

DEVELOPMENT OF AN ENTRY LEVEL COURSE IN LOCAL AREA NETWORKS

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Abstract

An introductory course in local area networks (LANs) for Penn State University at DuBois Campus has been designed. This course is tailored for first and second-year electrical and computer engineering students as well as for students in programs such as electrical engineering technology, management information systems, and business administration. Course topics include computer hardware basics, the hardware compatibility list, network cards and protocols, media, network operating system characteristics and network administration. The course is hands-on oriented with a one-hour lecture two-hour lab per week. The course has been very successful and it has been adapted for a five-day continuing education course.

I. Introduction

It is becoming evident that a good knowledge of networking is critical for success in many kinds of computer-based work. Understanding enough to be able to troubleshoot network problems could become a significant bargaining chip in the job market of the 21st century. Consequently, we have designed an introductory course in local area networks for Penn State University at DuBois Campus. This introductory course in networking is an appropriate selection not only for first- and second-year electrical and computer engineering students but also for students in programs such as electrical engineering technology, management information systems, and business administration. Today most students are comfortable with Windows-based software and have at least some familiarity with e-mail and Internet. With interest as the only pre-requisite, this course is designed to take students from this basic level of comfort and familiarity to a higher level, namely familiarity and comfort with networking concepts and the supporting computer hardware. Beginning with the basics of computer hardware and operating systems, the course builds step by step to the level of network administration. Concepts presented in the course incorporate familiar networking terms such as network protocols, network cards, the hardware compatibility list, and many others. Indeed, familiarity becomes the key to learning at each level. The hands-on lab activities provide an opportunity to test principles discussed in lecture, as well as to find new questions to be considered. By the end of the course students have been introduced to enough definitions and concepts to continue experiments or even expand knowledge of local area networks on the job. To design the course we researched similar courses on the WEB (please see web references at the end of the paper), the A+ certification courses, and

relevant Microsoft handbooks (Windows NT) [1-5]. Overall the response of the students at the end of the semester was very positive. With their input we were also able to develop a 5-day continuing education course with very good results.

II. Development

The course material is divided into four general areas: 1) PC Hardware, 2) Local Area Networks architecture and protocols, 3) Operating Systems, and 4) Windows NT Server Software and Administration. Proceeding through these topics should take the student from a point of just being comfortable putting an expansion card onto the motherboard to being able to proceed on their own, experimenting and learning more about network hardware, software and administration.

As indicated in our introduction, topic choices were guided by the A+ Certification Course for PC technicians, and then further expanded to provide a solid foundation of computer knowledge. Various sources of information were reviewed: computer related Internet sites, software and hardware manuals, and networking texts (Microsoft Windows NT).

III. Scheduling

We require that students taking this course should be familiar with MS-DOS and Windows 95 operating systems. When looking at the outline for this course, it was decided to adapt it for a 2-credit class that meets two days per week. The first class of each week is a 50-minute lecture session while the second is a 110-minute laboratory session. The semester at Penn State consists of 15 weeks. The course outline is provided next.

IV. Introduction to Local Area Networks course outline

1. PC Fundamentals Review
2. MS-DOS operating system fundamentals
3. Fundamentals of Windows 95
4. Local Area Networks Fundamentals
 - Networking Standards and the OSI model
 - Communication Protocols
 - Networking components
5. Types and topologies of Local Area Networks (LANs)
 - Type of LANs: Peer-to-peer, Client-Server.
 - Network topologies (star, ring, bus, etc.). Advantages/disadvantages
6. Introduction to Windows NT: Windows NT specific network planning

- Computer hardware requirements to run Windows NT and the Hardware Compatibility List
- Server Role (PDC, BDC, Member or Stand-alone, special purpose servers)
- Security Model (Domain vs. Workgroup)
- Types of accounts
- Licensing methods (per seat vs. per server)
- Organizing a hard drive (Partitioning considerations)

7. Windows NT Administration

8. Sharing Resources in NT

- Sharing Printers, files, other devices
- Mapping Network Drives

9. The OSI Model

- The seven layers of the OSI model
- Improvements of the OSI model

10. TCP/IP on Windows NT

- The Internet Protocol:
- Internet addresses and Quad Format Class A, B and C networks
- Internet Host names
- The transmission Control Protocol

11. Windows NT services

- E-mail
- Dynamic Host Configuration Protocol (DHCP)
- World Wide Web, Internet Information Server (IIS)
- Remote Access Service
- Other services : Services for Macintosh (SFM), Client Services for NetWare

12. Planning/Designing a Network, in general

- Load capacities of network (data link) technologies
- Locating server(s)
- Estimating load requirements of network clients
- Connecting sub-networks (use of bridges, routers or switches)

13. Diagnostic Tools, checking performance, view editor.

V. Description of the Outline

The first topic covers basic computer hardware. The students are presented with the following concepts: motherboard, drives, processor, input, output and memory. In addition, the students study expansion cards, mass storage and multimedia. A description of CMOS memory and explanations of common conflicts are also covered. In the first lab

students assembly and disassembly a PC. The second topic reviews MS-DOS fundamentals. The discussion is centered on its limitations, the command line environment, and basic DOS commands (FORMAT, FDISK etc.). Other items include how to write simple batch programs and how to set up a boot disk. Lab 2 involves reading and interpreting CMOS memory, and creating a boot disk. The third part of the outline includes a review of Windows 95, understanding common conflicts (such as Interrupt Requests, IRQs), definition of devices: physical and logical. A description of basic troubleshooting tips is presented. The lab involves partitioning and formatting a hard drive and installing Windows 95.

The next topic covers essentials of local area networks. The importance of computer communications in today's business environment is described in detail. Concepts of sharing software and hardware are emphasized. An implementation of a direct cable connection under Windows 95 is the lab developed for this section.

The next unit runs for two weeks. In the first week the concepts of networking standards, communication protocols, networking components, network interface cards, media and its limitations are discussed at some length. Other network hardware components such as hubs, bridges and routers are also introduced. Uses and limitations of peer-to-peer networks are discussed. The lab is based on installing and configuring network interface cards, setting up a peer-to-peer network under Windows 95, sharing resources, and finally controlling access to resources.

In the second week, we cover another model for networking, namely client-server, and network topologies such as bus, star, ring, and combination of these three architectures. At this point in the semester, Windows NT 4.0 is introduced. Topics in this section are computer hardware requirements for Windows NT 4.0, the Hardware Compatibility List, server roles (Primary Domain Controller, Back-up Domain Controller, Member or Stand-alone, special purpose servers), security models (Domain vs. Workgroup), types of accounts, licensing methods (per seat vs. per server) and organizing a hard drive. Installing and configuring Windows NT 4.0 is the lab for this section.

After the basic features of the Windows NT 4.0 are introduced, we proceed to discuss the administration characteristics of the network operating system. We cover three major administrative tools under Windows NT 4.0; namely user manager for domains, the server manager and the print manager. The lab for this part is basic Windows NT administration: creation of groups, and accounts and setting up security. A Windows 95 client is assumed in this part. We continue with sharing resources such as sharing printers, files, and other devices, and mapping network drives in Windows NT. The lab is based on installing printers, and sharing and mapping resources in a networked environment.

At this point in the semester the Open Systems Interconnection (OSI) model is explained. The OSI model is widely used to describe networking characteristics and it is used for many vendors to set up hardware and software specifications. The seven layered

structure of the model is discussed in some detail. Each of the seven layers is discussed in relation to adjacent layers. In addition, virtual communication with equivalent OSI layers in separate machines is covered. Students at this point have a sense of the theoretical and practical aspects of network architecture. It is emphasized that different network hardware and software components act at different layers of the OSI model. The 802 project model which defines standards for the physical components of a network is also discussed. The 802 standards have several areas of responsibilities, including network adapter cards, wide area network components, and components used to create twisted-pair and coaxial cable networks. Lab for this part includes setting up e-mail and the Microsoft post office in Windows NT 4.0.

The next area in the course outline is dedicated to transmission control protocol (TCP) and Internet protocol (IP) most commonly known as TCP/IP. The goals of TCP/IP are discussed as follows: good failure recovery, ability to plug in new sub-networks without disrupting services, the ability of handle high error rates, independence from a particular vendor and very little data overhead. Internet addresses and quad formats as well as class A, B, and C networks are covered in this section. In addition, subnet masks and setting up subnet masks are explained. An introduction to Dynamic Host Configuration Protocol (DHCP) is given. The lab for this part includes installing and configuring DHCP in Windows NT 4.0 (server) and also in Windows 95 (client).

In next section, the services provided by Windows NT are then discussed in some detail. We continue with our DHCP discussion and introduce other services such as e-mail, the Internet Information server (IIS), remote access services (RAS), services for Macintosh (SFM) and client services for NetWare. The lab for this section is setting a web server in Windows NT 4.0. One of the technical aspects that we did not overlook was planning and designing networks. This section covers the following items: load capacities of network (data link) technologies, locating (in a physical area) servers, estimating load requirements of clients and connecting sub-networks. Since 10 Mb/s Ethernet is the most common network data link technology, it is used as the basis for comparing loads and capacities of different networks as well as for estimating the number of servers in a given configuration. The lab in this section is tailored to examining diagnostic tools and checking performance in Windows NT 4.0.

Lecture and hands-on labs are embedded in this course; however, it was felt that students needed to work in teams and on their own. It was decided that final the project should be setting up a remote access service. The students were exposed to the basic concepts of RAS and were able to read manuals and other information (primarily in the web) to successfully install RAS. Our networking laboratory consists of 12 computers (PCs) divided in 4 groups. One machine in each group acts as server and the rest as clients. We have token-ring and Ethernet hubs to allow for a flexible configuration of network architecture. A sample lab outline is presented in appendix A.

VI. Conclusions

An introductory course in local area networks has been developed and implemented. Students taking this course were sophomores from the baccalaureate programs (electrical engineering, and computer science and engineering) as well as from associate degree programs. They seemed very enthusiastic about the course. The course starts with basic hardware concepts and ends with different network services under Windows NT. We have adapted the course outline for a 5-day (30 hours) continuing education course that was very well received by the participants from industry and service sectors in this area of Pennsylvania.

VII. References

- [1] J. Boyce, R. Tidrow, et. al., Inside Windows 95, Deluxe Edition. New Riders Publishing, 1996.
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- [4] Microsoft Press, Networking Essentials, 1997.
- [5] M. Minasi, C. Anderson, and E. Creegan, Mastering Windows NT Server 3.51, 2nd ed. SYBEX 1995.
- [6] S. Schaaf, Understanding Local Area Networks, 5th ed. SAMS publishing, 1996.

Web References

http://www.halcyon.com/cerelli/	Windows 95
http://www.verinet.com/pc/	Build your own PC
http://pclt.cis.yale.edu/pclt/pchw/platypus.htm	Intro to PC Hardware
http://members.aol.com/markbeard/build.html	Build your own PC
http://www.cit.ac.nz/smac/hf100/default.htm	Hardware
	Fundamentals
http://bpaosf.bpa.arizona.edu:80000/people/iviguier/mis111/NoteIndex.html	Lecture Notes
http://www.cse.ucsc.edu/~charlie/notes/cis2/05-hardware/hardware.html	Lecture Notes
http://escher.cs.ucdavis.edu:1024/classnotes/ecs15/ecs15.html	Lecture Notes
http://byerley.cs.waikato.ac.nz/~tonym/333/lectures/	Lecture Notes
http://musicb.marist.edu/~JZJ6/@httpd/notes.html	Lecture Notes
http://www.hesston.edu/academic/faculty/vickiea/itc/itemain.htm	Lecture Notes
http://www.pcmec.pair.com/index.htm	PC Mechanic
http://www.blackdown.org/~hwb/menu_Cable.html	Cabling
http://www.xmission.com/~trevin/help.trevhelp.html	PC Basics
http://log.on.ca/users/rhwatson/dos7/commandintro.html	MS DOS 7.0
http://fcit.coedu.usf.edu/network/overview.htm	Network Tutorial
http://www.warped.com/~jmaytum/dun/links/html	Win95 Dial-up
	Network
http://www.cit.ac.nz/smac/nm210/default.htm	Networks
http://web.syr.edu/~jmwobus/lans/	Local Area Network

http://www.baynetworks.com/Products/docframe.cgi?part=WP510-2620WC-C	Networking
http://web.syr.edu/~chhertz/ist452/	Lecture Notes
http://www.cyberwise.com/html/lan.htm	LAN
http://www.willamette.edu/~mquiner/network/ppframe.htm	Lecture Notes
http://www.bjcomputer.com/network.htm	Network Basics
http://indy.fccj.cc.fl.us/lsf/basic/basicprt.html	Network Basics
http://pwl.netcome.com/~mr_lee/network.htm	Network Design
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http://www.dixie.edu/CS101/networking.html	Networking
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http://www.amer-inst.com/netwk1.html	Outline
http://http.bsd.uchicago.edu/~g-haygood/pc-help/	Lecture Notes
http://www.cit.ac.nz/smac/dc100www/default.htm	Data Communications
http://www.stl.nps.navy.mil/~k12/Net_Shop/background.htm	Networking
http://www.jones.edu/local_hl/general.html/#Windows	Windows for
	Workgroups
http://factt.utsa.edu/training/wfw.htm	Windows for
	Workgroups
http://www.science.mcmaster.ca/csc/helpsheets/wfwg.html	Windows for
	Workgroups
http://www.engr.psu.edu/www/trg/net/default.html	Windows for
	Workgroups
http://www.cit.ac.nz/smac/winnt/default.htm	Windows NT

Regina Nelson

Regina Nelson earned her M.Ed. from the College of Education at the University of Pittsburgh in 1985. She is currently a student at The Pennsylvania State University and will receive a B.S. in Electrical Engineering in May 2000. Her current interests focus on biomedical signal processing and digital imaging. Ms. Nelson is a member of Tau Beta Pi and Eta Kappa Nu.

Aldo Morales

Dr. Morales received his electronic engineering degree with distinction from the University of Tarapaca, Arica, Chile (formerly North University) and M.S. and Ph.D. degrees in electrical and computer engineering from the State University of New York at Buffalo in 1978, 1986, and 1990, respectively. Since September 1990, he has been working as an assistant professor of engineering at the Penn State DuBois. He is now Associate Professor of Engineering. His research interests are in mathematical morphology, digital image processing, computer vision, and neural networks. Dr. Morales has been involved in teaching microprocessors applications, computer languages, software application and local area networks for many years. Dr. Morales was recently honored by the Institute of Electrical and Electronic Engineers (IEEE) with the Best Paper Award at the International Asia Pacific Conference on Circuits and Systems for the paper " Basis Matrix Representation of Morphological Filters with N-Dimensional Structuring Elements."

APPENDIX A: WINDOWS NT SERVER ADMINISTRATION LAB

Creation of Accounts and Groups

Advance planning is essential for Windows NT Server administration. Before working through these options on a system, a network administrator should spend time determining the number of users to be added, and how they will each be utilizing the system; i.e. whether or not access to specific domain is needed, access restrictions, etc. Time spent researching these needs up front will greatly reduce the need to modify the system at a later date.

Click on **Start, Programs, Administrative Tools, and Administrative Wizard**. This menu will appear: **Getting Started with Windows NT Server**. There will be a check box for the option **Show this Getting Started screen next time you log on**. A list of eight choices will be indicated. Each of these will be explained in detail:

- 1) **Add User Accounts** - creates new user accounts
- 2) **Add/Remove Programs** - installs or removes programs from the computer
- 3) **Group Management** - creates and modifies group accounts
- 4) **Install New Modem** - sets up modems that are connected to the computer
- 5) **Managing File and Folder Access** - sets permissions on file and folder access
- 6) **Network Client Administrator** - installs or updates network client workstations
- 7) **Add Printer** - sets up printers that are connected to the computer or are on a network
- 8) **License Compliance** - checks licensing for installed applications

Add User Accounts

Click the icon for **Add User Accounts**. If there is no Domain Name, add **EET01**. Click **Next**.

You will be asked to type the user's full name, then a unique name to identify the user for logon and resource usage. A description for the user is optional. Click **Next**.

Type a password, then confirm it. You will have several options to choose from for this password. Click **Next**.

Choose to allow access to **Users**. (At some point you should explore the other options as well.) Click **Next**.

You will be asked to configure options for the user. Click **Next**. The wizard will use a default file stored in the Default User folder if none is typed in. Click **Next**.

Additional questions will be asked about logon scripts, home directories, remote access, and restrictions. Click **Next** after every choice.

Changes can be made to existing user accounts by using **User Manager for Domains** in the **Administrative Tools** group. Click **Finish**, then **Yes** to restart the wizard.

Add as many users as needed using this system. Click **Cancel** when finished.

Group Management

This wizard allows you to create a new group and add members to that group, or to modify an existing group.

To **create** a new group, check that option and click **Next**.

Type a name for the group. Choose where to create this group, and add the users/groups you wish to allow access. Click **Next** after each choice.

From this point on, finish as you did for **Add User Accounts**.

To **modify** a group, click **Next**.

Choose the group to modify, then click **Next**.

From this point on, finish as you did for **Add User Accounts**.