

Intro to Networking



IST 523

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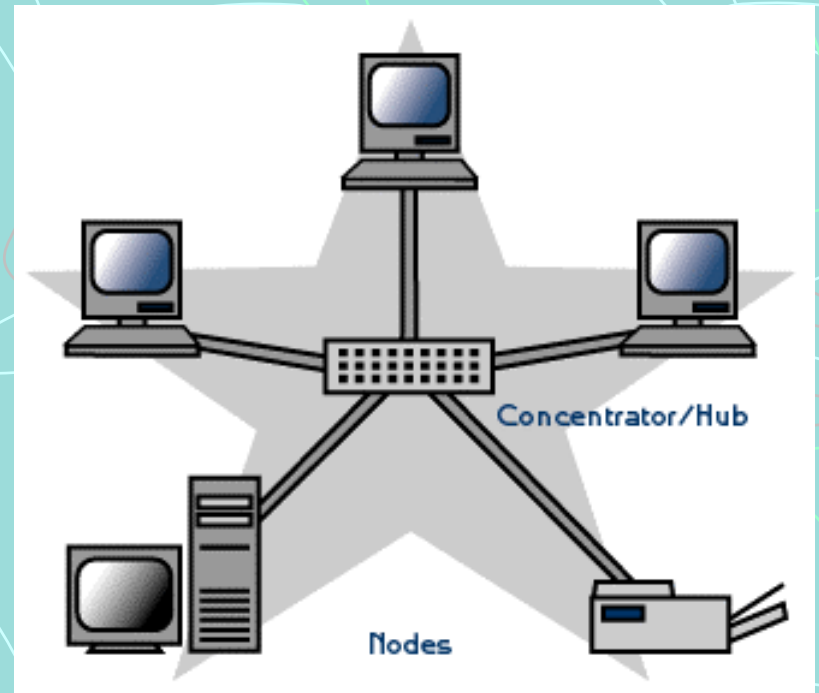
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Networking topics

- Types of networks
- Overview of networking hardware
- Cables
- Wireless
- Topologies
- Network operating systems

Types of networks





What is a network?

- two or more computers that are linked
- share resources
- exchange files
- allow electronic communications



What are the types of networks?

- LAN (local area network)
- MAN (metropolitan area network)
- WAN (wide area network)



What is a LAN?

- a network that is confined to a relatively small area, such as a building
- typically one computer is designated as the file server
- file server stores all of the software that controls the network and that can be shared
- computers connected to LAN are workstations
- usually computers are connected by cables



What is a MAN?

- covers larger geographic areas than a LAN, such as cities or school districts
- interconnecting smaller networks within a large geographic area allows for easy dissemination of info over the network



What is a WAN?

- a geographically dispersed telecom network
- connects larger geographic areas, such as New York, the United States, or the world
- dedicated transoceanic cabling or satellite uplinks may be used to connect to this type of network



Why install a network?

- Speed
- Cost
- Security
- Centralized software maintenance
- Resource sharing
- E-mail
- Flexible access
- Workgroup computing



Why not install a network?

- Expensive
 - Initial costs (install)
 - Ongoing (maintenance)
- File server may fail
- Cables may break



Network communications

- special sets of rules
- rules exist at several levels in a telecom connection
- hardware rules, software rules, and rules between each of several layers
- both end points in the communication must recognize and observe the rules
- these rules, called protocols, are often described in an industry or international standard



Protocols are important

- govern the communications between computers on a network
- include guidelines that regulate the network's access method, allowed physical topologies, types of cabling, and speed of data transfer
- most common protocols are Ethernet, LocalTalk, Token Ring, FDDI, and ATM



What is Ethernet?

- Most widely used networking protocol
- Uses CSMA/CD (Carrier Sense Multiple Access/Collision Detection)
 - each computer listens to the cable before sending anything through the network
 - if two computers attempt to transmit at the same instant a collision occurs
- Data can be transmitted over twisted pair, coaxial, or fiber optic cable at a speed of 10 Mbps up to 1000 Mbps



What is Fast Ethernet?

- allows for an increased speed of transmission that supports 100 Mbps
- requires the use of different, more expensive network concentrators/hubs and network interface cards
- category 5 twisted pair or fiber optic cable is necessary



What is gigabyte ethernet?

- Allows for a transmission speed of 1 Gbps
- primarily used for backbones on a network
- can be used with both fiber optic cabling and copper wire
- 1000BaseTX is the copper cable used for Gigabit Ethernet



What is LocalTalk?

- developed by Apple Computer, Inc. for Macs
- uses CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance)
 - similar to CSMA/CD except that a computer signals its intent to transmit before it actually does so
- adapters and special twisted pair cable can be used to connect a series of computers through the serial port.
- allows for linear bus, star, or tree topologies using twisted pair cable
- speed of transmission is only 230 Kbps.



What is Token Ring?

- Developed by IBM in the mid-1980s
- involves token-passing
 - computers are connected so the signal travels around the network from one computer to another in a logical ring
 - single electronic token moves around the ring from one computer to the next waiting for a PC to have data to transmit
- requires a star-wired ring using twisted pair or fiber optic cable
- transmission speeds are 4 Mbps or 16 Mbps



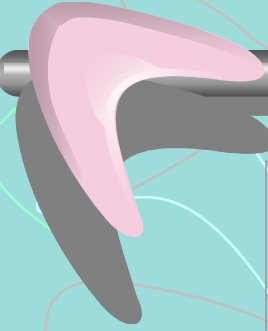
What is FDDI?

- Fiber Distributed Data Interface
- used primarily to interconnect two or more local area networks, often over large distances
- access involves token-passing
- uses a dual ring physical topology
- transmission normally occurs on one of the rings and if a break occurs, the system keeps information moving by automatically using portions of the second ring
- operates over fiber optic cable at 100 Mbps



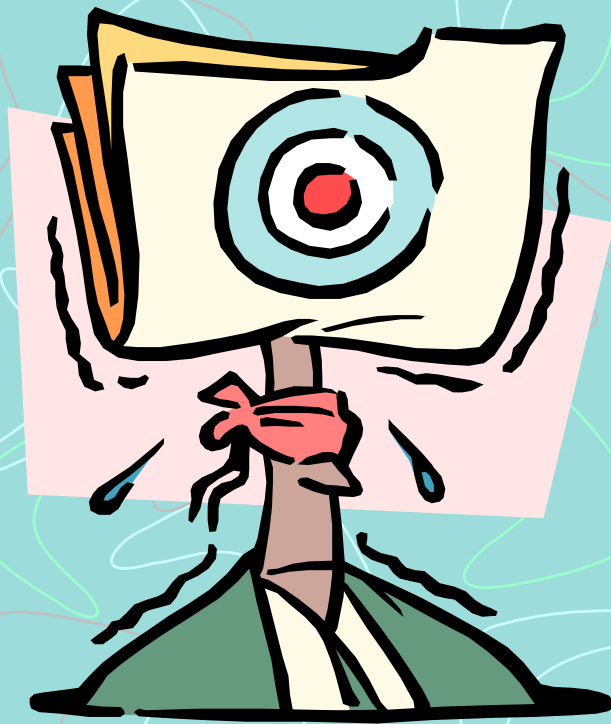
What is ATM?

- Asynchronous Transfer Mode transmits data at a speed of 155 Mbps and higher
- Transmits all data in small packets of a fixed size--other protocols transfer variable length packets
- supports a variety of media such as video, CD-quality audio, and imaging
- employs a star topology that works with fiber optic as well as twisted pair cable
- most often used to interconnect two or more local area networks or by ISPs



Protocol	Cable	Speed	Topology
Ethernet	Twisted pair, coax, fiber	10 Mbps	Linear bus, star, tree
Fast Ethernet	Twisted pair, fiber	100 Mbps	Star
LocalTalk	Twisted pair	.23 Mbps	Linear bus, star
Token Ring	Twisted pair	4 Mbps-16 Mbps	Star-wired ring
FDDI	Fiber	100 Mbps	Dual ring
ATM	Twisted pair, fiber	155-2488 Mbps	Linear bus, star, tree

Questions?

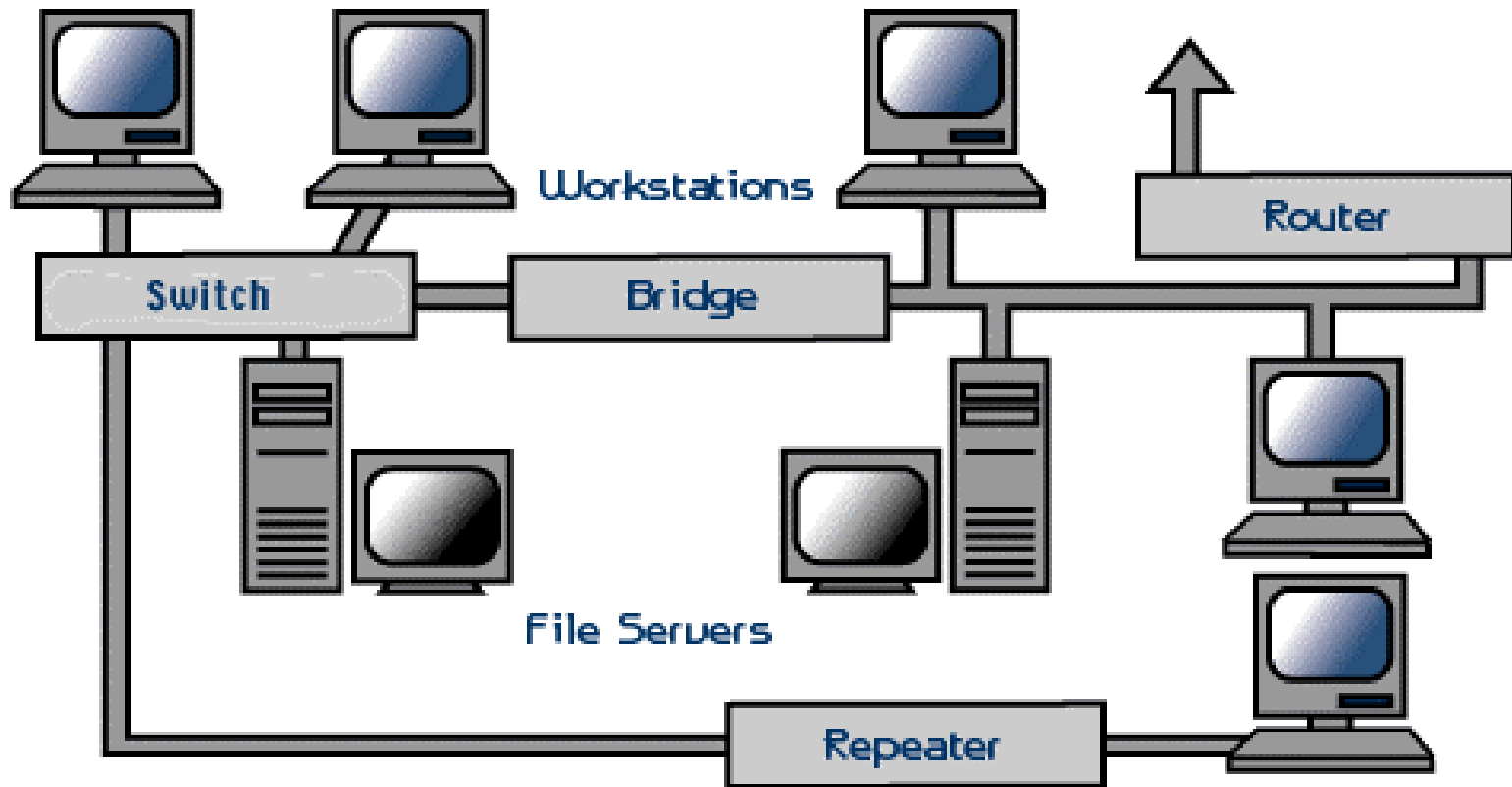




What is a node?

- a connection point on a network
- is either a redistribution point or an end point for data transmissions
- has programmed or engineered capability to recognize and process or forward transmissions to other nodes

Networking hardware





What is networking hardware?

- includes all computers, peripherals, interface cards and other equipment needed to perform data-processing and communications within the network
- networking hardware components include file servers, workstations, network interface cards (NICs), switches, repeaters, bridges and routers



What is a file server?

- the heart of most networks
- a very fast computer with a large amount of RAM and storage space and a fast NIC
- NOS software resides here, along with any software applications and data files that need to be shared or stored
- controls the communication of information between the nodes on a network
- requires a computer that can store a lot of information and share it very quickly



File server configuration example

- Pentium 4 or Xeon 2 GHz or faster microprocessor, or a PowerPC
- second microprocessor if needed
- fast hard drive (such as SCSI) with at least 60 gigabytes of storage
- 48x CD-ROM
- RAID (Redundant Array of Inexpensive Disks)
- Disk controllers
- A tape back-up unit
- Numerous expansion slots
- Fast NIC
- Network operating system
- Application software
- At least of 512 MB of RAM



What is a workstation?

- computer connected to the file server on a network
- typical workstation is a computer with a NIC, networking software, and the appropriate cables
- workstations do not necessarily need floppy disk drives or hard drives because files can be saved on the file server
- almost any computer can serve as a network workstation



What is a NIC?

- network interface card
- the physical connection between the network and the computer workstation
- most NICs are internal, with the card fitting into an expansion slot inside the computer
- laptops can have a NIC built-in or with network cards that slip into a PCMCIA (Personal Computer Memory Card International Association) slot



Why are NICs important?

- NICs are a major factor in determining the speed and performance of a network
- use the fastest network card available for the type of workstation you are using
- three most common network interface connections are Ethernet cards, LocalTalk connectors, and Token Ring cards
- according to a International Data Corporation study, Ethernet is the most popular, followed by Token Ring and LocalTalk



Ethernet card info

- usually purchased separately from a computer, although many PCs include an option for a pre-installed Ethernet card
- contain connections for either coaxial or twisted pair cables (or both)
- if designed for coaxial cable, the connection will be BNC (Bayonet Neil-Concelman, or sometimes British Naval Connector)
- if designed for twisted pair, it will have a RJ-45 connection
- some Ethernet cards also contain an AUI (attachment unit interface) connector, used to attach coaxial, twisted pair, or fiber optics cable
- AUI always has an external transceiver attached to the workstation



LocalTalk card info

- Apple's built-in solution for networking Macintosh computers
- utilizes a special adapter box and a cable that plugs into the printer port of a Macintosh
- major disadvantage is speed
 - most Ethernet connections operate at 10 Mbps (Megabits per second)
 - LocalTalk operates at only 230 Kbps (or .23 Mbps).



Token Ring card info

- look similar to Ethernet cards
- type of connector on the back end of the card is different
- generally have a nine pin DIN type connector to attach the card to the network cable
 - (DIN stands for **D**eutsches **I**nsitut *f*ür **N**ormung eV, the standards-setting organization for Germany)
 - DIN connector is a connector that conforms to one of the many standards defined by DIN
 - DIN connectors are used widely in PCs; the keyboard connector for PCs is a DIN connector).



Break time





What is a switch?

- a device that channels incoming data from any of multiple input ports to the specific output port that will take the data toward its intended destination
- on an Ethernet LAN a switch determines from the physical device (Media Access Control or MAC) address in each incoming message frame which output port to forward it to and out of
- on the Internet, a switch determines from the IP address in each packet which output port to use for the next part of its trip to the intended destination



More switch info

- **Switches are:**
 - Usually configured with 8, 12, or 24 RJ-45 ports
 - Often used in a star or star-wired ring topology
 - Sold with specialized software for port management
 - Also called hubs
 - Usually installed in a standardized metal rack that also may store netmodems, bridges, or routers



What is a packet?

- the unit of data that is routed between an origin and a destination on the Internet or any other packet-switched network
- Most modern WAN protocols (TCP/IP, X.25 and frame relay) are based on packet-switching technologies



What is packet-switching?

- Protocols where messages are divided into packets before sending
- each packet is transmitted individually and can follow different routes to its destination
- once all the packets forming a message arrive at the destination, they are recompiled into the original message



How is packet-switching different?

- normal telephone service is based on circuit-switching technology, where a dedicated line is allocated for transmission between two parties
- circuit-switching is ideal when data must be transmitted quickly and must arrive in the same order in which it's sent (real-time data such as live audio and video)
- packet switching is more efficient and robust for data that can withstand some delays in transmission, such as e-mail and Web pages



What is a repeater?

- device that electrically amplifies the signal it receives and rebroadcasts it
- signals lose strength as they pass along a cable and it is often necessary to boost the signal
- can be separate devices or incorporated into a concentrator
- used when the total length of network cable exceeds the standards set for the type of cable being used.



What is a bridge?

- a device that allows you to segment a large network into two smaller, more efficient networks
- monitors the information traffic on both sides of the network so that it can pass packets of information to the correct location
- manages the traffic to maintain optimum performance on both sides of the network
- like a traffic cop at a busy intersection during rush hour
- can be used to connect different types of cabling, or physical topologies (star, tree, etc.)



What is a router?

- translates information from one network to another
- similar to a superintelligent bridge
- selects the best path to route a message based on the destination address and origin
- can direct traffic to prevent head-on collisions
- smart enough to know when to direct traffic along back roads and shortcuts those sections until they clear up.
- Connects a LAN to the Internet



What is cabling?

- medium through which information usually moves from one network device to another
- several types of cable are commonly used with LANs
- some networks use only one type of cable, other networks will use a variety of cable types
- cable type chosen is related to the network's topology, protocol, and size
- connections to a LAN can also be wireless



What is twisted pair cabling?

- Twisted pair cabling comes in two varieties: shielded and unshielded
- Unshielded twisted pair (UTP) is the most popular and is generally the best option for library networks



What is UTP cable?

- Unshielded twisted pair (UTP) cable
- quality varies from telephone-grade wire to extremely high-speed cable
- cable has four pairs of wires inside the jacket
- each pair is twisted with a different number of twists per inch to help eliminate interference from adjacent pairs and other electrical devices
- tighter the twisting, the higher the supported transmission rate and the greater the cost per foot



What are the categories of UTP?

- EIA/TIA (Electronic Industry Association/Telecommunication Industry Association) has established standards of UTP and rated five categories of wire
 - Category 1 Voice Only (Telephone Wire)
 - Category 2 Data to 4 Mbps (LocalTalk)
 - Category 3 Data to 10 Mbps (Ethernet)
 - Category 4 Data to 20 Mbps (16 Mbps Token Ring)
 - Category 5 Data 100 to 1000 Mbps (Fast Ethernet)
 - Category 6 Data up to 400 MHz (Gigabyte Ethernet)
 - Category 7 Data 500-700 MHz (proposed standard)



What are the UTP connectors?

- standard connector for unshielded twisted pair cabling is an RJ-45 connector
- a plastic connector that looks like a large telephone-style connector
- slot allows the RJ-45 to be inserted only one way
- RJ stands for Registered Jack
- designates which wire goes with each pin inside the connector.



What is STP cable?

- Shielded twisted pair cable
- Suitable for environments with electrical interference
- Extra shielding can make STP cables bulky
- STP is often used on networks using Token Ring topology



What is coax cable?

- Coaxial cabling has a single copper conductor at its center
- plastic layer provides insulation between the center conductor and a braided metal shield
- metal shield helps to block any outside interference from fluorescent lights, motors, and other computers
- difficult to install but highly resistant to signal interference
- can support greater cable lengths between network devices than twisted pair cable



More coax cable info

- Thin coaxial cable is thinnet
- 10Base2 refers to the specifications for thin coaxial cable carrying Ethernet signals
- 2 refers to the approximate maximum segment length being 200 meters
- Thick coaxial cable is thicknet
- 10Base5 refers to the specifications for thick coaxial cable carrying Ethernet signals
- 5 refers to the maximum segment length being 500 meters



Coax cable connectors

- most common type of connector used with coaxial cables is the Bayone-Neill-Concelman (BNC) connector
- different types of adapters are available for BNC connectors
 - T-connector
 - barrel connector
 - Terminator
- connectors are the weakest points



What is fiber optic cable?

- consists of a center glass core surrounded by several layers of protective materials
- transmits light rather than electronic signals
- the standard for connecting networks between buildings, due to its immunity to the effects of moisture and lightning.
- has the ability to transmit signals over much longer distances than coaxial and twisted pair
- has the capability to carry information at vastly greater speeds
- 10BaseF refers to the specifications for fiber optic cable carrying Ethernet signals



More fiber optic cable info

- outer insulating jacket is made of Teflon or PVC
- Kevlar fibers help strengthen the cable and prevent breakage
- plastic coating is used to cushion the fiber center
- the center or core is made of glass or plastic fibers
- most common connector used with fiber optic cable is an ST connector
- newer connector, the SC, is becoming more popular

Wireless networks





What is wireless networking?

- used to describe telecommunications in which electromagnetic waves, high frequency radio signals, infrared light beams, or lasers (rather than some form of wire) carry the signal
- Most WiFi today is RADIO wave based
- workstations and file servers has some sort of transceiver/antenna to send and receive the data
- info is relayed as if physically connected
- longer distance wireless communications can also take place through cellular telephone technology, microwave transmission, or by satellite



More wireless networking info

- great for allowing laptop computers or remote computers to connect to the LAN
- beneficial in older buildings
- two most common types are line-of-sight and scattered broadcast
 - Line-of-sight communication=an unblocked direct line between the workstation and the transceiver
 - scattered infrared communication=a broadcast of infrared transmissions sent out in multiple directions that bounces off walls and ceilings until it eventually hits the receiver
 - communications with laser are virtually the same as line-of-sight infrared networks.



Wireless networking downsides

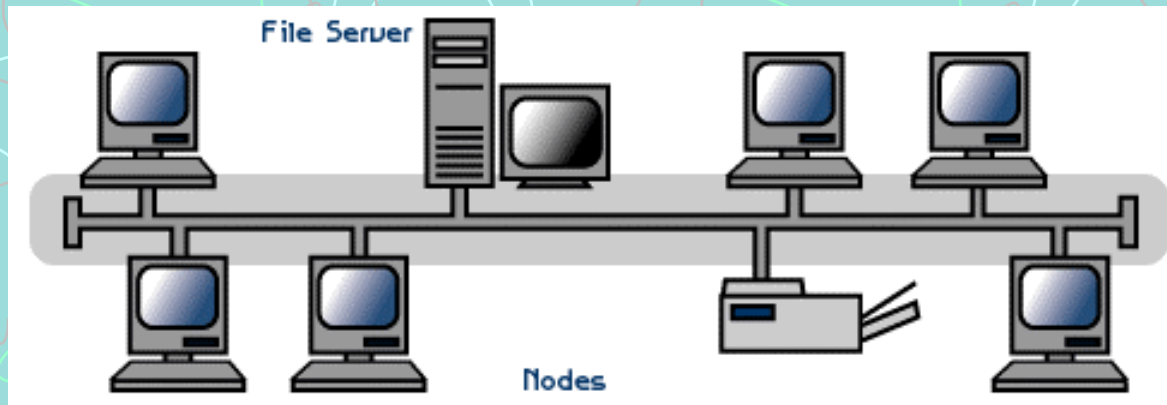
- provide poor security
- are susceptible to interference from lights and electronic devices
- are slower than LANs using cabling



What is a network topology?

- refers to the physical configuration of cables, computers, and other peripherals
- physical topology is not logical topology
 - Logical topology is the method used to pass information between workstations
 - Logical topology=protocols
- main types of physical topologies are linear bus, star, star-wired ring, and tree

Linear bus topology

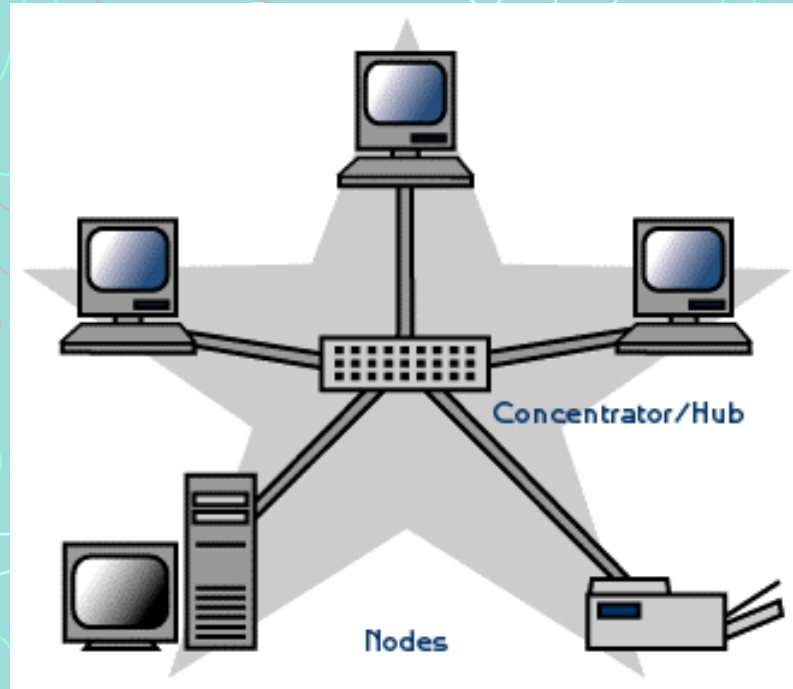




What is a linear bus topology?

- main run of cable with a terminator at each end
- all nodes are connected to the linear cable
- used by Ethernet and LocalTalk networks
- requires less cable than a star topology
- easy to connect a PC or peripheral
- require terminators at both ends of the backbone cable
- if there is a break in the main cable, the entire LAN shuts down

Star topology





What is a star topology?

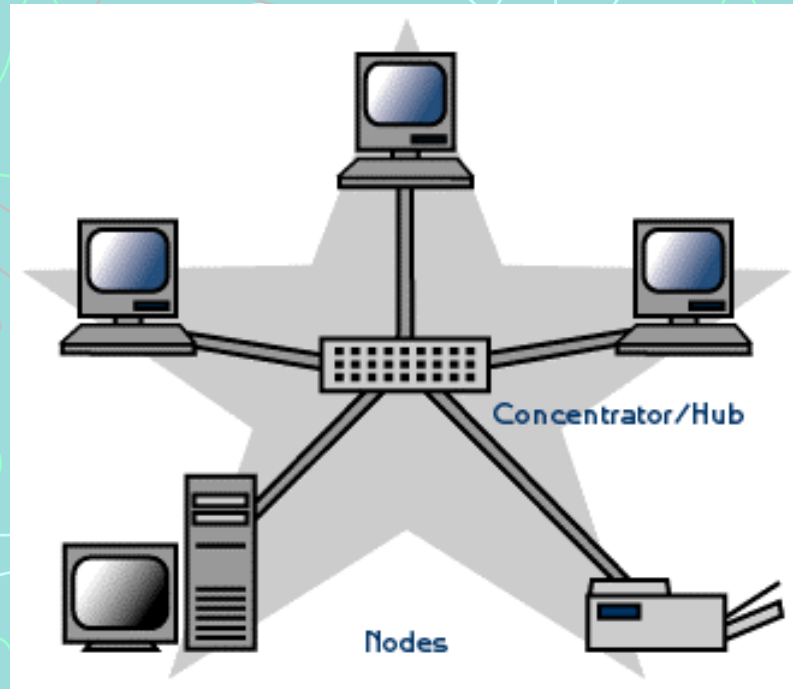
- designed with each node connected directly to a central network hub or concentrator.
- data passes through the hub or concentrator before continuing to its destination
- hub manages and controls all functions of the network
- hub acts as a repeater for the data flow
- common with twisted pair cable, but it can be used with coax or fiber
- Ethernet and LocalTalk are the protocols



More star topology info

- easy to install and wire
- there are no disruptions to the network when connecting or disconnecting devices to the LAN
- faults are easy to isolate
- require more cable length than linear topologies
- if the hub fails all the attached nodes are disabled
- concentrators are costly

Star-wired ring topology

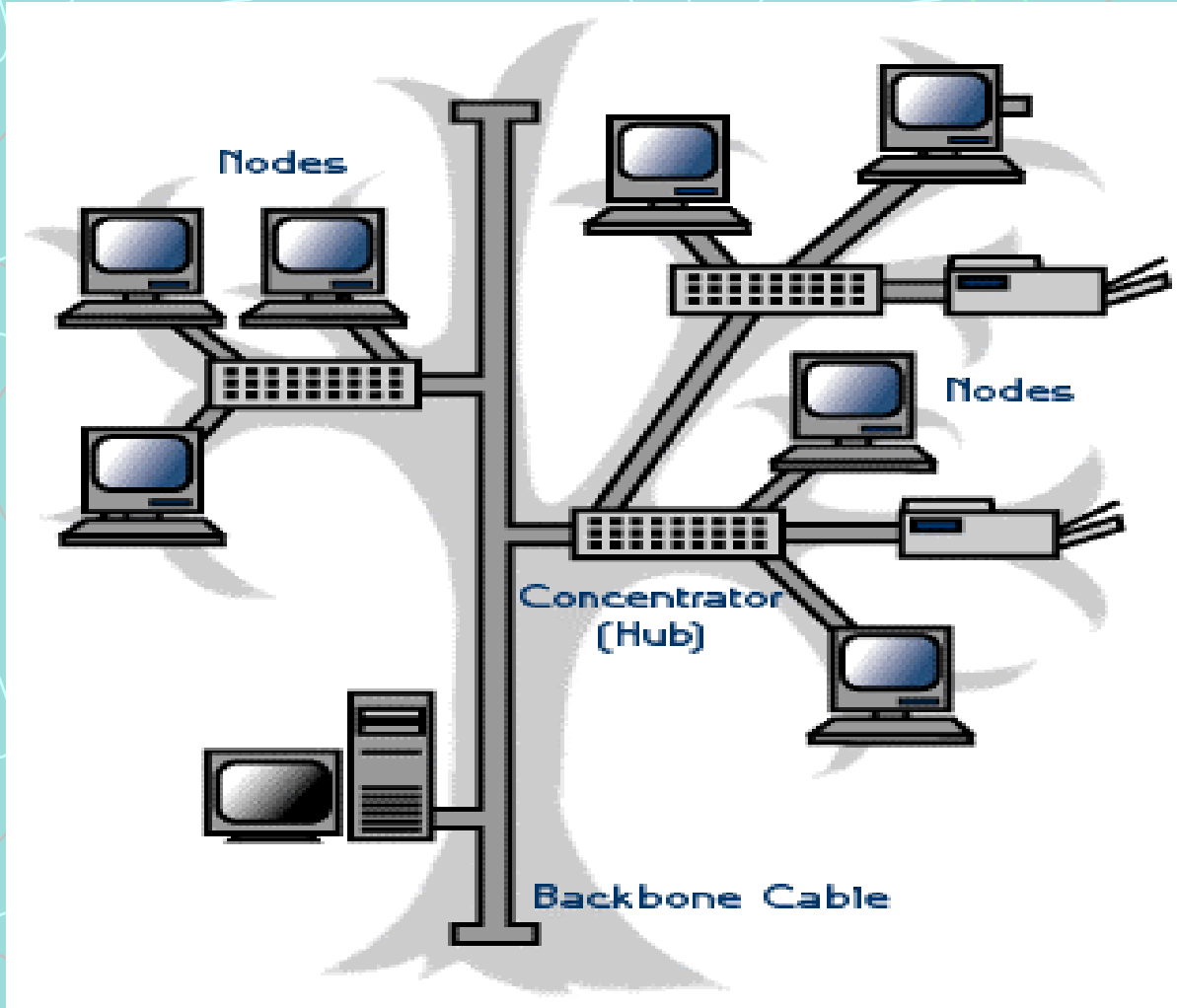




What is a star-wired ring topology?

- appears externally to be the same as a star topology
- internally the MAU (multistation access unit) contains wiring that allows information to pass from one device to another in a circle or ring
- Token Ring protocol uses a star-wired ring topology

Tree topology





What is a tree topology?

- combines characteristics of linear bus and star topologies
- consists of groups of star-configured workstations connected to a linear bus backbone cable
- allow for the expansion of an existing network
- allows for point-to-point wiring for individual segments



More tree topology info

- supported by several hardware and software vendors
- overall length of each segment is limited by the type of cabling used
- if the backbone breaks, the entire segment goes down
- more difficult to configure and wire




What to consider with topologies

- Money
- Length of cable needed
- Future growth
- Cable type

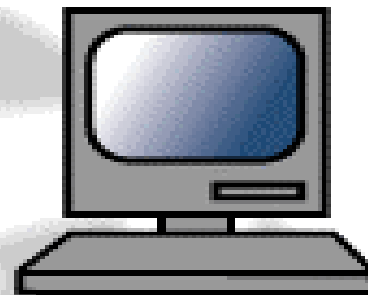
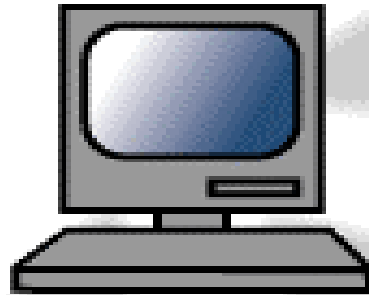


What is NOS?

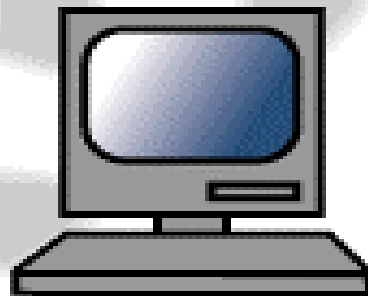
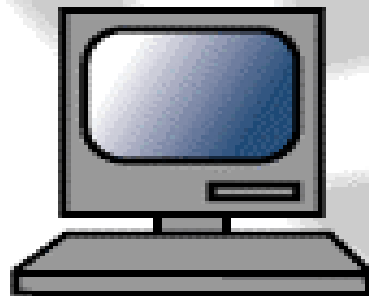
- Network operating system
- coordinates the activities of multiple computers across a network
- acts as a director to keep the network running smoothly
- two major types
 - peer-to-peer
 - client/server



Peer-to-peer



Resources are shared among equals
in a peer-to-peer network.





What is peer-to-peer?

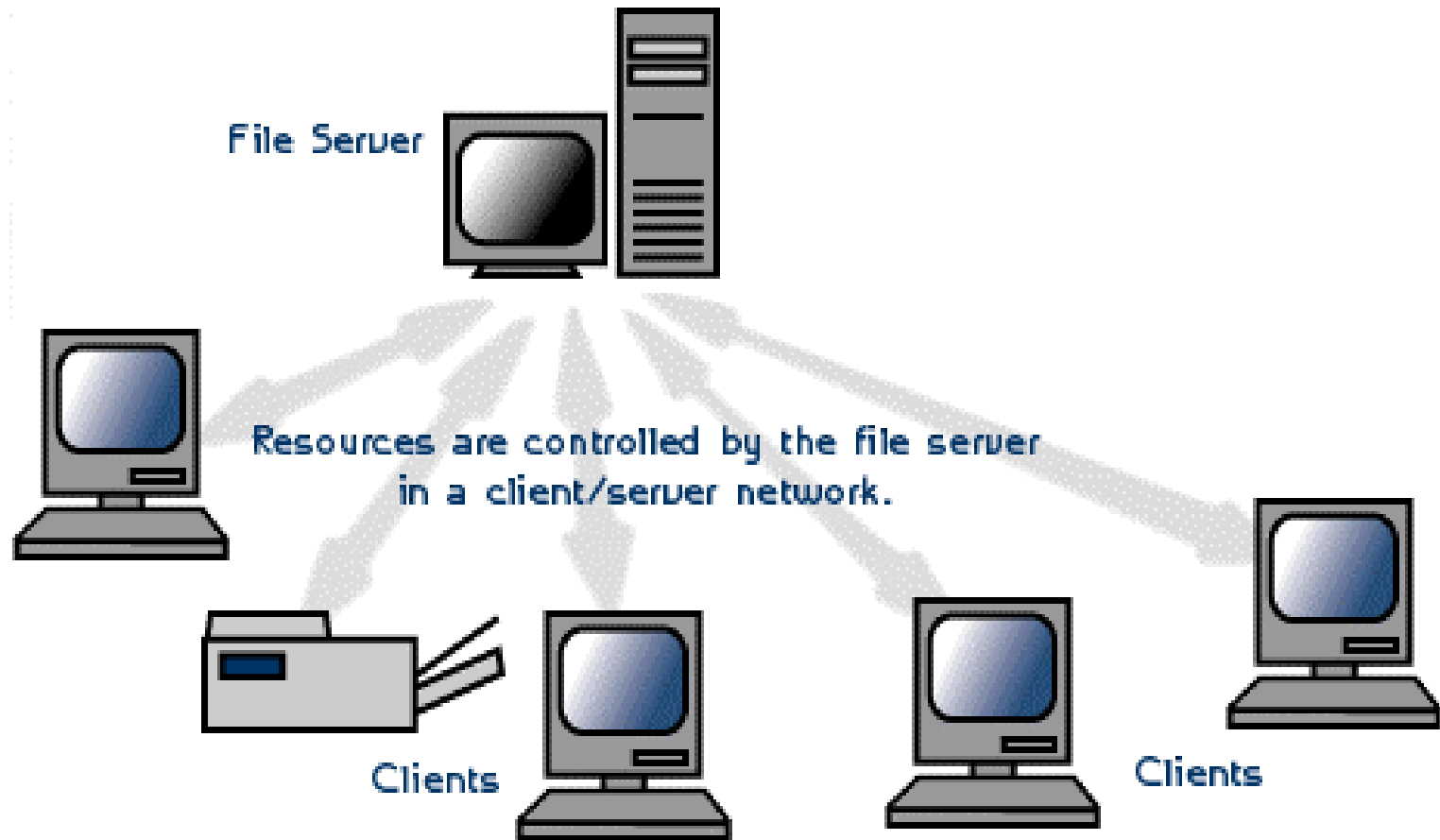
- can share resources and files located on computers and to access shared resources found on other computers
- do not have a file server or a centralized management source
- all computers are considered equal
 - all have the same abilities to use the resources available on the network
 - designed primarily for small to medium LANs
- AppleShare and Windows for Workgroups are examples.



More peer-to-peer info

- lower initial expense
 - no need for a dedicated server
- Decentralization is a downside
 - no central repository for files and applications
 - backups need to occur on each desktop
- have a lower level of security

Client-server





What is client-server?

- centralizes functions and applications in one or more dedicated file servers
- file servers become the heart of the system
 - provide access to resources
 - provide security
- Workstations (clients) access to the resources available on the file servers
- NOS provides the mechanism to integrate all the components of the network and allow multiple users to share the same resources
- Novell Netware and Windows 2000 Server are NOS examples



More client-server info

- centralized (all resources and data security is controlled via the server)
- scalable (elements can be replaced individually as needed)
- flexible (new technology can easily be integrated)
- interoperable (all components, the clients and the network and the server work together)
- accessible (the server can be accessed remotely and across multiple platforms)
- expensive (install and ongoing)

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Questions?

