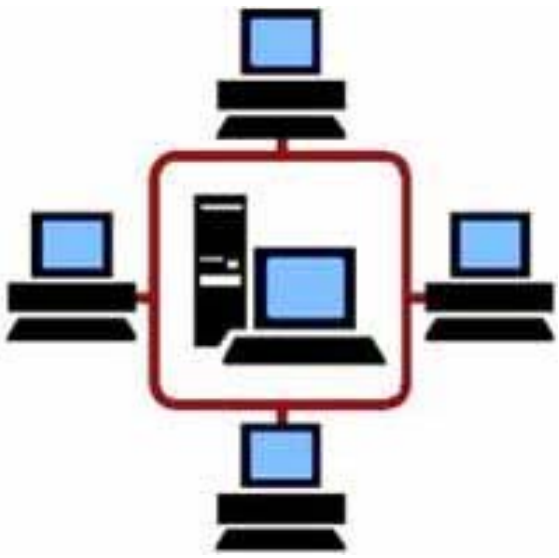
Networking

Network components, Types and Topologies



Including:

Introduction to Networks
Networking Components
Installation of Network Hardware
Planning a Network Topology
Planning Network Connections
Network Troubleshooting
Culminating Task (Summative)

A Unit for Grade 11

Written by:

David Keffer

Length of Unit: approximately: 20 hours

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Networking
Network components, Types and Topologies A Unit for Grade 11

Unit Context

This unit will allow students to develop the necessary skills to recognize and install networking hardware and software components, and to connect computers to construct a functioning network. During this process, they will use a variety of research and problem solving techniques, and will apply these to the troubleshooting of network malfunctions that arise.

Unit Summary

In this unit, students identify and explore network components, network types, and topologies, and apply networking concepts to design network configurations. The use of proper terminology (e.g., logical and physical topologies, standards) and the development of effective solutions to given situations are key components of this unit. Students use problem-solving skills to apply their knowledge to tasks such as installing network cards and activating the operating system. They create a computer network, based on an analysis of system requirements, installing the required network interface cards, operating systems, drivers and other software. They select and configure appropriate networking protocols, and then perform a variety of troubleshooting procedures. Students learn about the importance of network connectivity and infrastructure and how it impacts on our world as well as potential career opportunities in the area of computer networking.

Culminating Task Assessment

As a culminating task for this unit, students will create a simple network consisting of two computers. Students will install network adaptor cards into working computer systems, build the required networking cables, and physically connect the two computers in a star network topology using a hub. Students will then configure the operating system to connect the two computers in a peer-to-peer network, with file and print sharing, and troubleshoot any problems that arise. Students will maintain a log during the construction of the network, and will submit this with a report detailing the construction, including photographs and diagrams.

Links to Prior Knowledge

Students have already completed a unit in computer hardware, software and operating systems. They have learned to identify and explain the functions of basic components of a typical computer, including its internal components and peripheral devices. Using this knowledge, they have disassembled/assembled and upgraded computer hardware. They have also installed an operating system (OS) and drivers to configure and optimize the computer hardware they have assembled. Through these hardware and software activities, they have learned to recommend a computer system based on exacting requirements. Upon completion of these activities, students were able to place hardware and software developments in an historical perspective.
Emphasis was placed on safety as students handled a variety of internal and external components. In addition, a database of hardware components, logs of system changes and upgrades as well as a log of terminology was created by students to assist them in accurately defining terms and listing hardware management techniques.

Considerations

TECHNOLOGY
CAREER EDUCATION
HEALTH AND SAFETY

LIBRARY / INFORMATION CENTRE

Accommodations:

Teachers should consult individual student IEPs for specific direction on accommodation for individuals. The following accommodation strategies can be used in the activities throughout the unit. Specific strategies relating to course content are given in each activity.

Assessment Accommodations
· Provide additional review for students having difficulty integrating all the structures.
· Allow for non-timed evaluations.
· Ensure that students understand assessment/evaluation tools.
· Provide the option for oral testing and demonstrations of skills.
· Provide for alternative displays of achievement, such as oral testing, taped answers, and scribing for students with writing difficulties.

Enrichment
· Organize more advanced problems (design work, research paper, alternate interfacing projects).
· Appoint students as assistant site administrators.

Physical Accommodations
· Check to ensure all aids, environmental issues, safety precautions, and assistance for students to achieve success are in place.
· Provide appropriate adaptive devices, e.g., large screen monitors, touch screens, etc.
· Provide support for hands-on sessions.
· Most computer peripherals can be adapted to accommodate physical impairments.

Instructional Accommodations
· Provide peer tutoring.
· Provide flexible timelines.
· Encourage small-group learning.
· Facilitate student-to-student discussion and teacher-to-student discussion to encourage confidence and motivation.
· Provide written materials for students having difficulty processing auditory information.
· Provide handouts to reinforce demonstrations.
· Provide clarification to students of assessment/evaluation tools such as rubrics and checklists.

[From the course profile.]

Notes to Teacher

Since most of the unit deals with hands-on network planning and implementation, the instructor should have some considerable experience with these topics. Without this, the instructor will not be able to competently deal with troubleshooting of problems which will certainly occur.

Networking

Network components, Types and Topologies A Unit for Grade 11

1 Introduction to Networks

This initial subtask provides students with an introduction to the general concepts of local area networks. During the task, they will gain an introductory understanding of the main concepts of networking, including networking hardware and software, network topologies and types, and how networks connect to share data and resources. This introduction will prepare students for more detailed exploration in later subtasks.

2 Networking Components

In this subtask, students will now look in more detail at the different hardware and software components of a local area network. They will examine each component's role in the network, and how the components physically connect to form the network. Students will research networking components individually or in pairs, and will then present the results of their research to the class. This will be followed by a class discussion.

3 Installation of Network Hardware

Students will now apply their knowledge of network hardware components by installing network interface cards, and the required software drivers for the network components, and constructing and testing network cables. They will also learn to connect computers together into a small network, and configure the operating software to allow file and resource sharing. This will be accompanied by an introduction to troubleshooting, using either real or simulated problems. Students will work in pairs or small groups. Installation and troubleshooting exercises will be followed by class discussion.

4 Planning a Network Topology

Upon reaching this unit, students should be familiar with network components and standards. They will now learn how to properly design a network topology, or physical layout, based on the requirements of a particular scenario. This learning will be reinforced with example topology design projects. Students will work on these projects in pairs or small groups, and each project will be followed by class discussion.

5 Planning Network Connections

This subtask is an extension of the previous one, in which students will plan the physical wiring of networks. Students will work to extend their topology planning of the previous subtask, to complete their network planning projects. Example projects will include both new network installations and extensions to existing networks. Students will work on projects in pairs or small groups, and planning exercises will be followed by class discussion.

6 Network Troubleshooting

In this subtask, students will look at a variety of different problems which can occur in networks. They will examine how to recognize the source of the problem, and how best to resolve it. Learning will take place using a number of example problems, both real and simulated. Students will work on the troubleshooting exercises in pairs or small groups, and exercises will be followed by class discussion.

7 Culminating Task (Summative)

As a culminating task for this unit, students will create a simple network consisting of two computers. Students will install network adaptor cards into working computer systems, build the required networking cables, and physically connect the two computers in a star network topology using a hub. Students will then configure the operating system to connect the two computers in a peer-to-peer network, with file and print sharing, and troubleshoot any problems that arise. Students will maintain a log during the construction of the network, and will submit this with a report detailing the construction, including photographs and diagrams.

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Blackline Master / File

☐ **Culminating Task** **ST 7**
culminating task.doc
Culminating summative assessed task for the unit.

☐ **Culminating Task Rubric** **ST 7**
culminating task rubric.doc
This is a rubric for evaluation of the culminating task.

☐ **Making 100BaseT Cables** **ST 3**
making cables.ppt
Instructions for constructing 100BaseT unshielded twisted-pair cables.

☐ **Network Components Exercise** **ST 2**
network components exercise.doc
This exercise has students researching the role of different hardware and software components in a network. Students work either individually or in pairs, and present the results of their research to the class in the next lesson.

☐ **Network Terminology Quiz** **ST 1**
network terminology quiz.doc
Quiz on network terminology.

☐ **Network Topology Planning Exercise #1** **ST 4**
planning exercise 1.doc
Network topology planning exercise.

☐ **Network Topology Planning Exercise #1** **ST 4**
planning exercise 1.ppt
Network topology planning exercise.

☐ **Network Topology Planning Exercise #1** **ST 4**
planning exercise 1.jpg
Network topology planning exercise.

☐ **Network Topology Planning Exercise #2** **ST 5**
planning exercise 2.doc
Network topology planning exercise.

☐ **Network Topology Planning Exercise #2** **ST 5**
planning exercise 2.ppt
Network topology planning exercise.

☐ **Network Topology Planning Exercise #2** **ST 5**
planning exercise 2a.jpg
Network topology planning exercise.

☐ **Network Topology Planning Exercise #2** **ST 5**
planning exercise 2b.jpg
Network topology planning exercise.

☐ **Network Topology Planning Exercise #2** **ST 5**
planning exercise 2c.jpg
Network topology planning exercise.

☐ **Network Troubleshooting Exercise - Instructor** **ST 6**
troubleshooting teacher.doc
Instructors version of a network troubleshooting exercise.

☐ **Network Troubleshooting Exercise - Student** **ST 6**
troubleshooting student.doc
Student version of a network troubleshooting exercise.

☐ **Networking: A Primer** **ST 1**
Network Primer.pdf
Basic networking primer from Bay Networks. This is a bit out of date, but still has much useful information and terminology.

☐ **Networking Components Rubric** **ST 2**
network components rubric.doc
Rubric for networking components excercise.

☐ **Planning Exercise Rubric** **ST 4**
planning exercise rubric.doc
Rubric for network topology and connections planning exercise.

☐ **Planning Exercise Rubric** **ST 5**
planning exercise rubric.doc
Rubric for network topology and connections planning exercise.

☐ **Topology Quiz** **ST 4**
topology quiz.doc
Network topology quiz.

☐ **Troubleshooting a Network Connection** **ST 6**
troubleshoot network.doc
How to troubleshoot a network connection.

☐ **Windows XP Network Protocols** **ST 2**
winxp protocols.doc
An article from Practically Networked / EarthWeb on Windows XP network protocols. This is a good primer on network protocols.

Networking
Network components, Types and Topologies A Unit for Grade 11

Licensed Software

- ☐ **Corel WordPerfect Suite 8 Academic** — **Unit**
- ☐ **CorelDRAW 8 Academic** — **Unit**
- ☐ **Microsoft Works V3.0 (English)** — **Unit**

Print

- ☐ **Core MCSE: Networking Essentials** — **Unit**
  Keogh, Jim
  ISBN 0130107336
- ☐ **Intelligent Networks: Basic Technology, Standards & Evolution** — **Unit**
  Magendanz, Thomas and Radu Popescu-Zeletin
  ISBN 1850322937
- ☐ **Sams Teach Yourself Windows Networking in 24 Hours** — **Unit**
  Kearns, Dave
  ISBN 0672314754
- ☐ **Windows Networking Basics** — **Unit**
  Gregg, Kenneth
  ISBN 0764532146

Website

- ☐ **3Com's NetPrep Program** — **Unit**
  http://education.3com.com/Netprep/index.html
- ☐ **Assembling Patch Cables** — **Unit**
  http://www.startech.com/structuredwiring/patchcable.htm
- ☐ **Cisco Certification CCIE** — **Unit**
  http://www.cisco.com/warp/public/625/ccie/
- ☐ **Network Design and Research Centre** — **Unit**
  http://www.alaska.net/~research/Net/tutorial.htm
- ☐ **Network Tutorials** — **Unit**
  http://www.wizard.com/users/baker/public_html/NetTutor.html
- ☐ **Novell Network Primer** — **Unit**
  http://www.novell.com/catalog/primer/primer.html
- ☐ **Various Networking Tutorials and Information** — **Unit**
  http://compnetworking.about.com
- ☐ **Webopedia** — **Unit**
  http://www.webopedia.com

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Material

- ☐ **Basic Computer System** — **Unit**
  1
  per pair
  These should be computer systems that have been assembled by the students during the previous unit.
- ☐ **Cable Stripper and Crimper** — **Unit**
  4
  per class
- ☐ **Cable Tester** — **Unit**
  1
  per class
- ☐ **Computer System with Internet Access** — **Unit**
  1
  per person
- ☐ **Network Cabling and Connectors** — **Unit**
  Unshielded twisted-pair cabling and RJ-45 connectors, in bulk, as required.
- ☐ **Network Interfact Card** — **Unit**
  1
  per person
  With driver software.
- ☐ **Networked Laser Printer** — **Unit**
  1
  per class

Other

- ☐ **Microsoft Office XP Professional** — **Unit**
  Software
- ☐ **Microsoft Windows 98** — **Unit**
  Software - Operating System
- ☐ **Microsoft Windows XP Professional** — **Unit**
  Software - Operating System

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Network components, Types and Topologies A Unit for Grade 11

		Selected	Assessed
Computer Engineering---Theory and Foundation			
☐ **TFV.01**	· identify the function and interaction of basic computer components and peripherals;		1
☐ **TFV.02**	· describe the relationship among computer hardware, networks, and operating systems;		5
☐ **TF2.03**	– identify differences between stand-alone and network hardware;		5
☐ **TF2.04**	– describe similarities and differences between network and desktop operating systems.		1
Computer Engineering---Skills and Processes			
☐ **SPV.03**	· properly install and configure key computer hardware and software components;		3
☐ **SPV.04**	· use network services to facilitate intranetworking among workstations.		2
☐ **SP2.03**	– properly install and configure key software and hardware components and peripherals;		1
☐ **SP2.04**	– properly install and configure a workstation operating system, including a network connection;		3
☐ **SP2.07**	– properly implement standard network protocols for file transfer.		1
Computer Engineering---Impact and Consequences			
☐ **IC1.03**	– describe issues that arise from the growing use of networked systems (e.g., complexity, compatibility, security);		3
Computer Engineering---Theory and Foundation			
☐ **TFV.02**	· describe computer networks and operating systems;		3

Networking
Network components, Types and Topologies

Expectation Summary
Selected **Assessed**

ICE 3M

Theory and Foundation

Overall Expectations

TFV.01	**1**	TFV.02	**5**	TFV.03		TFV.04		TFV.05	

Computer Logic and Electronics

TF1.01		TF1.02		TF1.03		TF1.04		TF1.05	

Hardware, Interfaces, and Networking Systems

TF2.01		TF2.02		TF2.03	**5**	TF2.04	**1**		

Programming Concepts

TF3.01		TF3.02		TF3.03		TF3.04		TF3.05	

Skills and Processes

Overall Expectations

SPV.01		SPV.02		SPV.03	**3**	SPV.04	**2**		

Computer Logic and Electronics

SP1.01		SP1.02		SP1.03		SP1.04		SP1.05	

Hardware, Interfaces, and Networking Systems

SP2.01		SP2.02		SP2.03	**1**	SP2.04	**3**	SP2.05	SP2.06
SP2.07	**1**								

Programming Practices

SP3.01		SP3.02							

Impact and Consequences

Overall Expectations

ICV.01		ICV.02		ICV.03		ICV.04			

Specific Expectations

IC1.01		IC1.02		IC1.03	**3**	IC1.04		IC1.05	IC1.06
IC1.07		IC1.08							

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Analysis Of Unit Components

7 Subtasks
28 Expectations
47 Resources
74 Strategies & Groupings

-- Unique Expectations --
11 Technological Education

Resource Types

0 Rubrics
3 Blackline Masters
3 Licensed Software
4 Print Resources
0 Media Resources
8 Websites
7 Material Resources
0 Equipment / Manipulatives
0 Sample Graphics
3 Other Resources
0 Parent / Community
0 Companion Bookmarks

Groupings

6 Students Working As A Whole Class
6 Students Working In Pairs
4 Students Working In Small Groups
3 Students Working Individually

Teaching / Learning Strategies

4 Demonstration
6 Discussion
3 Independent Study
5 Internet Technologies
1 Lecture
5 Problem Solving
1 Report
1 Research Process
3 Technical Design Process

Assessment Recording Devices

7 Rubric

Assessment Strategies

5 Classroom Presentation
1 Exhibition/demonstration
5 Learning Log
5 Performance Task
2 Quiz, Test, Examination
1 Self Assessment

Description

This initial subtask provides students with an introduction to the general concepts of local area networks. During the task, they will gain an introductory understanding of the main concepts of networking, including networking hardware and software, network topologies and types, and how networks connect to share data and resources. This introduction will prepare students for more detailed exploration in later subtasks.

Expectations

TFV.02 A · describe the relationship among computer hardware, networks, and operating systems;
TF2.03 A – identify differences between stand-alone and network hardware;
TFV.02 A · describe computer networks and operating systems;

Groupings

Students Working Individually
Students Working In Pairs
Students Working As A Whole Class

Teaching / Learning Strategies

Lecture
Discussion
Independent Study
Internet Technologies

Assessment

Students will learn the basic concepts of networking. These will be assessed by a formative quiz.

Assessment Strategies

Quiz, Test, Examination

Assessment Recording Devices

Rubric

Teaching / Learning

Students will learn the general concepts of local area networks through a process of lecture, independent study, and class discussion.

Adaptations

See the Unit Overview under Considerations for general accommodations.

Resources

Network Terminology Quiz network terminology quiz.doc

Networking: A Primer Network Primer.pdf

Notes to Teacher

This subtask provides students with a basic understanding of networking terminology and concepts. Learning is reinforced with a formative quiz.

Teacher Reflections

The World of Computer Networking

In the last 15 years, LANs have gone from being an experimental technology to becoming a key business tool used by companies worldwide.

The World of Computer Networking

In the last 15 years, **LANs** have gone from being an experimental technology to becoming a key business tool used by companies worldwide. A LAN is a high-speed communications system designed to link computers and other data processing devices together within a small geographic area such as a workgroup, department, or a single floor of a multistory building. Several LANs can also be interconnected within a building or campus of buildings to extend connectivity.

Some Background on LANs

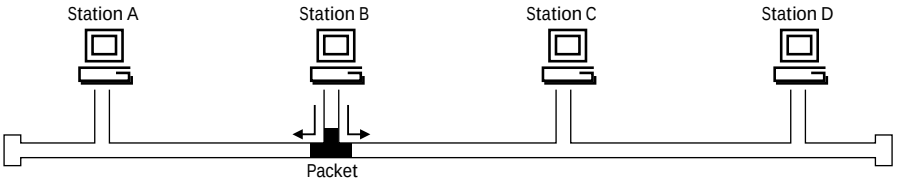
LANs have become popular because they allow users to share vital computing resources electronically, including expensive hardware such as printers and CD-ROM drives, application programs, and, most importantly, the information the users need to do their jobs. Prior to the development of LAN technology, individual computers were isolated from each other and limited in their range of applications. By linking these individual computers over LANs, their usefulness and productivity have been increased enormously. But a LAN by its very nature is a local network, confined to a fairly small area such as a building or even a single floor of a building. To realize the full benefit of computer networking, it is critical to link the individual LANs into an enterprise-wide backbone network that connects all of the company's employees and computing resources, no matter how geographically dispersed they may be.

Today's LANs and **LAN internetworks** are powerful, flexible, and easy to use, but they incorporate many sophisticated technologies that must work together flawlessly. For a LAN to really benefit an organization it must be designed to meet the organization's changing communications requirements. Building a LAN is a process of choosing different pieces and matching them together. This primer is designed to help first-time LAN equipment buyers and users understand the fundamentals of how LANs operate, what the different technology choices are for building a LAN, and the ramifications of choosing one option over another. Also discussed is the concept of internetworking or connecting disparate and geographically dispersed LANs together to form an enterprise system, the different technologies and products available to do so, and the benefits and limitations of each.

To aid readers unfamiliar with networking terminology, terms in boldface appear in a Glossary in the back of this primer.

Figure 1 | **A Basic LAN Bus Network**

When Station B sends a packet to another station on the LAN, it passes by all of the stations connected to that LAN. On the bus network illustrated here, the electrical signal representing the packet travels away from the sending station in both directions on the shared cable. All stations will see the packet, but only the station it is addressed to will pay attention to it.



The Basics of Local Area Networking

Today local area networking is a **shared access** technology. This means that all of the devices attached to the LAN share a single communications medium, usually a coaxial, twisted pair, or fiber optic cable. Figure 1 illustrates this concept: Several computers are connected to a single cable that serves as the communications medium for all of them. The physical connection to the network is made by putting a **network interface card (NIC)** inside the computer and connecting it to the network cable. Once the physical connection is in place, it is up to the network software to manage communications between stations on the network.

In a shared media network, when one station wishes to send a message to another station it uses the software in the workstation to put the message in an "envelope." This envelope, called a **packet**, consists of message data surrounded by a **header** and **trailer** that carry special information used by the network software to the destination station. One of the pieces of information placed in the packet header is the address of the destination station.

The NIC then transmits the packet onto the LAN. The packet is transmitted as a stream of data bits represented by changes in electrical signals. As it travels along the shared cable, all of the stations attached to it see the packet. As it goes by the NIC in each station, the NIC checks the destination address in the packet header to determine if the packet is addressed to it. When the packet passes the station it is addressed to, the NIC at that station copies the packet and then takes the data out of the envelope and gives it to the computer.

Figure 1 shows one source station sending a single message packet to one destination station. If the message the source station wants to send is too big to fit into one packet, it will send the message in a series of packets. On a shared access LAN, however, many stations all share the same cable. Since each individual packet is small, it takes very little time to travel to the ends of the cable where the electrical signal dissipates. So after a packet carrying a message between one pair of stations passes along the cable, another station can transmit a packet to whatever station it needs to send a message. In this way, many devices can share the same LAN medium.

Ethernet

The most widely used LAN technology in use today is **Ethernet**. It strikes a good balance between speed, price, ease of installation, and supportability. Approximately 80 percent of all LAN connections installed use Ethernet.

The Ethernet standard is defined by the Institute of Electrical and Electronics Engineers (IEEE) in a specification commonly known as **IEEE 802.3**. The 802.3 specification covers rules for configuring Ethernet LANs, the types of media that can be used, and how the elements of the network should interact. The Ethernet protocol provides the services called for in the Physical and Data Link Layers of the **OSI reference model** (please refer to the "Standards and Protocols" sidebar).

One element of the 802.3 specification states that Ethernet networks run at a data rate of 10 million bits per second (10 Mbps) or 100 million bits per second (100 Mbps) in the case of Fast Ethernet. This means that when a station transmits a packet onto the Ethernet medium it travels along that medium at 10 Mbps.

Another important element defined by the 802.3 specification is the access method to be used by stations connected to an Ethernet LAN, called **carrier sense multiple access with collision detection (CSMA/CD)**. In this method, each station contends for access to the shared medium. It is possible for two stations to try sending packets at the same time, which results in a **collision** on the LAN. In Ethernet networks, collisions are considered normal events and the CSMA/CD access method is designed to quickly restore the network to normal activity after a collision occurs.

Ethernet Media and Topologies An important part of designing and installing a LAN is selecting the appropriate medium and topology for the environment. Ethernet networks can be configured in either a star or bus topology and installed using any of three different media.

Coaxial cable was the original LAN medium and it is used in what is called a **bus topology** (see Figure 1 for a typical bus topology). In this configuration, the coaxial cable forms a single bus to which all stations are attached. This topology is rarely used in new LAN installations today because it is relatively difficult to accommodate adding new users or moving existing users from one location to another. It is also difficult to troubleshoot problems on a bus LAN unless it is very small.

Figure 2 illustrates a star topology LAN — which is a more robust topology. In a star topology, each station is connected to a central wiring concentrator, or hub, by an individual length of twisted pair cable. The cable is connected to the station's NIC at one end and to a port on the hub at the other. The hubs are placed in wiring closets centrally located in a building.

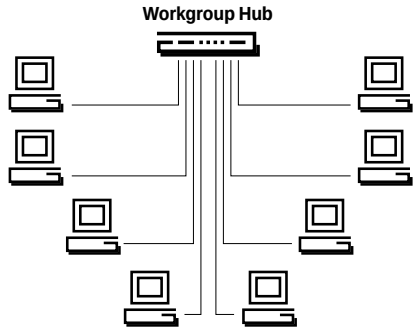
Ethernet networks can be built using three different types of media: shielded and unshielded twisted pair, coaxial, and fiber optic cables. By far the most common is twisted pair because it is associated with the more popular star topology. It is inexpensive, and very easy to install, troubleshoot, and repair. Twisted pair cable comes both unshielded and shielded. **Unshielded twisted pair (UTP)** cable used for LANs is similar to telephone cable but has somewhat more stringent specifications regarding its susceptibility to outside **electromagnetic interference (EMI)** than common telephone wire. **Shielded twisted pair (STP)**, as its name implies, comes with a shielding around the cable to provide more protection against EMI.

Of the two types of twisted pair cable, UTP is by far the most commonly used. The specification for running Ethernet on UTP is called **10BASE-T**. This stands for 10 Mbps, baseband signaling (the signaling method used by Ethernet networks), over twisted pair cable. Other Ethernet specifications include **10BASE5**, which uses a thick coaxial cable, and **10BASE2**, which uses a thin coaxial cable media. Today, 10BASE5 is seldom installed in new Ethernet networks, and 10BASE2 is used only in very small office networks. An additional standard allows 10BASE-F Ethernet to run on fiber optic cable.

Fast Ethernet An extension of the popular 10BASE-T Ethernet standard, Fast Ethernet transports data at 100 Mbps. With rules defined by the IEEE 802.3u standard, Fast Ethernet leverages the familiar Ethernet technology and retains the CSMA/CD protocol of 10 Mbps Ethernet. Two types of Fast Ethernet are available: 100BASE-TX, which runs over Category 5 UTP; and 100BASE-FX, which operates over multimode fiber optic cabling.

Figure 2 | **Basic Star Topology LAN**

In a star topology all stations are wired to a central wiring concentrator called a hub. Similar to a bus topology, packets sent from one station to another are repeated to all ports on the hub. This allows all stations to see each packet sent on the network, but only the station a packet is addressed to pays attention to it.



Token Ring

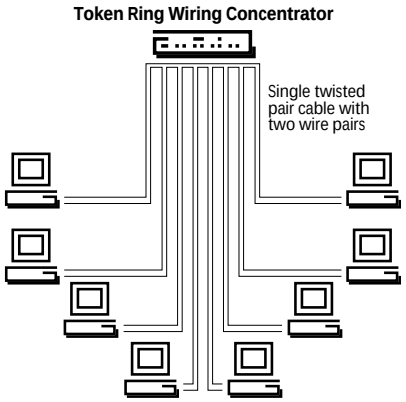
Another major LAN technology in use today is **Token Ring**. Token Ring rules are defined in the **IEEE 802.5** specification. Like Ethernet, the Token Ring protocol provides services at the Physical and Data Link Layers of the OSI model. Token Ring networks can be run at two different data rates, 4 Mbps or 16 Mbps.

The access method used on Token Ring networks is called **token passing**. Token passing is a deterministic access method in which collisions are prevented by assuring that only one station can transmit at any given time. This is accomplished by passing a special packet called a **token** from one station to another around a ring. A station can only send a packet when it gets the free token. When a station gets a free token and transmits a packet, it travels in one direction around the ring, passing all of the other stations along the way. As with Ethernet, the packet is usually addressed to a single station, and when it passes by that station the packet is copied. The packet continues to travel around the ring until it returns to the sending station, which removes it and sends a free token to the next station around the ring.

Token Ring Topology and Media Token Ring networks use what is called a **ring topology**. However, it is actually implemented in what can best be described as a **collapsed ring** that looks like a physical star topology (see Figure 3). In Token Ring LANs, each station is connected to a Token Ring wiring concentrator, called a **multistation access unit (MAU)**, using an individual run of twisted pair cable. Like Ethernet hubs, MAUs are located in wiring closets.

Figure 3 | **Basic Ring Toplogy LAN**

The ring topology used in Token Ring networks is a collapsed ring that looks like a physical star. Each station is connected to a Token Ring wiring connector by a single twisted pair cable with two wire pairs. One pair serves as the "inbound" portion of the ring (also known as the receive pair) and the other pair serves as the "outbound" or transmit pair.



FDDI

Fiber Distributed Data Interface, commonly known as FDDI, provides data transport at 100 Mbps, a much higher data rate than Ethernet or Token Ring. Originally, FDDI networks required fiber optic cable, but today they can be run on UTP as well. Fiber is still preferred in many FDDI networks because it can be used over much greater distances than UTP cable. Like Token Ring, FDDI uses a token passing media access method. It is also usually configured in a collapsed ring, or physical star, topology. FDDI is used primarily as a **backbone**, a segment of network that links several individual workgroup or department LANs together in a single building. It is also used to link several building LANs together in a campus environment.

Structured Wiring Both the Ethernet star topology and the "collapsed ring" topology used in Token Ring LANs are supported by what is called a **structured wiring architecture**. With structured wiring, all of the network stations are physically star wired to **intelligent hubs**. Intelligent hubs are hubs that can be monitored and managed by network operators. This combination of a star topology and intelligent hubs make troubleshooting and fault isolation easier and faster because each endstation is attached to the network on its own individual port, which means it can be monitored easily and, if necessary, can be easily turned off. In addition, structured wiring makes adding users to the network, moving them, or making other physical changes on the network very simple. Since both Ethernet and Token Ring networks can use twisted pair cable and can be configured in a physical star topology, a structured wiring architecture will support either network technology.

Hubs: The Central Connection Point

The **hub** is one of the most important elements of a LAN. It is a central connection point for wiring the network (see Figure 4), and all stations on the LAN are linked to each other through the hub. The term hub is generally associated with 10BASE-T Ethernet networks, while the term multistation access unit (MAU) is used to refer to the Token Ring wiring concentrator. Just as these two LAN technologies use different media access methods, hubs and MAUs perform different media access functions internally, but at one level they perform the same function: They are both network wiring concentrators.

A typical hub has multiple user ports to which computers and peripheral devices such as servers are attached. Each port supports a single 10BASE-T twisted pair connection from a network station. When an Ethernet packet is transmitted to the hub by one station, it is **repeated**, or copied, over onto all of the other ports of the hub. In this way, all of the stations "see" every packet just as they do on a bus network, so even though each station is connected to the hub with its own dedicated twisted pair cable, a hub-based network is still a shared media LAN — picture it as a LAN in a box.

Manageable Hubs Intelligent hubs have been defined as **manageable hubs**, meaning that each of the ports on the hub can be configured, monitored, enabled, or disabled by a network operator from a hub management console. Hub management can also include gathering information on a variety of network parameters, such as the numbers of packets that pass through the hub and each of its ports, what types of packets they are, whether the packets contain errors, and how many collisions have occurred. Each hub vendor has some type of management package it sells with its products. These applications vary in how much information they can gather, what commands can be issued, and how the information is presented to the network operator.

Standalone Hubs Both hubs and MAUs come in three configurations: **standalone hubs**, **stackable hubs**, and **modular hubs**. Some products are combinations of the best configurations. Standalone hubs are — as the term implies — single box-level products with a number of ports. Standalone hubs usually include some method of linking them to other standalone hubs — either by connecting them together with a length of 10BASE5 coaxial cable or cascading them using twisted pair between individual ports on each hub (see Figure 5). Standalone hubs are usually the least expensive type of hub and are often not managed. They are best suited for small, independent workgroups, departments, or offices typically with fewer than 12 users per LAN.

Figure 4 | **Basic LAN with the Hub as the Central Connection Point**

The cornerstone of the network is the intelligent hub, or concentrator, which serves as the control point for systems activity, management, and growth. By integrating any combination of connectivity, internetworking, and management capabilities into intelligent hubs, network managers can create the perfect physical network infrastructure for their environment.

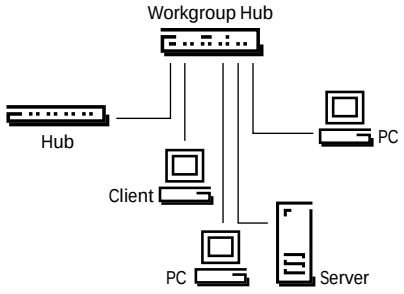
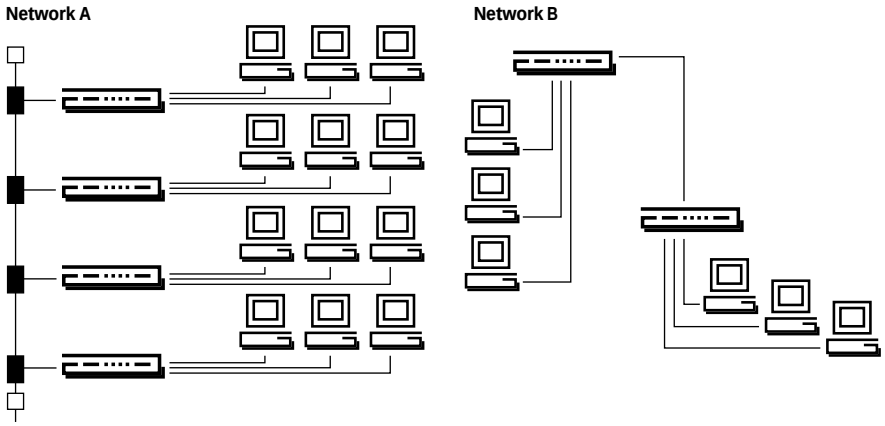


Figure 5 | **Summary of Network Architectures**

Network A illustrates four 10BASE-T hubs connected together by a single cable. This cable could be a coaxial or an optical fiber cable. All of the hubs are part of a single LAN. Network B illustrates two 10BASE-T hubs cascaded. Here the cable connecting the two ports is unshielded twisted pair wire. All of the hubs that are cascaded in this fashion are part of a single LAN.



Stackable Hubs A third type of hub is the stackable hub. Stackable hubs look and act like standalone hubs except that several of them can be stacked or connected together, usually by short lengths of cable. When they are linked together, they act like a modular hub in that they can be managed as a single unit. One manageable hub, used within a stack, can typically provide the management for all other hubs in the stack. These hubs are ideal when an organization wants to start with a minimal investment but knows that its LAN will grow. By utilizing stackable hubs, an organization doesn't need to invest in a large chassis, which may only have one or two cards in it for a considerable length of time until more are needed.

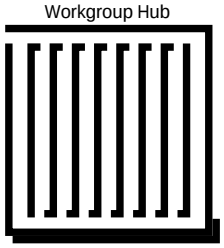
Linking Hubs Each hub usually represents a single LAN. In most organizations it is desirable to interconnect all of the LANs, which means linking hubs in some way. One way to link hubs is to use an **interrepeater link** or cascaded segment. This type of connection simply repeats all of the packets from one hub to the other hub it is linked to, so that in effect the two hubs are part of the same LAN.

Modular Hubs Modular hubs are popular in networks because they are easily expanded and always have a management option. A modular hub starts with a chassis, or card cage, with multiple card slots, each of which accepts a communications card, or module. Each module acts like a standalone hub; when the communications modules are placed in the card slots in the chassis, they connect to a communications backplane that links them together so that a station connected to a port on one module can easily communicate with a station on another module. Figure 6 illustrates a modular hub.

Modular hubs typically range in size from four to 14 slots, so the network can be easily expanded. Typically, several slots in a modular hub will be filled with 10BASE-T Ethernet modules. For instance, with 10 modules, each supporting 12 users, a single hub could support 120 users over 10BASE-T. The modules are linked by the high-speed backplane, which can also be used to connect the communications modules to a management module that manages all of the cards in the chassis. In addition to using one management module for a large number of ports, all of the modules share a common power supply. Another advantage of some modular hubs is that Ethernet, Token Ring, and even FDDI communications modules can be placed in the same chassis, using the same common power supplies.

Figure 6 | **Modular Hubs**

Modular hubs provide a central point where multiple concentrators located in different wiring closets can be united into a LAN or WAN. The modular hub can be equipped with a wide variety of connectivity and network management modules designed to provide a customized solution for the creation of enterprise-wide LANs and WANs.



Internetworking

The term **internetworking** refers to linking individual LANs together to form a single internetwork. This internetwork is sometimes called an enterprise network because it interconnects all of the computer networks throughout the entire enterprise. Workgroup LANs on different floors of a building or in separate buildings on a business campus can be linked together so that all of the computing systems at that site are interconnected. Geographically distant company sites can also be tied together in the enterprise-wide internetwork.

An individual LAN is subject to limits on such things as how far it can extend, how many stations can be connected to it, how fast data can be transmitted between stations, and how much traffic it can support. If a company wants to go beyond those limits — link more stations than that LAN can support, for example — it must install another LAN and connect the two together in an internetwork.

There are two main reasons for implementing multiple LANs and internetworking them. One is to extend the geographic coverage of the network beyond what a single LAN can support — to multiple floors in a building, to nearby buildings, and to remote sites. The other key reason for creating internetworks is to share traffic loads between more than one LAN. A single LAN can only support so much traffic. If the load increases beyond its carrying capacity, users will suffer reduced throughput and much of the productivity achieved by installing the LAN in the first place will be lost. One way to handle heavy network traffic is to divide it between multiple internetworked LANs.

There are three major types of devices used for internetworking: **bridges**, **routers**, and **switches**. Today the most commonly used internetworking devices are high-speed routers, especially in wide area internetworks linking geographically remote sites. But routers are also heavily used in building and campus internetworks. Bridges have also been popular, even though they offer less functionality than routers, because they are less expensive to purchase, implement, and maintain.

LAN switches are a new class of internetworking device, and many people believe that switched internetworks will become the most common design for linking building and campus LANs in the future. Today's LAN switches and switching hubs are the first steps on a migration path to something called **asynchronous transfer mode (ATM)** switching, an emerging technology that will be widely implemented in both LANs and wide area networks in the coming years.

Bridges and Routers

Bridges and routers are both special kinds of devices used for internetworking LANs — that is, linking different LANs or LAN segments together. Many organizations have LANs located at sites that are geographically distant from each other. Routers were originally designed to allow users to connect these remote LANs across a wide area network, but bridges can also be used for this purpose. By placing routers or bridges on LANs at two distant sites and connecting them with a telecommunications link, a user on one of the LANs can access resources on the other LAN as if those resources were local.

Bridges and routers link adjacent LANs. Local bridges and routers were first used to extend the area a network could cover by allowing users to connect two adjacent LANs to maintain performance by reducing the number of users per segment. Both Ethernet and Token Ring specify limits on maximum distances between workstations and hubs, hubs and hubs, and a maximum number of stations that can be connected to a single LAN. To provide network connectivity for more people, or extend it to cover a larger area, it is sometimes necessary to link two different LANs or LAN segments. Bridges and routers can both provide this function.

Today, however, these internetworking devices are also increasingly used to **segment** LANs to maintain performance by reducing the number of users per segment. When users on a single LAN begin to experience slower response times, the culprit is often congestion: too much traffic on the LAN. One method users are employing to deal with this is to break large LANs with many users into smaller LANs, each with fewer users. Adding new network users may require the organization to create new LANs to accommodate them. Implementing new applications on an existing LAN can create so much incremental traffic that the organization may need to break the LAN into smaller LANs segments to maintain acceptable performance levels.

In all of these cases, it is still critical that users on one LAN be able to reach resources on other LANs within the organization. But the LANs must be connected in such a way that packets are **filtered**, so that only those packets that need to pass from one LAN to another are forwarded across the link. This keeps the packets sent between two stations on any one LAN from crossing over onto the other LANs and thereby congesting them. A general rule of thumb suggests that 80 percent of the packets transmitted on a typical workgroup or department LAN are destined for stations on that LAN. Both bridges and routers can be used to segment LANs.

Bridges Bridges are the simpler, and often less expensive, type of device. Bridges filter packets between LANs by making a simple forward/don't forward decision on each packet they receive from any of the networks they are connected to. Filtering is done based on the destination address of the packet. If a packet's destination is a station on the same segment where it originated, it is not forwarded. If it is destined for a station on another LAN, it is connected to a different bridge port and forwarded to that port. Many bridges today filter and forward packets with very little delay, making them good for large traffic volumes.

Routers Routers are more complex internetworking devices and are also typically more expensive than bridges. They use Network Layer Protocol Information within each packet to route it from one LAN to another. This means that a router must be able to recognize all of the different Network Layer Protocols that may be used on the networks it is linking together. This is where the term multiprotocol router comes from — a device that can route using many different protocols. Routers communicate with each other and share information that allows them to determine the best route through a complex internetwork that links many LANs.

Switches

Switches are another type of device used to link several separate LANs and provide packet filtering between them. A LAN switch is a device with multiple ports, each of which can support a single endstation or an entire Ethernet or Token Ring LAN. With a different LAN connected to each of the switch's ports, it can switch packets between LANs as needed. In effect, it acts like a very fast multiport bridge — packets are filtered by the switch based on the destination address.

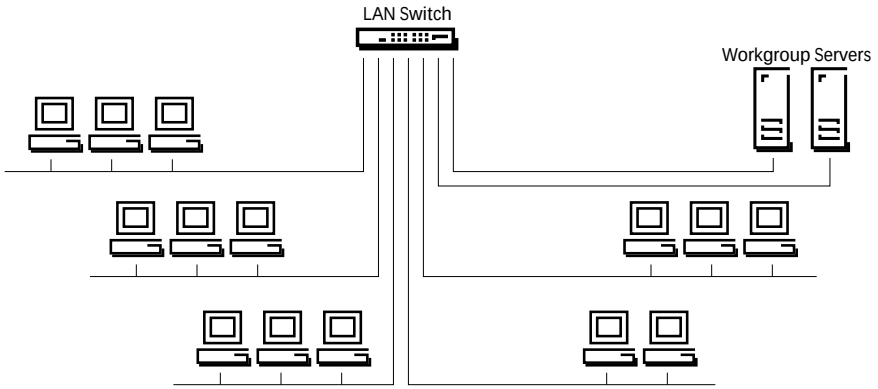


Figure 7 | **Switches**

Using LAN switches allows a network designer to create several small network segments. These smaller segments mean that fewer stations are competing for bandwidth, thereby diminishing network congestion.

Switches are used to increase performance on an organization's network by segmenting large networks into many smaller, less congested LANs, while still providing necessary interconnectivity between them. Switches increase network performance by providing each port with dedicated bandwidth, without requiring users to change any existing equipment, such as NICs, hubs, wiring, or any routers or bridges that are currently in place. Switches can also support numerous transmissions simultaneously.

Deploying technology called **dedicated LANs** is another advantage of using switches. Each port on an Ethernet switch supports a dedicated 10 Mbps Ethernet LAN. Usually, these LANs comprise multiple stations linked to a 10BASE-T hub (see Figure 7), but it is also possible to connect a single high-performance station, such as a server, to a switch port. In this case, that one station has an uncontested 10 Mbps Ethernet LAN all to itself. Packets forwarded over it from other ports on the switch will never produce any collisions because there are no other stations on the LAN at that port.

As was noted earlier, LAN switching is a relatively new technology. Today's switching devices switch relatively large, variable-length LAN packets between different local area networks. ATM is another type of switching technology that switches small, fixed-length cells containing data. ATM networks can be run at much higher data rates than today's LANs. Eventually, they will be used to carry voice, video, and multimedia traffic, as well as computer-generated data over both short and long distances. ATM will be one of the dominant enterprise networking technologies of the future, and many companies are beginning to develop strategies to incorporate ATM in their existing LANs and LAN internetworks.

Networking Today

LAN technology is evolving. In the early 1980s LANs were strictly local area networks, linking small groups of computers in company departments. As workgroup LANs proliferated over the past 10 years, users began connecting them to form internetworks, first with bridges and later with routers. Today's networks typically comprise a combination of workgroup and campus hubs, bridges, and routers. Switches are also beginning to become more prevalent.

The next few years will see networks evolve to include more sophisticated LAN switches and switching hubs. They will be designed using several different types of components, both old and new. Ethernet and Token Ring LANs will be built with stackable workgroup hubs, which, in turn, will be interconnected by larger modular hubs that may incorporate LAN switching functionality. Large networks will include another layer of consolidation with **network center** hubs linking workgroup hubs and switches. Routers will continue to be used as gateways to the wide area network linking other buildings and remote sites.

For networks to deliver the performance today's users require, their many components must work together to deliver seamless connectivity between all of the users and computing systems throughout the enterprise. Flexibility to grow, power to support applications, and seamless connectivity are what users expect in the products they choose to build LANs and enterprise networks.

About Bay Networks

Born from the merger of SynOptics Communications and Wellfleet Communications on October 20, 1994, Bay Networks, Inc., is one of the world's largest networking companies with revenues exceeding $2 billion and earnings of over $250 million.

Headquartered in Santa Clara, California, Bay Networks manufactures and markets a comprehensive line of networking equipment used to build both small and large-scale corporate networks for companies around the world.

Through both direct and indirect channels, the company sells a complete line of intelligent hubs, high-speed switches, multiprotocol routers, and sophisticated network management systems to virtually every Fortune 100 company.

The foundation of Bay Networks networking solutions is its system of intelligent hardware and software products. Designed to meet current and future networking needs, these solutions provide the flexibility to create a network today that can easily grow into a vast, multienterprise network in the future.

Bay Networks product portfolio includes modular, multiprotocol intelligent hubs for both network center and wiring closet applications, highly scalable, high-performance multiprotocol routers for corporate and branch office connectivity, multiservice WAN switches, fixed configuration "stackable" workgroup hubs for Token Ring, FDDI, and Ethernet environments, standalone ATM and 10/100 Mbps Ethernet switches, and a comprehensive network management system that allows for sophisticated control and monitoring of these devices.

Bay Networks markets these products to large and small end-user organizations through a combination of original equipment manufacturers (OEMs), distributors, value-added resellers, and a direct sales force. Typical target users include worldwide retailers, food service companies, financial institutions, technology manufacturers, telecommunications companies, hospitals and universities, and government organizations.

A representative list of Bay Networks customers include: AT&T, Australia Department of Social Services, Bank of International Settlements, Bear Stearns, Boeing Aircraft, British Petroleum, Chase Manhattan Bank, Ford Motor Company, General Motors, McDonald's, MCI, Northwestern Mutual Life, Sprint, 3M, and Wal-Mart.

A major force in the internetworking industry with an installed base of more than 31 million desktop connections, Bay Networks employs over 5,400 people around the world.

The company pioneered the networking industry in the mid-1980s by innovating the ability to run Ethernet networks over common phone wire, as well as being one of the first companies to bring to market high-speed multiprotocol routing.

Additionally, Bay Networks has a number of strategic development and technology partnerships with a variety of industry-leading companies, including IBM, Microsoft, Novell, Intel, Hewlett-Packard, and Sun Microsystems.

Publicly held and traded on the New York Stock Exchange, Bay Networks is led by chairman of the board Paul Severino.

Glossary of Terms

asynchronous transfer mode (ATM) — A type of switching technology in which the switches are small, fixed-length cells containing data.

backbone — A segment of network that links several individual workgroup or department LANs together in a single building. It is also used to link several building LANs together in a campus environment.

bridges — Devices that filter packets between LANs by making a simple forward/don't forward decision on each packet they receive from any of the networks they are connected to.

bus topology — The original coaxial cable-based LAN topology in which the medium forms a single bus to which all stations are attached. The bus topology is rarely used in LAN installations today because it is relatively difficult to add new users or more existing users from one location to another. It is also difficult to troubleshoot a bus-based LAN unless it is very small.

carrier sense multiple access with collision detection (CSMA/CD) — An element defined by the IEEE 802.3 specification. It is an access method that is used by stations connected to an Ethernet LAN. In this method, each station contends for access to the shared medium.

collision — This occurs when two stations try to send packets at the same time. In Ethernet networks, collisions are considered normal events and the CSMA/CD access method is designed to quickly restore the network to normal activity after a collision occurs.

dedicated LAN — Switch configurations in which a port supports a "dedicated" 10 Mbps Ethernet LAN connected to a single high-performance station such as a server, providing an uncontested 10 Mbps Ethernet link all to itself.

EMI — Electromagnetic interference.

Ethernet — The most widely used LAN technology, accounting for approximately 80 percent of all network connections. Standard Ethernet runs at 10 million bits per second (10 Mbps) and balances speed, price, ease of installation, and availability. The rules of Ethernet are defined by the IEEE 802.3 specification. The most popular form of Ethernet is 10BASE-T.

Fast Ethernet — An extension of 10 Mbps Ethernet, Fast Ethernet runs at 100 million bits per second (Mbps). The rules of Fast Ethernet are defined by the IEEE 802.3u specification. Because they use the same protocol, data can be moved between Ethernet and Fast Ethernet without protocol translation.

Fiber Distributed Data Interface (FDDI) — LAN technology that runs at 100 Mbps, a much higher data rate than Ethernet or Token Ring. Originally, FDDI networks required fiber optic cable, but today they can also be run on UTP.

Standards and Protocols

LANs are complex systems that implement many different services in order to provide communication between all of the types of devices that can be connected to them. A communications model called the Open Systems Interconnect (OSI) reference model was developed by the International Standards Organization (ISO) to define all of the services a LAN should provide (see Figure 8). This model defines seven layers, each of which provides a subset of all of the LAN services. This layered approach allows small groups of related services to be implemented in a modular fashion that makes designing network software much more flexible. A network software module that implements services at the Network and Transport Layers of the model can be paired up with different Physical and Data Link Layer modules depending on the requirements of the user's application.

But the OSI model doesn't say how these services should actually be implemented in LAN equipment. The "how to" part has been defined in a number of different **protocols** that have been developed by international standards bodies, individual LAN equipment vendors, and ad hoc groups of interested parties. These protocols typically define how to implement a group of services in one or two layers of the OSI model. For example, Ethernet and Token Ring are both protocols that define different ways to provide the services called for in the Physical and Data Link Layers of the OSI model. They have both been approved by the Institute of Electrical and Electronics Engineers (IEEE), an international communications standards body.

Because they are approved and published by the IEEE, both the Ethernet and Token Ring protocols are said to be industry standards. Any company can acquire the specifications and design Ethernet or Token Ring NICs. Users can purchase an Ethernet NIC, for example, from any vendor and be assured that it will operate in a network with Ethernet NICs from other vendors. This degree of **interoperability** is highly desirable. However, there are many more

filtering — Occurs when a data packet is examined on the network to determine its destination. By looking at a packet's address, network hardware decides whether it should be retained in the local LAN or copied to another LAN. Filtering, which provides some control over internetwork traffic and security, is usually performed by bridges, switches, and routers.

header — A message at the beginning of a data packet that carries special information used by the network to identify the destination station. It is similar to a trailer, which comes at the end of a packet.

IEEE 802.3 — An Ethernet specification commonly defined by the Institute of Electrical and Electronics Engineers (IEEE). The 802.3 specification covers rules for configuring Ethernet LANs, the types of media that can be used, and how the elements of the network should interact.

IEEE 802.5 — A Token Ring specification commonly defined by the Institute of Electrical and Electronics Engineers (IEEE). The 802.5 specification covers rules for configuring Token Ring LANs, the types of media that can be used, and how the elements of the network should interact.

intelligent hubs —Wiring concentrators that can be monitored and managed by network operators.

interoperability — The ability of software and hardware on multiple machines from multiple vendors to communicate.

interrepeater link — One method of linking hubs. This type of connection simply repeats all of the packets from one hub to the other hub it is linked to, so that in effect the two hubs are part of the same LAN.

LAN internetwork — Connecting disparate and geographically dispersed LANs together to form an enterprise system.

local area network (LAN) — A high-speed communications system designed to link computers and other data processing devices together within a small geographic area such as a workgroup, department, or a single floor of a multistory building.

manageable hubs —Another definition for intelligent hubs. Each of the ports on the managed hub can be configured, monitored, and enabled or disabled by a network operator from a hub management console.

modular hubs — A hub that starts with a chassis, or card cage, with multiple card slots, each of which can accept a communications card, or module. Each module acts like a standalone hub; when the communications modules are placed in the card slots in the chassis, they connect to a high-speed communications backplane that links them together so that a station connected to a port on one module can easily communicate with a station on another module.

protocols for providing services at the higher layers of the OSI model and very few of them have been approved by an international standards bodies. In fact, most upper layer LAN protocols are incorporated into proprietary network operating systems, such as Novell's NetWare, IBM's LAN Server, and Microsoft's LAN Manager. A user has to buy only that vendor's products in order to be assured that they will interoperate on a LAN.

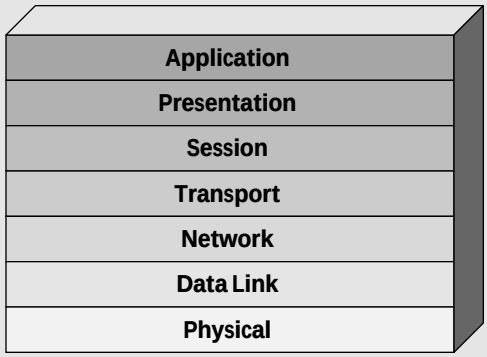


Figure 8 | **ISO Reference Model**

The International Standards Organization (ISO), the primary standard-setting body in the data communications industry, developed a framework for LAN standards called the Open Systems Interconnect reference model. This reference model represents a standard approach to communicate information throughout a network so that a variety of independently developed computer and communications devices can interoperate.

multistation access unit (MAU) — A Token Ring wiring concentrator that connects each station in a Token Ring LAN.

network center — A single, secure, fire-safe location where a company consolidates its network resources.

network interface card (NIC) — The physical connection from the computer to the network is made by putting a NIC inside the computer and connecting it to the shared cable.

Open Systems Interconnect reference model (OSI) — A communications model developed by the International Standards Organization (ISO) to define all of the services a LAN should provide. This model defines seven layers, each of which provides a subset of all of the LAN services. This layered approach allows small groups of related services to be implemented in a modular fashion that makes designing network software much more flexible.

packet — In a shared media network, when one stations wishes to send a message to another station, it uses the network software to put the message in an "envelope." This envelope is called a packet.

protocols — Developed by international standards bodies, individual LAN equipment vendors, and ad hoc groups of interested parties to define how to implement a group of services in one or two layers of the OSI model.

repeaters — Devices that amplify and regenerate signals so they can travel farther on a cable. The term "repeater" is often used to describe hubs.

ring topology — A network whose nodes are connected in a continuous loop.

routers — These are more complex internetworking devices that are also typically more expensive than bridges. They use Network Layer Protocol Information within each packet to route it from one LAN to another.

segmentation — The act of improving network performance by dividing a single large network into multiple smaller, less congested LANs while maintaining connectivity between them. Switches offer an effective segmentation tool by providing each port with dedicated bandwith without requiring users to change any existing equipment such as NICs, hubs, wiring, or any routers or bridges that are currently in place. Switches can also support numerous transmissions simultaneously.

shared access — Shared media technology means that all of the devices attached to the LAN share a single communications medium, usually a coaxial, twisted pair, or fiber optic cable.

shielded twisted pair (STP) — Cable that has shielding around it to provide more protection against electromagnetic interference (EMI).

Network Operating Systems

Ethernet and Token Ring technologies are just one part of a complete LAN. They provide the services specified in the Physical and Data Link Layers of the OSI model, but several other services must be added on top of the connectivity of Ethernet or Token Ring. Network operating systems (NOSs) are most often used to provide the additional communications services.

A NOS defines client and server systems. Clients are individual user workstations attached to the network where application programs are run and data is generated. Servers are shared network resources that provide hard disk space for users to store files, printer services, and a number of other network services. The network operating system provides a set of protocols in software that run on both servers and client systems and allow them to communicate with each other, share files, printers, and other network resources.

stackable hubs — Hubs that look and act like standalone hubs except that several of them can be "stacked" or connected together, usually by short lengths of cable. When they are linked together they can be managed as a single unit.

standalone hubs — Single box-level hubs with a number of ports. Standalone hubs usually include some method of linking them to other standalone hubs — either by connecting them together with a length of 10BASE5 coaxial cable or cascading them using twisted pair between individual ports on each hub.

structured wiring architecture — A wiring architecture that physically star-wires all network stations to intelligent hubs.

switches — A device that links several separate LANs and provides packet filtering between them. A LAN switch is a device with multiple ports, each of which can support an entire Ethernet or Token Ring LAN.

token — a signal used in a Token Ring network that coordinates the transmission of data among the nodes. The token travels around the network, and a node can transmit data only when it has a token.

token passing — The access method used on Token Ring networks.

Token Ring — A major LAN technology in use today. Token Ring rules are defined in the IEEE 802.5 specification. Like Ethernet, the Token Ring protocol provides services at the Physical and Data Link Layers of the OSI model. Token Ring networks can be run at two different data rates, 4 Mbps or 16 Mbps.

trailer — A message a the end of a data packet that carries special information used by the network to identify the destination station. It is similar to a header, which comes at the beginning of a packet.

10BASE-T — The specification for running Ethernet on UTP. This stands for 10 Mbps, baseband signaling (the signaling method used by Ethernet networks), over twisted pair cable.

10BASE5 — An Ethernet specification that uses a thick coaxial cable. 10BASE5 is seldom installed in new Ethernet networks today.

10BASE2 — An Ethernet specification that uses a thin coaxial cable medium. 10BASE2 is only used in very small office networks.

unshielded twisted pair (UTP) — UTP cable is similar to telephone cable but has somewhat more stringent specifications regarding its susceptibility to outside EMI than common telephone wire. UTP is used much more often than STP.

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Hong Kong +852-2-539-1388
India +91-11-301-0404
Japan +81-3-5402-7001
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World Wide Web: **http://www.baynetworks.com**

10/96 WP510-2620WC-C

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Network Terminology Quiz

Name: _____ Date: _____

Match the following phrases to their definitions ...

Peer-to-peer	__c__	IP address	__d__
Dial-up access	__a__	Avatar	__l__
Domain name	__i__	100BaseTx	__b__
Groupware	__q__	TCP/IP	__m__
Topology	__p__	Throughput	__k__
Packet	__h__	Intranet	__j__
Net operating system	__g__	Bridge	__f__

a) Connecting to a network from somewhere remote.

b) Network standard describing network adaptor cards, cable and hubs for faster performance.

c) Kind of network where any computer can share its devices.

d) Unique numerical address for a computer on a network – like a post box number.

e) The program that the network administrator uses to add and modify users and groups on a Windows NT network.

f) Hardware device to connect two LANs, or two segments of the same LAN.

g) Software that controls how the network computers work together.

h) The smallest piece of data that can be transmitted across a network.

i) A name for a number of computers connected together in the same organization – used a lot on the Internet.

j) A system for sharing information across a network – like the Internet, but only in one organization or company.

k) The speed at which data are transmitted across a network.

l) A picture or icon that you choose to represent yourself in 3D chat.

m) A network protocol, or language, used to connect Internet host computers.

n) Type of network that uses coaxial cable, T-connectors, and terminators, but no hubs.

o) A computer on the network that uses resources that are being shared by other computers.

p) The shape of a network – the way the computers are connected.

q) Software or programs to help people in the same organization work together.

r) The computer on a Windows NT network that contains all the user and group information.

Description

In this subtask, students will now look in more detail at the different hardware and software components of a local area network. They will examine each component's role in the network, and how the components physically connect to form the network. Students will research networking components individually or in pairs, and will then present the results of their research to the class. This will be followed by a class discussion.

Expectations

TFV.02 A · describe the relationship among computer hardware, networks, and operating systems;
TFV.01 A · identify the function and interaction of basic computer components and peripherals;
TF2.03 A – identify differences between stand-alone and network hardware;

Groupings

Students Working Individually
Students Working In Pairs
Students Working As A Whole Class

Teaching / Learning Strategies

Discussion
Independent Study
Internet Technologies
Research Process
Report

Assessment

Students will research different network hardware and software components in small groups, and present their findings to the class as a small presentation. This will be followed by a class discussion of the different components and their role in the network. Finally, there will be a formative quiz on the materials researched and discussed.

Assessment Strategies

Classroom Presentation
Quiz, Test, Examination

Assessment Recording Devices

Rubric

Teaching / Learning

Students will use their research and Internet skills, either individually or in pairs, to discover the role of different networking components in a local area network. They will then present this information to the class in the form of a report, which will be followed by a class discussion.

Adaptations

See the Unit Overview under Considerations for general accommodations.

Resources

Network Components Exercise	network components exercise.doc
Networking Components Rubric	network components rubric.doc
Windows XP Network Protocols	winxp protocols.doc

Notes to Teacher

This subtask provides students with a more detailed understanding of network hardware and software components, and of networking protocols. Students research different components, and then present their findings to the class.

Teacher Reflections

Outline potential changes and improvements you would make to the subtask, or raise questions or concerns for future thought.

Record any decisions you wish to pass on to others in the Subtask Notes, because the contents of this field are not passed along in the published unit.

Windows XP Network Protocols

From: Practically Networked / EarthWeb
http://www.practicallynetworked.com/sharing/xp/network_protocols.htm
[accessed 09/03/2005]

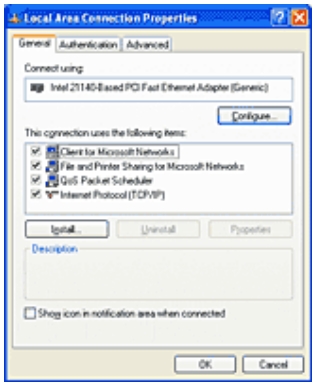
In Windows XP networking, TCP/IP is the preferred protocol. It's automatically installed, can't be un-installed, and is used by default for all networking functions. This reflects the state of networking in the 21st century. With the widespread use of the Internet, which uses TCP/IP, other network protocols are fading away everywhere.

Windows XP provides one other supported protocol -- IPX/SPX -- and one unsupported protocol, NetBEUI. Unusual protocols that have been included in earlier versions of Windows (Banyan Vines, DLC, etc) are no longer available.

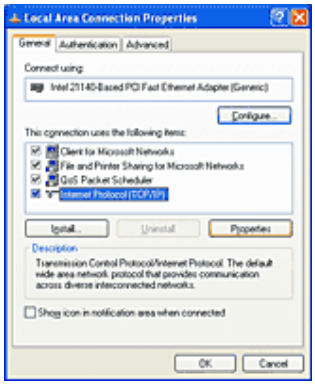
If you're setting up a new network that includes XP, TCP/IP is almost certainly the only protocol to use. If you have an existing network that uses IPX/SPX or NetBEUI, we'll show you how you can continue to use that protocol in XP.

To see the network components, including protocols, which are associated with a network connection, open the **Network Connections** folder, right click, the connection, and select **Properties**.

Here are the components that XP installs by default:



To see the settings for a particular protocol, click the protocol and then click Properties.



TCP/IP

By default, XP configures TCP/IP to obtain an IP address automatically. If there's a DHCP server on the network, it will assign the IP address and other TCP/IP settings to the connection. Otherwise, Windows XP will use Automatic Private IP Addressing to assign an IP address to the connection.

This default configuration should work, unchanged, to connect a Windows XP computer to a network that uses TCP/IP for File and Printer Sharing in these common configurations:

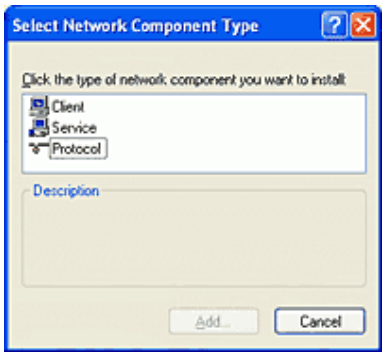
- One computer on the network is running Internet sharing software, such as Internet Connection Sharing, and provides a DHCP server for assigning TCP/IP settings to the other computers.
- A hardware router provides shared Internet access and a DHCP server.
- All computers run either Windows 98, 98SE, Me, 2000, or XP, with no DHCP server. The computers can use Automatic Private IP Addressing to assign themselves compatible IP addresses.

Using an Internet sharing program or a hardware router protects the local area network from access by other Internet users, so it's safe to use TCP/IP for File and Printer Sharing on the LAN. The computers have private IP addresses that aren't accessible from the Internet. No other protocol is needed.

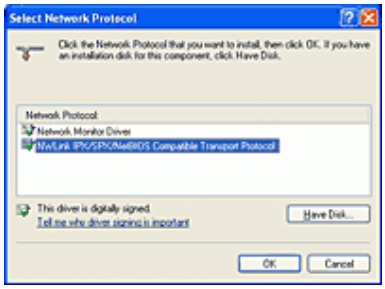
If your network uses static IP addresses, click **Use the following IP address** and enter the configuration information. For example, here are possible settings for a network that uses a proxy server at IP address 192.168.1.1 for Internet access.

IPX/SPX

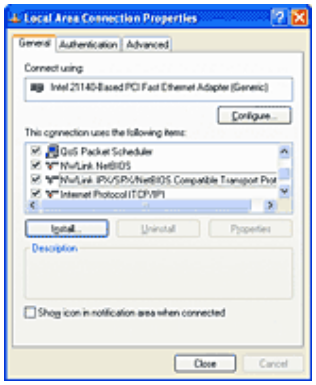
If the existing network uses IPX/SPX for File and Printer Sharing, you can add that protocol to the Windows XP computer. IPX/SPX is fully supported in XP. In the connection's Properties, click the **Install** button to add a network component. XP will ask what type of network component to install.



Click **Protocol** and **Add**.



Click **NWLink IPX/SPX/NetBIOS Compatible Transport Protocol** and click **OK**. Two NWLink items are added to the connection's Properties



NetBEUI

NetBEUI was the default protocol in Windows 95, but Microsoft has been moving away from NetBEUI ever since. Starting with Windows 98, TCP/IP has been the default protocol, and NetBEUI has been available for installation as a supported protocol.

Starting with Windows XP, NetBEUI is unsupported. This doesn't mean that NetBEUI won't work! It means that:

- Microsoft recommends against using it.
- It doesn't appear in the list of protocols that can be installed.
- Microsoft's technical support staff won't answer questions about NetBEUI or help solve problems with it.

Because it's been around for so long, some people think that NetBEUI is required, and they install it on all Windows networks. Actually, nothing in Windows networking has ever required NetBEUI. You can even un-install NetBEUI in Windows 95 and use a different protocol.

If your existing network uses NetBEUI for File and Printer Sharing, consider changing to a different protocol. Most networks can safely use TCP/IP. The main exceptions to this rule are when:

- All of the networked computers are connected directly to a cable or DSL modem and receive public IP addresses from an Internet service provider.
- You've separated your LAN from the Internet, but you've opened ports or have placed a computer outside the firewall to use certain applications or services.

For more information, read Sections 1-3 of our article on Securing Your LAN. If that article says that you need NetBEUI, consider using IPX/SPX instead - even the gang here at PracticallyNetworked has promoted NetBEUI in the past.

If, after considering all of the options, you decide to install NetBEUI on Windows XP, follow the instructions in this Microsoft Knowledge Base article. If the **Welcome to Microsoft Windows XP** screen appears when you insert the CD-ROM, click **Perform additional tasks** followed by **Browse this CD**.

If you have more than one local area network connection, this procedure will install NetBEUI on all of them. It isn't possible to install NetBEUI on a dial-up connection

You can un-bind NetBEUI from a LAN connection by opening the connection's **Properties** screen and un-checking the **NetBEUI Protocol** box.

If you have a new computer that didn't come with a Windows XP CD-ROM, see if the computer manufacturer will send you the CD-ROM or the necessary NetBEUI files. If that isn't possible, you'll have to use a different protocol on your network.

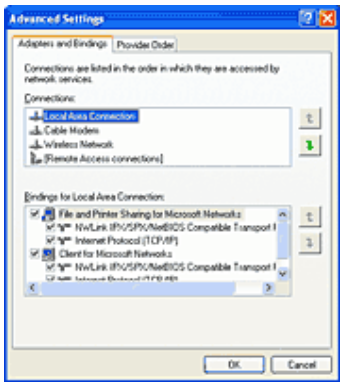
If you need them, here are instructions on [implementing NetBEUI in Windows 2000].

Un-Binding a Protocol

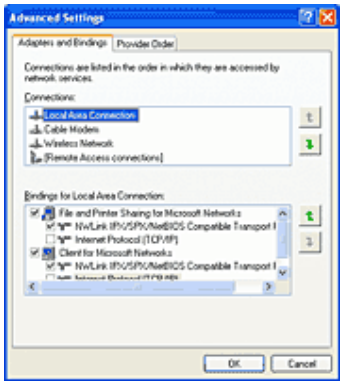
By default, Windows XP binds an installed protocol to each network connection and service. You can remove the binding, preventing that service from using that protocol.

Open the **Network Connections** folder and click **Advanced** followed by **Advanced Settings**.

To see the bindings for a connection, click the connection name under **Connections**. The bindings appear under **Bindings**.



To remove a binding, un-check the corresponding box. For example, to use IPX/SPX instead of TCP/IP for file sharing, un-bind TCP/IP from both **File and Printer Sharing** and **Client for Microsoft Networks**.


Advanced Settings
Adapters and Bindings
Provider Order
Connections are listed in the order in which they are accessed by network services.
Connections:
Local Area Connection
Cable Modem
Wireless Network
Remote Access connections
Bindings for Local Area Connection:
File and Printer Sharing for Microsoft Networks
Internet Protocol (TCP/IP)
Client for Microsoft Networks
OK
Cancel

Network Components Exercise

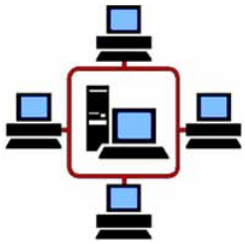
Students will do this exercise alone or in groups of two.

Choose one of the network hardware or software components below, and inform the teacher. Depending on selections of other groups, you may have to choose a different component.

Use the library, the Internet, and any other resources you can find, to describe your component and explain its role in a network. One good Internet site is http://www.webopedia.com. This site provides only the most basic definition, though, and should not be your only reference.

Prepare a short report (maximum one page), and a brief presentation for the class. Each group will present this information in the next period, and there will be a class discussion.

- Network Interface Card (NIC)
- Cables and Connector
- Hub
- Terminator
- Router
- Bridge
- Repeater
- Gateways
- Workstation
- Server
- Network Operating System
- Access Point
- Horizontal Wiring
- Backbone Wiring



Teacher: **Mr. David Keffer**
School:
Date:
Course: ICE3B: Computer Engineering
Grade 11, Workplace
Network Components Rubric

Research Network Components

Students will use their research and Internet skills, either individually or in pairs, to discover the role of different networking components in a local area network. They will then present this information to the class in the form of a report, which will be followed by a class discussion.

Expectations: TFV.01, TFV.02, TF2.03

Criteria:	Level 1	Level 2	Level 3	Level 4
Knowledge				
describe networking component, providing details	description of networking component provides limited details (1 mark)	description of networking component provides some details (2 marks)	description of networking component provides considerable details (3 marks)	description of networking component provides thorough details (4 marks)
describe networking component, providing examples	description of networking component makes limited reference to examples (1 mark)	description of networking component makes some reference to examples (2 marks)	description of networking component makes considerable reference to examples (3 marks)	description of networking component makes thorough reference to examples (4 marks)
Thinking				
describe networking component in an organized manner	description of networking component demonstrates limited organization (1 mark)	description of networking component demonstrates some organization (2 marks)	description of networking component demonstrates considerable organization (3 marks)	description of networking component demonstrates a high level of organization (4 marks)
Communication				
describe networking component clearly (eg. in report)	describes networking component with limited clarity (1 mark)	describes networking component with some clarity (2 marks)	describes networking component with considerable clarity (3 marks)	describes networking component with a high level of clarity (4 marks)

communicate information clearly and effectively (eg. in report)	communicates information with limited clarity and effectiveness (1 mark)	communicates information with some clarity and effectiveness (2 marks)	communicates information with considerable clarity and effectiveness (3 marks)	communicates information with a high level of clarity and effectiveness (4 marks)
communicate information accurately (eg. in report)	communicates information with limited accuracy (1 mark)	communicates information with some accuracy (2 marks)	communicates information with considerable accuracy (3 marks)	communicates information with a high level of accuracy (4 marks)

Totals: Knowledge: _____ /8 x2 = _____ /16

Thinking: _____ /4 = _____ /4

Communication: _____ /12 = _____ /12

Total Mark: = _____ /32 = _____ %

Parent Name (please print): _____

Signature: _____

Date: _____

Please sign and return this complete form to Mr. Keffer. Thank you.

Mr. D. Keffer

Description

Students will now apply their knowledge of network hardware components by installing network interface cards, and the required software drivers for the network components, and constructing and testing network cables. They will also learn to connect computers together into a small network, and configure the operating software to allow file and resource sharing. This will be accompanied by an introduction to troubleshooting, using either real or simulated problems. Students will work in pairs or small groups. Installation and troubleshooting exercises will be followed by class discussion.

Expectations

SPV.03 A · properly install and configure key computer hardware and software components;
SP2.04 A – properly install and configure a workstation operating system, including a network connection;
SPV.04 A · use network services to facilitate intranetworking among workstations.

Groupings

Students Working In Pairs
Students Working In Small Groups
Students Working As A Whole Class

Teaching / Learning Strategies

Discussion
Problem Solving
Demonstration

Assessment

Students will keep a log of their hardware and software installations, as well as any required troubleshooting. The troubleshooting will be discussed as a class.

Assessment Strategies

Classroom Presentation
Learning Log
Performance Task

Assessment Recording Devices

Checklist

Teaching / Learning

Following a demonstration by the instructor, students will install network interface cards and cables, and the required software drivers for the network components. They will then connect computers together into a small network, and configure the operating software to allow file and resource sharing. They must also resolve any problems which occur, or are simulated by the instructor.

Adaptations

See the Unit Overview under Considerations for general accommodations.

Resources

Making 100BaseT Cables making cables.ppt

NIC Checklist nic checklist.doc

Cable Construction Checklist cable checklist.doc

Notes to Teacher

In this unit, students begin to get more hands-on exposure to network components, learning to install and configure them, and to construct network cables. Students are also exposed to the basics of troubleshooting network problems, which is revisited in subtask 6.

Teacher Reflections

Outline potential changes and improvements you would make to the subtask, or raise questions or concerns for future thought.

Record any decisions you wish to pass on to others in the Subtask Notes, because the contents of this field are not passed along in the published unit.

Making 100BaseT Cables

ICE3M: Computer Engineering
Unit 2: Networking

Making 100BaseT Cabling

- Making 100BaseT cables is easy, if you are careful.
- Measure the length of cable **carefully**.
  - check to make sure it is the correct length
  - leave a little spare in case the RJ-45 connector is not properly installed, and must be replaced

Making 100BaseT Cables

- Use the correct tools for the job.
- You must have an RJ-45 crimping tool, and a UTP cable stripper or sharp knife.
- Gently cut through the outer casing about the length of the RJ-45 connector from the cable end.

Making 100BaseT Cables

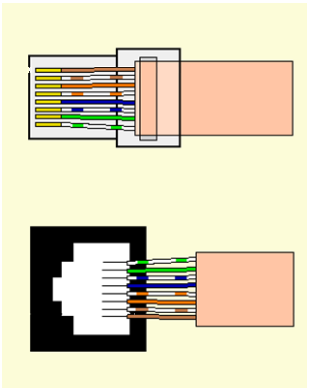
- Remove the cut outer casing, and gently separate the twisted cable pairs.

Making 100BaseT Cables

- Line up the cables side by side, with each coloured cable beside **its own** paired white wire.
- Trim the wires so that they are the same length.
- Gently push the RJ-45 connector all the way onto the wires.

Making 100BaseT Cables

- Look at the RJ-45 connector - the coloured wires should still be beside the white ones, and they should all go **all the way** to the end of the connector.



Making 100BaseT Cables

- Push the outer casing into the RJ-45 connector until it is about half-way into the connector.
- Put the RJ-45 connector **carefully** into the crimping tool until you hear a click, and crimp it firmly. Press the release tab to take the connector out of the crimping tool.

Making 100BaseT Cables

- **That's it!** Now make the other end of the cable the same way.
- **Be careful** - when you put the two ends of the cable together, with the **same** side up, and facing in the **same** direction, the wires **must** be in the same order!!!

Making 100BaseT Cables

- If you have a cable tester, **test the cable** before using it.
- **All** pairs must match with their opposite ends for the cable to work!

100BaseT Cable Construction
Checklist

Name: _____ Date: _____

Grade: ____ / 9

properly measured and cut cable to appropriate length	
correctly stripped cable ends, without cutting individual wires	
left appropriate length of shielding on cable after stripping	
placed RJ-45 connectors onto cable end properly, with wires pushed all the way into the connector	
placed wires into RJ-45 connector in correct sequence/order	
properly crimped RJ-45 connector, with no wires exposed, and shielding locked into connector	
placed wires into second RJ-45 connector (opposite end of cable) in correct sequence/order	
properly crimped second RJ-45 connector	
cable tested good on first attempt	

Network Interface Card Installation
Checklist

Name: _____ Date: _____

Grade: ____ / 7

handled network interface card in an appropriate manner, so as to minimize chance of physical or electrical damage	
installed network interface card properly, so as to minimize chance of damage to card or computer system	
showed proper caution when installing network interface card, so as to minimize danger to installer	
correctly installed software drivers for network interface card	
correctly tested installation of network interface card and drivers, using Hardware Manager	
appropriately resolved any hardware or software conflicts which arose during installation of network interface card or driver software	
network interface card and driver software were installed correctly on first attempt	

Description

Upon reaching this unit, students should be familiar with network components and standards. They will now learn how to properly design a network topology, or physical layout, based on the requirements of a particular scenario. This learning will be reinforced with example topology design projects. Students will work on these projects in pairs or small groups, and each project will be followed by class discussion.

Expectations

TFV.02 A · describe the relationship among computer hardware, networks, and operating systems;
TF2.03 A – identify differences between stand-alone and network hardware;
TFV.02 A · describe computer networks and operating systems;
IC1.03 A – describe issues that arise from the growing use of networked systems (e.g., complexity, compatibility, security);

Groupings

Students Working In Pairs
Students Working In Small Groups
Students Working As A Whole Class

Teaching / Learning Strategies

Demonstration
Discussion
Internet Technologies
Problem Solving
Technical Design Process

Assessment

Students will keep a log of their network design exercises. The designs for each group will be presented to the class, and discussed.

Assessment Strategies

Classroom Presentation
Learning Log
Performance Task

Assessment Recording Devices

Rubric

Teaching / Learning

Students will properly design a network topology, or physical layout, based on the requirements of a particular scenario or scenarios, using example topology design projects.

Adaptations

See the Unit Overview under Considerations for general accommodations.

Resources

Topology Quiz	topology quiz.doc
Network Topology Planning Exercise #1	planning exercise 1.doc
Network Topology Planning Exercise #1	planning exercise 1.ppt

Network Topology Planning Exercise #1	planning exercise 1.jpg
Planning Exercise Rubric	planning exercise rubric.doc

Notes to Teacher

In this subtask, students learn about planning a network topology, using a real-world scenario. Learning is reinforced by class presentations and discussion, and by a formative quiz.

Teacher Reflections

Network Planning Exercise

Exemplary Technical Services (ETS) is a consulting company which provides technical advice and services to all types of international companies. It is based in Oshawa, and has 3 offices on the fifth floor of the Superficial Vision building. A floor plan is attached.

The company is planning to upgrade its network from a Windows 95 peer-to-peer network to a Windows XP network, and add 8 more workstations. All six existing computers currently have 10 Mbps 3Com EtherLink network adaptors, and are connected using thin ethernet coaxial cable. These computers are shown on the attached floor plan, as well as the new workstations that will be bought. The Windows 95 on the existing computers will be upgraded to Windows XP Professional. ETS will also install a **new** Windows XP Server system.

There is no false ceiling or raised floor in the offices, so all cabling will have to go around and through the walls.

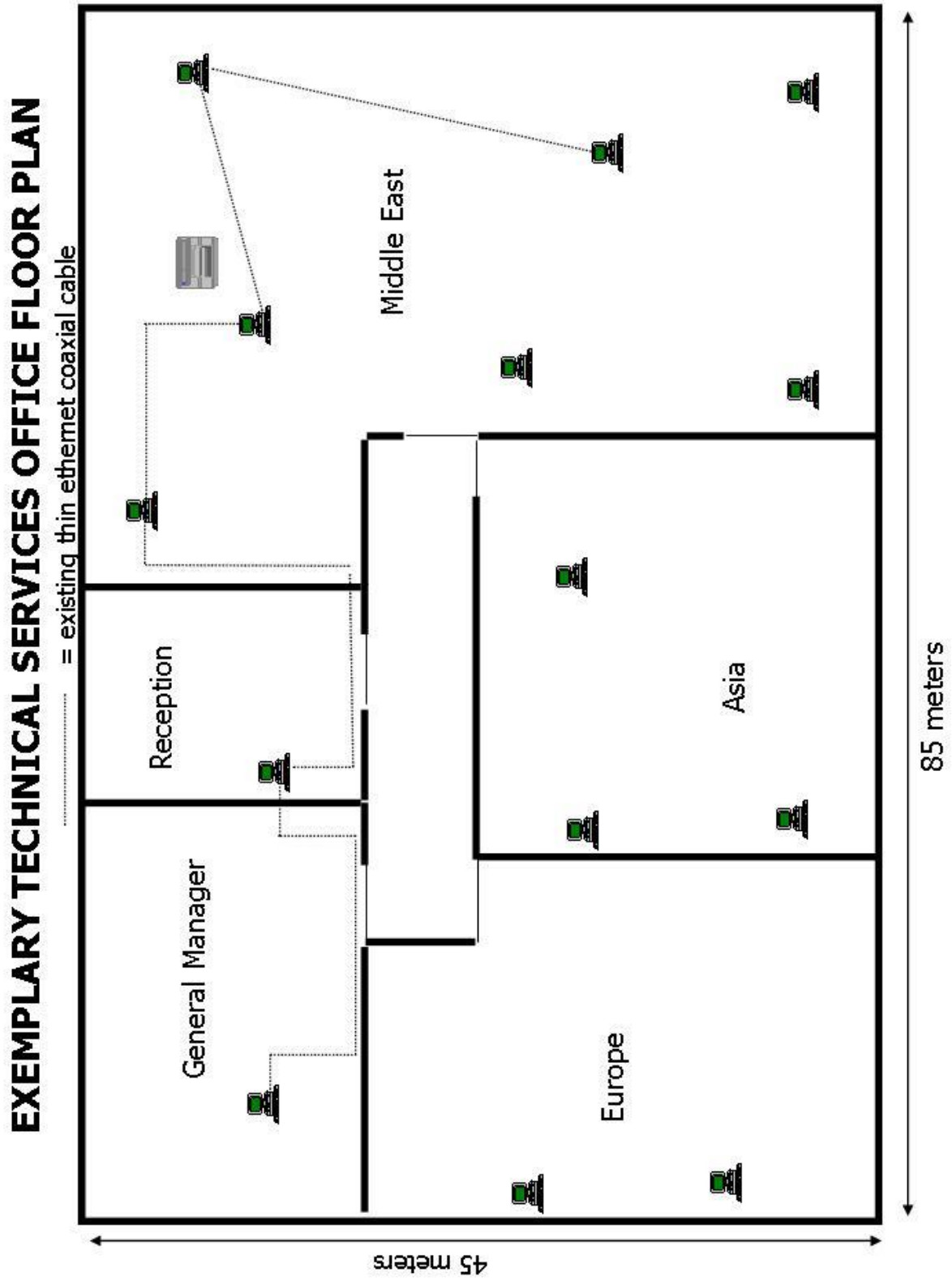
You are to do the following tasks with the information below, using the planning worksheets provided.

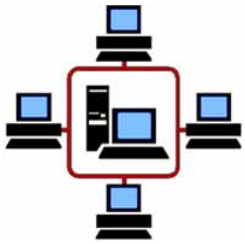
- plan a suitable network topology (bus, star, ring, etc.)
- specify any new components that are needed
- locate the new components on the attached floor plan
- indicate planned wiring on the attached floor plan

- prepare a suitable hardware specification (RAM, hard drive size, video, and anything else you feel is needed) for the new Windows XP Server computer – use your imagination!
- decide where the new server should be located, and indicate it on the floor plan

Print your hardware specification, and hand it in with the completed floor plan. Clearly indicate the names of all of the group members who worked on your design, on both the specification and the floor plan.

Designs will be presented in class, followed by discussion.


EXEMPLARY TECHNICAL SERVICES OFFICE FLOOR PLAN
= existing thin ethernet coaxial cable
Middle East
Reception
General Manager
Asia
Europe
85 meters
45 meters



Teacher: **Mr. David Keffer**
School:
Date:
Course: ICE3B: Computer Engineering
Grade 11, Workplace
Network Planning Rubric

Planning a Network Topology and Connections

Students will plan a network to extend the existing stand-alone and/or networked computer facilities at a specified location. They will be provided with a list of existing equipment, connectivity to be accomplished, a floor plan of the location, showing existing equipment, and some of the additional equipment which will be purchased. They must plan the network topology, wiring type and layout, and additional equipment and software which must be purchased. Students will indicate their planned network expansion on the floor plans, and will submit this with a report. The report will detail their rationale for their plan, and an itemized list of the additional equipment and software, along with any additional diagrams or references.

Expectations: TFV.02, TF2.03, TF2.04, IC1.03

Criteria:	Level 1	Level 2	Level 3	Level 4
Knowledge				
describe networking concepts, providing examples	description of networking concepts makes limited reference to examples (1 mark)	description of networking concepts makes some reference to examples (2 marks)	description of networking concepts makes considerable reference to examples (3 marks)	description of networking concepts makes thorough reference to examples (4 marks)
identify networking hardware components (eg. network cards, hub, cables, tools)	identifies networking hardware components with limited success (1 mark)	identifies networking hardware components with some success (2 marks)	identifies networking hardware components with considerable success (3 marks)	identifies networking hardware components with excellent success (4 marks)
identify proper layout for network topology	identifies proper layout for network topology with some limited success (1 mark)	identifies proper layout for network topology with some success (2 marks)	identifies proper layout for network topology with considerable success (3 marks)	identifies proper layout for network topology with excellent success (4 marks)
identify proper additional required equipment and software	identifies little of the additional required equipment and software, or with frequent errors (1 mark)	identifies some of the additional required equipment and software, or with some errors (2 marks)	identifies most of the additional required equipment and software, with few errors (3 marks)	identifies all of the additional required equipment and software, with no errors and some creativity (4 marks)

Thinking				
describe networking concepts in an organized manner	description of networking concepts demonstrates limited organization (1 mark)	description of networking concepts demonstrates some organization (2 marks)	description of networking concepts demonstrates considerable organization (3 marks)	description of networking concepts demonstrates a high level of organization (4 marks)
design an appropriate network topology	design an appropriate network topology with limited accuracy (1 mark)	design an appropriate network topology with some accuracy (2 marks)	design an appropriate network topology with considerable accuracy (3 marks)	design an appropriate network topology with a high level of accuracy (4 marks)
explain proper rationale for locating network cabling as planned	gives a limited explanation of the proper rationale for locating network cabling as planned (1 mark)	gives some explanation of the proper rationale for locating network cabling as planned (2 marks)	gives a good explanation of the proper rationale for locating network cabling as planned (3 marks)	gives a thorough explanation of the proper rationale for locating network cabling as planned (4 marks)
explain proper rationale for selection of additional required equipment and software	gives a limited explanation of the proper rationale for selection of additional required equipment and software (1 mark)	gives some explanation of the proper rationale for selection of additional required equipment and software (2 marks)	gives a good explanation of the proper rationale for selection of additional required equipment and software (3 marks)	gives a thorough explanation of the proper rationale for selection of additional required equipment and software (4 marks)
Communication				
describe networking concepts clearly (eg. in report)	describes networking concepts with limited clarity (1 mark)	describes networking concepts with some clarity (2 marks)	describes networking concepts with considerable clarity (3 marks)	describes networking concepts with a high level of clarity (4 marks)
communicate information clearly and effectively (eg. in report)	communicates information with limited clarity and effectiveness (1 mark)	communicates information with some clarity and effectiveness (2 marks)	communicates information with considerable clarity and effectiveness (3 marks)	communicates information with a high level of clarity and effectiveness (4 marks)
communicate information accurately (eg. in report)	communicates information with limited accuracy (1 mark)	communicates information with some accuracy (2 marks)	communicates information with considerable accuracy (3 marks)	communicates information with a high level of accuracy (4 marks)
communicate information using an appropriate format (eg. use of photographs and diagrams in report)	demonstrates limited ability to communicate information using an appropriate format (1 mark)	demonstrates some ability to communicate information using an appropriate format (2 marks)	demonstrates considerable ability to communicate information using an appropriate format (3 marks)	demonstrates a high level of ability to communicate information using an appropriate format (4 marks)
Application				
evaluates information to reach conclusions (eg. selection of appropriate topology)	evaluates information to reach conclusions with limited supporting detail (1 mark)	evaluates information to reach conclusions with some supporting detail (2 marks)	evaluates information to reach conclusions with considerable supporting detail (3 marks)	evaluates information to reach conclusions with thorough supporting detail (4 marks)

select additional required equipment and software accurately	selects additional required equipment and software with limited accuracy (1 mark)	selects additional required equipment and software with some accuracy (2 marks)	selects additional required equipment and software with considerable accuracy (3 marks)	selects additional required equipment and software with complete accuracy and creativity (4 marks)

Totals:

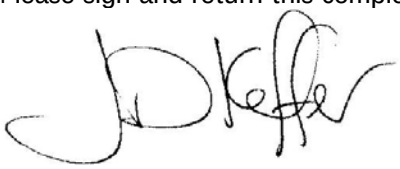
Knowledge:	_____ /16	= _____ /16
Thinking:	_____ /16	= _____ /16
Communication:	_____ /16	= _____ /16
Application:	_____ /8 (x2)	= _____ /16
Total Mark:		= _____ /64 = _____ %

Parent Name (please print): _____

Signature: _____

Date: _____

Please sign and return this complete form to Mr. Keffer. Thank you.

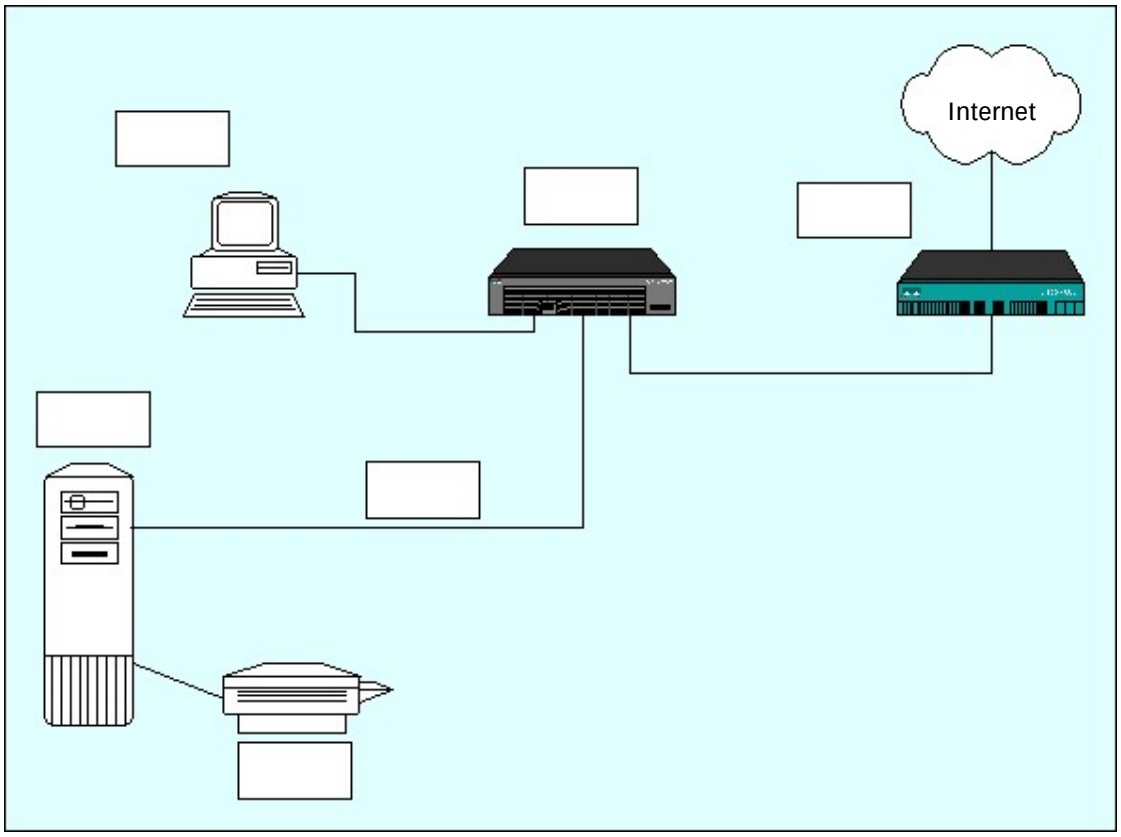


Mr. D. Keffer

Network Topology Quiz

Name: _____ Date: _____

1. On the drawing below of a star network, correctly label the following devices. (8 marks)



- server
- workstations
- UTP cabling
- router or gateway
- hub
- network printer

Also indicate where the following would be.

- network interface card(s)
- RJ-45 connectors

Grading: One mark lost for each incorrect label, to a total of 8.

Grade: ____ / 8 = ____ %

Description

This subtask is an extension of the previous one, in which students will plan the physical wiring of networks. Students will work to extend their topology planning of the previous subtask, to complete their network planning projects. Example projects will include both new network installations and extensions to existing networks. Students will work on projects in pairs or small groups, and planning exercises will be followed by class discussion.

Expectations

TFV.02 A · describe the relationship among computer hardware, networks, and operating systems;
TF2.03 A – identify differences between stand-alone and network hardware;
TFV.02 A · describe computer networks and operating systems;
IC1.03 A – describe issues that arise from the growing use of networked systems (e.g., complexity, compatibility, security);

Groupings

Students Working As A Whole Class
Students Working In Pairs
Students Working In Small Groups

Teaching / Learning Strategies

Discussion
Internet Technologies
Problem Solving
Demonstration
Technical Design Process

Assessment

Students will keep a log of their network design exercises. The designs for each group will be presented to the class, and discussed.

Assessment Strategies

Exhibition/demonstration
Learning Log
Classroom Presentation
Performance Task

Assessment Recording Devices

Rubric

Teaching / Learning

Students will extend their topology planning of the previous subtask, to complete their network planning projects. Example projects will include both new network installations and extensions to existing networks.

Adaptations

See the Unit Overview under Considerations for general accommodations.

Resources

Network Topology Planning Exercise #2 planning exercise 2.doc

Network Topology Planning Exercise #2 planning exercise 2.ppt

Network Topology Planning Exercise #2	planning exercise 2a.jpg
Network Topology Planning Exercise #2	planning exercise 2b.jpg
Network Topology Planning Exercise #2	planning exercise 2c.jpg
Planning Exercise Rubric	planning exercise rubric.doc

Notes to Teacher

Students continue their planning exercises with a more complicated scenario. Learning is reinforced with presentations and class discussion.

Teacher Reflections

Network Planning Exercise

The Murphy Medical Center

General Information

The Murphy Medical Centre is a small medical centre in Whitby. It occupies 2 single story buildings. One is used by doctors and specialists to examine patients. This includes X-rays. The other building contains the administration, and labs for blood testing.

The clinic currently has four computers used by the administration and labs. The computers are stand-alone and are used for:

Administration:

Patient appointment scheduling (Word)

Labs:

Blood test records (Access)
Blood test schedule (Word)

The medical centre is considering installing a network. They want to buy more computers, to do the following:

provide E-mail for all employees

provide an Internet connection for labs and doctors

implement a patient database - doctors and lab technicians could then update patient records immediately following appointments

implement a patient billing system, using Access

Your tasks are as follows:

- justify the use of a network to improve the operations of the medical center
- decide what network topology and media should be used, including what equipment will be needed
- design the network
- specify the network hardware needed, including a server

The building plans are attached.

Physical Planning Information

- the medical centre plans to put workstations in:
  - doctors' offices
  - x-ray and scanning offices
  - examining areas
  - nurses stations
  - each clerks' desk
  - the Director's office and secretary
  - stores
  - blood labs
- Standard laser printers will be put in:
  - medical records
  - blood labs
  - nurses station in the doctors and lab building

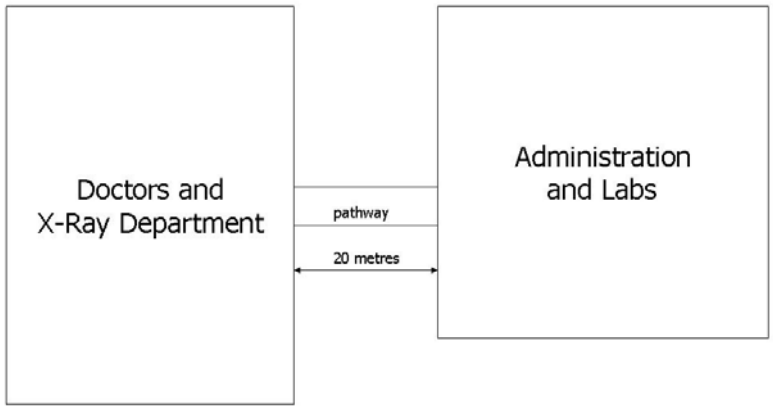
Additional Information

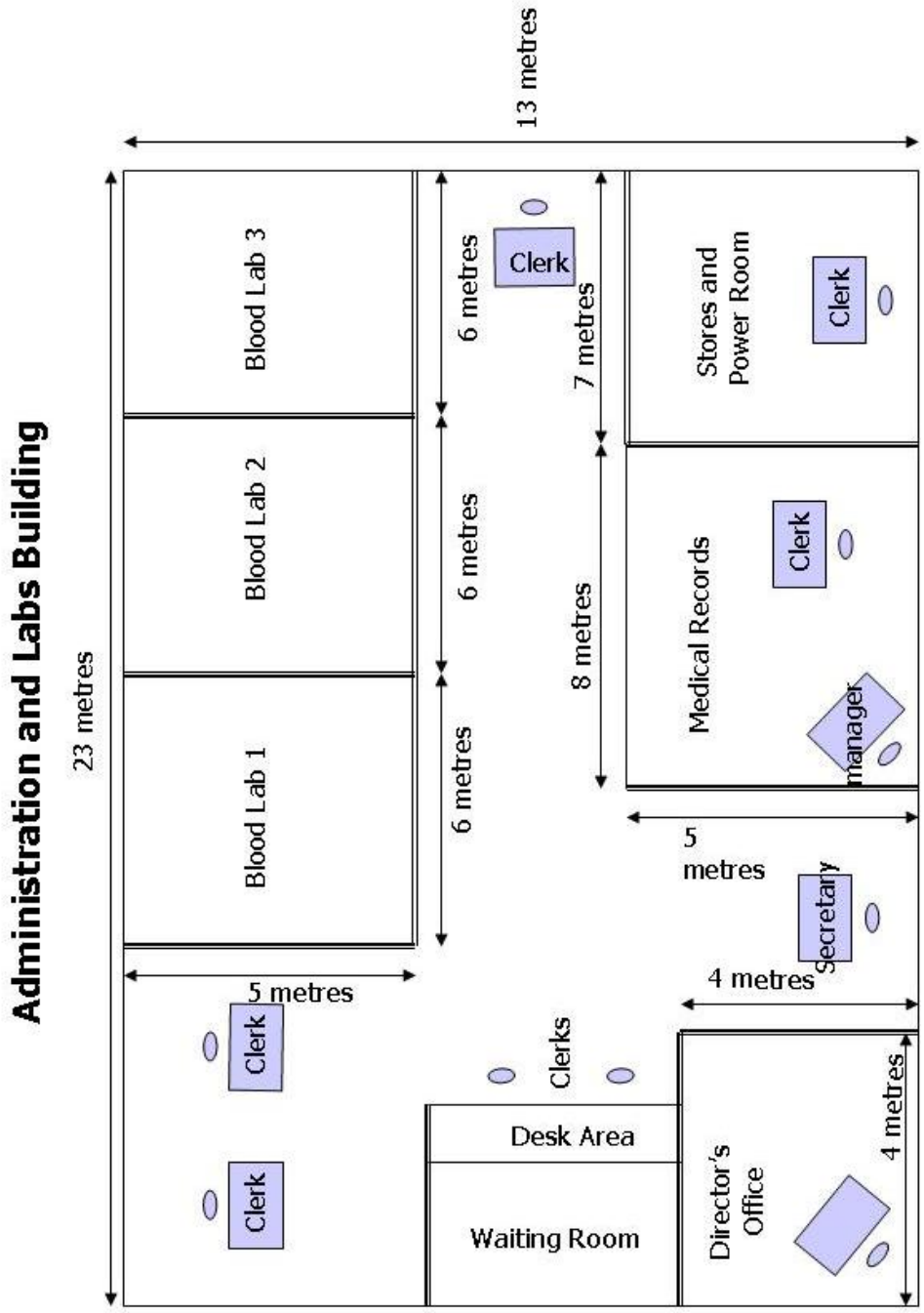
- the server must be in the Administration area
- cables may go over ceilings but not through walls
- the x-ray and scanning areas have high electro-magnetic interference

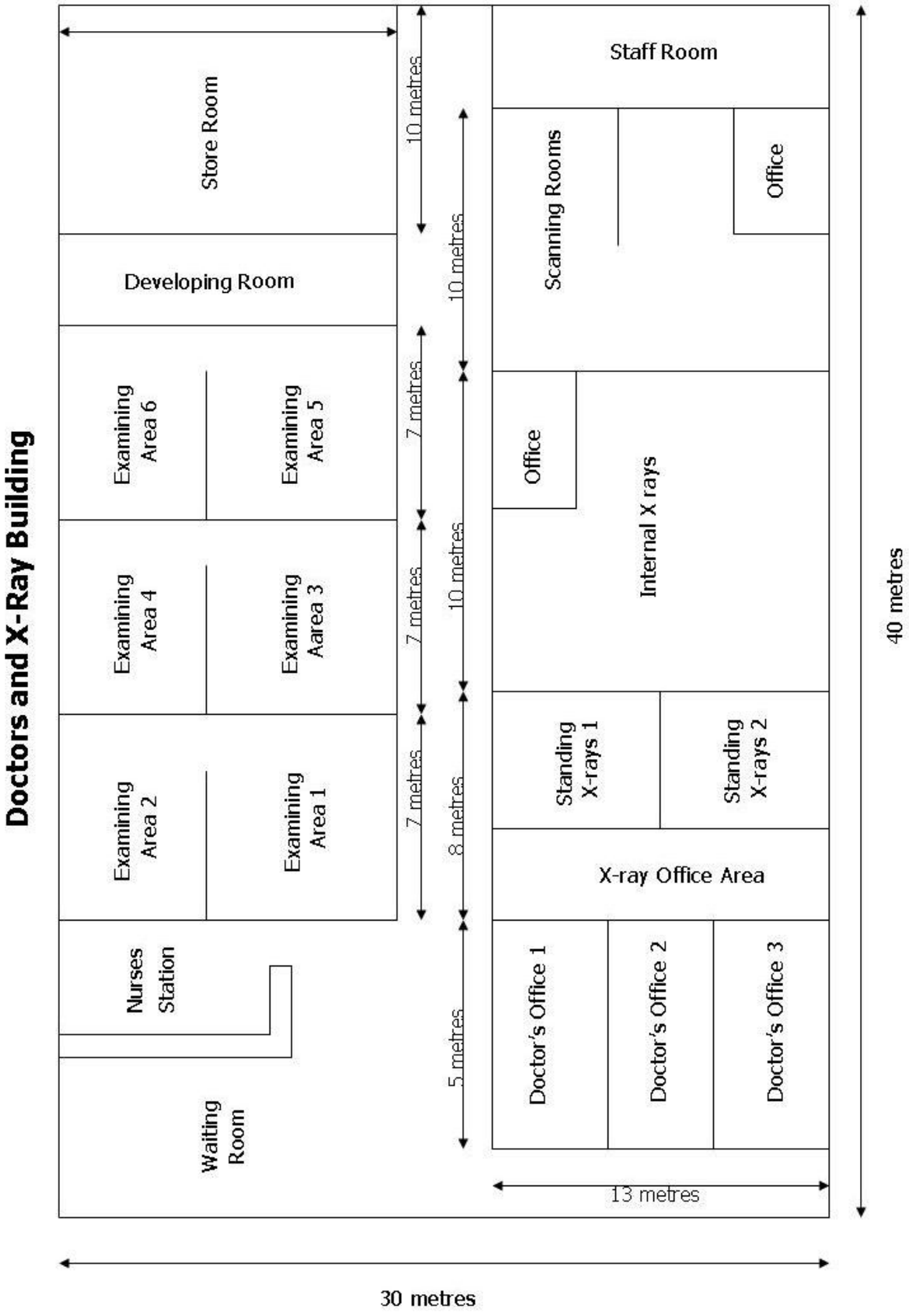
Print your hardware specification, and hand it in with the completed floor plan. Clearly indicate the names of all of the group members who worked on your design, on both the specification and the floor plan.

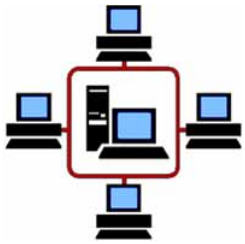
Designs will be presented in class, followed by discussion.

Murphy Medical Centre - General Plan




Administration and Labs Building
23 metres
13 metres
Blood Lab 3
Blood Lab 2
Blood Lab 1
6 metres
6 metres
6 metres
5 metres
Clerk
Clerk
Clerk
Clerks
Desk Area
Waiting Room
7 metres
8 metres
Stores and Power Room
Clerk
Medical Records
Clerk
manager
5 metres
Secretary
4 metres
Director's Office
4 metres


Doctors and X-Ray Building
Store Room
Developing Room
Examining Area 6
Examining Area 5
Examining Area 4
Examining Aarea 3
Examining Area 2
Examining Area 1
Nurses Station
Waiting Room
Staff Room
Scanning Rooms
Office
Office
Internal X rays
Standing X-rays 1
Standing X-rays 2
X-ray Office Area
Doctor's Office 1
Doctor's Office 2
Doctor's Office 3
10 metres
10 metres
7 metres
7 metres
7 metres
8 metres
5 metres
13 metres
40 metres
30 metres



Teacher: **Mr. David Keffer**
School:
Date:
Course: ICE3B: Computer Engineering
Grade 11, Workplace
Network Planning Rubric

Planning a Network Topology and Connections

Students will plan a network to extend the existing stand-alone and/or networked computer facilities at a specified location. They will be provided with a list of existing equipment, connectivity to be accomplished, a floor plan of the location, showing existing equipment, and some of the additional equipment which will be purchased. They must plan the network topology, wiring type and layout, and additional equipment and software which must be purchased. Students will indicate their planned network expansion on the floor plans, and will submit this with a report. The report will detail their rationale for their plan, and an itemized list of the additional equipment and software, along with any additional diagrams or references.

Expectations: TFV.02, TF2.03, TF2.04, IC1.03

Criteria:	Level 1	Level 2	Level 3	Level 4
Knowledge				
describe networking concepts, providing examples	description of networking concepts makes limited reference to examples (1 mark)	description of networking concepts makes some reference to examples (2 marks)	description of networking concepts makes considerable reference to examples (3 marks)	description of networking concepts makes thorough reference to examples (4 marks)
identify networking hardware components (eg. network cards, hub, cables, tools)	identifies networking hardware components with limited success (1 mark)	identifies networking hardware components with some success (2 marks)	identifies networking hardware components with considerable success (3 marks)	identifies networking hardware components with excellent success (4 marks)
identify proper layout for network topology	identifies proper layout for network topology with some limited success (1 mark)	identifies proper layout for network topology with some success (2 marks)	identifies proper layout for network topology with considerable success (3 marks)	identifies proper layout for network topology with excellent success (4 marks)
identify proper additional required equipment and software	identifies little of the additional required equipment and software, or with frequent errors (1 mark)	identifies some of the additional required equipment and software, or with some errors (2 marks)	identifies most of the additional required equipment and software, with few errors (3 marks)	identifies all of the additional required equipment and software, with no errors and some creativity (4 marks)

Thinking				
describe networking concepts in an organized manner	description of networking concepts demonstrates limited organization (1 mark)	description of networking concepts demonstrates some organization (2 marks)	description of networking concepts demonstrates considerable organization (3 marks)	description of networking concepts demonstrates a high level of organization (4 marks)
design an appropriate network topology	design an appropriate network topology with limited accuracy (1 mark)	design an appropriate network topology with some accuracy (2 marks)	design an appropriate network topology with considerable accuracy (3 marks)	design an appropriate network topology with a high level of accuracy (4 marks)
explain proper rationale for locating network cabling as planned	gives a limited explanation of the proper rationale for locating network cabling as planned (1 mark)	gives some explanation of the proper rationale for locating network cabling as planned (2 marks)	gives a good explanation of the proper rationale for locating network cabling as planned (3 marks)	gives a thorough explanation of the proper rationale for locating network cabling as planned (4 marks)
explain proper rationale for selection of additional required equipment and software	gives a limited explanation of the proper rationale for selection of additional required equipment and software (1 mark)	gives some explanation of the proper rationale for selection of additional required equipment and software (2 marks)	gives a good explanation of the proper rationale for selection of additional required equipment and software (3 marks)	gives a thorough explanation of the proper rationale for selection of additional required equipment and software (4 marks)
Communication				
describe networking concepts clearly (eg. in report)	describes networking concepts with limited clarity (1 mark)	describes networking concepts with some clarity (2 marks)	describes networking concepts with considerable clarity (3 marks)	describes networking concepts with a high level of clarity (4 marks)
communicate information clearly and effectively (eg. in report)	communicates information with limited clarity and effectiveness (1 mark)	communicates information with some clarity and effectiveness (2 marks)	communicates information with considerable clarity and effectiveness (3 marks)	communicates information with a high level of clarity and effectiveness (4 marks)
communicate information accurately (eg. in report)	communicates information with limited accuracy (1 mark)	communicates information with some accuracy (2 marks)	communicates information with considerable accuracy (3 marks)	communicates information with a high level of accuracy (4 marks)
communicate information using an appropriate format (eg. use of photographs and diagrams in report)	demonstrates limited ability to communicate information using an appropriate format (1 mark)	demonstrates some ability to communicate information using an appropriate format (2 marks)	demonstrates considerable ability to communicate information using an appropriate format (3 marks)	demonstrates a high level of ability to communicate information using an appropriate format (4 marks)
Application				
evaluates information to reach conclusions (eg. selection of appropriate topology)	evaluates information to reach conclusions with limited supporting detail (1 mark)	evaluates information to reach conclusions with some supporting detail (2 marks)	evaluates information to reach conclusions with considerable supporting detail (3 marks)	evaluates information to reach conclusions with thorough supporting detail (4 marks)

select additional required equipment and software accurately	selects additional required equipment and software with limited accuracy (1 mark)	selects additional required equipment and software with some accuracy (2 marks)	selects additional required equipment and software with considerable accuracy (3 marks)	selects additional required equipment and software with complete accuracy and creativity (4 marks)

Totals:

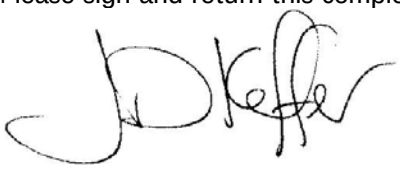
Knowledge:	_____ /16	= _____ /16
Thinking:	_____ /16	= _____ /16
Communication:	_____ /16	= _____ /16
Application:	_____ /8 (x2)	= _____ /16
Total Mark:		= _____ /64 = _____ %

Parent Name (please print): _____

Signature: _____

Date: _____

Please sign and return this complete form to Mr. Keffer. Thank you.



Mr. D. Keffer

Description

In this subtask, students will look at a variety of different problems which can occur in networks. They will examine how to recognize the source of the problem, and how best to resolve it. Learning will take place using a number of example problems, both real and simulated. Students will work on the troubleshooting exercises in pairs or small groups, and exercises will be followed by class discussion.

Expectations

SP2.04 A – properly install and configure a workstation operating system, including a network connection;
SPV.03 A · properly install and configure key computer hardware and software components;

Groupings

Students Working As A Whole Class
Students Working In Pairs
Students Working In Small Groups

Teaching / Learning Strategies

Demonstration
Discussion
Independent Study
Internet Technologies
Problem Solving

Assessment

Students will keep a log of their troubleshooting exercises and their outcomes. This will be presented, and discussed as a class.

Assessment Strategies

Learning Log
Classroom Presentation
Performance Task

Assessment Recording Devices

Rubric

Teaching / Learning

Students will look at a variety of different problems which can occur in networks. They will examine how to recognize the source of the problem, and how best to resolve it. Learning will take place using a number of example problems, both real and simulated.

Adaptations

See the Unit Overview under Considerations for general accommodations.

Resources

Troubleshooting a Network Connection	troubleshoot network.doc
Network Troubleshooting Exercise - Instructor	troubleshooting teacher.doc

Network Troubleshooting Exercise - Student troubleshooting student.doc

Notes to Teacher

In this unit, students are exposed to a wider variety of network problems, in order to properly learn how to troubleshoot them. Problems can be both actual and simulated.

Teacher Reflections

Troubleshooting a Network Connection

First, almost of all communication problems are caused by bad connections or cables. So, if your computer will not connect to the network, the first and easiest things to check are that

- the wires in each connector actually touch the end of the connector, and are in the same sequence of colours at both ends of the cable
- the cable connectors are inserted tightly into the jacks
- the computer was shut down and restarted after a cable change (this is not always necessary, but can't hurt and may help)
- the cable is actually connected to a working wall jack or hub

How to Test the Connection

1. Open the *Network Neighborhood*, and look to see if any other computers are listed. It may take a few minutes to view them, and you may have to refresh the display. If all you see is your own computer, then your connection to the network is not working.

2. On the network server, try to broadcast a message. The way to do this will vary, depending on which network operating system you are using. Only correctly connected computers should receive the message, if they are logged on to your domain.

3. If you are using the TCP/IP network protocol, use the *Ping* command. In a command prompt window, type:

   ping 111.0.0.11 (replacing 111.0.0.11 with the IP address of the server or another computer you know is connected properly to the network)

   In Windows, you can find the IP address of a computer by looking in the *Protocols* tab, *TCP/IP* selection of the *Network Neighborhood* dialog. If the ping packet is received correctly by the computer at the address you selected (ie. the connection is good), you will get a message similar to:

   ```
   Reply from "address/computer name ": bytes=32 time = 100ms  TTL = 50
   Reply from "address/computer name ": bytes=32 time = 100ms  TTL = 50
   Reply from "address/computer name ": bytes=32 time = 100ms  TTL = 50
   ```

   If the ping packet is never returned (ie. the connection is not a good one), you will receive the message:

   Request timed out:

If the *Network Neighborhood* on your computer does not show any other computers, you may have a faulty network interface card (NIC) installation. Some of the problems could be that:

- you made a change to the setup, and did not restart the computer
- you did not restart the computer after re-connecting the network cable
- when the computer is started as a Server, it may have a different TCP/IP address than it has as a Workstation – correct this by making them the same
- there may be no NIC installed, or the NIC may defective – check the back of the computer to see if a green light is showing on the NIC (it may be flashing – this is alright)
- the Adapter dialog box may show the wrong NIC installed, even though TCP/IP is installed – make sure you have the right adapter specified, and that there are proper TCP/IP and Default Gateway addresses assigned
- you may not have the right device drivers installed for the NIC – check the driver version, and reinstall

Some other indications of a faulty installation could be:

- if you cannot use the *User Manager* in Server mode, it may mean that there is no NIC installed or that it is incorrectly set up
- if there is a NIC correctly installed, but you cannot logon to your server, then check the *Properties* dialog for a proper network *Identification*
- if a workstation is setup as part of a Workgroup, when you should be connecting to a Domain, then it will not be able to recognize a domain – you can correct this by clicking on *Change* and entering the domain name in the appropriate place in the *Properties* dialog box
- if the workstation is associated with a Server, then make sure that the server name is correct – then log on again, selecting the correct domain in the logon dialog box

Many things can go wrong with a network installation. It will often take patience and persistence to correctly diagnose the fault and fix it. Get into the habit of ***keeping a log*** of your troubleshooting adventures, and you can save yourself a lot of time in the future!

Network Troubleshooting Exercise
Instructor's Version

Students will do this exercise in pairs or in small groups, as assigned by the instructor.

Choose one of the network hardware or software components below, and inform the teacher. Depending on selections of other groups, you may have to choose a different component.

Following is a possible lab setup for the network troubleshooting exercise. Allow about an hour to set up the lab before the class. Each pair or group of students should spend 5 to 10 minutes on a computer, writing down the problems they find and their solutions. They can test the solutions if they have time, but they should leave the computers as they found them. They then rotate to the next computer, as time permits. The problems and solutions should be discussed as a class afterwards, especially since not all students will have seen all problems.

wrong domain name, and TCP/IP set to automatic
NetBeui left off NIC bindings, and wrong IRQ on network interface card
Client for Netware selected, NetBeui set as default protocol
Access Control Domain name is blank
wrong TCP/IP address and/or subnet mask
IPX/SPX set as default protocol, instead of TCP/IP
wrong IP address, subnet address and bindings
wrong driver used for network interface card, and wrong IRQ settings
file and print sharing not added to configuration
workstation set to access a Workgroup, rather than a Domain
wrong client name, and *share level* access selected, rather than *user level*
workstation IP address not in the same network as server
cable has a defective connector (2 pins damaged)
cable has only 7 wires in one RJ-45 connector

one cable is disconnected from hub
all hub ports are occupied, but three cables go nowhere
the operating system is configured for the wrong type of network card (it has recently been changed)
must install new NIC on workstation 6 new XL PCI 3C900
defective network interface card
workstation is connected to printer, but not to hub
workstation goes to exit port on hub
wires in RJ-45 connectors at each end of the cable are not in the same order (by colour)
additional or alternative problems, as instructor feels appropriate, depending on what has been covered in class

Network Troubleshooting Exercise

Students will do this exercise in pairs or in small groups, as assigned by the instructor.

Visit as many of the workstations identified as having network problems as possible. For each workstation, try to determine what the problem(s) are, and what you could do to fix them. Make good notes of the symptoms, problems and possible solutions. Test your solutions if you have time, but ***you must leave the workstations as you found them***, so that the next group has a proper chance!

Group: _____

Workstation: _____

Problem(s): _____

_____

Solution(s): _____

_____

_____

_____

Workstation: _____

Problem(s): _____

_____

Solution(s): _____

_____

_____

_____

Workstation: _____

Problem(s): _____

_____

Solution(s): _____

_____

_____

_____

Workstation: _____

Problem(s): _____

_____

Solution(s): _____

_____

_____

_____

Workstation: _____

Problem(s): _____

_____

Solution(s): _____

_____

_____

_____

Description

As a culminating task for this unit, students will create a simple network consisting of two computers. Students will install network adaptor cards into working computer systems, build the required networking cables, and physically connect the two computers in a star network topology using a hub. Students will then configure the operating system to connect the two computers in a peer-to-peer network, with file and print sharing, and troubleshoot any problems that arise. Students will maintain a log during the construction of the network, and will submit this with a report detailing the construction, including photographs and diagrams.

Expectations

TFV.02 A	· describe the relationship among computer hardware, networks, and operating systems;
SPV.04 A	· use network services to facilitate intranetworking among workstations.
TF2.03 A	– identify differences between stand-alone and network hardware;
TF2.04 A	– describe similarities and differences between network and desktop operating systems.
SPV.03 A	· properly install and configure key computer hardware and software components;
SP2.03 A	– properly install and configure key software and hardware components and peripherals;
SP2.04 A	– properly install and configure a workstation operating system, including a network connection;
SP2.07 A	– properly implement standard network protocols for file transfer.
IC1.03 A	– describe issues that arise from the growing use of networked systems (e.g., complexity, compatibility, security);

Groupings

Students Working Individually

Teaching / Learning Strategies

Problem Solving
Technical Design Process

Assessment

An additional assessment strategy will be a written project report.

Students will maintain a log during the construction of the network, and will submit this with a report detailing the construction, including photographs and diagrams. The final report will be submitted with a self-evaluation, which will be marked according to a separate rubric.

Assessment Strategies

Performance Task
Learning Log
Self Assessment

Assessment Recording Devices

Rubric

Teaching / Learning

For this culminating task, students will work individually to construct a working network. They will use problem solving and technical design processes to plan and design their network, and to implement their plan. Problem solving will also be used to identify and resolve any problems arising during the troubleshooting phase of the implementation, as required.

Adaptations

See the Unit Overview under Considerations for general accommodations.

Resources

Culminating Task Rubric	culminating task rubric.doc
Culminating Task	culminating task.doc

Notes to Teacher

This is the culminating task of the unit, and is summative in nature. Students construct a simple network, installing and configuring components and troubleshooting any problems. They then prepare a written report, including photographs and diagrams, and submit this with a written log of the task.

Teacher Reflections

Culminating Networking Task

As the culminating task for this unit, you are to create a simple network of two computers and one hub. You are given the following equipment and materials:

- 2 x working computer systems, with Windows 98
- 1 x 100baseT 100 Mbps hub
- 2 x 3-metre lengths of unshielded twisted pair cable
- 6 x RJ-45 connectors
- 2 x 100 Mbps network interface cards, with drivers
- 1 x printer
- 1 x cable stripping/crimping tool
- 1 x cable tester
- 1 x digital camera

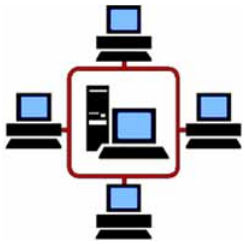
Your tasks are:

1. Construct two working UTP cables.
2. Install the two network interface cards and drivers.
3. Connect the two computers into a star network, using the hub.
4. Configure the two computers in a peer-to-peer network.
5. Set up the network to share file folders and the printer.

Note: You must keep a log during this culminating task, including any troubleshooting that you find necessary. This log will be part of the evaluation of this task. You should also be taking pictures at various stages, to include in your report.

When you have finished the above tasks, your instructor will evaluate your performance and your log. You will then create a report of the process, including any pictures you have taken and any diagrams you have made. This report is to be submitted within two days of completing the performance task.

The evaluation rubric is attached.



Teacher: **Mr. David Keffer**
School:
Date:
Course: ICE3B: Computer Engineering
Grade 11, Workplace
Culminating Task Rubric

Constructing and Configuring a Network

Students will create a simple network consisting of two computers. Students will install network adaptor cards into working computer systems, build the required networking cables, and physically connect the two computers in a star network topology using a hub. Students will then configure the operating system to connect the two computers in a peer-to-peer network, with file and print sharing. Students will maintain a log during the construction of the network, and will submit this with a report detailing the construction, including photographs and diagrams.

Expectations: TFV.02, TF2.03, TF2.04, SPV.03, SPV.04, SP2.03, SP2.04, SP2.07, IC1.03

Criteria:	Level 1	Level 2	Level 3	Level 4
Knowledge				
describe networking concepts, providing details	description of networking concepts provides limited details (1 mark)	description of networking concepts provides some details (2 marks)	description of networking concepts provides considerable details (3 marks)	description of networking concepts provides thorough details (4 marks)
describe networking concepts, providing examples	description of networking concepts makes limited reference to examples (1 mark)	description of networking concepts makes some reference to examples (2 marks)	description of networking concepts makes considerable reference to examples (3 marks)	description of networking concepts makes thorough reference to examples (4 marks)
identify networking hardware components (eg. network cards, hub, cables, tools)	identifies networking hardware components with limited success (1 mark)	identifies networking hardware components with some success (2 marks)	identifies networking hardware components with considerable success (3 marks)	identifies networking hardware components with excellent success (4 marks)
identify proper layout for star network topology	identifies proper layout for star network topology with some limited success (1 mark)	identifies proper layout for star network topology with some success (2 marks)	identifies proper layout for star network topology with considerable success (3 marks)	identifies proper layout for star network topology with excellent success (4 marks)

Thinking				
describe networking concepts in an organized manner	description of networking concepts demonstrates limited organization (1 mark)	description of networking concepts demonstrates some organization (2 marks)	description of networking concepts demonstrates considerable organization (3 marks)	description of networking concepts demonstrates a high level of organization (4 marks)
explain proper procedure for handling electronic networking components	gives a limited explanation of the proper procedure for handling electronic networking components (1 mark)	gives some explanation of the proper procedure for handling electronic networking components (2 marks)	gives a good explanation of the proper procedure for handling electronic networking components (3 marks)	gives a thorough explanation of the proper procedure for handling electronic networking components (4 marks)
design an appropriate star topology network	design an appropriate star topology network with limited accuracy (1 mark)	design an appropriate star topology network with some accuracy (2 marks)	design an appropriate star topology network with considerable accuracy (3 marks)	design an appropriate star topology network with a high level of accuracy (4 marks)
Communication				
describe networking concepts clearly (eg. in report)	describes networking concepts with limited clarity (1 mark)	describes networking concepts with some clarity (2 marks)	describes networking concepts with considerable clarity (3 marks)	describes networking concepts with a high level of clarity (4 marks)
communicate information clearly and effectively (eg. in log and report)	communicates information with limited clarity and effectiveness (1 mark)	communicates information with some clarity and effectiveness (2 marks)	communicates information with considerable clarity and effectiveness (3 marks)	communicates information with a high level of clarity and effectiveness (4 marks)
communicate information accurately (eg. in log and report)	communicates information with limited accuracy (1 mark)	communicates information with some accuracy (2 marks)	communicates information with considerable accuracy (3 marks)	communicates information with a high level of accuracy (4 marks)
communicate information using an appropriate format (eg. use of photographs and diagrams in log and report)	demonstrates limited ability to communicate information using an appropriate format (1 mark)	demonstrates some ability to communicate information using an appropriate format (2 marks)	demonstrates considerable ability to communicate information using an appropriate format (3 marks)	demonstrates a high level of ability to communicate information using an appropriate format (4 marks)
Application				
handle computer hardware appropriately (eg. with regard to proper and safe care of equipment)	rarely handles computer hardware appropriately (1 mark)	sometimes handles computer hardware appropriately (2 marks)	often handles computer hardware appropriately (3 marks)	always or almost always handles computer hardware appropriately (4 marks)
use appropriate strategies to keep safe and healthy in a computer environment (eg. with regard to personal safety)	rarely uses appropriate strategies to keep safe and healthy in a computer environment (1 mark)	sometimes uses appropriate strategies to keep safe and healthy in a computer environment (2 marks)	often uses appropriate strategies to keep safe and healthy in a computer environment (3 marks)	always or almost always uses appropriate strategies to keep safe and healthy in a computer environment (4 marks)

properly install and configures network cards and device drivers	properly installs and configures network cards and device drivers with limited success (1 mark)	properly installs and configures network cards and device drivers with some success (2 marks)	properly installs and configures network cards and device drivers with considerable success (3 marks)	properly installs and configures network cards and device drivers with excellent success (4 marks)
properly construct network cables (2)	properly constructs network cables (2) with limited success (1 mark)	properly constructs network cables (2) with some success (2 marks)	properly constructs network cables (2) with considerable success (3 marks)	properly constructs network cables (2) with excellent success (4 marks)
properly connect computers and other network components in peer-to-peer network	properly connect computers and other network components in peer-to-peer network with limited success (1 mark)	properly connect computers and other network components in peer-to-peer network with some success (2 marks)	properly connect computers and other network components in peer-to-peer network with considerable success (3 marks)	properly connect computers and other network components in peer-to-peer network with excellent success (4 marks)
properly configure operating system software for networking	properly configures operating system software for networking with limited effectiveness (1 mark)	properly configures operating system software for networking with some effectiveness (2 marks)	properly configures operating system software for networking with considerable effectiveness (3 marks)	properly configures operating system software for networking with excellent effectiveness (4 marks)
properly test and demonstrate working network (eg. demonstrate file and print sharing)	properly test and demonstrate working network with limited success (1 mark)	properly test and demonstrate working network with some success (2 marks)	properly test and demonstrate working network with considerable success (3 marks)	properly test and demonstrate working network with excellent success (4 marks)

Totals:

Knowledge:	_____ /16	=	_____ /16
Thinking:	_____ /12	=	_____ /12
Communication:	_____ /16	=	_____ /16
Application:	_____ /28 (x2)	=	_____ /56
Total Mark:		= _____ /100 =	_____ %

Parent Name (please print): _____

Signature: _____

Date: _____

Please sign and return this complete form to Mr. Keffer. Thank you.

Mr. D. Keffer