Design of a Distance Learning Course
in
Data Communications and Networking

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Abstract

This paper presents teaching activities of a distance-learning course in Networking and Data Communications via a combination of live TV lectures, hands-on and web labs, lectures posted on the web, and email. All course materials including lecture and labs are described. A web-based information delivery system that is used for the course, is also described.

I. Introduction

With today's sophisticated education system, we must have the ability to add distance delivery courses to accommodate many different students. Full time, part time, students with mobile job assignments, and continuing professional development students are all critical to the success of an educational institution such as Indiana University-Purdue University Fort Wayne (IPFW). The Electrical and Computer Engineering Technology (ECET) department is a leader in delivering courses live on the IPFW TV channel.

In a world of rapid change, business and industries are relying more and more on distributed computing and networked computing through the Internet (also known as the World Wide Web), e-mail, Intranets, local area networks, wide area networks, client/server applications, etc. The Internet has evolved rapidly from its early use as a way to transfer files between systems and to send electronic mail into its present form as an interactive and multimedia environment. Many engineers and IT professionals want to understand the concepts and mechanisms of the fastest growing technologies in our culture today, namely, networking and communications technologies. It is therefore essential for us to provide students with this new knowledge that might help their careers and prepare them for jobs in these challenging areas.

The course entitled CPET/EET 355 Introduction to Data Communications introduces students to data communication and networking principles, protocols, new technologies and practices. CPET/EET 355 is required for the Computer Engineering Technology option of the Electrical Engineering Technology degree program offered at IPFW. The goal of this course is to examine the current status and future direction of technologies related to data communication, communication architecture and protocols, local area networks, and wide area networks. The course as a whole is divided into two distinct parts: a live lecture in a TV studio with a TV videotape option, and a laboratory section.

The media technologies for delivering this course in the spring of 2001 will support both synchronous and asynchronous learning, and a hands-on laboratory via the Web. It is expected that this course will enhance our ability to serve nontraditional students and enable distance learners to work on the simulated labs without coming to our physical lab. We also expect to reach other prospective students in other states and around the globe.

II. Course Description

Traditionally, this course is taught with a combination of classroom lecturing and two-hours of lab per week. It was offered in the spring of 1999 via the college TV channel with a videotape option and Web supplements for the first time. It contained three hours of lecture per week with some students in the TV studio, other students watching on TV and other students watching videotapes. In addition, a two-hour lab is required for each student. All students are expected to have access to a PC with an Internet service connection. Students are encouraged to use Email for communications, and turn-in homework and lab reports. Tests for regular classroom students are conducted in the TV studio classroom. Other students who enrolled in the TV sections are expected to schedule their exams to be proctored by the Placement and Testing Office staffs at IPFW.

We, at IPFW, are trying to deliver courses to distance learners, part-time students who work full time, and those students who have class time conflicts. However, all students who signed up for the technical TV courses with lab component are required to come to IPFW for labs. Due to the nature of the course, it is possible for us to deliver this course via a combination of TV lectures and about 70 percent of the hands-on lab through the Web. This arrangement will minimize the need to use the computer hardware installed in the ECET department lab. The TV lecture portion allows students who have time conflicts to watch videotapes off the air. The hands-on lab via the Web will be a cost effective solution to enable us to offer high-technology courses with lab components without extensive resources. Through a combination of TV lectures, course information posting on Web, and hands-on labs via the Web and Internet, we can assist students to participate in the class instruction and learning activities at a time that is convenient for them.

The reasons for choosing the delivery method as a combination of TV lecture and a major portion of the hands-on labs via the Web are discussed below:

- Greater Scheduling Flexibility: with the availability of hands-on labs via the Internet and Web, students would be able to receive a complete technical distance course from the ECET department without coming to IPFW.
- Cost Effective: we recognize this delivery method is cost effective for offering technical courses with a lab component, because it requires only one set of the equipment while traditional labs require multiple sets of the same equipment.
- Reach Out to Broader Audiences: it not only assists students who need flexible schedules but also allows us to reach out to more audiences that are looking for high-tech courses for their professional development or continuing education.

III. Course Materials on the Web

All the materials including the course outline, lecture notes, labs, homework assignments, supplementary handouts are prepared with Microsoft Office tools for Web posting. We started by creating lecture notes with Microsoft Word and then converting them to Microsoft PowerPoint files. Finally, these files are saved as HTML files and uploaded to a Web server for Web presentation. We use Microsoft FrontPage for creating our web pages and linking all the presentation files. The presentation materials can be viewed with the two most popular Web browsers, namely, Netscape or Internet Explorer Web browsers. The web site for the course can be found at http://etcs.ipfw.edu/~lin.
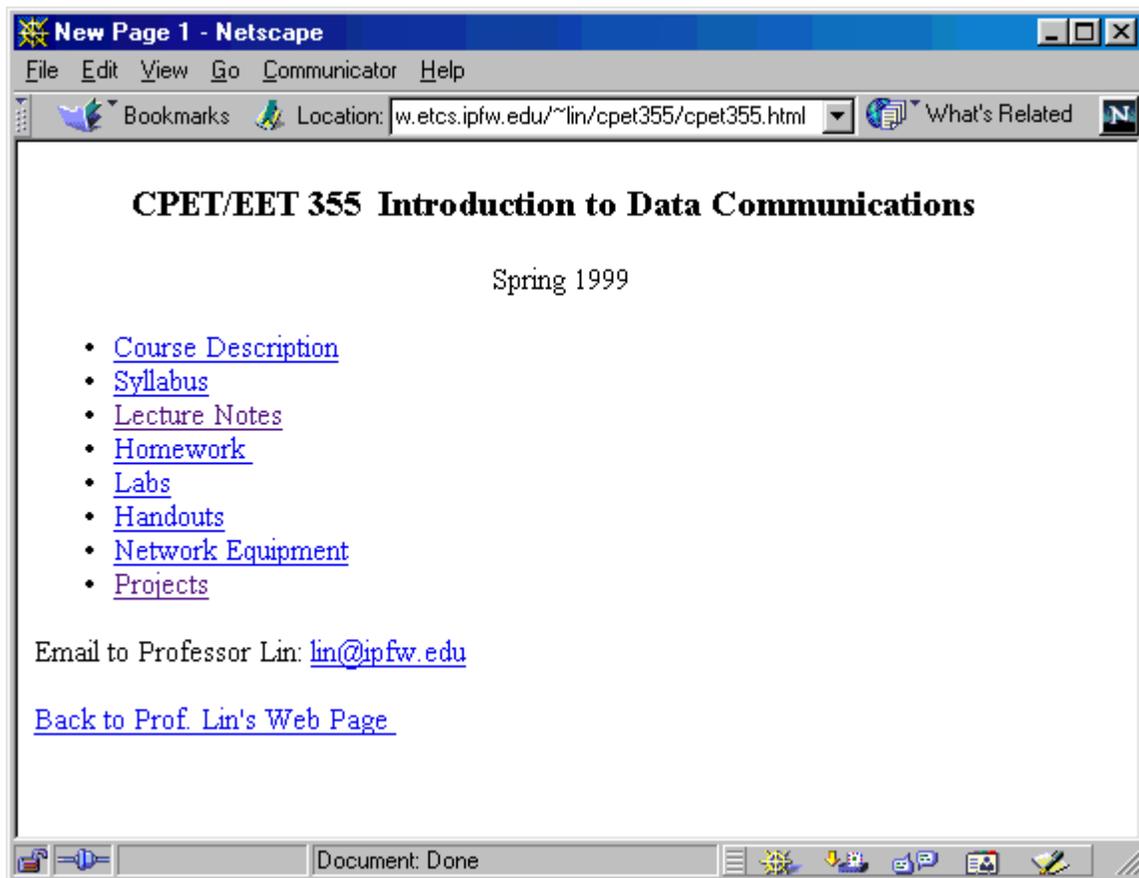
Figure 1. A Snap Shot of the Course Web Site

The course materials are divided into sixteen modules and are covered in approximately 40 contact hours. Each set of lecture notes, in Microsoft PowerPoint file format, is prepared and posted before the class lecture. Students can download the files and print them as slides to help them write down lecture details. They can also view the presentation slides using a Web browser through an Internet connection at home, work, or at IPFW. The 16 modules of lecture notes containing about 450 slides are prepared and posted on the Web, as shown in Figure 2:
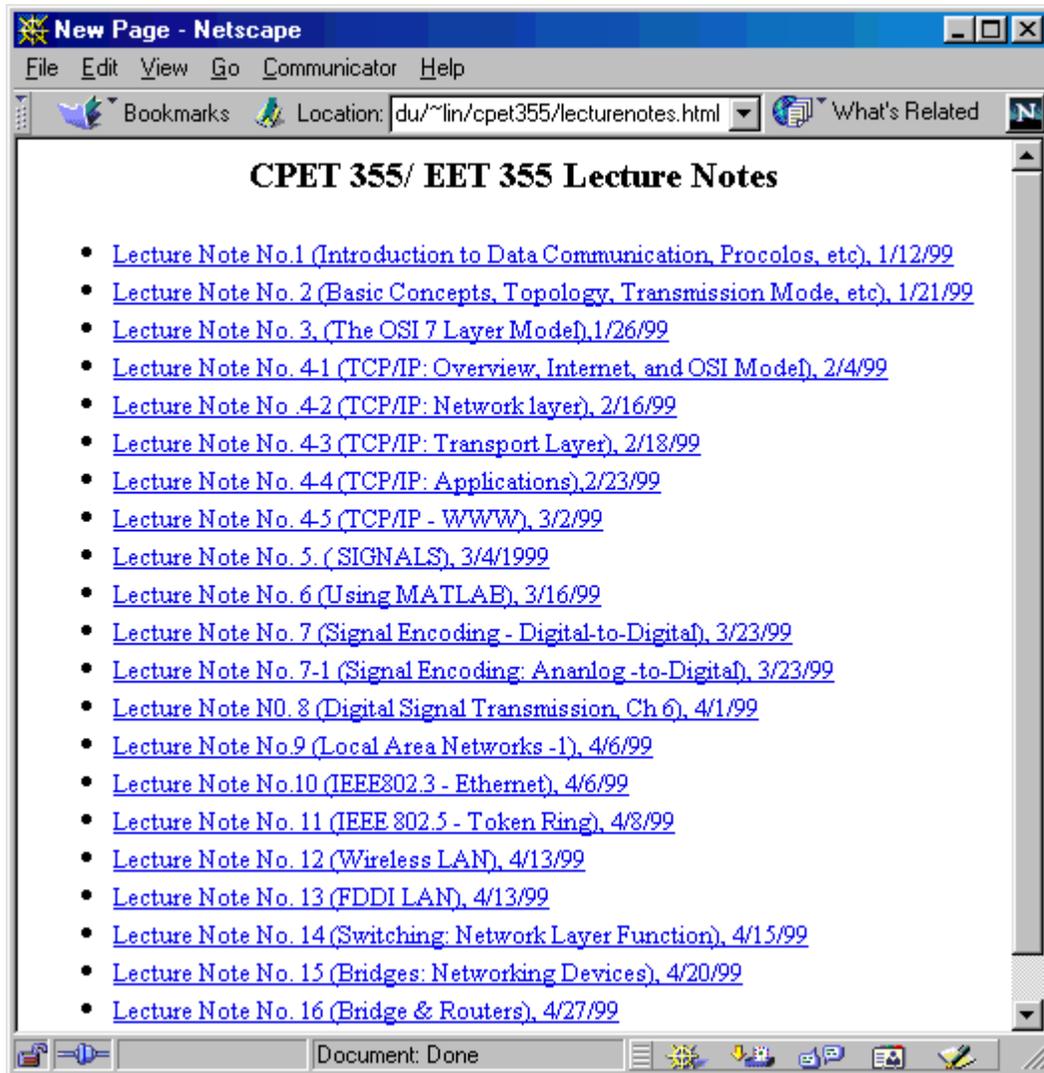

Figure 2. Lecture Notes on the Web

IV. Laboratory Experiments

Before the Internet was available for general use, the laboratory experiments designed for this course (late 1980s) were focused on communications between PC and microcomputer. Typical labs used in the course were:
- Transmission Media and Bandwidth

- NRZ-L and NRZ-M Code Generation
- Asynchronous Communications between two SDK-85 Microcomputers
- PC Asynchronous Communication Port
- PC-to-PC communications, and
- Local Area Network Familiarization

The most recent laboratory experiments were designed to cover such concepts as PC-to-PC communications for file transfers and direct resource sharing, network operating systems and their applications, HyperText Markup Language (HTML) and HyperText Transfer Protocol (HTTP), TCP/IP networking and monitoring, and local area networks and servers.

Our laboratory environment for the support of instruction in the course mainly consists of the following computers which are linked as shown in Figure 3:
- A Web server
- A Microsoft NT server
- A PC with LINUX operating system
- A PC with Solaris operating system
- 10-BaseT Hub and RJ 45 wiring
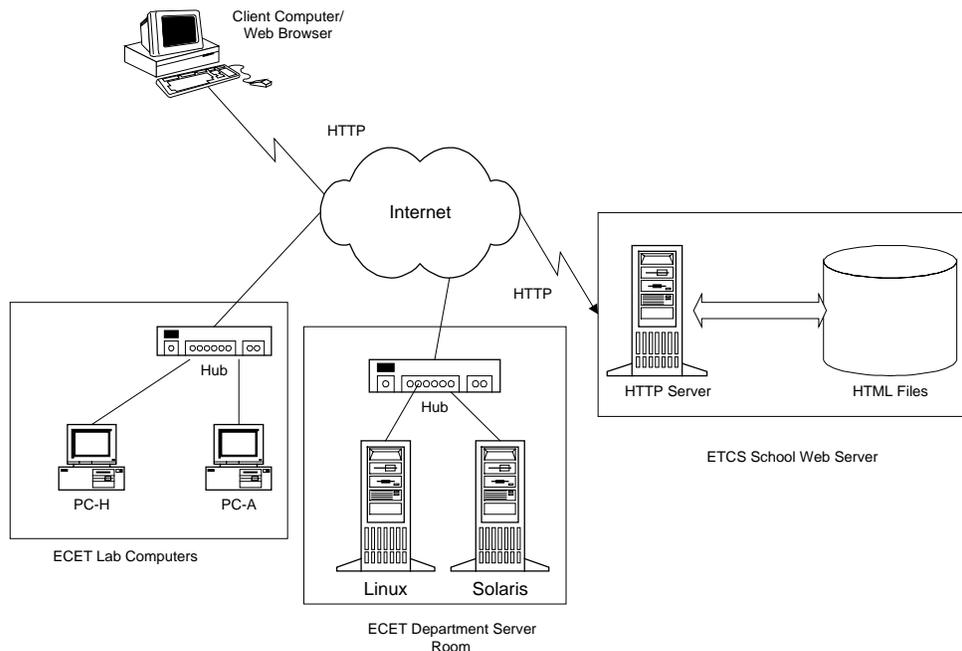- 8 PCs with network interface cards

Figure 3. Networking Lab Environment

Lab1 – PC-To-PC Direct Connection Network (performed in the ECET lab):
   This laboratory is designed to familiarize the student with the basics of peer-to-peer networking through direct serial and parallel cable connection. Main activities of this lab include:
- Allowing remote users to access local folders and printers

- PC-to-PC direct connection service through serial port
- PC-to-PC direct connection service through parallel port

Lab 2 – Introduction to Web Publishing with HTML Language (can be a Web lab):
   This laboratory assumes that the students have some experience with a text editor, and Web browsers. The HTTP architecture, HTML language syntax, and web page layout are covered briefly through lecture notes posted on the course web page. The lab requires the student to design a web page, view it at the local drive using commercial web browsers such as Netscape and Internet Explorer, and then post it on a Web server.

Lab 3 – Exploring UNIX and LINUX Operating System (can be a Web lab):
   UNIX system has been a favorite development system for networks since the mid 1970s. Today, few UNIX systems exist without some network connection. This lab allows students to learn about the UNIX system through the following activities:
- Login and logout
- Telnet applications
- Understand some useful commands: date, who, who am i, echo
- Creating and examining files: cat, ls
- Sorting the contents of files: sort
- Copy files, rename files, remove files, working with directories
- File systems

Lab 4 - TCP/IP Network Monitoring and Management (can be a Web lab):
   This lab involves some TCP/IP network management tasks including traffic monitoring, troubleshooting network access, adding new hosts (also known as nodes or stations) to the network, mounting remote disks and exporting local disks with Network File System (NFS). Large networks probably need a commercial network analyzer, or at least a hardware tester such as a time domain reflectometer (TDR). But many smaller networks can get by with publicly available free tools. A list of diagnostic service functions for helping network monitoring, management, and troubleshooting as shown below are discussed:
- Testing the network connection: ping command (for both Windows and UNIX)
- Troubleshooting Network Access using: winipcfg command (Windows), ifconfig (UNIX), netstat, and arp command
- Configure the network interface: winipcfg command (Windows), and ifconfig (UNIX)
- Network monitoring: netstat command (for both Windows and UNIX)
- Display active network connections: netstat command (for both Windows and UNIX)
- Display interface statistics: netstat command (for both Windows and UNIX)
- Display active routes of connections: route command (for both Windows and UNIX)
- Manipulate static routing tables: route command (for both Windows and UNIX)
- Tracing routes: tracert command (Windows), traceroute command (UNIX)

Main activities of the lab are
- Testing the network connections using ping command
- Configure the network interface of a PC with winipcfg command
- Display active network connections and network interface statistics
- Display routing tables
- Manipulate routing tables
- Tracing routes

Lab 5 - Signal Generation Using MATLAB (can be a Web lab):
    Students are introduced to MATLAB a simulation tool for generating signals that we discussed in the class.
- Complex numbers and signal representations
- Signal transmission line
- Signals and Harmonics

Lab 6 – Setup 10-BaseT Network:
    How to make up a 10BaseT cable is one of the most common problems for a network engineer/technician. The Ethernet 10BaseT wiring specification combines an RJ-45 connector (a small plastic connector) for direct connection to an unshielded twisted-pair (UTP) network segment. The 10BaseT is compliant with IEEE 802.3 specification. The 802.3 standard states that the maximum length of a 10BaseT link segment is 100 meters or 328 feet of UTP wiring. The cable connectors and jacks that are most commonly used with the Ethernet 10BaseT UTP cables are RJ45. The RJ simply means Registered Jack and the 45 designation specifies the pin numbering scheme. The connector is attached to the cable and the jack is the device that the connector plugs into, whether it is in the wall, the network interface card in the computer, or the hub. The lab activities include
- Cable planning
- Making cables for Ethernet 10BaseT networks
- Making cables for connecting two PCs

Lab 7- Understanding Network Server and LAN (performed in the ECET lab):
    An Ethernet local area network set up for this lab is prepared. In this lab, a student is both a system administrator and a PC client user. It allows students to practice network operating system commands and Windows NT system administrative tools for adding new computers and new user accounts. This lab familiarizes students with some tasks performed by a network system administrator such as:
- Setup Windows 95/98 PCs to login to the Windows NT server
- Adding new clients from Windows NT server
- Add new user account (from NT server)
- Using network client commands

V. Summary

In this paper, we outlined the course materials and laboratory experiments associated with a networking and data communications course. This course requires constant

updating of its course contents and labs. The lecture portion of the course was delivered through a live TV lecture and a majority of the labs can be performed via the Web. Some interesting comments from student evaluation on the question "What did you like most about this course?" are: "Interesting topics", " Subject matter - very applicable," "Network: as far as I wanted to know being taped," "hands on networking experience," "Making a web page," "Provided a good understanding of networks + networking class notes available on Web was a great help," "The professor has given good material in all lectures," and "The flexibility of taking it on TV."

By tailoring the presentation of the course material to student's needs, the authors believe students learned more efficiently and more effectively. Students who would not ordinarily have taken the course due to work schedules were able to pursue knowledge, a certificate or a degree.

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Lin is Associate Professor and Chair of Electrical and Computer Technology Department of Indiana University - Purdue University Fort Wayne. He has been with Purdue University since 1985. He is a registered Professional Engineer in Electrical Engineering at State of California and at the State of Indiana. Previously, he taught at Engineering and Technology Department of Dutchess Community College (NY) for three years (from 1982-1985), at Electrical Engineering Department of National Taipei Institute of Technology for two years, and worked in industry for 8 years. Lin is a Senior member of IEEE and was the Chairman of the Manufacturing Systems Development and Application Department of IEEE-Industry Applications Society from January 1998 to December 1999. Lin's current interests include distributed intelligent control of embedded real-time system, and sensors in industrial control applications.

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Hal taught Electrical Engineering for 3 years at the U.S. naval Academy and after retirement from the Marine Corps as a Lieutenant Colonel, chose to continue teaching. He received his PE license in Indiana in 1988 and his PhD in Engineering (EE) in 1993. His research area is servo systems and he has consulted and worked for ITT (Aerospace-Communications) on weather satellite servos for the past 8 years. He is currently an Associate Professor in the ECET department at Indiana Purdue University in Fort Wayne, IN, a senior member of IEEE and a program evaluator for IEEE with ten TAC/ABET accreditation visits completed.