Lesson 1: Networking Review

At a Glance



This lesson contains a review of the characteristics and requirements for sharing information across networks that one should be aware of to understand switched networks. Topics reviewed include: networking terminology, components, topologies, standards, types, forms, cabling systems, operating systems, configurations, and architectures.

What You Will Learn

After completing this lesson, you will be able to:

- Explain the need for computer networks
- Name and describe the function of basic internetworking components
- Describe ring, star, bus, and hybrid topologies, and list some advantages and disadvantages of each
- Explain the function of the OSI Reference Model
- Describe peer-to-peer and client/server networks and the benefits of each
- Describe a LAN, MAN, and WAN.
- Explain the purpose and list several network operating systems.
- Identify Ethernet, Token Ring, Fiber Distributed Data Interface, LocalTalk, and ARCNet network characteristics.



Student Notes:

Tech Talk



- **ARCNet**—A ring topology network that runs over twisted pair RJ-62/U cable at speeds of either 2.5 or 4 Mbs.
- **Bridge**—Networking hardware used to pass information from one network segment to the other.
- **Bus Topology**—A type of network topology in which computer devices are connected in a row to a continuous cable segment. Each end of the cable segment must be terminated with a terminating resistor.
- Carrier Sense Multiple Access/Collision Detection (CSMA/CD)—
 Network service where all parties have equal access to the network and
 workstations sense when other devices are transmitting and wait for a
 clear line. "Collisions" occur when two parties transmit
 simultaneously. When a collision occurs, both devices stop
 transmitting, wait a random time interval, and then retransmit.
 Ethernet is a CSMA/CD network. An alternate to token-based
 networks where a token is required before signals can be sent.
- **Client**—A computer that uses the shared resources located on a server. The computer it accesses to obtain these shared resources is called a host or server.
- **Client/Server**—A type of network relationship in which computer devices (clients) request resources and information from a central, usually more powerful, server computer.
- **Ethernet**—A local area network technology developed by DEC (Digital Equipment Corporation), Intel, and Xerox in the early 1970's.
- Fiber Distributed Data Interface (FDDI) Architecture—A high speed, dual counter-rotational ring network that uses fiber optic cable.
- **Fiber-Optic Cable**—Uses light to transmit data encoded as light pulses across a network. The core of the cable is made of glass, which is protected by a layer of insulation.
- **File Servers**—A computer device with a large disk drive used to store files to be shared over the network.
- **Gateway**—A hardware device used to connect two networks that use different communications protocols.
- **Hub**—A hardware device that resides in the core of the LAN cabling system. Hubs connect workstations and send transmissions to all the connected workstations. Another name for a hub is a concentrator.



• **Hybrid Topology**—Topology that uses a combination of bus topology, ring topology, and/or star topology. Sometimes referred to as mesh topology.

- **Internetworking Components**—All of the hardware that makes up a network, including cables, interfaces, hubs, routers, satellites, and switches.
- Local Area Network (LAN)—A network of two or more computers linked together (usually through a hub) for the purpose of sharing information and resources.
- **Metropolitan Area Networks**—A series of LAN networks connected together over a local geographical area.
- **Network**—A system of shared resources (both hardware and software) that allows computers and other devices to communicate with one another across LANs, MANs, or WANs.
- **Network Interface Card**—NICs are printed circuit boards installed in computer workstations to provide the physical connection and circuitry required to access the network.
- Network Operating System (NOS)—A combination of software
 programs that instruct computers and peripherals to accept requests
 for services across the network and then provide those services.
 Examples include NetWare, LINUX, and Windows NT server that
 allow DOS, Windows, and Mac clients to connect and use the services.
- Open Systems Interconnection (OSI) Reference Model—A generalized, theoretical description of a set of seven "layers" that together provide a mechanism for transferring data from one device to another over a network. The OSI model is not implemented in any current protocol, but protocols such as Ethernet and FDDI can be compared by reference to this model.
- **Peer-to-Peer**—A network in which computers share resources and information equally. There are no central computers (servers) sharing information and resources.
- **Print Server**—A computer device that accepts print jobs sent by authorized network users.
- **Ring Topology** —A network topology in the form of a closed ring. In ring topology, all computer devices are connected in a continuous ring. Termination devices are not necessary. All computers have equal access to the network.

- **Router**—Networking hardware that links two or more local area networks together. A router receives packets and selects the optimum path to forward the packets across the network.
- **Server**—A central computer on a network that shares resources with other computers. Some examples of servers are file servers, database servers, and print servers.
- **Star Topology**—A network topology in which all devices are connected to a central hub. The hub receives and routes signals over the network.
- **Switch**—A connection device in a network that looks like a hub, but directs transmissions to specific workstations rather than forwarding data to all workstations on the network.
- **Token Frame**—Specialized data packet used in Token Ring networks to give permission to computer devices to transmit data.
- **Token Ring Architecture**—An IBM, IEEE 802.5 physical star, logical ring topology that uses a token passing access method for transmitting data.
- **Transceiver**—Networking hardware at each workstation that transmits and receives signals from the network. The name transceiver is derived from the combination of the words *trans*mitter and receiver. A transceiver may be external or located internally on the NIC.
- **Unshielded Twisted-Pair Cable (UTP)**—UTP is network cable that consists of up to 4 pairs of wires. Each pair is twisted around the other at a different rate and the entire cable is encased in a protective plastic covering.
- Wide Area Networks—A series of LAN and MAN networks connected together. WAN networks generally span a large geographic area; they may even span the globe.
- Workstation—A standalone computer that has its own central processing unit (CPU). Your home or school computer is most likely a workstation. Workstations can be networked together.



Networking Overview

As our dependence on global internetworking increases, instantaneous access to information on an international scale is essential for success in today's economy. In order to understand switching technology, a basic knowledge of how information is transmitted across an internetwork is required.

Let's start our discussion of switching by reviewing some of the networking basics. As you learned in *Internetworking Fundamentals*, networking is the process of sharing or transporting information. A telephone network transmits information from one telephone to another, through the telephone wires, to the telephone office, through switches, to other telephone offices, down the wire, and finally to the other telephone. An overnight-package delivery network transports packages from a spoke of the network to a hub then back out to another spoke; and, finally, to its destination. We are concerned with computer networks; that is, a system of shared resources that allows computers and other devices to communicate with each other.

In order to communicate:

- Computers in a network must be able to identify each other, and
- Information must be delivered in a timely fashion, consistently and reliably.

The way in which these goals are accomplished involves standards, architectural schemes, protocols, wires, routers, switches, hubs, transceivers, network interface cards, etc. For a computer internetwork to function efficiently, all pieces of the network must be able to interact and communicate effectively with each other. Data must be delivered in a reliable and consistent manner.

Check Your Understanding

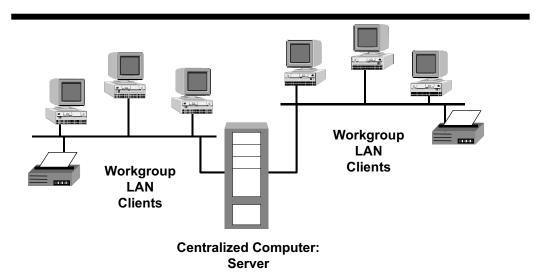
• Explain why schools, businesses, newspapers, etc., need computer networks. Give an example.

Network Components

The major components of a network are the software and the hardware devices. The hardware devices that make up a computer network include:

- Workstation—A computer device where the user works. A workstation can also run special software that tells the network manager the status of the network. Workstations are often referred to as nodes.
- **Server**—A computer device that is accessed by many, if not all, members of the network. It provides (serves) files and information to workstations and other network devices. It can be thought of as a "shared" computer.
- **Printer**—While not necessarily part of the network, with additional hardware and software, printers can be shared devices, often referred to as print servers. As with any other device, printers are connected via cable to the network. In addition to printing documents from data received, printers also communicate with workstations sharing information on the status of print jobs.

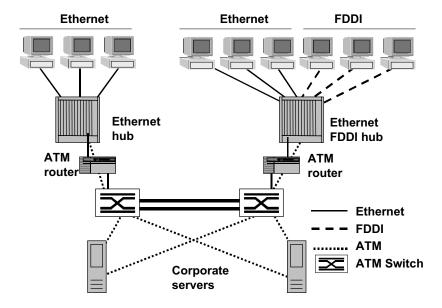
Workstation/Server/Printer





• Router, Bridge, Gateway, Switch—These are the traffic managers. They work by moving data from one part of the network to another or from one network to another.

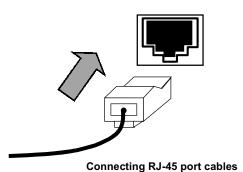
Workstations/Hubs/Routers/Switches

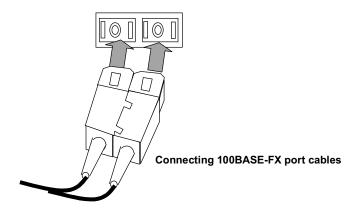


• **Cabling**—The wiring that provides the link between network devices. Cable is run from the workstations to the wall jacks, from the wall jacks to hubs/routers, from routers to servers, and any other possible network device. Except for wireless communications, any device that is part of a network must have a cable attached to it.

• Connector, transceiver, jack, etc.—The many smaller hardware pieces that allow computer devices to connect to the cable. All devices connected on a network must be able to communicate with one another. This is achieved through the use of network interface cards, or NICs. A transceiver *trans*mits information to and receives information from the network. The wall jacks give devices an easy way to connect to the network by just "plugging in" to a standard outlet.

Connectors





• Satellite, radio tower, microwave dish, etc.—These devices are used for wireless data transmission.



Networking Cable

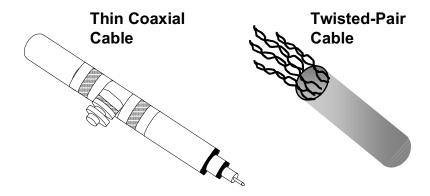
Cable comes in many different shapes and sizes. The earliest wires for carrying telephone conversations were copper, and that remained the standard for many years. In fact, some of Alexander Graham Bell's original copper wires are still underground in Boston's Beacon Hill, the neighborhood in which Dr. Bell had his historic first telephone conversation. Copper remains the most popular choice for cabling today for shorter runs from workstation to wall jack or patch panel to hub. It is less expensive than other options, and very robust.

Types of cable include coaxial, shielded twisted-pair (STP), and unshielded twisted-pair (UTP). Category 5 Unshielded Twisted Pair (UTP) cable can run Ethernet at speeds of 10 Mbps, 100 Mbps or, in the near future, 1000 Mbs (Gigabit Ethernet).

Copper

Generally, copper is installed as a UTP cable with 8 wires, color-coded in four pairs. A phone conversation needs only one pair to transmit and receive across a circuit between the telephone, and telephone office and back. Data communications generally use two pair for full duplex (simultaneous send and receive) communication. Copper also exists as thick and thin coaxial cable, which is the kind of cable used to transmit cable television signals. "Coax" has a copper core surrounded by plastic, a layer of metal foil or mesh, and insulation.

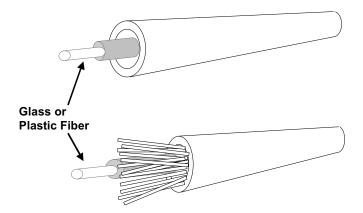
Coaxial and UTP Cable



Fiber-Optic

Fiber-optic cable is made of glass that has been drawn or pulled into a thin fiber. The great advantage of fiber-optic over copper cable is the ability to transmit without interference from other electromagnetic signals. Because of its higher cost, however, fiber is most often limited to use as a backbone in a network for transmissions between routers. However, as the price of fiber continues to drop, its use will increase. One drawback to fiber is its delicacy. Any extreme bending of the cable will result in a break in the fiber and that segment will need to be replaced because the cracked glass will refract the signal.

Fiber-Optic Cable





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Check Your Understanding

♦ Name and describe the function of five internetworking components.

- List several cable types.
- Describe a situation where the choice would be fiber-optic cable.

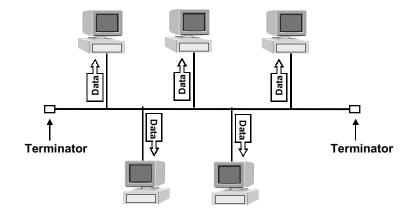
Network Topologies

There are different ways in which networks can be arranged. The layout of network devices and their paths of communication are called the topology of the network. The three basic types of network topology are bus, ring, and star.

Bus Topology

The earliest and easiest way to implement internetworking topology is bus topology. Bus topology receives its name because it functions somewhat like a bus route, an analogy frequently made by network administrators. People travel along a bus route, from end to end, getting on and off at various stops. With internetworking bus topology, data travels along a route from end to end and the workstations along the way make decisions about whether or not the data should continue or get off at their "stop." Data travels the length of the cable. Each computer looks at the destination address and either keeps it (accepts it) or ignores it (passes it on) depending upon its address. As with some bus routes, bus networks have a clear termination at either end. Without a termination, the signals would bounce back causing serious network errors. Bus networks were sufficient during the days of smaller, simpler networks, but today they are too inefficient for larger, more complicated internetworking designs.

Bus Topology

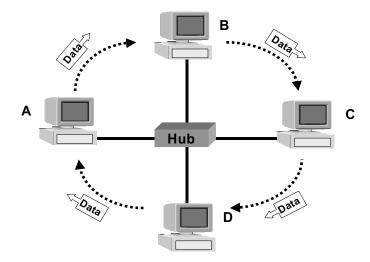




Ring Topology

Ring topology networks are similar to bus networks in that all devices are connected to a single wire. Unlike bus networks, however, there is no clear beginning or end to ring topology. All transmissions travel in one direction in a ring topology. While the network is logically a ring, it usually looks like a star physically because the devices are all connected to a central hub, which performs the ring function. Ring networks use tokens for media access, and workstations must have a token before they can transmit data packets. Each computer device on the ring examines the token and checks the destination address and decides either to keep it or pass it on. Ring networks are not as easy to maintain or expand as bus networks. Any interruption in the ring brings the entire network to a halt. In a bus, devices are merely off-line or on-line for different periods of time.

Ring Topology

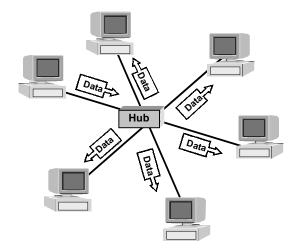


Star Topology

With star topology, data travels across a cable to a central point, called a hub or concentrator, making a design that looks like a star. A bus is created inside the hub with each device connected to a different port on the hub. All the information in a star topology network passes through the central device, making this topology easy to implement, manage, and troubleshoot.

Star topology configurations are quite common in today's LANs. The connections make use of installed telephone wiring schemes that branch from a central wiring closet to each device.

Star Topology

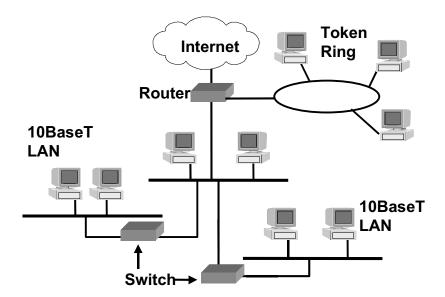




Hybrid (Mesh) Topology

As the name implies, hybrid (mesh) topology is any combination of the other three types of topology. The most common configuration for networks is a combination of star topologies with the hubs connected to a bus topology. This bus line of hubs is often referred to as the backbone of the network, and, as with a human spinal cord, it brings data to and from every corner of the entity.

Mesh Topology



Check Your Understanding

- ♦ Describe bus, star, ring, and hybrid (mesh) topologies, listing advantages and disadvantages for each.
- Give an example of when a network administrator would choose bus topology; star topology; ring topology, and hybrid topology.

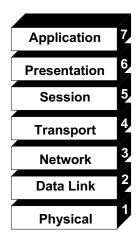


Networking Standards/OSI

In order to communicate with each other, computer devices on networks have standard ways of "speaking" with one another. In the earliest days of networking, there were no internationally recognized standards or protocols. As time went on, it became apparent that standards were essential for efficient, reliable global communication. This led to the advent, in the 1980s, of the OSI Reference Model, a seven-layer set of protocols that serves as a model for other protocols used in networking. When we meet a person and begin a conversation, we must speak the same language, understand the language being used by the other individual, or have an interpreter. Networking protocols enable computer devices from a variety of vendors to communicate with one another.

The Open Systems Interconnection (OSI) Reference Model describes how computers and protocols communicate with each other and attempts to standardize the ways in which they do this. This model, developed by the International Standardization Organization (ISO) has been voluntarily accepted as a set of standards by which network communication can occur.

The Seven Layers of the OSI Reference Model

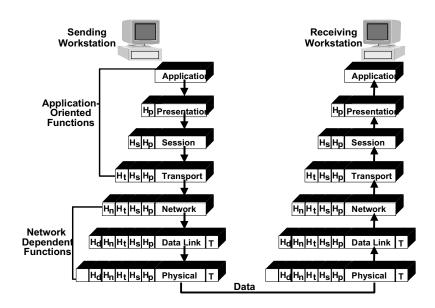


The bottom three layers, the physical, data link, and network layers, are concerned with network dependent functions. The upper layers (transport, session, presentation, and application) deal with user or software functions. This is covered in greater detail in the *Internetworking Fundamentals* course but will be briefly reviewed here.

What is important to remember about the OSI model is that data travels down the layers from the sending device and up the layers to the receiving device, as well as communicating across peer levels (i.e., network layer to network layer.) For example, sending an email message from one workstation to another involves the seven-layer protocol stack as follows:

- The physical cables from each workstation at Layer 1.
- The switching of the Ethernet or token ring data packets at Layer 2.
- The network packet headers being added and stripped off at Layer 3.
- The protocol to transmit the message at Layer 4.
- The identification of the logged-on (or not) user in the session layer, Layer 5.
- The formatting of the data in a window or full-screen in the presentation layer, Layer 6.
- The translation of the message into the particular email program in use at both the sender's and receiver's computer in the application layer, Layer 7.

An E-mail Travels Through the Seven Lavers of the OSI Model



This is clearly an over-simplification, but the important thing to remember is that data transmissions happen in many ways at once, and networks need to provide the means for all of them to happen.



Check Your Understanding

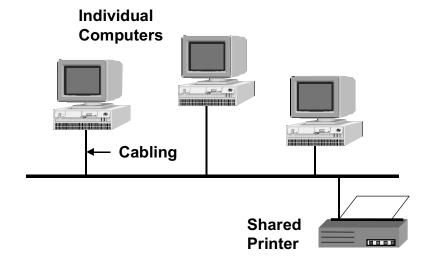
• Explain how the OSI Reference model functions in a network. Give an example.

Network Types

There are essentially two types of networks in use today: peer-to-peer and client/server.

In a peer-to-peer network, every computer on the network can share data with every other computer. In a peer-to-peer configuration, there is no single, central location for files. A small company may have five employees, each of whom is responsible for one function. One does advertising/marketing; another is the salesperson; the third is the engineer who plans new products; the fourth is the production manager who contacts factories to build their products; and the fifth may be the financial person who manages anything related to money. Each employee may have a need to see data on each of the other's computers, and a peer-to-peer network allows this to happen. In a peer-to-peer network, every workstation must be connected to every other computer device in that workgroup. Peer-to-peer networks are cost effective and easy to design and install. They do not, however, allow for central management, and they have a weak security system with limited growth potential.

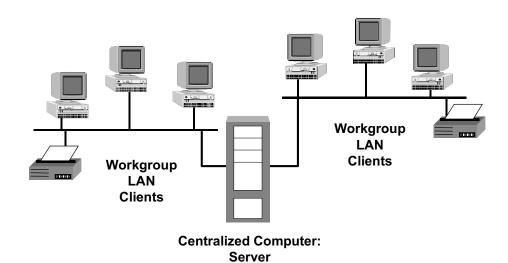
Peer-to-Peer Network





A more common configuration for computer networks is the client/server model, where one (or more) computers is designated as the server whose purpose is to provide shared information to other network devices, typically workstations.

Client/Server Network



In client/server networks, the client is a workstation that requests information from the server. The main advantages of this model are its scalability and the ease with which network management and security may be implemented. With a client/server network, devices need not all be connected to one another. It is only necessary to be connected to the network. Client/server networks are more expensive and difficult to set up and install than peer-to-peer networks and generally require a network administrator.

Check Your Understanding

- Describe peer-to-peer networking.
- Describe client/server networking.
- Give an example of when peer-to-peer would be the network of choice.
- Give an example of when client/server would be the network of choice.

LANs, MANs, and WANs

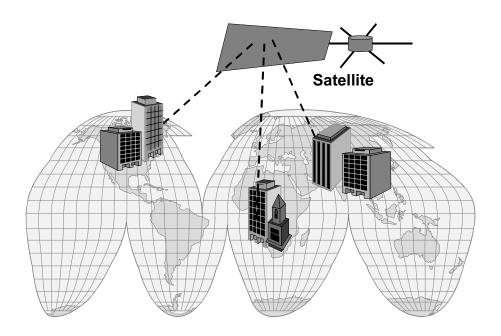
The network in your school or workplace may be considered your local network. The most common network form is called a local area network, or LAN. Much of our discussion of switching will refer to LANs, especially when we discuss individual devices and connectivity. But LANs can be combined into larger networks, and these networks can cover great geographical areas. The Internet is made of networks connected together spanning the entire globe, which forms the largest WAN on the globe.

A set of networks that exist in a city or region is sometimes referred to as a metropolitan area network (MAN). This may be because the network occupies historic space in older smaller buildings that are physically separated by several blocks. It may be that the merger of two smaller businesses in the same city formed a new company, and for many reasons, the decision was made to keep each part of the new company in its original space. You can probably think of other reasons why there may be networks that once existed alone and are now connected.



In the same way, there is sometimes a need to connect networks over larger areas than just a small metropolitan region. If you manufacture computers, you may be assembling your circuit boards in California, your cases in Brazil, your keyboards in Hong Kong, and your monitors in Nigeria. When someone in your company sends you an e-mail message asking when the next generation of PCs will be ready for shipment, you may need to check all of these locations. By connecting the networks in each of these places, a wide area network (WAN) is formed.

Wide Area Network



LANs are configured, planned, and installed at the local level. This is not necessarily the case with WANs. Instead, the means of transmitting data over large geographical spaces dictates the configuration of a WAN. In the example above, it may be easy to run cable to the keyboard factory in Hong Kong, but the monitor factory in Nigeria may have a problem that makes it unreliable to use cable connections. In this case, a geo-stationary satellite may be the solution.

One of the growing uses of the Internet is to connect LANs to form virtual WANs. Virtual WANs are not the same as a company's enterprise WAN, since they utilize networks other than their own. This necessitates security software to prevent unauthorized Internet users from entering LANs.

Check Your Understanding

• Describe a LAN, MAN, and WAN.

Network Operating Systems

A Network Operating System (NOS) is the set of software that manages the operation of a network. Network operating systems make it possible for computer users to share files and resources. Without a network operating system, users could not access a network. There are many different operating systems. The are two major categories: Windows and non Windows.

The Windows Family

Windows for Workgroups (WfW), also known as Windows 3.11, was one of Microsoft's first peer to peer networking protocols. The advantage of WfW was that it introduced many smaller, non Macintosh workplaces to the advantages of networking. Along with Windows 3.1's successor, Windows 95, it used Microsoft's small network protocol, NetBEUI. With the ability to run Transmission Control Protocol/Internet Protocol (TCP/IP) as well as Novell's IPX/SPX, WfW and Win95 were able to simplify networking in the Windows client world.

Windows 95/98





Windows NT (New Technology) was introduced in the late 1980's and is a client/server NOS. After some initial criticism, Windows NT has become a robust set of programs with extensive security features and different versions of software for the workstation and the server.

Non Windows

Novell NetWare was once the unquestioned leader in the world of Network Operating Systems, but it did not initially implement TCP/IP and was slow to do so. That, coupled with the advent of Windows NT, has caused it to lose some of its market share. Still, it is robust client/server software that is relatively easy to install and maintain.

UNIX was first developed at Bell Laboratories (now Lucent Technology) as an attempt to create an operating system for both workstations and shared servers. Since its original creation, there have been many versions, one of the most popular being the free software LINUX. UNIX/LINUX has been developed over many years by people all over the world, and thus is the world's most democratically created software. It is also very robust and secure, and has traditionally supported TCP/IP and internetworking. Many of the world's Web sites run on UNIX servers. UNIX is very closely tied to the programming languages C and C++. Although it is harder to learn than other Network Operating Systems, it remains the choice of many computer academics.

UNIX



AppleShare is software that provides network services for the Macintosh operating system. While in use in small or moderately sized workgroup settings and specialized fields such as graphic arts, it has not been adopted widely in large-scale corporate LAN environments. Apple built network capability into all of its personal computers, thus exposing the advantages of networking to general consumers. Apple computers frequently run other network operating systems.

Check Your Understanding

- What is the purpose of a Network Operating System?
- List several network operating systems.

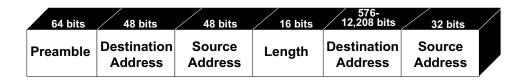
Network Architectures

Network architecture refers to the topology and protocols a network utilizes for transmission of data. The most common architecture currently is Ethernet architecture.

Ethernet

Ethernet is a broadcast topology (all signals go to all devices) that may be structured as a physical bus or, more commonly, a physical star and logical bus. The latter is accomplished by having all cable runs go to a common hub and having the hub act as the bus line.

Ethernet IEEE 802.3 Frame Format



Ethernet uses Carrier Sense Multiple Access/Collision Detection (CSMA/CD) when transmitting data. CSMA/CD is contention-based, which in a sense means, first-come is first-served. This sounds very complicated, but really isn't, especially if we break it into smaller parts to define it. "Carrier Sense" means that the Ethernet device checks to see if the line it wishes to transmit on is currently busy; if so, it waits until the line is free and then sends its packets. "Multiple Access" refers to the democracy of Ethernet—all devices have equal access to the network. Information can be transmitted at any time by any device, and, because of the broadcast nature of Ethernet, all devices will receive it. Only when there is a match between the destination address and the receiving device will it be processed.

"Collision Detection" means that devices can perceive when there is contention for the cable line. When two or more devices try to grab the line for a transmission, their signals collide. They then wait a randomly generated amount of time before trying a re-transmission. The reason this



is randomly generated is that, if every device waited, for example, exactly .002 seconds to re-transmit, they would keep colliding, over and over.

Other Network Architectures

Token Ring

Token Ring architecture is a physical star, logical ring topology introduced by IBM in the mid-1980s. The hub to which token ring devices connect is a special form of hub called a Multistation Access Unit (MAU). In token ring, a "token" is a 24-bit frame that continuously travels the ring. When a device wants to transmit data, it captures an unused token and encapsulates its data in the token, passing it on to its destination. (In order to send data, the computer device must have the token.) At the destination, the receiving device empties the token and sends it back to the sending device, which in turn resets the token as "available." If you think of yellow taxis roaming city streets as tokens, then the taxis that have riders are like full packets, while those looking for riders are like empty packets.

Token Ring Frame Format

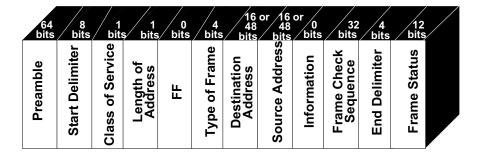
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	Start De	Access (Frame C	Destination Address	Source Address	RIF	DSAP	SSAP	CTR	Data	, S	End Del	Frame \$	
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Token ring is not as popular as Ethernet, for several reasons. First, most of the existing installs are either 4 or 16 Mbps, which is relatively slow given the speeds that Ethernet can approach. Another reason is that it has a complicated protocol, making it difficult to support.

Fiber Distributed Data Interface (FDDI)

Fiber Distributed Data Interface (FDDI) is a high-speed fiber optic technology that uses token passing to greater advantage than Token Ring. FDDI runs at 100 Mbps and uses dual-ring topology, instead of the single ring that token ring employs. One ring is called the "primary" and the other the "secondary." The secondary ring is typically used as a redundant backup and can take over for the primary in the event of any type of failure. The two rings can be connected by hubs or workstations; typically, a hub will connect to both rings whereas a workstation will connect to just the primary ring.

FDDI Frame Format





LocalTalk

LocalTalk began on the Apple Macintosh in 1984. It is intended to be a low-speed network for small workgroups (it operates at 230 Kbps) and originally used a shielded 2-wire copper cable. It uses a bus topology. Every Macintosh came with a LocalTalk port on the back, so the installation of a LocalTalk network (peer-to-peer) was simply a matter of plugging in the wires! For small departments with no computer support, this was a simple way to create a network.

Because of speed limitations, however, most Apple computers now use more common networking technologies, such as Ethernet.

ARCNet

Attached Resource Computer Network (ARCNet) was developed in the late 1970s and is fairly flexible in its topology, able to pass tokens in a bus, star or ring. It is rarely used today.

• Name the network architecture (FDDI, Token Ring, Ethernet, Local Talk, or

Check Your Understanding

RCNet).	· · · · · · · · · · · · · · · · · · ·
1	1. Uses dual ring topology.
2	2. Introduced in 1984 operating at 230 Kbps.
3	3. Uses hub called a Multistation Access Unit (MAU).
4	4. Relatively slow, 4-16 Mbps.
5	5. Proprietary, owned by IBM.
6	6. Contention based network.
7	7. Senses collisions.
8	8. Uses tokens, but rarely used today.
9	9. Uses high-speed fiber-optic cable.
10	10. Most popular network in use today.

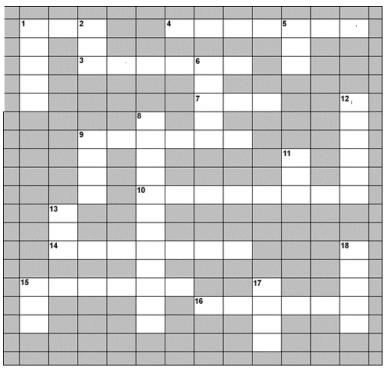
Try It Out

Materials Needed:

None







Across

- 1. LANs connected together over a local geographic area.
- 3. This device directs transmissions to specific workstations.
- 4. A device used to connect two networks using different communication protocols.
- 7. A topology with a clear termination at both ends.
- 9. Computer device that shares applications, print services, etc.
- 10. A network architecture where all signals go to all devices.
- 14. First-come, first-serve method of transmitting data.
- 15. A topology that uses a combination of bus, ring, and/or star.



16. Networking hardware used to pass information from one network segment to another.

Down

- 1. A device that converts between digital signals and analog signals.
- 2. Software that allows computer devices to communicate with one another.
- 5. Internet is the largest.
- 6. Category 5, fiber-optic, etc.
- 8. The application layer communicates with this layer.
- 9. Topology where data travels across a cable to a central point.
- 11. Created when two or more computers are linked.
- 12. A computer that uses shared resources located on the server.
- 13. A card that operates at both the physical and data link layer of the OSI model.
- 15. Another name for concentrator.
- 17. A network topology where termination devices are not necessary.
- 18. This ring architecture uses a _____ passing access method for transmitting data.

Rubric: Suggested Evaluation Criteria and Weightings:

Criteria	%	Your Score
On time delivery of assignment	10	
Accurately completed puzzle	90	
TOTAL	100	

Stretch Yourself

Materials Needed:

- Three (3) workstations
- Hub
- Switch
- Router
- STP/UTP Category 5, crossover cable with RJ-45 connectors
- STP/UTP Category 5 straight through cable with RJ-45 connectors
- Serial console/modem cable with 9-pin receptacle at one end and a 25-pin plug at the other end (Model 110307 Nortel Networks)
- Standard AT serial cable with a 25-pin plug
- Null modem crossover adapter with two 25-pin receptacle connectors (Model 1103078 Nortel Networks)

Build a LAN and WAN Network

In previous NetKnowledge courses, you acquired the skills necessary to connect computer devices to form both a LAN and WAN. Use your portfolio from earlier course(s) to assist you in building the LAN and WAN. Record your experiences during this activity in your portfolio. Be sure to document any problems you encounter during this activity and how you troubleshoot them.

Separate into two groups and work with your group to build a LAN with at least three workstations, two hubs, a switch, and a router. The LAN must adhere to accepted networking standards.

Your group is expected to complete this task with little or no assistance from your instructor. This may involve some review and research. Your instructor will make available the NetKnowledge *Internetworking Fundamentals* course materials, if necessary.

Diagram the LAN. Complete two different sketches, one showing the front of the hardware devices, and the other showing the back of the devices. Label all ports and interfaces, label the cables and indicate whether they are straight through or crossover. If need be, refer to the manuals that come with the hardware.

When the hardware for the two separate LANs is functioning, coordinate with the other groups to connect and form a WAN.

Diagram the WAN. Check the MAC addresses of the devices and accurately label the hardware on the diagram.





Rubric: Suggested Evaluation Criteria and Weightings:

Criteria	%	Your Score
Followed directions and completed task in a timely fashion	10	
Independent research and troubleshooting with little or no assistance from instructor	10	
Selected correct interfaces, cabling, etc., for building the network	10	
Active, cooperative group participation	20	
Diagrams of LAN and WAN with MAC addresses and hardware parts accurately labeled	20	
Successful LAN connectivity	10	
Successful WAN connectivity	10	
Documentation included in portfolio	10	
Other		
TOTAL	100	

Network Wizards

Materials Needed:

BayStack 10/100 Autosense 350T Switch and owner's manual





In this lab, you will become familiar with the BayStack 10/100 Autosense 350T Switch. If you have not yet taken the NetKnowledge Routing course, use the documentation that comes with the switch, work with another student who has taken the course, or search the Nortel Networks Internet site to assist you with the questions in this lab.

- 1. Keep notes of your progress during this lab in your portfolio. Include all diagrams.
- 2. Diagram and label the components of the switch. Complete a diagram of both the front and back panels. Place the diagram in your portfolio.
- 3. Does the switch support Spanning Tree Protocol (STP)?
- 4. What is Spanning Tree Protocol (STP) IEEE 802.1d?
- 5. Why is IEEE 802.1d important?
- 6. Which Management Information Bases (MIBs) does the switch support?
- 7. Does the switch support Telnet?
- 8. What are the four modes of compliance with IEEE 802.3u supported by the switch?



- 9. What is multilink trunking?
- 10. Is the switch capable of multilink trunking?
- 11. What is the MAC address of the switch your group is using?
- 12. Why is a correct MAC address for your particular switch important? When troubleshooting the BayStack 350T Switch, it is helpful to know what the LED displays indicate. Answer the following questions about the LED indications. For example, when the Power LED is green, it means that the DC power is available to the switch's internal circuitry.
- 13. When the diagnostics LED is green, what does that indicate?
- 14. When the 100 LED (100BASE-FX/TX port status) is green, what does that indicate?
- 15. When the 10 LED (10BASE-T port status) is yellow what does that indicate?

- 16. When the F Dx LED (Full duplex port status) is green, what does that indicate?
- 17. When the Port Activity LED is green, what does that indicate?

Rubric: Suggested Evaluation Criteria and Weightings:

Criteria	%	Your Score
Complete, accurate answers to questions, indicating a thorough understanding of concepts	45	
Portfolio entries complete	15	
On time delivery of assignment	10	
Professional quality switch diagrams	30	
Other		
TOTAL	100	



Summary

Network Review

In this lesson, you learned to do the following:

- Explain the need for computer networks
- Name and describe the function of basic internetworking components
- Describe ring, star, bus, and hybrid topologies and list some advantages and disadvantages of each
- Describe the function of the OSI Reference Model in networking
- Describe peer-to-peer and client/server networks and the benefits of each
- Describe a LAN, MAN, and WAN
- List several types of cables
- Identify the purpose of, and list several network operating systems
- Identify Ethernet, Token Ring, Fiber Distributed Data Interface, LocalTalk, and ARCNet network characteristics

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Networking Review

Multiple Choice

Directions: Select the best answer.

- 1. You have to build a network in a manufacturing facility where security is an issue and cost is not a factor. Which type of cable would you use?
 - a. Category 5 STP
 - b. IBM Type 7
 - c. UTP
 - d. Fiber-optic
 - e. Wireless
- 2. Why were standards committees formed?
 - a. To change the OSI model
 - b. To develop new technologies
 - c. To help achieve interconnectivity among vendors
 - d. All of the above
- 3. Which network architecture sends data as broadcast transmissions?
 - a. Token Ring
 - b. FDDI
 - c. ARCNet
 - d. Ethernet
 - e. LocalTalk



4.	Which	network	architecture	is a	dual	ring	topolo	gy'	?
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- a. Token Ring
- b. FDDI
- c. ARCNet
- d. Ethernet
- e. LocalTalk
- 5. Which network architecture operates at 230 Kbps and originally used a shielded 2-wire copper cable?
 - a. Token Ring
 - b. FDDI
 - c. ARCNet
 - d. Ethernet
 - e. LocalTalk
- 6. Which network architecture uses CSMA/CD?
 - a. Token Ring
 - b. FDDI
 - c. ARCNet
 - d. Ethernet
 - e. LocalTalk
- 7. Which type of cabling is the easiest to install and the most cost effective for a five device office where the computers are all lined up in a row?
 - a. Wireless
 - b. Fiber-optic
 - c. Coaxial
 - d. Twisted-pair

- 8. Which of the following is true of bus topology?
 - a. If a device malfunctions, the entire network crashes
 - b. It requires a token to transmit data
 - c. It is the most difficult design to configure
 - d. It provides excellent security
- 9. The following is true of ring topology.
 - a. Network segments must be terminated
 - b. It is the easiest topology to implement
 - c. Each computer device examines the packets and decides whether to keep it or pass it on
 - d. All transmissions travel in one direction
 - e. Both c and d
- 10. The formatting of data takes place at which layer of the OSI model?
 - a. Application
 - b. Presentation
 - c. Physical
 - d. Network
 - e. Transport
- 11. The transmission of data takes place at which layer of the OSI model?
 - a. Application
 - b. Presentation
 - c. Physical
 - d. Network
 - e. Transport



- 12. Which of the following is a characteristic of a server-based network?
 - a. Individuals are responsible for their own security
 - b. There is no central location for a data base
 - c. Is managed from a central location
 - d. It has a dedicated server
- 13. How many computers can transmit at a time with Token Ring topology?
 - a. All computers on the network
 - b. One computer
 - c. Both the source and destination devices
 - d. Only the source device
 - e. Only the destination device
- 14. How many computers can transmit at a time with bus topology?
 - a. All computers on the network
 - b. One computer
 - c. Both the source and destination devices
 - d. Only the source device
 - e. Only the destination device
- 15. You are hired to install a network where the president of the company will manage the network and not hire a network administrator. What concerns should you address with the president?
 - a. Her or his networking knowledge/ability
 - b. How long he or she has worked for the organization
 - c. How many customers he or she has
 - d. How large the facility is
- 16. What are the rules or standards used when building networks?
 - a. Resources
 - b. Data transmissions
 - c. IEEE
 - d. Protocols

- 17. Of the following, why might you want to install a network?
 - a. To share data
 - b. To share a printer
 - c. To communicate via e-mail
 - d. To share applications
 - e. All of the above
- 18. A network that includes several buildings over a small geographical area is called what?
 - a. Local area network
 - b. Wide area network
 - c. Metropolitan area network
 - d. Workgroup area network
- 19. Circle all of the following that are types of networks
 - a. Local area network
 - b. A city's plumbing infrastructure
 - c. A Cable Television company's infrastructure
 - d. A Telephone Company's infrastructure
 - e. All of the above



20.	W]	hat is	NOT	one of	the 7	layers	of the	OSI	Model:
	a.	Tran	sport						

- b. Session
- c. Communication
- d. Data Link
- 21. When computer devices communicate with one another on an equal basis, it is referred to as what?
 - a. Local server networking
 - b. Client/peer networking
 - c. Peer/client networking
 - d. Peer-to-peer networking
- 22. Which of the following operate at the physical layer of the OSI?
 - a. Routers, cables, and NICs
 - b. Cables, NICs, and satellites
 - c. Cables, repeaters, and connectors
 - d. Cables, switches, and NICs
- 23. A Token Ring LAN may have a physical star topology, but the logical topology of a Token Ring LAN is always a _____.
 - a. Bus
 - b. Ring
 - c. Star
 - d. Mesh

- 24. When choosing the transmission media for a network, an administrator should consider which of the following?
 - a. Electromagnetic Interference
 - b. Crimping tools
 - c. Age of the building
 - d. Both a and c
 - e. Both a and b
- 25. Which communications media is the most likely to be the most expensive to install and maintain?
 - a. Coaxial Cable
 - b. Fiber-optic cable
 - c. UTP Cable
 - d. STP cable
- 26. When is peer networking appropriate for your network?
 - a. Security is a major concern
 - b. Lost data is a major concern
 - c. Your network consists of 10 users
 - d. You have large data bases
- 27. A network administrator should seriously consider centralizing the network when the following conditions occur.
 - a. You need to have files backed up
 - b. You anticipate increased growth
 - c. Need a reliable network
 - d. Both a and c
 - e. All of the above
- 28. Which of the following uses NetBEUI protocols?
 - a. AppleShare
 - b. Novell NetWare
 - c. UNIX
 - d. Windows 95



29. FDDI is a fiber-optic network based on which type of topology?

- a. Bus
- b. Star
- c. Ring
- d. Hybrid(Mesh)
- 30. Of the following, which is considered media?
 - a. Television
 - b. Radio signals
 - c. Fiber-optic cable
 - d. Microwave signals
 - e. All of the above
- 31. Which topology is the easiest to troubleshoot?
 - a. Star topology
 - b. Bus topology
 - c. Ring topology
 - d. Hybrid topology

32.		nen referencing the OSI Model: are Layer 1 (physical); are Layer 2 (data link); are Layer 3 (network)?
	a.	Routers; hubs; NMMs
	b.	Hubs; switches; routers
	c.	UTP cables; routers; hubs
	d.	IEEEs; ISOs; IABs
33.		gically, a star network transmits data like which of the following ologies?
	a.	Star topology
	b.	Bus topology
	c.	Ring topology
	d.	Hybrid topology
34.	Wh	nich network access method does FDDI use?
	a.	CSMA/CA
	b.	Token Passing
	c.	CSMA/CD
	d.	NetBEUI
35.		nich of the following devices must be installed in a computer in order it to access the LAN?
	a.	Modem
	b.	Sound Card



c. Server

d. Network Interface Card (NIC)

Scoring

Criteria	Points	Your Score
Check Your Understanding		
Explain the need for computer networks	10	
Name and describe the function of basic internetworking components	12	
Describe ring, star, bus, and hybrid topologies and list some advantages and disadvantages of each	12	
Describe the function of the OSI Reference Model in networking	12	
Describe peer-to-peer and client/server networks and the benefits of each	10	
Describe a LAN, MAN, and WAN	10	
List several types of cables	10	
Identify the purpose of, and list several network operating systems	12	
Identify Ethernet, Token Ring, Fiber Distributed Data Interface, LocalTalk, and ARCNet network characteristics	12	
Try It Out: Networking Vocabulary Review	100	
Stretch Yourself: Classroom Networking Presentation	100	
Network Wizards: Build a Network	100	
Lesson Review	100	
TOTAL	500	

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