



SCI 207 COMPUTER NETWORK

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INTRODUCTION

- **Networking** is the concept of sharing resources and services.
- A network of computers is a group of interconnected systems sharing resources and interacting using a shared **communications link** .
- A **network**, therefore, is a set of interconnected systems with something to share. It can also be defined as the interconnection of a set of devices capable of communication.
- In this definition, a device can be a **host** (or an *end system* as it is sometimes called) such as a large computer, desktop, laptop, workstation, cellular phone, or security system.
- The individual systems must be connected through a pathway (***transmission medium***) that is used to transmit the resource or service between the computers.
- All systems on the pathway must follow a set of common communication rules for data to arrive at its intended
- The set of rules governing computer communication are called ***protocols***.



CONT:

- A device in this definition can also be a **connecting device** such as:
 - **a router** which connects the network to other networks, a switch, which connects devices together
 - **a modem** (modulator-demodulator), which changes the form of data, and so on.



CONT:

- A computer network consists of two or more computers that are connected in order to communicate and share resources.
- Computers may be connected through bound and unbound media.
- This means they can be wired or wireless.
- All networks must have:
 - A resource to share (resource)
 - A pathway to transfer data (transmission medium)
 - A set of rules governing how to communicate (protocols)



MODELS OF NETWORK COMPUTING

- **Centralized computing**- In centralized computing all the Processing is done by a central computer
- **Distributed computing** -Distributed computing involves multiple computers capable of processing independently.
- **Collaborative or cooperative computing**- Enables computers in a distributed computing environment to share processing power in addition to data, resources, and services. Multiple computers cooperating to perform a task. Software designed to take advantage of the collaborative environment



NETWORK ARCHITECTURES

- **Peer-to-peer networks**

Each node has the ability to talk directly to any node on the network that has the information or service it needs. i.e. no central control over the network.

- **Server Based networks**

A server-based network maintains the “server” as the manager of the network, with all nodes connected to the server,



ADVANTAGES OF SERVER-BASED NETWORKS

- Strong central security
- Central file storage, which allows all users to work from the same set of data and provides easy backup of critical data
- Ability of servers to pool available hardware and software, lowering overall costs
- Ability to share expensive equipment, such as laser printers
- Optimized dedicated servers, which are faster than peers at sharing network resources
- Less intrusive security, since a single password allows access to all shared resources on the network
- Freeing of users from the task of managing the sharing of resources
- Easy manageability of a large number of users
- Central organization, which keeps data from getting lost among computers



DISADVANTAGES OF SERVER-BASED NETWORKS

- Expensive dedicated hardware
- Expensive network operating system software and client licenses
- A dedicated network administrator (usually required)



ADVANTAGES OF PEER NETWORKS

- No extra investment in server hardware or software is required
- Easy setup
- No network administrator required
- Ability of users to control resources sharing
- No reliance on other computers for their operation
- Lower cost for small networks





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DISADVANTAGES OF OF PEER NETWORKS

- Additional load on computers because of resource sharing
- Inability of peers to handle as many network connections as servers
- Lack of central organization, which can make data hard to find
- No central point of storage for file archiving
- Requirement that users administer their own computers
- Weak and intrusive security
- Lack of central management, which makes large peer networks hard to work with



HYBRID NETWORKS

- Hybrid networks have all types of computers operating on them and generally most shared resources are located on servers, network users still have access to any resources being shared by peers. It also means network users do not have to log on to the network to access peer resources being shared.
- **Advantages of Hybrid Computing**
- The advantages of server-based networking
- Many of the advantages of peer-based networking
- Ability of users and network administrators to control security based on the importance of the shared resource
- **Disadvantages of Hybrid Computing**
- Hybrid computing shares
- the disadvantages of
- server-based & peer-to-peer networking



ADVANTAGES OF HYBRID COMPUTING

- The advantages of server-based networking
- Many of the advantages of peer-based networking
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DISADVANTAGES OF HYBRID COMPUTING

- Hybrid computing shares
- the disadvantages of
- server-based & peer-to-peer networking



TYPES OF NETWORKS

- Networks are categorized by **distribution, size, and architecture.**
- A network can be as simple as a single serial, parallel, or USB cable joining two computers in a peer-to-peer relationship.
- The common classifications of networks are;
 - According to span of control
 - According to ownership
 - According to Geographic span or size



TYPES OF NETWORKS ACCORDING SPAN OF CONTROL

- **Centralized:** One main CPU processes all information requests from dumb terminals and handles communication. An example is the mainframe computer.
- **Distributed:** A collection of workstations/terminals connected to each other, along with various shared storage devices and input output devices. Each workstation can handle some or all of its own processing
- **Hybrid:** This combines the characteristics of centralized and the distributed network type.



TYPES OF COMPUTER NETWORKS ACCORDING TO OWNERSHIP

- **Public Networks:** Owned and operated by a common carrier e.g. a telecommunication carrier that serves a large number of subscribers. An example is public switched telephone network(PSTN).
- **Value Added Networks (VANs):** A privately owned packet-switched network whose services are sold to the public. They charge in terms of time or volume of information transferred.
- **Private Networks:** An organization has exclusive rights to use the communication facility

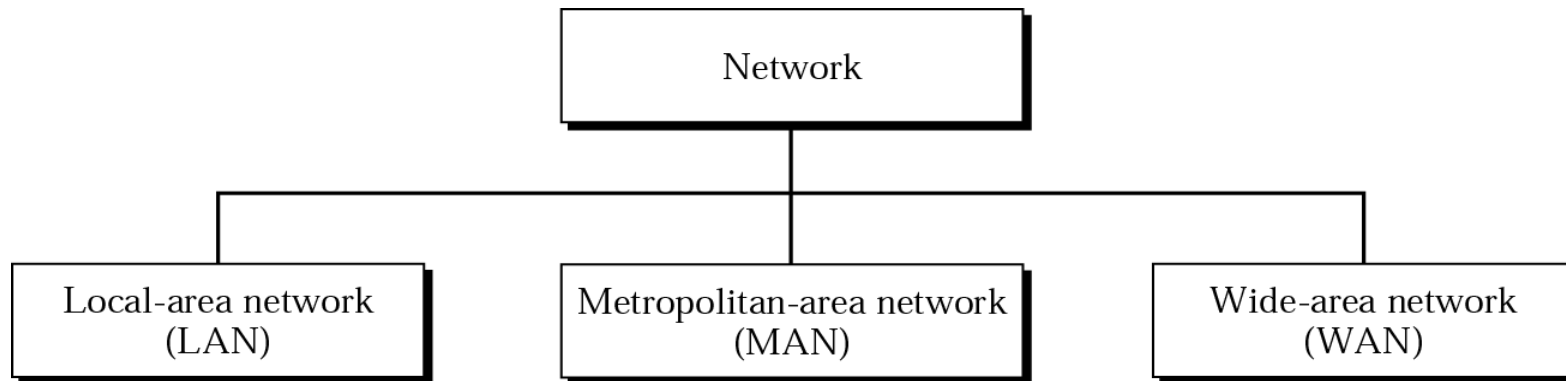


TYPES OF NETWORK ACCORDING TO SIZE

- Networks are divided into three categories based on size.
- These are:
 - Local area network(LAN),
 - Metropolitan area network (MAN)
 - wide area network (WAN)



FIGURE 1 NETWORK TYPES ACCORDING TO SIZE(BEHROUZ A. FOROUZAN 2004)



LOCAL AREA NETWORKS (LANs):

- This is a high-speed, fault-tolerant data network that covers a relatively small geographic area approximately 10 km radius e.g. an office campus etc. It typically connects workstations, personal computers, printers, and other devices.
- A local area network (LAN) is usually privately owned and links the devices in a single office, building, or campus



METROPOLITAN AREA NETWORKS (MANs):

- A metropolitan area network (MAN) is a network with a size between a LAN and a WAN. It normally covers the area inside a town or a city. Cover distances no greater than 50km radius and rely on the communication facilities provided by a common carrier. The term metropolitan implies that it is a “city or big town” network.



WIDE AREA NETWORKS (WANs):

- This is a world wide network that covers a large geographic areas e.g. countries or continents.
- A wide area network (WAN) provides long-distance transmission of data, image, audio, and video information over large geographic areas that may comprise a country, a continent, or even the whole world.



COMPONENTS OF A COMPUTER NETWORK.

- A computer network has two major elements:
 - Communication hardware
 - Communication software



COMMUNICATION HARDWARE IN A COMPUTER NETWORK

- The hardware used in a computer network can be broadly classified into three broad categories namely:
 - Data Terminal Equipment (DTE): Sources or destinations of information. Comprises of communications equipment such as terminals, host computer, printer etc.
 - Data Circuit Terminating Equipment (DCE): Made up of interface devices such as the modem, switches, routers etc.
 - Data communications channels: Paths through which information travels. Can be Electrical, Optical or Electromagnetic based.



DATA TERMINALS EQUIPMENT

- These devices are the data sources and destinations in a network (ie., end nodes where data originates or is received).
- Examples of DTEs:
 - Personal computers
 - Terminals
 - Workstations
 - Mobile phones
 - Point of sale cash registers
 - Automatic teller machines



TRANSMISSION MEDIA

- These are pathways used to transmit data from one point to another. Transmission media may be bounded (cable) or unbounded (wireless).



- Bounded Media

- - Twisted pair wire

- - Co-axial cable

- - Fiber optic cables

- Microwave

- Transmission shall be discussed further in topic 3.

- Unbounded

- Radio waves

- Infrared waves

- Satellite



NETWORK SOFTWARE

- Connection software is ubiquitous/ present in all systems that must be networked together.
- You will find network software inside your computers' operating systems, inside your networking hardware (routers or firewalls), in custom ASICs (Application Specific Integrated Circuit) or flash memory in network cards or hubs, and even inside the physical transmission medium if the medium is intelligently switched or amplified.
- Software in end nodes implements techniques and protocols which define the rules and end procedures for initiating and terminating data transfers, interpreting how data is represented and transmitted and how errors are handled. Network software shall be discussed further in Topic 9



NETWORKING TOPOLOGIES

- The term topology refers to the distribution or arrangement of network elements, usually both devices as well as connections.
- Commonly it is used to discuss the properties of various types of networks.
- Networks have shapes, and the shape of a network determines the way it functions.
- Different types of topologies are used because each topology has strength and weaknesses.



FACTORS AFFECTING THE CHOICE OF A TOPOLOGY

- Impact of cable breaks on a network.
- Impact of adding or removing nodes.
- Flow of messages and which nodes see the messages.
- Ability to use nodes as repeaters.
- Maximum physical size of the network.
- Amount of cable used.



TYPES OF TOPOLOGIES

- Topology can be divided into broad types namely:
 - **Physical topology:** The layout or actual appearance of the cabling scheme used on a network . The term *physical topology* refers to the way in which a network is laid out physically.
 - **Logical topology:** Describes how data flows through the physical topology.
 - Data are packaged in frames
 - Electrical pulses are sent over network's physical media
 - Similar-looking networks can have quite different logical topologies



PHYSICAL TOPOLOGIES

- A physical topology describes the arrangement of devices used to implement the network.
- Topological devices can be either nodes or endpoints, or they can be connections or links.
- All physical topologies are variations of two fundamental methods of connecting devices:
 - Point-to-point.
 - Multi-point.



POINT-TO-POINT TOPOLOGIES

- A point-to-point connection provides a dedicated link between two devices. The entire capacity of the link is reserved for transmission between those two devices.
- Most point-to-point connections use an actual length of wire or cable to connect the two ends, but other options, such as microwave or satellite links, are also possible.



EXAMPLES OF POINT-TO-POINT LINKS:

- Two computers communicating via modems.
- A workstation communicating along a parallel cable to a printer.
- When you change television channels by infrared remote control, you are establishing a point-to-point connection between the remote control and the television's control system.
- In this examples: Two devices monopolize a communication medium meaning the medium is not shared, hence no need for addressing.



POINT-TO-POINT TOPOLOGIES

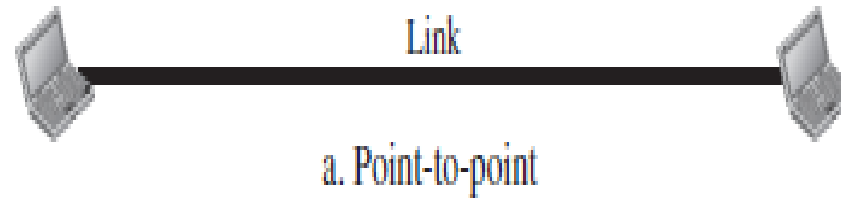


Figure 2 point to point (Behrouz A. Forouzan 2013)

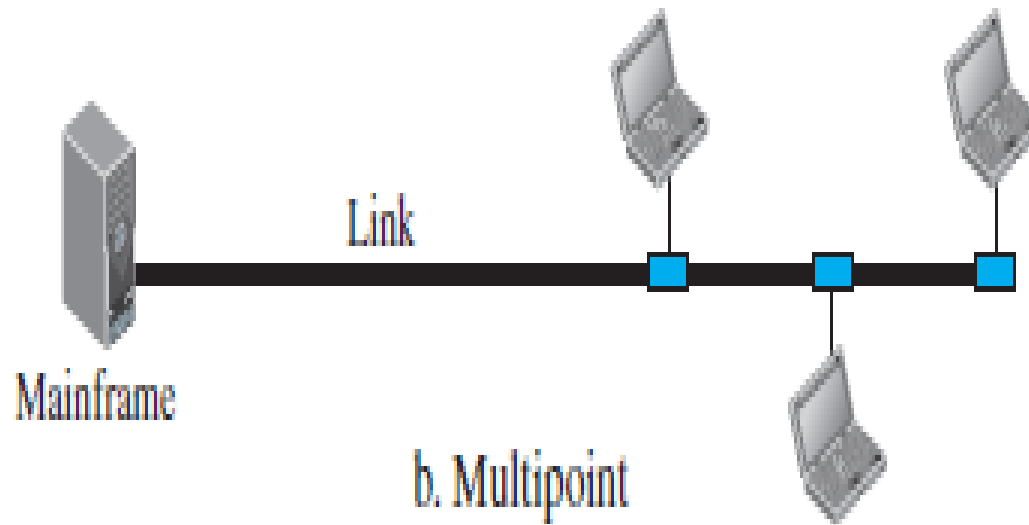


MULTIPOINT TOPOLOGY

- A multipoint (also called multidrop) connection is one in which more than two specific devices share a single link.
- In a multipoint environment, the capacity of the channel is shared, either spatially or temporally.
- If several devices can use the link simultaneously, it is a ***spatially shared*** connection. If users must take turns, it is a ***timeshared*** connection



MULTIPOINT PHYSICAL TOPOLOGIES



Multipoint (Behrouz A. Forouzan 2013)

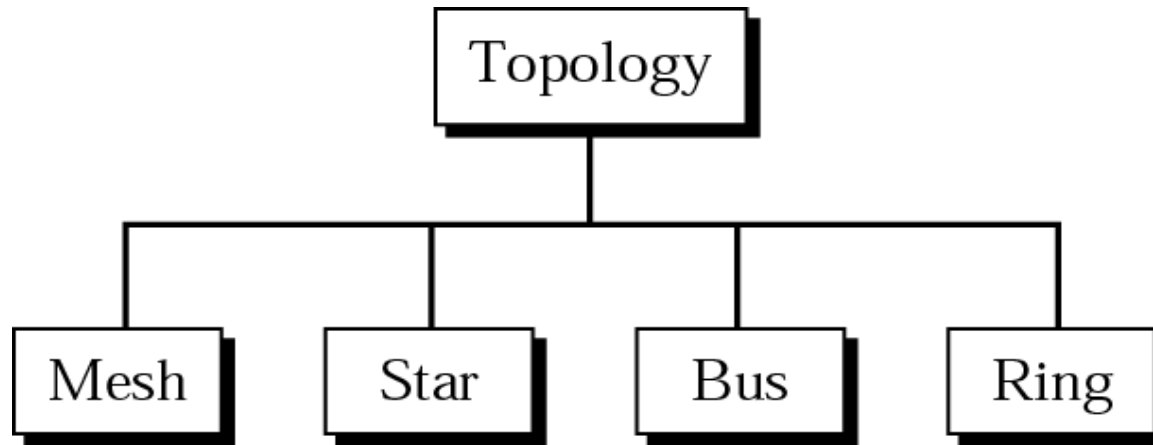


CONT:

- Each device needs a way to identify itself using an address and the device to which it wants to send information.
- Multipoint Physical Topologies can be classified as shown in the diagram below.



TOPOLOGY TAXONOMY(BEHROUZ A. FOROUZAN 2004)



The star, the bus and the ring are the basic topologies from which complex and hybrid topologies derived.

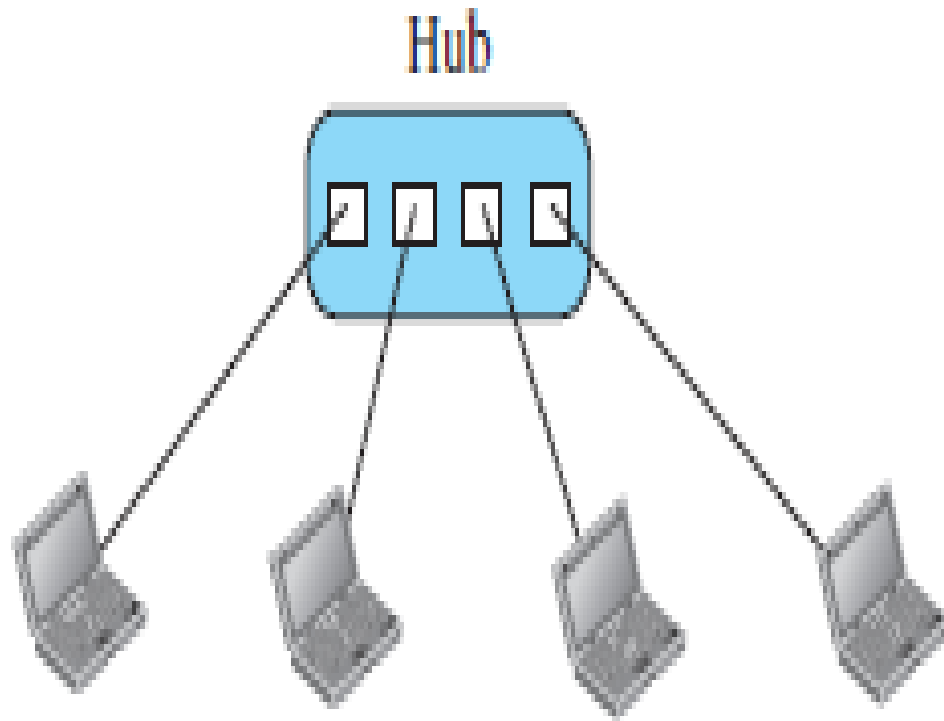


STAR TOPOLOGY

- Has its roots in the mainframe world. Each device connects to a central point via a point-to-point link. Depending on the logical architecture used, several names are used for the central point including the following:
 - Hub
 - Multipoint Repeater
 - Concentrator
 - Multi-Access Unit (MAU)
 - Switch
- In its most basic configuration, cables radiate from a hub or switch as shown in the figures below.



STAR TOPOLOGY (BEHROUZ A. FOROUZAN 2013)



CONT:

- It can also be designed using the following configurations:
 - **Distributed star:** This is a modification of the basic star topology in which the stations are not connected
 - Clustered star: It is similar to the tree topology but there are clusters of devices at the end of each branch.
 - **Hierarchical star:** It is an extension of the star topology.
 - The devices are connected to a hub or switch as in a star topology.
 - These hubs or switches are connected to each other via a central hub.



ADVANTAGES OF STAR TOPOLOGY

- Network control is centralized at one point
- Network intelligence is limited to the central workstation
- Radiating workstations can use the CPU processing of the central workstation



DISADVANTAGES OF STAR TOPOLOGY

- Congestion at the central workstation can slow transmissions
- Failure of the central workstation renders the network useless.
- Workstations can only communicate with each other by going through the central workstation.
- All workstations have their own communication media, which can become expensive
- The central workstation has a physical limitation for the number of workstations that can be connected

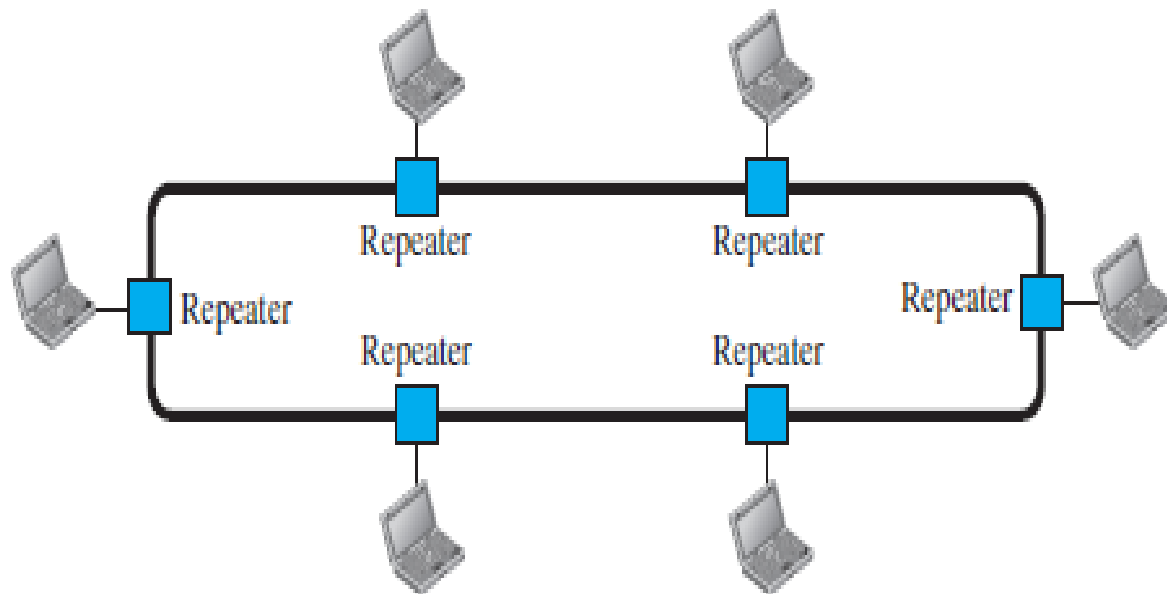


RING TOPOLOGY

- It is a physical, closed loop consisting of point-to-point links.
- Each node is connected to the two nearest nodes so the entire network forms a circle



RING TOPOLOGY(BEHROUZ A. FOROUZAN 2013)



ADVANTAGES OF RING TOPOLOGY

- All workstations share the same communication medium.
- The loss of one workstation does not affect the functionality of the network.
- The cost of a single shared medium is low.
- Adding another station amounts to making a connection to the single communication medium



DISADVANTAGES OF RING TOPOLOGY

- Each workstation must pass on unintended messages.
- Response speed degrades as the network size increases.
- Network intelligence must be distributed.

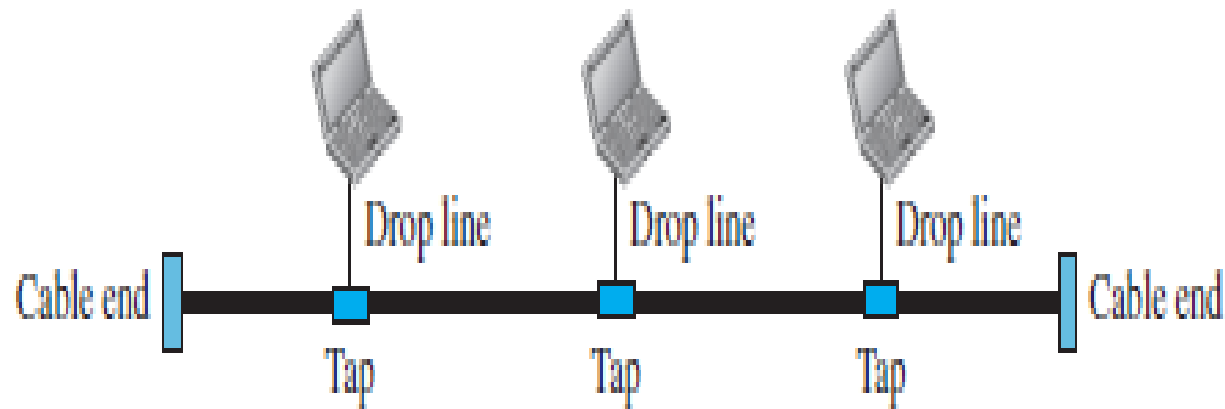


BUS TOPOLOGY

- A Bus topology consists of a single cable called a bus connecting all nodes on a network without intervening connectivity devices. In bus topologies, all data signals are broadcast throughout the bus structure.



BUS TOPOLOGY(BEHROUZ A. FOROUZAN 2013)



ADVANTAGES OF BUS TOPOLOGY

- Workstations can communicate directly with each other.
- A single shared medium is inexpensive
- The loss of one workstation does not affect the functionality of the network
- High transmission speed is possible.
- Adding another station amounts to making another connection to the bus



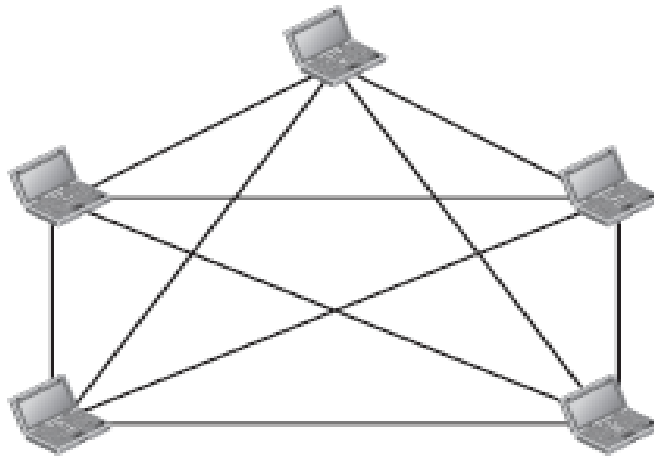
○ **Disadvantages of Bus Topology**

- The approach is appropriate to a limited geographical area.
- The causes of faults and failures are difficult to determine.
- Failure of the backbone renders the network useless.
- Network intelligence may have to be distributed to all workstations.



MESH TOPOLOGY

- In this topology computers are interconnected with at least two pathways connecting each computer.



Mesh Topology (Behrouz A. Forouzan 2013)



ADVANTAGES OF MESH TOPOLOGY

- Fast response time.
- Single workstation failure does not affect network.
- Connections determined by movement of data



ADVANTAGES OF MESH TOPOLOGY

- Network intelligence must be distributed.
- Adding a new station can be expensive.
- Making connections between many stations is expensive.



HYBRID TOPOLOGIES

- Complex combination of the simple physical topologies. Examples are Star-wired ring, Star-wired bus, daisy-chained and hierarchical or tree topologies
- **Star Ring**
Star-wired topologies use physical layout of a star in conjunction with token ring-passing data transmission method
- **Star Bus**
- In a star-wired bus topology, groups of workstations are star-connected to hubs and then networked via a single bus



- **Advantages of Hybrid Topology**
- Benefits of several topologies can be combined.
- Workgroup efficiency and traffic can be customized.
- **Disadvantages of Hybrid Topology**
- Devices on one topology can not be placed onto another topology without hardware changes.



ADVANTAGES OF NETWORKING

- **Resource sharing** – The resources include data/information, files, printers, modems, communication links, storage devices, fax machines, application programs and any other component that can be accessed by users over the network.
- **Remote communication** – This refers to the transmission of data signals between two communication devices located at different geographical locations. This enables people to be able to share information, ideas and pass messages while far from each other e.g. through use of Internet.



CONT:

- **Distributed processing** – This refers to the act of running the same program on different computers which are on the same network. The processed data is then sent to central computer (server) storage or further processing. E.g. the operations in banks.
- **Increased efficiency and effectiveness** – Due to fast transfer of data and information, operations in an organization can be executed quickly and timely.
- **Centralized control of data.**
- **Reduced cost** of transfer of data and information.
- **Reliability** – In a computer network, data transfer can be done with minimal errors and breakdown of one computer may not bring all operations in an organization to a halt.



DISADVANTAGES OF NETWORKING

- **Security** – data and information may be prone to unauthorized access.
- **High initial cost** – Initial cost network hardware and software is high.
- **Moral and cultural decancy** – Poor observing of network etiquettes (netiquettes) e.g. in use of Internet may lead to moral and cultural decancy.
- **Over-reliance** on a computer network may grind a whole system to a halt should one of the network components fail e.g. where all computer are connected through a central computer (server) and it fails/crashes.
- **Slow response time** – this may be due to limited resources within the network components e.g. small RAM memory in a file server computer may slow down the system especially when many users access files at the same time.
-

