

COMPUTER NETWORKS

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What is a Computer Network?

A network is the interconnection of two or more computers and other devices for the sharing of information and resources.

The computers must be linked by a medium such as cables, a wireless device or a telecommunications system in order to exchange data. The network may be limited to a group of users in a local area Network (LAN), or to a wide area network (WAN) covering several cities or regions, may cover the entire world as the Internet does.

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Reasons for Computer networks instead of standalone computers?

- To Allow people to share information,
- To enable sharing of software,
- To enable sharing of hardware.
- To enable communication between computer users through tools like e-mail.
- To enable data communication. i.e. transmission of electronic content over a given medium.
- To ensure security of data by putting in place administrative controls over the network.

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Advantages of computer networks

- Facilitates easy communications e.g. through Electronic mail
- Reduces on cost by sharing hardware like printers and sharing software
- it allows for tight control over who has access to data in the system
- It enables sharing of data and information stored on any other computer on the network.
- It enables online learning and collaborative research
- It allows access to free common databases and databanks like free software and ATM services

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Disadvantages of networks

- Easy spread of viruses and malware over the network
- Increased exposure hackers
- Can be expensive to setup e.g. high cost of network equipment.
- High administrative costs due to the need for network administration.
- The system comes to a standstill if there is a problem with the server.

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Components of a computer network

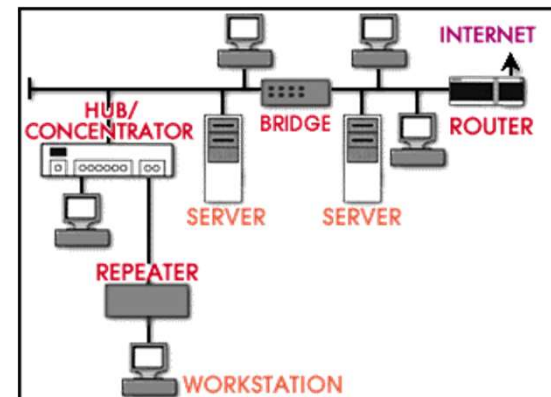
- Network hardware devices e.g. a network card
- Terminal nodes e.g. Computers and Printers
- Communication (Network) media/Channels
- Network software e.g. network protocols

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Network hardware devices

- Hubs/concentrators
- MODEM
- Switches
- Repeaters
- Bridges
- Routers
- Network Interface Cards (NICs)
- etc.

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Network Interface Cards (NICs)

- The NIC (or network adaptor) provides the link between your computer and your network.
- It provides the physical connection between the network and the workstation
- most NICs are internal, with the card fitting into an expansion slot inside the computer
- Some are built on the motherboard
- Type of NIC determines the speed and performance of a network.
- There are three common network interface connections: Ethernet cards, Local Talk connectors, Token Ring cards



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MAC address

- A Media Access Control address (MAC address) is a unique identifier assigned to network interfaces (NIC) for communications on the physical network segment.
- MAC addresses are most often assigned by the manufacturer of a network interface card (NIC) and are stored in its hardware, the card's read-only memory.

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Hubs/Concentrators/Aggregators

- A hub is a device whose primary function is to send and receive signals along the network between the nodes connected to it.
- It connects multiple devices to the network
- It is commonly found in star and star-wired ring topology networks
- The entire network shuts down if there is a problem on a hub
- It serves as a central meeting place for cables from computers, servers and peripherals on the network
- It is usually configured with 4, 8, 12, or 24 RJ-45 ports



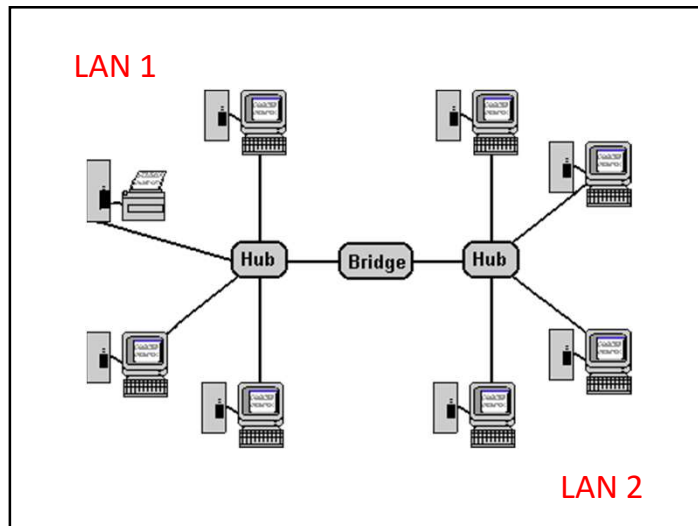
Repeaters

- A repeater is a device that is used to regenerate and amplify signals along a communication channel to create long-distance networks by placing it between two segments of the network channel.
- It simply receives, amplifies and rebroadcast the signals
- It can exist as a separate device on the network or it can be incorporated into a concentrator
- It is a relatively cheap device to buy and use to overcome distance limitations



Bridges

- A bridge is a device that links two local area networks . It accepts all packets from each network addressed to devices on the other, buffers them, and retransmits them to the other network.
- It is often used when LANs reach their capacity of nodes to separate them.
- It connects two or more networks using the same address method or protocol
- It monitors and manages the data traffic to maintain optimum performance on both sides of the network



Switches

- A network switch is a computer networking device that connects devices together on a computer network
- A switch is a high-speed multiport bridge. Today, switches are replacing multiport repeaters or concentrators in a UTP environment.
- The switch maintains a bridging table, keeping track of which hardware addresses are located on which network segment

It maps the IP address with the MAC address of the LAN card.

Unlike the hubs, a switch does not broadcast the data to all the computers, it sends the data packets only to the destined computer.

In an Ethernet network, computers are directly connected with the switch via twisted pair cables



Router

- A router is a device that links one network to other physically and logically separate networks.
- The main function of the router is sorting and the distribution of the data packets to their destinations based on their IP addresses. Routers provides the connectivity between the enterprise businesses, ISPs and in the internet infrastructure.

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Linksys Wireless Router



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Gateway

A gateway is a hardware device that acts as a "gate" between two networks.

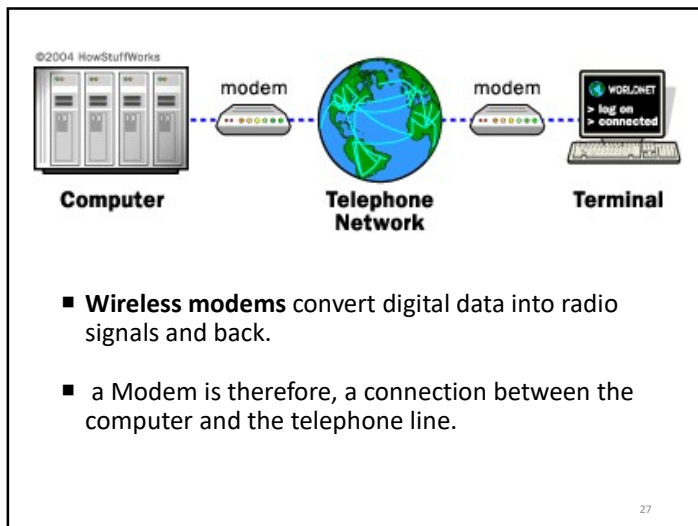
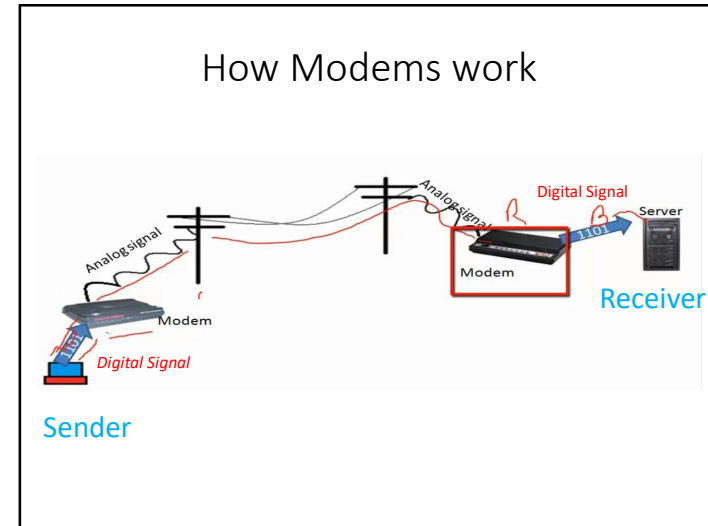
Gateways are used to regulate network traffic between two or more different networks

It may be a router, firewall, server, or other device that enables traffic to flow in and out of the network.

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MODEM (MOdulator/DEModulator)

- A modem is a network hardware device that converts digital signals generated by the computer into analog signals which can be transmitted over a telephone or cable line and transforms incoming analog signals into their digital signals.



Fax modem

- A fax modem enables a computer to transmit and receive documents as faxes. A fax modem is like a data modem but is designed to transmit and receive documents to and from a fax machine or another fax modem.
- Some, but not all, fax modems do double duty as data modems. As with other modems, fax modems can be internal or external. Internal fax modems are often called fax boards.

What is a fax machine?

- Fax, sometimes called (facsimile machine) telecopying or telefax, is the telephonic transmission of scanned printed material, normally to a telephone number connected to a printer or other output device.

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Quick Business Hacks

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Communication media/channels

Also known as communication links or Data links

- a communication channel is a medium over which Data travels/ is transmitted from one computer(device) to another.
- There are both physical (cable or wired) media, and wireless media.

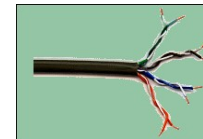
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Types of cable media

■ Twisted pair cables

A twisted pair cable consists of eight insulated copper wires twisted in pairs and arranged in a regular spiral pattern to minimize the electromagnetic interference between adjacent pairs

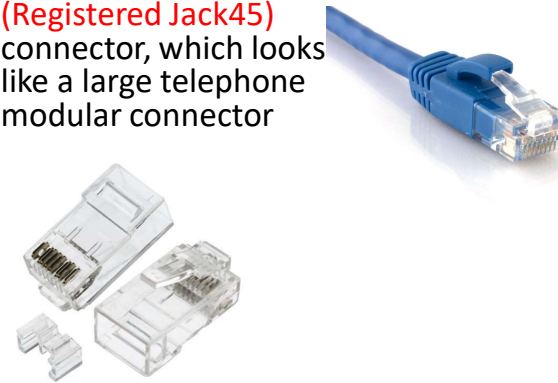
there are two types; shielded twisted pair (STP) and unshielded twisted pair (UTP)



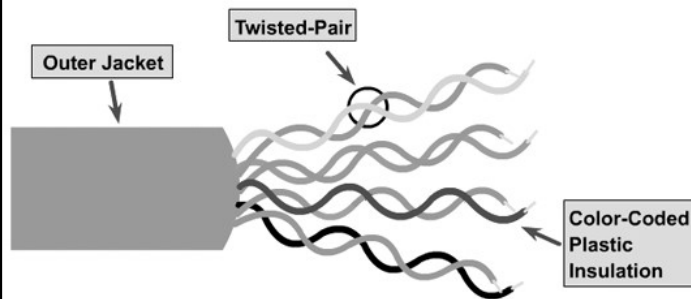
- the most popular and is generally the best option for school networks Categories of UTP Cable
- Category 1 Voice Only (Telephone Wire)
- Category 2 Data to 4 Mbps (Local Talk)
- Category 3 Data to 10 Mbps (Ethernet)
- Category 4 Data to 20 Mbps (16 Mbps Token Ring)
- Category 5 Data to 100 Mbps (Fast Ethernet)
- Category 5 cable is widely used for a 10 Mbps Ethernet network
- Category 5 enhanced (Cat5e), is an improvement on Category 5 cabling.
- It was made to support 1000 Mbps "gigabit" speeds, hence faster than Cat5.
- It also cuts down on crosstalk, the interference you can sometimes get between wires inside the cable

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- The standard connector for UTP cable is an RJ-45 (Registered Jack45) connector, which looks like a large telephone modular connector

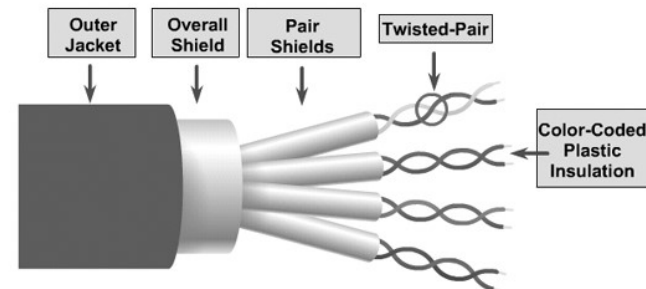


Unshielded twisted pair



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Shielded twisted pair(STP)



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Each pair is twisted to decrease interference.

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Advantages of twisted pair

- They are relatively cheap to use because its cost per unit length is low.
- They are convenient to use because they are small size.
- they are easy to install because of their flexibility it is easily strung around the room or wall.
- Shielded twisted pair has a foil shielding to help provide a more reliable data communication.
- Because UTP is small, it does not quickly fill up wiring ducts
- TP is easy to terminate

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Disadvantages of twisted pair

- Used over a short distance, usually less than 100 meters
- Twisted pair's susceptibility (prone) to the electromagnetic interference which leads to signal loss.
- They are easily damaged. Especial the UTP.
- They are low frequency cables. So they are not suitable for transmission of very high frequency signals like cable TV, TV antenna and radio antenna signals

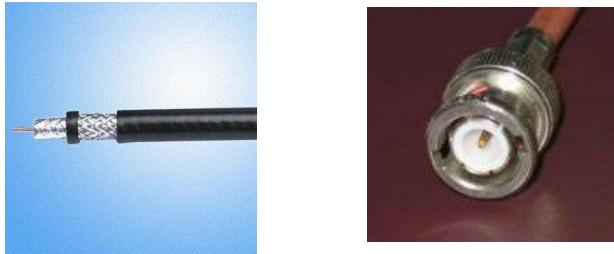
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Coaxial cables

- A coaxial cable is one that consists of two conductors that share a common axis hence the name "co-axial". The inner conductor is typically a straight wire, either solid or stranded and the outer conductor is typically a shield that might be braided or a foil. The two conductors are separated by a nonconductive element.

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Coaxial cable and BNC connector



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- both conductors share a common center axial, hence the term "co-axial"
- It has a bandwidth of up to 400 MHz
- It is highly resistant to signal interference
- It is used for long distance (300-600 meters)
- It is quite bulky and sometimes difficult to install
- the most common type of connector used with coaxial cables is the BNC (**Bayone-Neill-Concelman**) connector

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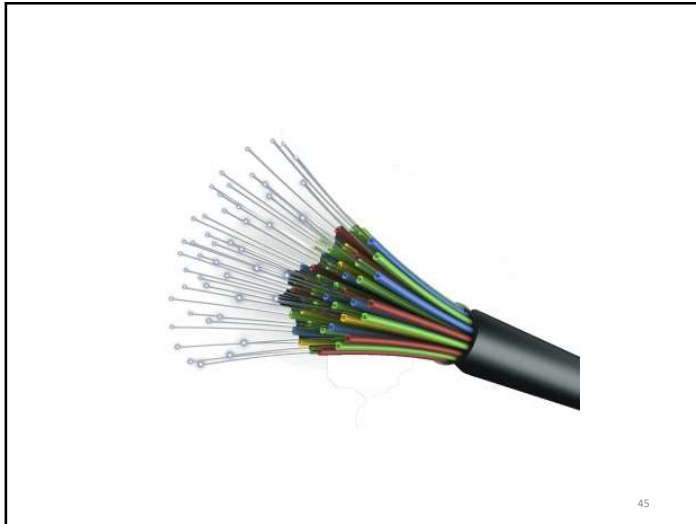
- It has higher installation costs
- Coaxial is prone to lightning strikes which damage the cables or equipment on which it is connected .
- It is more expensive than twisted pair cables
- It is not flexible

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Fiber Optic cables

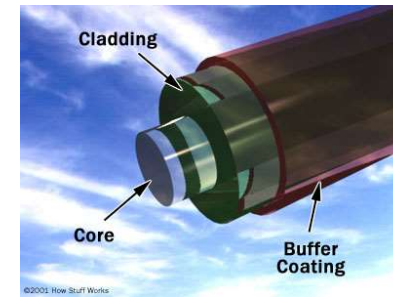
- Fiber Optic Cable is a transmission medium, which is made up of hundreds to thousands of fine, "light-conducting filaments made up of glass or plastic. Data is changed into pulses of light, which are sent down these glass or plastic fibers at very high speed over long distances.

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Parts of a single optical fiber



Optical fibers are long, thin strands of very pure glass about the diameter of a human hair. They are arranged in bundles called **optical cables** and used to transmit light signals over long distances.

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- **Core** - Thin glass center of the fiber where the light travels
- **Cladding** - Outer optical material surrounding the core that reflects the light back into the core
- **Buffer coating** - Plastic coating that protects the fiber from damage and moisture
- Hundreds or thousands of these optical fibers are arranged in bundles in optical cables. The bundles are protected by the cable's outer covering, called a **jacket**.

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- consist of a center glass core surrounded by several layers of protective materials
- immunity to environmental interference
- high carrying capacity (bandwidth of up to 2 Gbps)
- Can be used over greater distances due to the low loss, high bandwidth properties. It can be used for 2km without the use of a repeater
- Fiber optic networks operate at high speeds - up into the gigabits

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- Greater resistance to electromagnetic noise such as radios, motors or other nearby cables.
- Fiber optic cables costs much less to maintain.
- They are light weight and small in size, which makes them ideal for applications where running copper wires would be impractical .
- Cannot easily tap data over a fiber optic without being noticed due to difficulty of connecting new nodes when others are switched on.
- They are poor conductors of electricity which eliminates possibility of electrical shocks.

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- very expensive.
- difficult to install and modify, require highly skilled installers adding additional nodes is difficult .
- It is much more costly than other cables to install

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- Wireless communication technology, sometimes known as WI-FI, is one where the transfer of information over a distance is done without the use of electrical conductors or "wires" as a medium. Wireless technology overcomes the inconvenience of using too many wires for communication, and in places where cabling would be practically impossible, it is also convenient where a lot of flexibility and mobility at the work place is inevitable. Wireless technology is applied in Local area networks (WLANS), extended local area

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- networks using a wireless bridge, wireless wide area networks (WWANs), Wireless personal area networks(WPANs)and in mobile computing. The extraordinary convenience of wireless communications has placed an increased emphasis on wireless networks in recent years. Wireless Technology is expanding rapidly and will continue to expand into the near future, offering more and better options for wireless networks. There are different wireless technologies available

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Wave transmission

- Transmission of waves take place in the electromagnetic (EM) spectrum. The carrier frequency of the data is expressed in cycles per second called hertz(Hz). Low frequency signals can travel for long distances through many obstacles but can not carry a high bandwidth of data while high frequency signals can travel for shorter distances through few obstacles and carry a narrow bandwidth. Also the noise effect on the signal is inversely proportional to the power of the radio transmitter.

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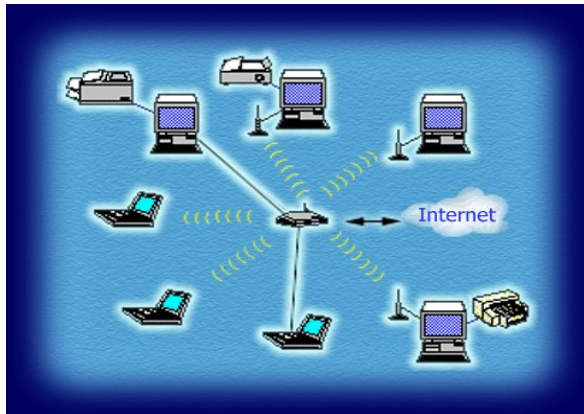
Types of wireless media

The three broad categories of wireless media are:

- Radio
- Microwave
- Infrared
- Bluetooth

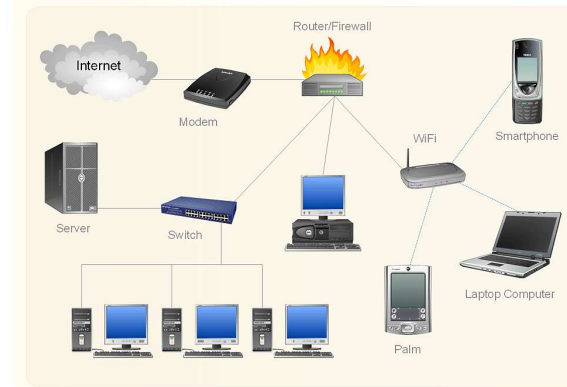
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Wireless network



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Network Diagram



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Microwave transmission

- Microwaves are electromagnetic waves with wavelengths ranging from as long as one meter to as short as one millimeter, or equivalently, with frequencies between 0.3 GHz and 300 GHz. Microwave can be used to provide high speed transmission of both voice and digital signals.
- Microwave communication can take two forms: terrestrial (ground) links and satellite links. The frequencies and technologies employed by these two forms are similar, though distinct differences exist between them.

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Terrestrial microwaves

- Terrestrial microwaves use Earth-based transmitters and receivers, sending data from one microwave station to another. Terrestrial microwaves use frequencies in the low-gigahertz range (typically at 4-6 GHz and 21-23 GHz), which limits all communications to line-of-sight transmission. This means microwave must be transmitted in a straight line (with no obstacles in the line of sight such as buildings or hills between the microwave stations). The Path between relay stations spaced a few kilometers apart.

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Terrestrial Microwave

- Microwave antennas are usually placed on top of buildings, towers, hills, and mountain peaks to avoid obstructions. Microwave transmissions typically use parabolic antenna or dishes that produce a narrow, highly directional signal. A similar antenna at the receiving site is sensitive to signals only within a narrow focus. Because the transmitter and receiver are highly focused, they must be adjusted carefully so that the transmitted signal is aligned with the receiver.

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- A microwave link frequently is used to transmit signals in instances in which it would be impractical to run cables. If you need to connect two networks separated by a public road, for example, you might find that regulations restrict you from running cables above or below the road. In such a case, a microwave link is an ideal solution.
- Microwave systems are highly susceptible to atmospheric interference and also can be vulnerable to electronic eavesdropping. For this reason, signals transmitted through microwave are frequently encrypted.

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Communications Satellites

- The satellites use microwave radio as their telecommunications medium which are not deflected by the Earth's atmosphere. The satellites are stationed in space, 22,000 miles above the equator. These Earth-orbiting systems are capable of receiving and relaying voice, data, and TV signals to and from earth based communication facilities (earth stations). Earth stations use parabolic antennas (satellite dishes) to communicate with satellites. These satellites then can regenerate and retransmit signals in broad or narrow beams, depending on the locations set to receive the

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- signals. When the destination is on the opposite side of the earth, for example, the first satellite cannot transmit directly to the receiver and thus must relay the signal through another satellite.
- Because no cables are required, satellite microwave communication is possible with most remote sites and with mobile devices, which enables transmission with ships at sea and motor vehicles.

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Radio transmission

- Radio is the transmission of signals, by modulation of electromagnetic waves with frequencies below those of visible light. Electromagnetic radiation travels by means of oscillating electromagnetic fields that pass through the air and the vacuum of space, making it possible to transmit over long distances. Radio waves are not a line of sight transmission, therefore not affected by presence of objects between the transmitter and receiver. Information is carried by systematically modulating (changing) some property of the radiated waves, such as amplitude, frequency, or phase.

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- When radio waves pass an electrical conductor, the oscillating fields induce an alternating current in the conductor. This can be detected by a receiver and transformed into sound or other signals that carry information.

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Cellular and PCS Systems

- Cellular and PCS Systems use several radio communication technologies. The systems are divided into different geographic areas referred to as cells. Each area has low-power transmitter or radio relay antenna device to relay signals from one area to the next area. Cellular phone companies use this technology for their networks.

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Infrared transmission

- Infrared transmission refers to energy in the region of the electromagnetic radiation spectrum at wavelengths longer than those of visible light, but shorter than those of radio waves. Correspondingly, infrared frequencies are higher than those of microwaves, but lower than those of visible light. Infrared signal is usually transmitted across relatively short distances to transmit data between personal devices for example, between a computer and a cell phone. Infrared can be either beamed between two points or broadcast from one point to many receivers.

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Wireless Local area networks (WLANs)

- Wireless local area networks use high frequency radio signals or infrared light beams or microwave or Bluetooth to communicate between the workstations and other devices. The wireless LAN network devices include; Wireless network adaptors, wireless access points, wireless bridges, wireless routers, and antennae.
- A wireless access point (WAP or AP) is a device that connects wireless communication devices together to form a wireless network. To be able to communicate with wireless device, the computer must have a wireless network adaptor.

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- The WAP usually connects to a wired network, and can relay data between wireless devices and wired devices. Several WAPs can link together to form a larger network that allows "roaming". Roaming is a general term in wireless telecommunications that refers to the extending of connectivity service in a location that is different from the home location where the service was registered. Wireless LANs use spread spectrum technology to enable communication between multiple devices in a limited area. An example of open-standards wireless radio-wave technology is IEEE 802.11b.

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Bluetooth

- Bluetooth is a short range wireless technology which Operates at approximately 1Mbps with range from 10 to 100 meters. Bluetooth is an open wireless protocol for data exchange over short distances.

The Wireless Web

- The wireless web refers to the use of the World Wide Web through equipment like cellular phones, Pagers, PDAs, and other portable communications devices. The wireless web service offers anytime/anywhere connection

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Wireless application Protocol (WAP)

- The Wireless Application Protocol (WAP) refers to a group of related technologies and protocols widely used as a standard protocol in providing Internet access to mobile phones or other thin-client devices.
- Typical use of the WAP protocol involves a website transmitting scaled-down versions of normal web pages specifically optimized for use by wireless telecommunications devices.

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Here's what happens when you access a Web site using a WAP-enabled device:

- You turn on the device and open the minibrowser.
- The device sends out a radio signal, searching for service.
- A connection is made with your service provider.
- You select a Web site that you wish to view.
- A request is sent to a gateway server using WAP.
- The gateway server retrieves the information via HTTP from the Web site.
- The gateway server encodes the HTTP data as WML.
- The WML-encoded data is sent to your device.
- You see the wireless Internet version of the Web page you selected.

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Advantages of a wireless network

- There is no need to lay cables which reduces cost and work.
- It enables a variety of devices such as personal digital assistants (PDA), blackberry devices, and other cell phones to be networked.
- It enhances mobility and flexibility of a network due to ability to move devices without the restriction of cables for example, mobile phones and laptops.

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- Fast data transfer rates can be possible where there are no environmental obstacles.
- It also allows an organisation to offer visitors wireless internet access or hot-desk or hotspot facilities.
- Wireless technology makes it easy to set up temporary network installations. These situations include any temporary department set up for a specific purpose that soon will be torn down or relocated.
- Wireless technology is becoming cheaper and affordable over time

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Disadvantages of a wireless network

- Poor security of data on a wireless network, outsiders can easily log on an unsecured wireless network.
- They are slower than LANs using cabling
- They are prone to electrical interference from lights and radios
- They are Subject to obstructions such as walls.
- Wireless access points and WI-FI technology in general have a limited spectrum/range. signal strength decreases as the range increases.

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- A big number of access points in the area, especially on the same or neighboring channel, can prevent access and cause interfere with the use of other access points by others due to overlapping of frequencies.

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Network software

- These are Communication programs that enable the transmission of data between network devices.
- They have features such as Dialing, file transfer, internet access and others.

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Categories of network software

- Network operating system (NOS)
- Network protocols

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Network Operating System (NOS)

- A network operating system is a supervisory software program that resides on the server and controls a network by; (i) defining who can use the network (ii) how information is shared (iii) controlling access by multiple users to network resources such as files and hardware, (iv) providing for certain administrative functions, including security.
- Examples of common NOS;
 - Novell Netware
 - Microsoft Windows NT, windows server* , AppleShare, UNIX, Linux

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NOS

NOS carries out administration activities which include:

1. Managing the Security of network by providing Security features such as authentication, authorization, logon restrictions and access control.
2. File management.
3. Providing basic operating system features such as support for processors, protocols, automatic hardware detection and supporting multi-processing of applications.
4. Providing name and directory services

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- Coordinates the activities of multiple computers across a network.
- Providing file, print, web services, back-up and replication services

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Network protocols

- A protocol is a set of rules and procedure (standard) for connection and data transfer between devices on a network. Protocols control all aspects of data exchange, which include the following:
 - How the physical network is built.
 - How devices connect to the network.
 - How the data is formatted for transmission.
 - How that data is sent/transmitted.
 - How to deal with errors in data transfer.

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Protocols (continued)

- These network rules are created and maintained by many different organizations and committees. Included in these groups are the Institute of Electrical and Electronic Engineers (IEEE), American National Standards Institute (ANSI), Telecommunications Industry Association (TIA), Electronic Industries Alliance (EIA) and the International Telecommunications Union (ITU), formerly known as the Comité Consultatif International Téléphonique et Télégraphique (CCITT).

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Commonly used protocols

- TCP/IP- transmission control protocol/Internet protocol.
- HTTP- Hypertext transfer protocol
- FTP- file transfer protocol.
- POP- post office protocol

- ☐ SMTP-Simple mail transfer protocol

- ☐ IPX/SPX-stands for **Internetwork Packet Exchange/Sequenced Packet Exchange**. IPX and SPX are networking protocols used primarily on networks using the Novell NetWare operating systems

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- NETBEUI-(NetBIOS Extended User Interface) is a new, extended version of NetBIOS, the program that lets computers communicate within a local area network. it does not support the routing of messages to other networks,

- Telnet (**TE**lecommunication **NE**twork) for Remote access between computers
- IMAP; Internet Message Access Protocol .

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TYPES OF NETWORKS

- LOCAL AREA NETWORK (LAN)
- WIDE AREA NETWORK (WAN)
- METROPOLITAN AREA NETWORK (MAN)
- INTERNATIONAL NETWORK (INTERNET)

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WHAT IS A LAN?

- This is a group of computers, printers and other devices interconnected within a small geographical area such as a room or a building.
- They are interconnected using a medium such as cables or wireless medium.
- LANs allow individual users to locally share computer files and printers

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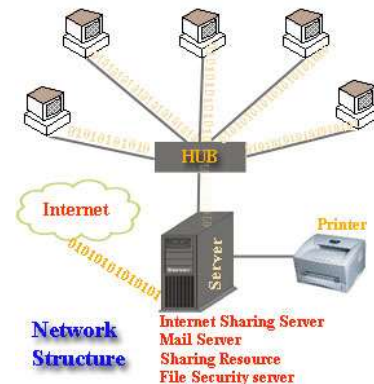
LANs

A LAN is made up of the following components:

- Workstations
- Network interface cards
- Peripheral devices
- Networking media
- Networking devices .
- Network server

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A local area network



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USE OF A LAN IN A SCHOOL SETTING

Computers have become an important part of today's classrooms and any other organisation. They are an important tool for both teachers and students. An effective way to connect these computers, and everyone using them, is to set up a network. Networks have many uses in an academic setting which include;

- **Sharing Information.** Information can be shared by posting it on the content server and made available to all users.

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- **It enables Sharing of hardware**

hardware such as computer Cd or DVD drives, printers are jointly used on the network which lowers cost on them.

- **It enables Sharing of files or documents** is made possible for collaborative work among many users.
- **It ensures security** of files on the network by putting security controls on the server.

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- **It enables sharing Application software**

- Application software like MS Exchange can be very costly for an organization and furthermore it must be run in a networked environment. In such cases, sharing of MS Exchange is beneficial to all.

Application software which is shared by several users is called **Groupware**.

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- **It enables centralizing administration and Support**

Networking PCs and devices reduce the need for decentralized IT resources by providing a single point of management for all users and computers. All authorized user accounts and necessary security features can be controlled by the network administrator from a centralized server.

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Advantages of LANs over Standalone computers

- ❑- Collaborative learning is made possible as Information is easily shared among network users.
- ❑It enables easy communication on the network using the email/message system.
- ❑It lowers the cost on software licenses since software is only installed on the server.
- ❑- Sharing of hardware lowers expenses on hardware since one device is jointly used on the network instead of installing devices to each computer.
- ❑- Software is easily upgraded on the network since it is done at ago on the server.

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- Workgroup Computing. Workgroup software (such as Microsoft BackOffice) allows many users to work on a document or project concurrently. For example, educators located at various schools within a county could simultaneously contribute their ideas about new curriculum standards to the same document and spreadsheets.
- It allows multiple access to the same database or Intranet.
- It allows sharing of data and information

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- The administrator has a greater control and monitoring of all workstations on the network through centralized administration.
- Flexible access. Users can log on and access their work from any workstation on the network.
- Networks provide a very rapid method for sharing and transferring files. Without a network, files are shared by copying them to f movable disks, then carrying or sending the disks from one computer to another which is very time-consuming.

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Disadvantages of LANs

- **The initial cost of installing a network may be high.** Although a network will generally save money over time, the initial costs of installation are high. Cables, network cards, and software are expensive, and the installation may require the services of a technician.
- **Requires Administrative Time.** Proper maintenance of a network requires considerable time and expertise. This requires additional cost. Many schools have installed a network, only to find that they did not budget for the necessary administrative support.

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- The entire network fails if the server crashes, When this happens, the entire organization loses access to necessary programs and files.
- There is increased risk of data corruption, since many users will be using the system to access the same documents, some of whom may be careless or deliberately tamper with it.

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- There is a greater risk from viruses, because they are easily spread between the computers that are part of the LAN.
- A break in the communication channel can stop the entire network.

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TYPES OF LANs

- Peer to Peer network
- Client-server.

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Peer to peer

This is an interconnected group of equal computers where there is no hierarchy among them, each computer acts as both a client and a server to others on the network. Each computer has resources it shares with others on the network.

- Its very easy to set up.
- Its appropriate in case of a small network(few computers)
- Inexpensive to set up and maintain.
- Enables easy sharing of devices such as CDs and printer.

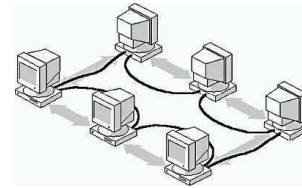
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Peer to peer(continued)

- Its flexible
- However;
- It lacks security due to absence of a server.
 - There is no central administration
 - Its not appropriate for big networks(cannot be used for big networks).

101

Peer to peer configurations



102

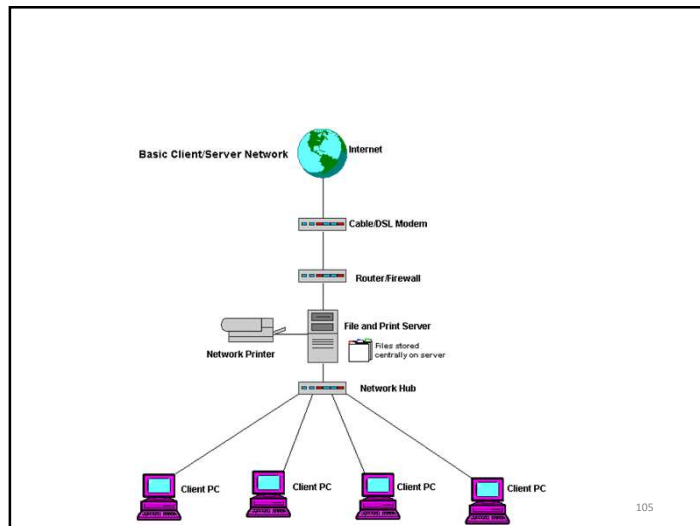
Client server network

A network that consists of a central computer referred to as the server on which other computers referred to as clients are connected. The central computer providing services to client computers.

103



104



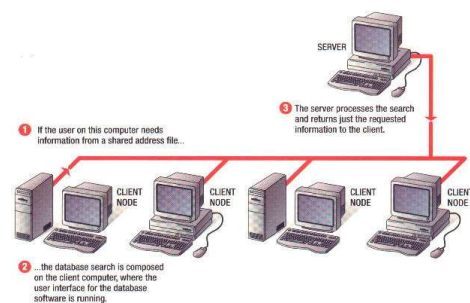
105

WHAT IS A SERVER?

- A server (Network server) is a computer on a network that hosts, controls and manages the network resources, making them available to its clients (computers connected to it).

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Client-Server



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TYPES OF NETWORK SERVERS

- File server: One that stores various files and making them available to network users
- Application servers: stores application software packages run directly on it and made for users on the network.
- Printer server: a central computer that manages a networked printer from a single location.
- Web server: It allows users to access outside networks, also providing web content/web pages to users.

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TYPES OF NETWORK SERVERS

- Mail server: Manages mail by receiving, moving and storing mail on the network.
- Proxy server: A computer placed between a LAN and an external server or networks(Internet), to filter requests and restrict access to data
- A proxy server receives a request for an Internet service from a user. If it passes filtering requirements, looks in its local cache of previously downloaded Web pages. If it finds the page,

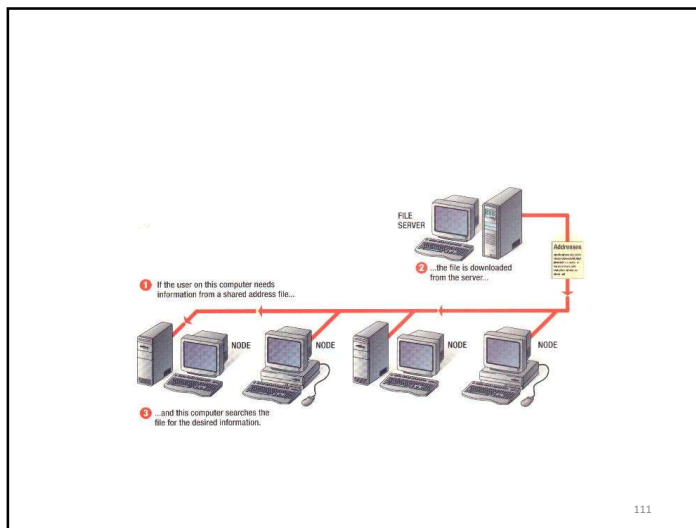
109

Proxy server (continued)

it returns it to the user without needing to forward the request to the Internet.

If the page is not in the cache, the proxy server, acting as a client on behalf of the user, uses its own IP addresses to request the page from the server out on the Internet. When the page is returned, the proxy server relates it to the original request and forwards it on to the user.

110



111

Advantages of Client-server network

- It offers a reliable centralized storage and sharing of files.
- It ensures high security of the network through access controls installed on the server.
- It is easy to monitor the network performance on the server
- It is easy to solve network problems.
- Its cheap to install software which can be done on the server alone instead of all computers on the network.

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Disadvantages of client-server network.

- Its expensive to setup.
- Extra expenses on buying a server computer
- Extra expenses on hiring a network administrator
- The server is one point of failure. In case the server fails to work, the whole network comes to a stand still.

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Network topology

- Topology is the physical and logical arrangement of a local area network. Hence physical topology and logical topology.
- The physical topology of a network refers to the physical arrangement of cables, computers, and other peripheral devices in relation to each other on a network.
- logical topology is the method used to pass information between workstations on a network.

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Types of physical Network topologies

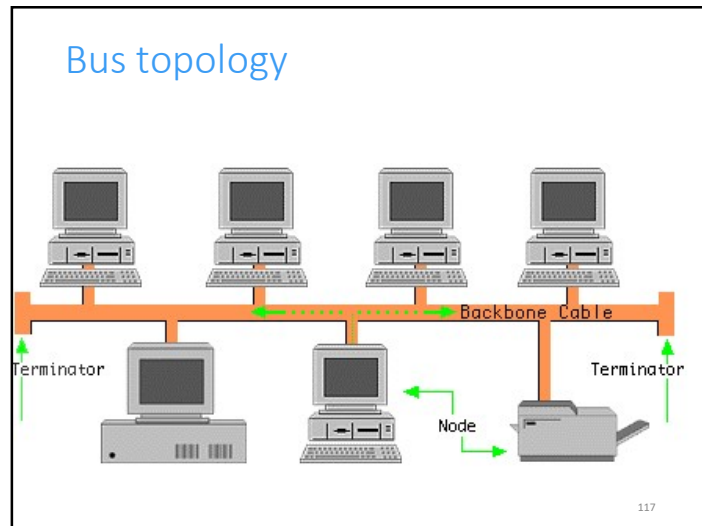
- **Bus network topology**
- **Ring network topology**
- **Star network topology**
- **hierarchical network topology**
- **Mesh network topology**
- **Hybrid topology**
- **Tree topology**

115

Bus topology or linear bus topology

- **Bus network topology is one that** consists of a main, central cable known as the backbone with a terminator at each end of it, and all devices on the network are connected to the main/central cable.

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Advantages of Bus topology

- It is less expensive than a star topology due to less footage of cabling, only needs one main cable and no network hubs
- It is good for smaller networks not requiring higher speeds
- It has a high transmission speed if coaxial cable is used.
- It is easy to add new workstations on the network.
- Multiple servers can be used.
- Easy to connect a computer or peripheral to a bus.
- Requires less cable length than a star topology.

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Disadvantages of Bus network

- It is Limited in size and speed
- The Entire network shuts down if there is a break in the main cable.
- Difficult to troubleshoot. it is difficult to identify the problem if the entire network shuts down
- It Less secure since all data is transmitted down one main cable.
- Transmission slows down as more work stations are added.
- If the main cable fails, then all workstations are affected.

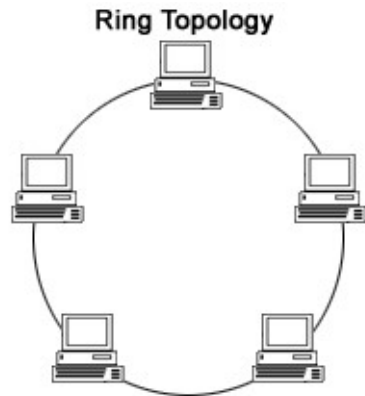
119

Ring topology

- This is a topology where all devices on the network are connected to one another in the shape of a closed loop, so that each device is connected directly to two other devices, one on either side of it to form a ring. Each data packet is sent around the ring until it reaches its final destination.

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Ring topology



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Advantages of ring topology

- It is a Very orderly network where every device has access to the token and the opportunity to transmit
- It Performs better than a star topology under heavy network load
- Can create much larger network using Token Ring
- It is Cheaper to install than star network as there is only one cable between each workstation.
- High speed can be achieved as each workstation can boast the signal.

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Disadvantages of a Ring network

- One malfunctioning workstation or bad port in the MAU(central hub) can create problems for the entire network
- Moves, additions and changes of devices affects the entire network.
- Network adapter cards are expensive.
- It is much slower than an Ethernet network under normal load
- Less secure than star network as data pass through a number of workstations before reaching its destination.

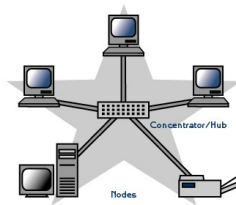
123

Star topology

- A star topology is designed with each device/node (file server, workstations, and peripherals) connected **directly** to a **central** network hub or switch.
- Data on a star network passes through the hub or switch before continuing to its destination. The hub or switch manages and controls all functions of the network. It also acts as a repeater for the data flow.

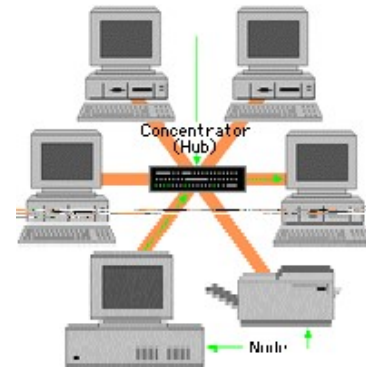
124

Star topology



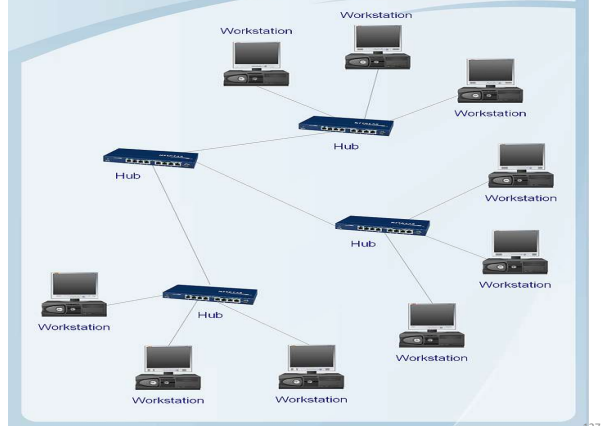
125

Star network



126

STAR TOPOLOGY 10BASE-T



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Extended Star topology

- This is a network where more than one individual star topologies are connected together.
- At the center of the star is a hub or a switch.
- It extends the length and size of the network.

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Advantages of Star topology

- It is suited for large networks
- It is easy to expand the network without negatively affecting it.
- If one cable or station fails, the entire network is not affected
- It is easy to install, maintain and troubleshoot because the problem usually isolates itself. That is, its easy to detect faults and to remove parts.
- Cabling types can be mixed to maximize efficiency.
- High speed transmission is possible since each station has a dedicated cable.
- Greater security as connection from one station to server is unique.

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- No disruptions to the network when connecting or removing devices.

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Disadvantages of Star topology

- breakdown of the central computer or Hub become a single point of network failure, not the cabling
- Its expensive to set up due to increased cabling costs and the need for a switch or hub.
- It easy to have a mass of cables around in case of a large network.
- If the cable fails the workstation cannot receive data via any other route.

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- Requires more cable length than a bus topology.
- If the hub or concentrator fails, nodes attached are disabled.
- The server can get congested as all communication must pass through it

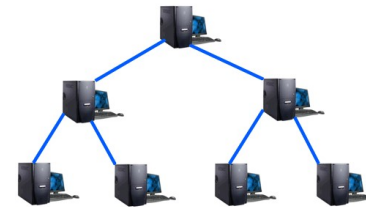
132

Hierarchical topology

- It is like the extended star topology, except a computer controls traffic instead of a hub or a switch.

133

Hierarchical topology



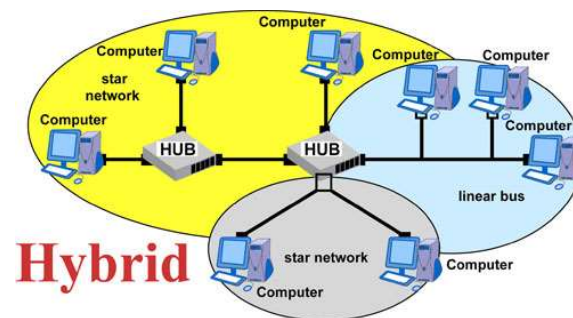
134

Hybrid Topology

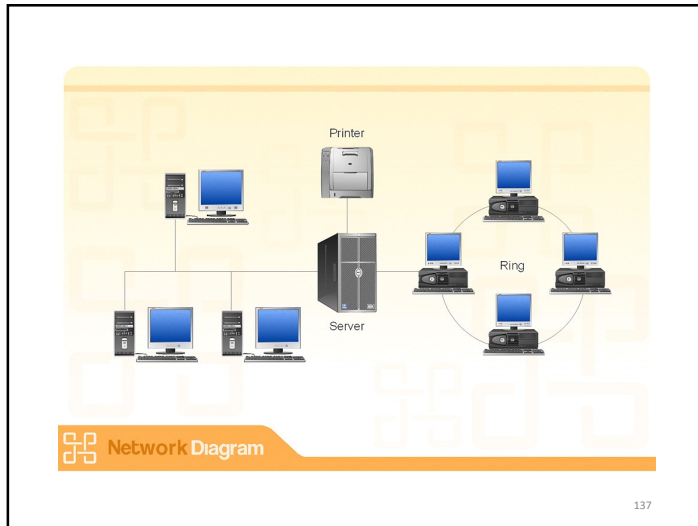
- Hybrid Topology is a network that has two or more physical topologies connected to each other to form a complete network. There are many different combinations that can be created such as bus plus Star(tree).
- A hybrid topology is easier to connect to other computers than some other topologies. Also the hybrid topology has a faster connection.

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Hybrid topology



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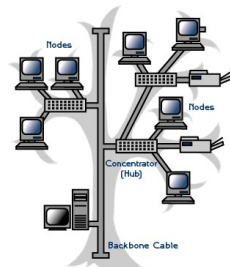


Tree topology

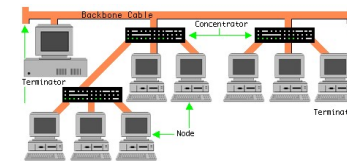
- A tree topology combines characteristics of bus and star topologies; It consists of groups of star-configured workstations connected to a bus backbone cable. Tree topologies allow for the expansion of an existing network, and enable organisations to configure a network to meet their needs

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Tree topology



Tree topology



Advantages of Tree topology

- Allows for Point-to-point wiring for individual segments.
- Supported by several hardware and software vendors.

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Disadvantages Tree topology

- Overall length of each segment is limited by the type of cabling used.
- If the backbone line breaks, the entire segment goes down.
- More difficult to configure and wire than other topologies.

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Mesh topology

- This is a network where each device has its own connections to all other devices . It provides each device with a point-to-point connection to every other device in the network. This topology is commonly used in WAN's, which connect networks over telecommunication links. Mesh topologies use routers to determine the best path.
- Mesh networks provide redundancy, in the event of a link failure, meshed networks enable data to be routed through any other site connected to the network.

143

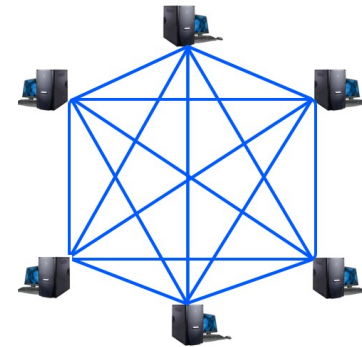
- A mesh topology is implemented to provide as much protection as possible from interruption of service
- If there are other possible routes through the network, the damage of one or several cables or computers may not have vital impact except the involved computers.

144

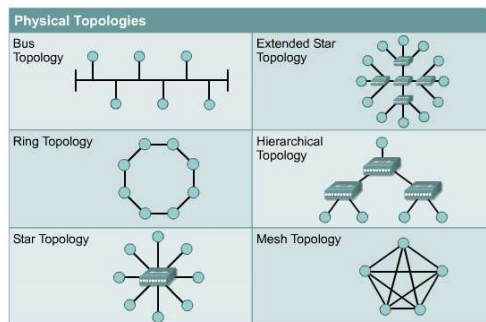
- Because each device has a point-to-point connection to every other device, mesh topologies are the most expensive and difficult to maintain.
- If there are only few cables in the network, the loss of even one cable or device may damage the network seriously.

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Mesh topology



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Considerations When Choosing a Topology:

- **Cost of installation.** A linear bus network may be the least expensive way to install a network; you do not have to purchase concentrators.
- Number of computers and other devices to connect
- The architecture of the building to be used.
- The purpose of the network
- Distance of connectivity
- Safety provisions of the network

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- Personnel provisions/technicalities involved
- Ease in accessing the network
- **Length of cable needed.** The linear bus network uses shorter lengths of cable.
- **Future growth.** With a star topology, expanding a network is easily done by adding another concentrator.
- **Cable type.** The most common cable in schools is unshielded twisted pair, which is most often used with star topologies.

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Summary Chart:

Physical Topology	Common Cable	Common Protocol
Linear Bus	Twisted pair Coaxial fiber	Ethernet LocalTalk
Star	Twisted pair Fiber	Ethernet LocalTalk
Star-Wired Ring	Twisted pair	Token Ring
Tree	Twisted pair Coaxial fiber	Ethernet

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Logical topology (Media Access Method)

Logical topology is how computing devices access the network and send data over the network. The logical topology of a network determines how the hosts communicate across the medium. There are four commonly used media access methods:

Ethernet,
Token Ring,
Local Talk, and
FDDI.

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Ethernet

- Ethernet was invented by Xerox Corporation and developed jointly by Xerox, Intel and Digital Equipment Corporation. Ethernet is a type of local area network technology that typically uses coaxial cable or special grades of twisted pair wires. Ethernet is also used in wireless LANs. The most commonly installed Ethernet systems are called 10BASE-T; Baseband transmission technology of speeds up to 10 Mbps using twisted pair cables. The Devices are connected to the cable and compete for access using a Carrier Sense Multiple Access with Collision Detection (CSMA/CD) protocol.

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- The Fast Ethernet or 100BASE-T provides transmission speeds up to 100 megabits per second and is typically used for LAN backbone systems, supporting workstations with 10BASE-T cards. Gigabit Ethernet provides an even higher level of backbone support at 1000 megabits per second (1 gigabit or 1 billion bits per second). 10-Gigabit Ethernet provides up to 10 billion bits per second.
- Fast Ethernet supports 100 Mbps, but requires faster hubs and network interface cards.
- It is the most popular media access method

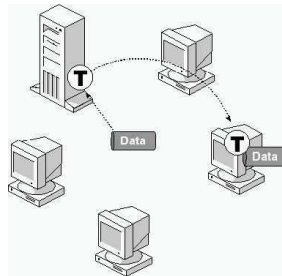
153

Token Ring

- A network topology developed by IBM in which computers access the network through token-passing.
- **A Token** is a special packet that contains data and acts as a messenger or carrier between each computer and device on a ring topology. Each computer must wait for the messenger to stop at its node before it can send data over the network so as to avoid collision of data packets on the network.

154

Token passing



155

Local Talk

- Local talk was developed by Apple Computer, Inc. for Macintosh computers. It uses CSMA/CA media access scheme and supports transmissions at speeds of 230 Kbps (Kilobytes per second).

156

FDDI (Fiber Distributed Data Interface)

A network topology that is used primarily to interconnect two or more local area networks, often over large distances.

- It uses fiber optics for speeds of up to 100 Mbps
- It is used primarily to interconnect two or more LANs, often over long distances
- It also employs Token Ring passing process to transmit data; but use a dual counter-rotating ring topology, meaning there are two rings of cable with two tokens circulating in opposite directions.

157

Packet switching

- This is a data transmission technique which involves transmitting and routing of messages by dividing the electronic message/data into packet segments and sending them rapidly and sequentially over a network channel which are then reassembled into the original message at their destination.
- It involves breaking the data into individual segments known as packets which are transmitted individually and then re-assembled when they reach the destination computer.

158

Circuit switching

- A method of communicating in which a dedicated communications path referred to as a circuit or channel is established between two devices through one or more intermediate switching nodes before communication between the devices takes place. Unlike packet switching, digital data is sent as a continuous stream of bits on a circuit. The telephone system uses circuit switching. Each circuit that is dedicated cannot be used by others on the network until the circuit is released and a new connection is set up.

159