified equipments and elaborate how it can provide students an integrated network environment where traditional telephone network, VoIP, data network and backbone fiber optic network coexist with data, voice and video traffic. Our preliminary study indicates that our students show much more interest in working in such a lab environment. No matter what individual course they are taking, the students can always see a big picture of the network, which shows great resemblance of the real world Internet and applications. In the meanwhile, more research work, such as the topics require a mixed type network and traffic, can be conducted conveniently.

1. Introduction

The Telecommunications and Computer Networking (TCN) program at Southeast Missouri State University aims to provide students a balanced education between theory and technical expertise, considering that standard engineering courses focus on the technical aspects, but under-address the challenges in system design and configuration, maintenance and troubleshooting, and pure technical schools do not equip students with enough theoretical background. The TCN curriculum covers digital circuit design, telecommunications and fiber optics, computer networking, network routing and switching, network design and maintenance, system analysis and design, wireless communications and networks, server techniques, and network security, IP telephony and network management.

Originally, the TCN option had two laboratories including a general networking lab and a network security lab. The functions, application, and limitations of the current laboratories in the TCN curriculum have been identified in our previous work[1], and a framework of an integrated laboratory was proposed as well. The main concerns with the previous laboratory setup are twofold: one is that even though the laboratories offer versatile experiments, the activities are mostly confined in specific subjects, and students are not put in a complete telecommunications system environment where they can integrate knowledge from different TCN courses; the other is that how to build an integrated lab featuring LANs, WANs, voice, data, wire line, wireless and security technologies based on the current available lab resources.

Recently, the department received donations from Falcon Communications Inc.[3] and Time Warner Telecom[4] including SONET OC-3 add/drop multiplexers, a Nortel DMS-10 switching system, an IP/PBX and IP phones. Together with the equipment in the current two networking laboratories, we are developing an integrated advanced TCN laboratory. A similar SONET setup is also available at the Wireless and Optical Networking Laboratory at the College of Technology at the University of Houston[2], except that our purposes focus more on teaching outcome than doing pure research. This paper will present the implementation of the laboratory and how traditional telephone network, VOIP, data network and backbone fiber optic network coexist with data, voice and video traffic in the lab environment.

2. Implementation of the Integrated Telecommunications Laboratory

In [1], we presented a prototype of the integrated laboratory which is presented in Figure 1 here. Figure 2 shows our current implementation. In this section, we will present the implementation of each network segment in Figure 2, namely SONET Ring, Network Security, IP Telephony, PSTN CO (Public Switched Telephone Network Central Office), WLAN (Wireless Local Area Network), and the Wired Data Network. All the network segments are located in Networking Lab 2 in Room 210, except the Wired Data Network which is located in Networking Lab 1 in Room 218.

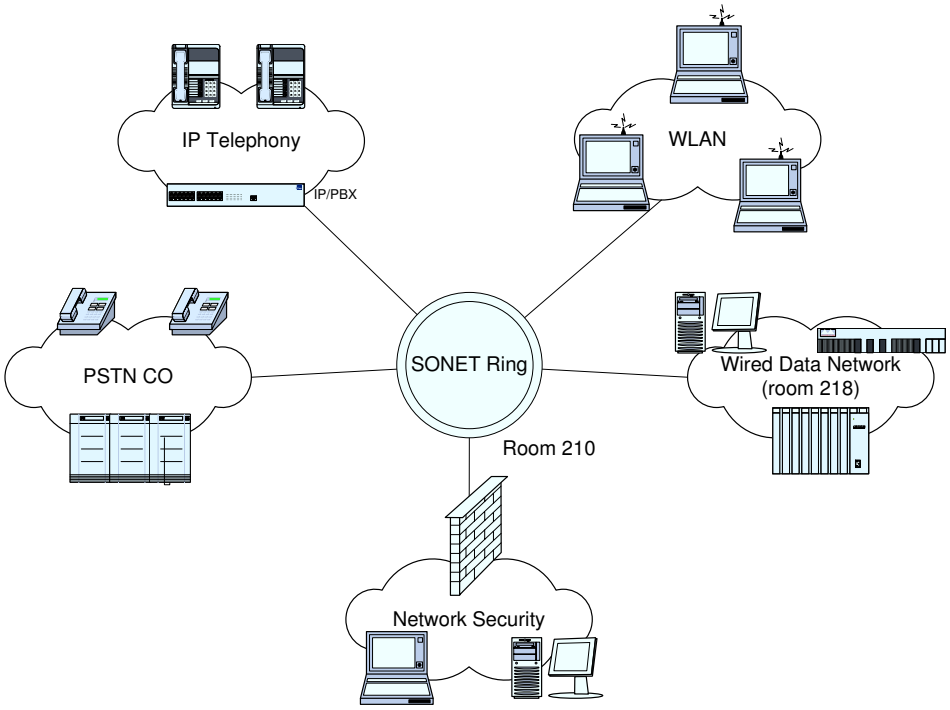

Figure 1 Prototype of the Integrated Advanced TCN Laboratory

2.1 SONET Ring

The backbone networks that interconnect all the other network segments consist of three Positron OSIRIS SONET OC-3 add/drop multiplexers. The network connections provided by the multiplexers include OC-3, DS-3, DS-1, and Ethernet. In Figure 2, the SONET equipments are connected through OC-3 fiber optic connections. DS-1 connections are used to connect the IP Telephony segment, the PSTN segment and the Wired Data Network segment in room 218 to the backbone network. Ethernet connections are used to connect the Network Security segment and the WLAN segment. These options enable students to see, configure, maintain and troubleshoot various local area and wide area connections, and to apply theory knowledge to real world application scenarios in different TCN courses.

2.2 Network Security Segment

The network security segments allow students to build and simulate enterprise-like networks that incorporate intranet, extranet, DMZ (Demilitarized Zone), and VPN (Virtual Private Network), etc., as shown in Figure 2. This part only shows a simplified network topology for one of the network security lab topologies.

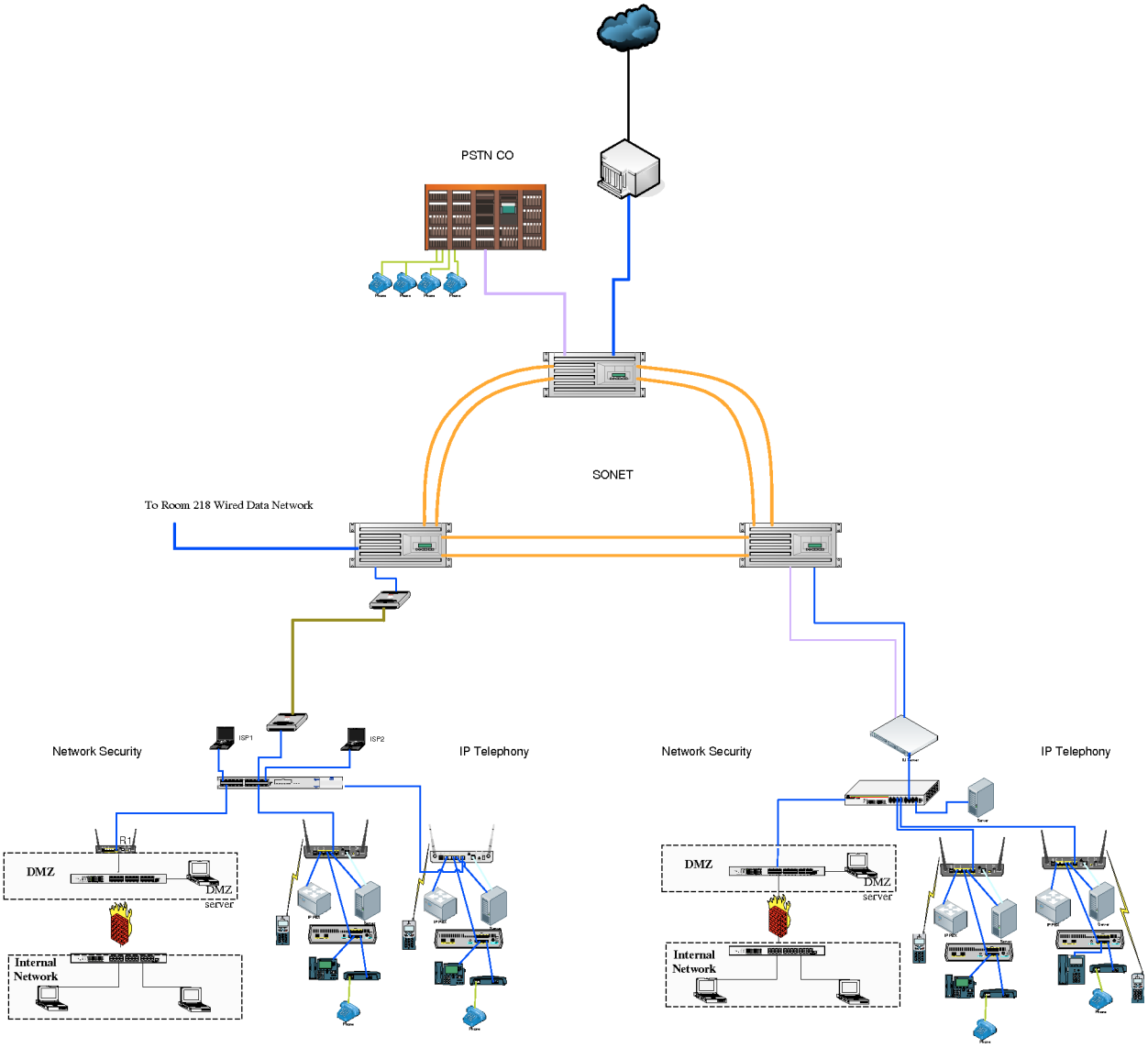

Figure 2 Implementation of the Integrated Advanced TCN Laboratory

Note that due to space limitation, Figure 2 shows two network security networks, the physical implementation includes four networks. With such a set up, lab activities are performed over local area network and wide area network to address topics such as vulnerability detection, intrusion detection, security policies, firewall configuration, access control, authentication, encryption and remote access.

2.3 IP Telephony segment

IP Telephony is a newly-developed course that is first being offered in Spring 2009. The course covers the core concepts of designing and developing IP telephony networks, while providing opportunities for practical application and hands-on experience. This class takes the advantage of our integrated lab environment and delivers Voice over IP (VoIP) telephony service between IP phones, data network (with softphones), and PSTN-like traditional telephone network (in progress). The students will enjoy configuring various hardwares (IP phones, wireless IP phones, IP/PBX, routers and switchs, as shown in Figure 2) and software (SIP servers and network servers such as DHCP and DNS, etc.). More importantly, the integrated lab offers students the experience of service provisioning in a more realistic network environment.

2.4 PSTN CO segment

The traditional PSTN-like service in Figure 2 is provided by a Nortel DMS-10 carrier class switching system. Although today much attention has been given to IP Telephony, traditional telephone service will continue to play its role for a long time until IP Telephony can be secure, economical, and reliable enough to outplace it.

The DMS-10 central office setup is also very beneficial to demonstrate voice communication theories and technologies such as multiplexing. The lab DMS-10 configuration also includes two loop-backed T1 trunks, thus enabling the simulation of long distance voice communications. Currently, we are working on interconnecting this segment to the backbone network through T1 connections, and after that, the traditional telephone network will be fully integrated with the IP telephony segment.

Students working on this segment gain hands-on experience such as telephone wiring, central office maintenance such as phone number allocation, service configuration (voice mail box, call forwarding, 3-party call conferencing, etc.), and long-distance trunk configuration,

2.5 WLAN segment

Wireless LAN is an integral part of the lab. Integrated service routers that provide both wired connections and wireless access capability are used. The students in wireless networking classes (undergraduate and graduate) perform laboratory experiments beyond the range of the integrated telecommunications laboratory, considering that lab and project activities involve the wireless LANs covering buildings or even the entire campus.

2.6 Wired Data Network segment (Room 218)

This segment was the first TCN networking lab. It features fifteen computer stations, each equipped with two computers. Other networking devices include fifteen Cisco routers, nine Cisco switches and one 3com switch. The devices are used by the students of several TCN courses to set up, configure and troubleshoot computer networks and related services (e.g., routing, switching, networking services configuration such as DHCP, DNS, WWW, FTP, SMTP in both Windows and Linux operating systems).

Currently, this networking lab is managed under a lab domain by a dedicated server with Microsoft Windows Server 2003. This laboratory will be integrated to the backbone laboratory network through a DS1/DS3 link. In the near future, we plan to add a Gigabit Ethernet connection between Room 218 and Room 210 when supporting hardware equipments are available on both sides.

2.7 Administration and Management

In addition to the above components, the integrated laboratory requires dedicated server and software tools to perform network administration and management. Currently, Windows server 2003, Linux, VUE craft tool for Positron OSIRIOS are used to manage the lab networks.

3. Preliminary Study

Since this is the first semester (Spring 2009) of having the integrated telecommunications laboratory, evaluations using posttests, comments and suggestions from student have not been performed. However, students have actively contributed to the development. In Fall 2008, we introduced the lab development to students from different TCN courses and they all expressed excitement and looked forward to utilizing the new lab.

4. Conclusions and Future Works

In this paper, we describe the implementation of the integrated undergraduate telecommunications laboratory at Southeast Missouri State University. The new laboratory integrates traditional telephone network, VOIP, data network and backbone fiber optic network where data, voice and video traffic (to be added in) will coexist. Our goal for the lab is to allow students to see an integrated telecommunication system, rather than many isolated parts. The hands-on experiences obtained through such a complete system will also enhance the theory knowledge from our integrated curriculum, no matter what topic they are learning.

Following the testing, we will interconnect the different networks. Additionally, we will develop new courses and lab activities to fully utilize the integrated laboratory resources. We also plan to evaluate how this new integrated laboratory affects teaching and the learning experience. Finally, we will continue to expand the integrated curriculum and laboratory, such as setting up a student-operated Network Operations Center (NOC) for the campus or even the local region and adding wireless cellular communications to the laboratory.

Bibliography

1. S. Wu, R. Athinarayanan, X. Hou, “Integrated Curriculum and Laboratory Development of an Undergraduate Telecommunications and Computer Networking Program,” Proceeding of ASEE Annual Conference and Exposition, Pittsburgh, PA 2008.
2. http://www.tech.uh.edu/WON/index.php
3. Falcon Communications Inc., http://www.falconcommunications.com/
4. Time Warner Telecom, http://www.twtelecom.com/