



Introduction to Data Communications

IN 1501 Data Communication



Course Learning Outcomes

- Differentiate between features and requirements of communication techniques
- Explain reference models for data communications, including layers, functions, services, and protocols
- Identify data link layer functions



Outline Syllabus

- PhysicalAspects of Data Transmission
- Communication Techniques
- Data Link Control
- Broadcast CommunicationNetworks
- The Network Layer
- The Transport Layer



Reference

- Behrouz A. Forouzan, Data Communications and Networking, 5th Edition, Tata McGraw-Hill, 2013
- William Stallings, Data and Computer Communication, 10th Edition, Pearson Education, 2014



What is Data Communication?

- Data: Information stored in digital form
- Data Communication: Process of transferring digital information between two or more points.
- Information: the knowledge or intelligence.
- Data communication can be summarized as the transmission, reception, and processing of digital information.
- For data communication to occur, the communicating devices must be part of a communication system made up of a combination of hardware (physical equipment) and software (programs).
- Components: Hardware (physical equipment) and software (programs)
- Purpose: Transmission, reception, and processing of digital information



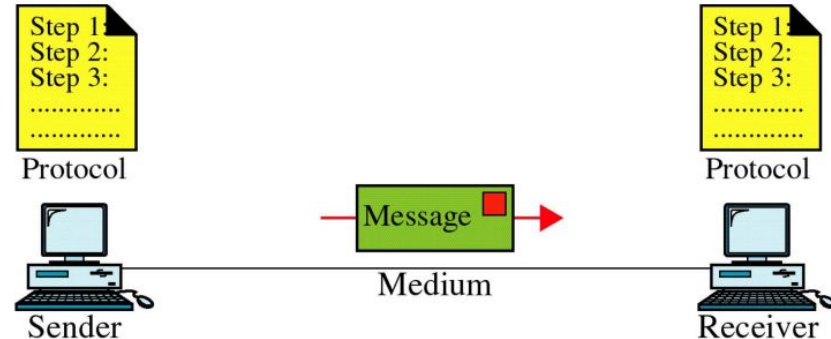
Fundamental Characteristics

The effectiveness of a data communications system depends on four fundamental characteristics:

- Delivery: Accurate routing to correct destination
- Accuracy: Error-free data transmission
- Timeliness: Efficient delivery timing
- Jitter: Variation in packet arrival time

Components of Data Communication System

- Message: Information to be communicated (text, numbers, pictures, audio, and video)
- Sender: device that sends the data message eg: computer, workstation, telephone handset, video camera, etc
- Receiver: device that receives the message.
- Transmission Medium: Physical path by which message travel from sender to receiver
- Protocol: Set of rules that govern data communications



Understanding Protocols



- In information technology, a protocol (from the Greek protocollon, which was a leaf of paper glued to a manuscript volume, describing its contents) is the special set of rules that end points in a telecommunication connection use when they communicate.
- Protocols exist at several levels in a telecommunication connection.
- For example, there are protocols for the data interchange at the hardware device level and protocols for data interchange at the application program level.
- Protocols are often described in an industry or international standard.
- Multiple Protocol Levels:
 - Hardware device level
 - Application program level
 - Industry Standards Compliance
 - Essential for Device Compatibility



Major Standards Organizations

- Standards mean a common set of rules.
- An association of organizations, governments, manufacturers and users form the standards organizations are responsible for developing, coordinating and maintaining the standards.
- The intent is that all data communication equipment manufacturers and users comply with these standards.
- The primary standards organizations for data communication are:
 - ISO (International Standard Organization)
 - ITU-T (International Telecommunications Union)
 - IEEE (Institute of Electrical and Electronics Engineers)
 - ANSI (American National Standards Institute)
 - IAB (Internet Architecture Board)



International Standard Organization(ISO)

- ISO is the international organization for standardization on a wide range of subjects.
- It is comprised mainly of members from the standards committee of various governments throughout the world.
- It is even responsible for developing models which provides high level of system compatibility, quality enhancement, improved productivity and reduced costs.



International Telecommunications Union- Telecommunication Sector (ITU-T)

- ITU-T is one of the four permanent parts of the International Telecommunications Union based in Geneva, Switzerland.
- It has developed three sets of specifications: the V series for modem interfacing and data transmission over telephone lines, the X series for data transmission over public digital networks, email and directory services; the I and Q series for Integrated Services Digital Network (ISDN) and its extension Broadband ISDN.



Institute of Electrical and Electronics Engineers(IEEE)

- IEEE is an international professional organization founded in United States and is comprised of electronics, computer and communications engineers.
- It is currently the world's largest professional society with over 200,000 members.
- It develops communication and information processing standards with the underlying goal of advancing theory, creativity, and product quality in any field related to electrical engineering.



ANSI: American National Standards Institute

- ANSI is the official standards agency for the United States and is the U.S voting representative for the ISO.
- ANSI is a completely private, non-profit organization comprised of equipment manufacturers and users of data processing equipment and services.
- ANSI membership is comprised of people from professional societies, industry associations, governmental and regulatory bodies, and consumer goods.



Internet Architecture Board(IAB)

- IAB earlier known as Internet Activities Board is a committee created by ARPA (Advanced Research Projects Agency) so as to analyze the activities of ARPANET whose purpose is to accelerate the advancement of technologies useful for U.S military.
- IAB is a technical advisory group of the Internet Society and its responsibilities are:
 - Oversees the architecture protocols and procedures used by the Internet.
 - Manages the processes used to create Internet Standards and also serves as an appeal board for complaints regarding improper execution of standardization process.
 - Responsible for administration of the various Internet assigned numbers



Network Basics

- Definition: The practice of linking two or more computing devices together for the purpose of sharing data
- Components: Hardware and software elements
- Purpose: Resource sharing and communication
- Structure: Nodes connected through digital interconnections

“A computer network is a group of computers that use a set of common communication protocols over digital interconnections for the purpose of sharing resources located on or provided by the network nodes.”



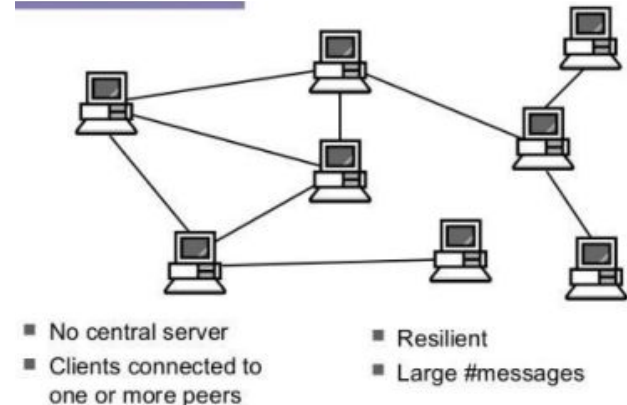
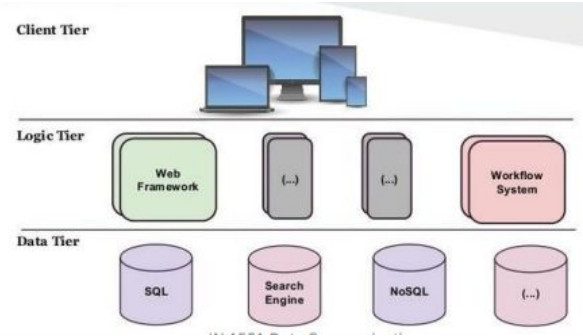
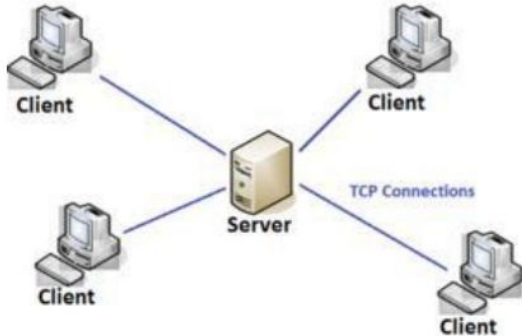
Distributed Systems

- Multiple autonomous computers that communicate through a computer network.
- The computers interact with each other in order to achieve a common goal.
- Distributed program: A computer program that runs in a distributed system
- Distributed programming: The process of writing such programs.
- Task division and problem-solving: a problem is divided into many tasks, each of which is solved by one or more computers.
- Resource sharing capabilities

Distributed Architectures

Distributed programming typically falls into one of several basic architectures or categories:

- Client-server: Smart client code contacts the server for data then formats and displays it to the user. Input at the client is committed back to the server when it represents a permanent change.
- 3-tier architecture: Three tier systems move the client intelligence to a middle tier so that stateless clients can be used. This simplifies application deployment. Most web applications are 3-Tier.
- Peer-to-peer: an architecture where there is no special machine or machines that provide a service or manage the network resources. Instead all responsibilities are uniformly divided among all machines, known as peers. Peers can serve both as clients and servers.





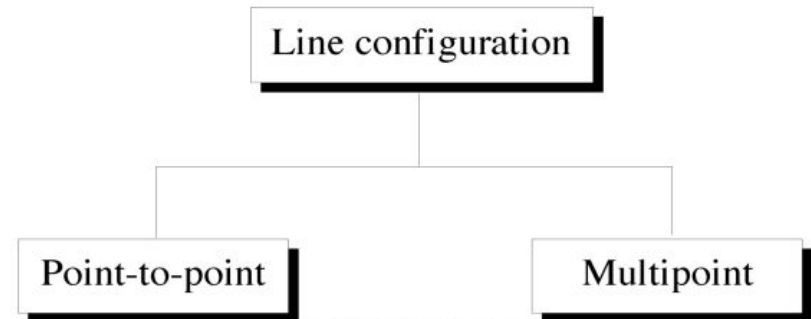
Basic Concepts

Before examining the specifics of how data are transmitted from one device to another, it is important to understand the relationship between the communicating devices. Five general concepts that provide the basis for this relationship:

- Line Configuration : the way two or more communication devices attached to a link.
 - A Link is the physical communication pathway that transfers data from one device to another. For communication to occur, two devices must be connected in same way to the same link at the same time.
- Topology : The way in which the end points or stations/computer systems, attached to the networks, are interconnected.
- Transmission mode : The transmission is characterized by
 - the direction of the exchanges
 - the transmission mode: the number of bits sent simultaneously
 - synchronization between the transmitter and receiver
- Categories of Networks : WAN, LAN, MAN
- Internetworks: Internetworking is the practice of connecting a computer network with other networks through the use of gateways that provide a common method of routing information packets between the networks.

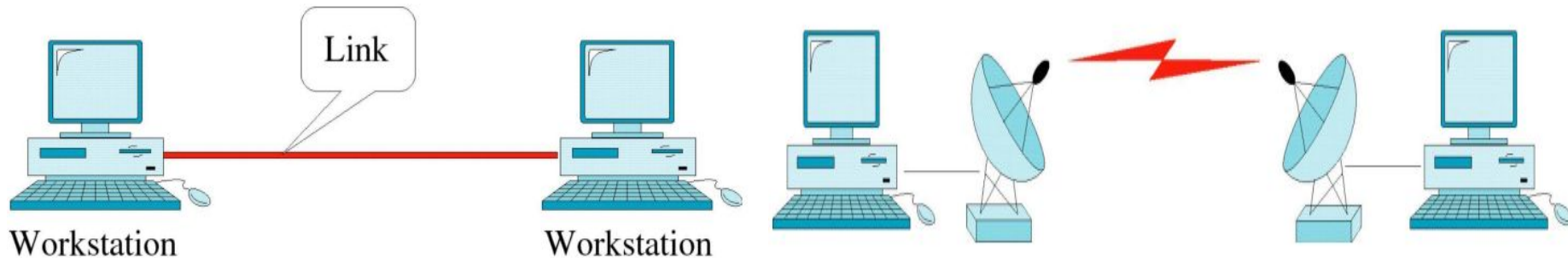
Line Configurations

- A Link is the physical communication pathway that transfers data from one device to another. For communication to occur, two devices must be connected in same way to the same link at the same time.
- Point-to-Point: Direct connection between two devices
- Multipoint: Multiple devices sharing a link
- Spatial Sharing: Simultaneous link usage
- Temporal Sharing: Time-divided usage



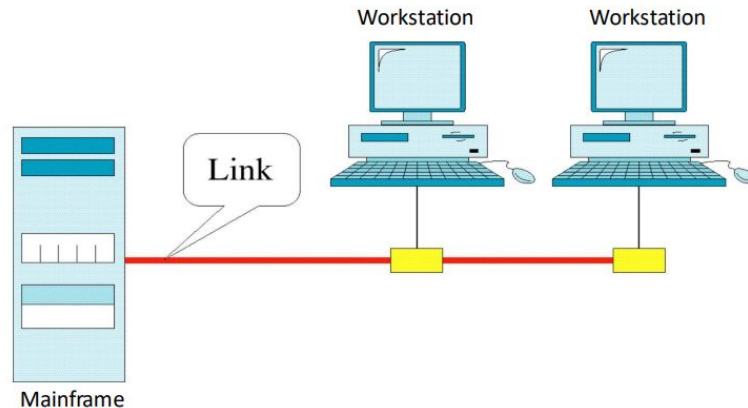
Point-to-Point Line Configuration

- A Point to Point Line Configuration Provide dedicated link between two devices use actual length of wire or cable to connect the two end including Microwave & satellite link.
- Infrared remote control & televisions remote control.
- The entire capacity of the channel is reserved for transmission between those two devices.
- Most point-to-point line configurations 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.
- Point to point network topology is considered to be one of the easiest and most conventional network topologies.
- It is also the simplest to establish and understand.
- To visualize, one can consider point to point network topology as two phones connected end to end for a two way communication



Multipoint Line Configuration

- Multipoint Configuration also known as Multi drop line configuration one or more than two specific devices share a single link capacity of the channel is shared.
- More than two devices share the Link that is the capacity of the channel is shared now. With shared capacity, there can be two possibilities in a Multipoint Line Configure:
 - Spatial Sharing: If several devices can share the link simultaneously, its called Spatially shared line configuration
 - Temporal (Time) Sharing: If users must take turns using the link , then its called Temporally shared or Time Shared Line Configuration





Network Topologies

- The term “Topology” refers to the way in which the end points or stations/computer systems, attached to the networks, are interconnected.
- We have seen that a topology is essentially a stable geometric arrangement of computers in a network. If you want to select a topology for doing networking.
- You have attention to the following points.
 - Application S/W and protocols
 - Types of data communicating devices
 - Geographic scope of the network
 - Cost
 - Reliability

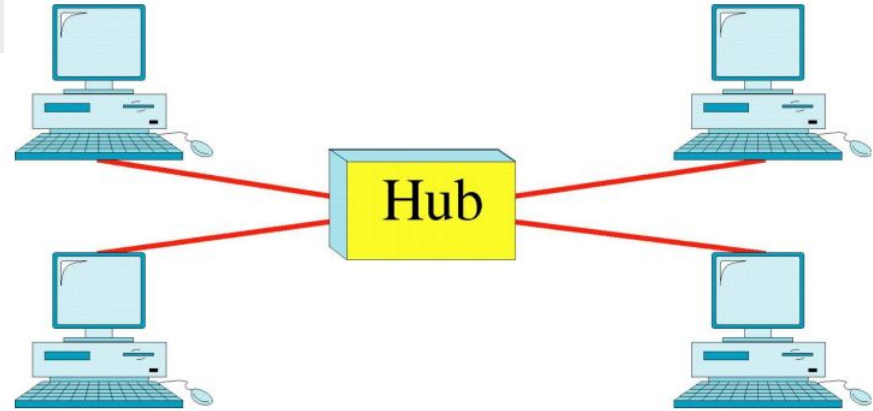


Network Topologies

- Mesh: Full device interconnection
- Star: Central hub connection
- Tree: Hierarchical structure
- Bus: Linear connection
- Ring: Circular connection
- Cellular: Wireless area division

Ring and mesh topologies are felt convenient for peer to peer transmission. Star and tree are more convenient for client server. Bus topology is equally convenient for either of them

Star Topology Details

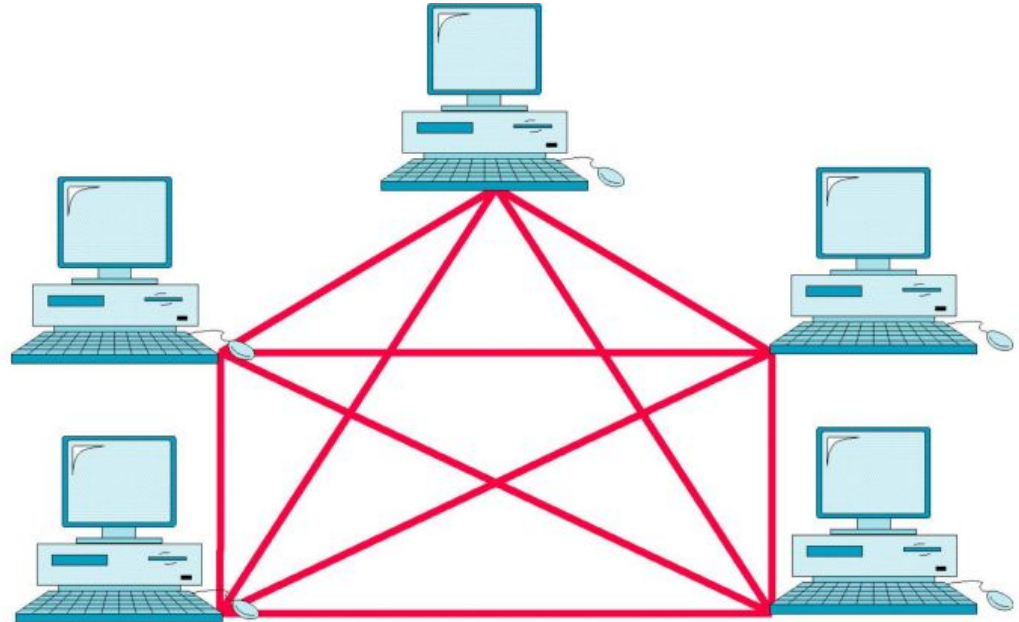


- In a star topology, cables run from every computer to a centrally located device called a HUB.
- Star topology networks require a central point of connection between media segment.
- These central points are referred to as Hubs.
- Hubs are special repeaters that overcome the electromechanical limitations of a media.
- Each computer on a star network communicates with a central hub that resends the message either to all the computers (In a broadcast network) or only the destination computer(In a switched network).
- Ethernet 10 base T is a popular network based on the star topology.

Mesh Topology

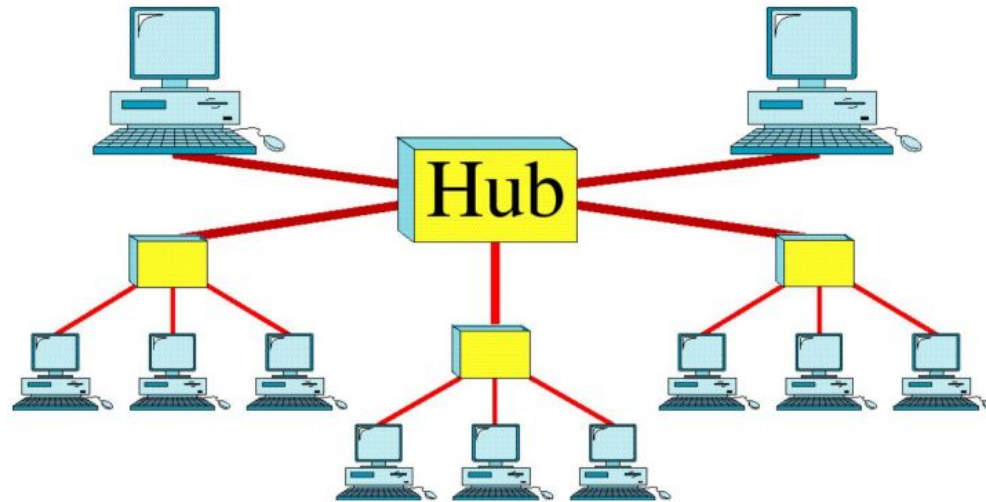
The value of fully meshed networks is proportional to the exponent of the number of subscribers, assuming that communicating groups of any two endpoints, up to and including all the endpoints, is approximated by Reed's Law.

The number of connections in a full mesh = $\frac{n(n - 1)}{2}$



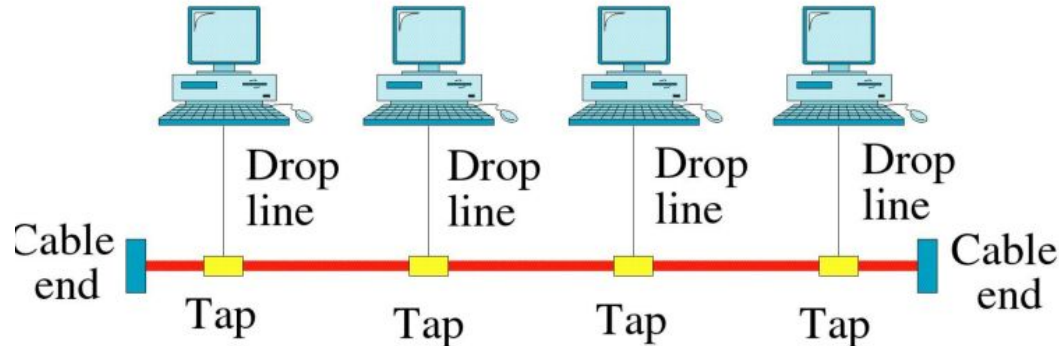
Tree (Hierarchical) topology

- It is similar to the star network, but the nodes are connected to the secondary hub that in turn is connected to the central hub.
- The central hub is the active hub.
- The active hub contains the repeater, which regenerates the bits pattern it receives before sending them out.
- The secondary hub can be either active or passive.
- A passive hub provides a simple physical connection between the attached devices.

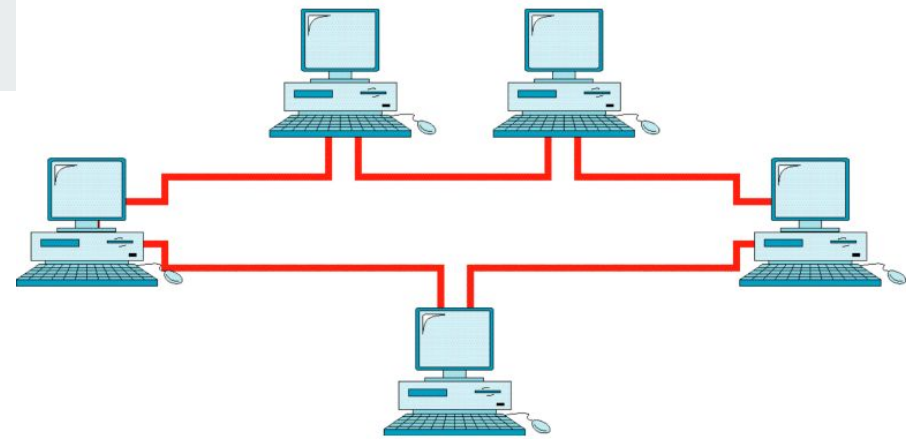


Tree (Hierarchical) topology

- A bus topology connects computers along a single or more cable to connect linearly.
- A network that uses a bus topology is referred to as a "bus network" which was the original form of Ethernet networks.
- Ethernet 10Base2 (also known as thinnet) is used for bus topology.



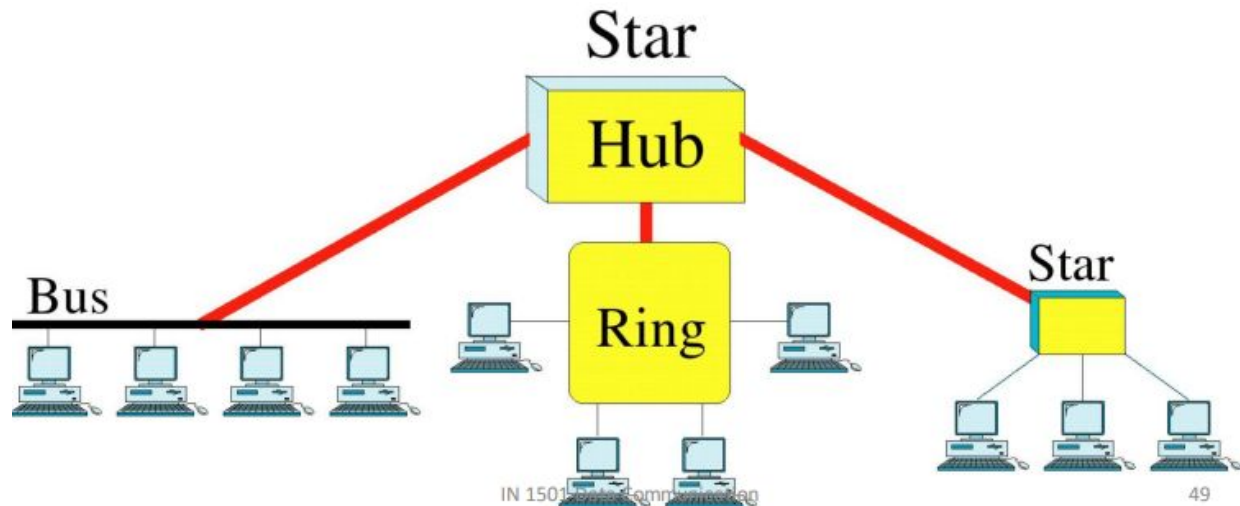
Ring Topology Features



- In ring topology, each device has a dedicated point-to-point line configuration only with two devices on either side of it.
- A signal is passed along the ring in one direction, from device to device until it reaches its destination.
- Each device in the ring has a repeater.
- When the devices receive the signal intended for the other node, it just regenerates the bits and passes them along.
- Ring network passes a token.
- A token is a short message with the electronic address of the receiver.
- Each network interface card is given a unique electronic address, which is used to identify the computer on the network.

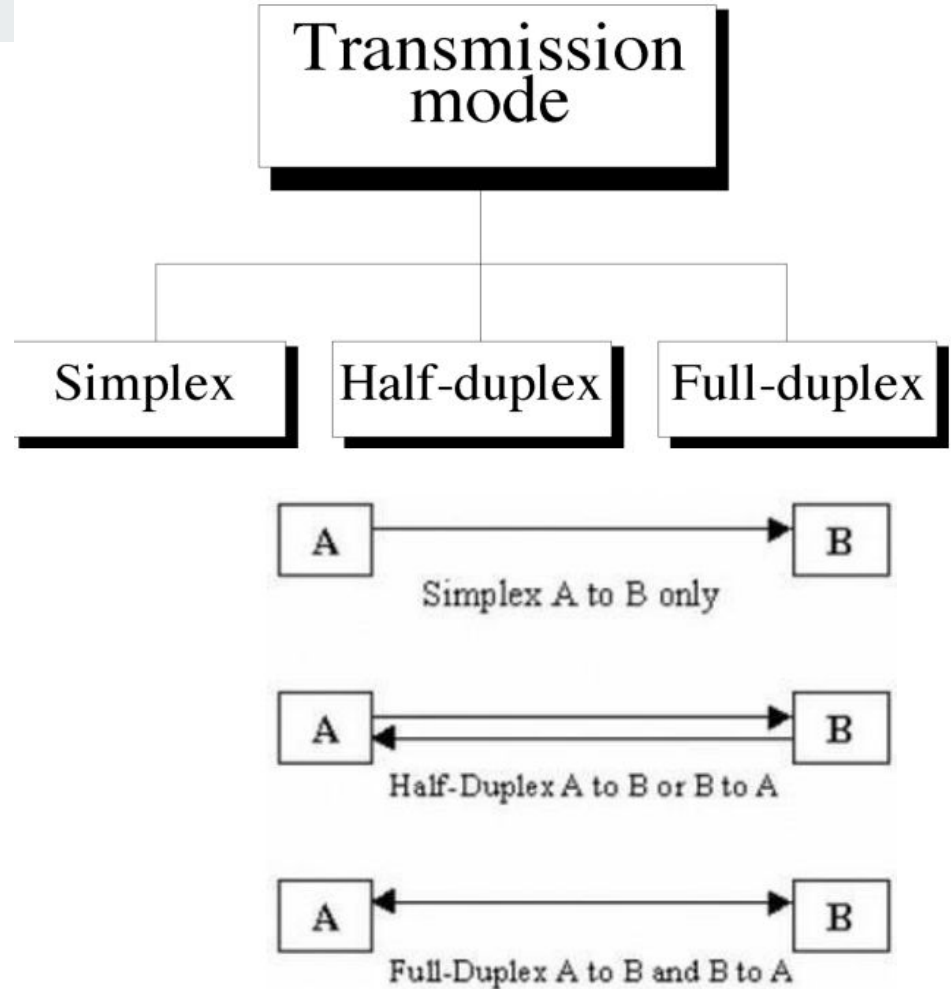
Hybrid Topology

Hybrid topology is an integration of two or more different topologies to form a resultant topology which has many advantages (as well as disadvantages) of all the constituent basic topologies rather than having characteristics of one specific topology.



Transmission Modes

- Simplex: One-way communication
- Half-Duplex: Two-way alternate communication
- Full-Duplex: Simultaneous two-way communication
- Mode selection based on requirements



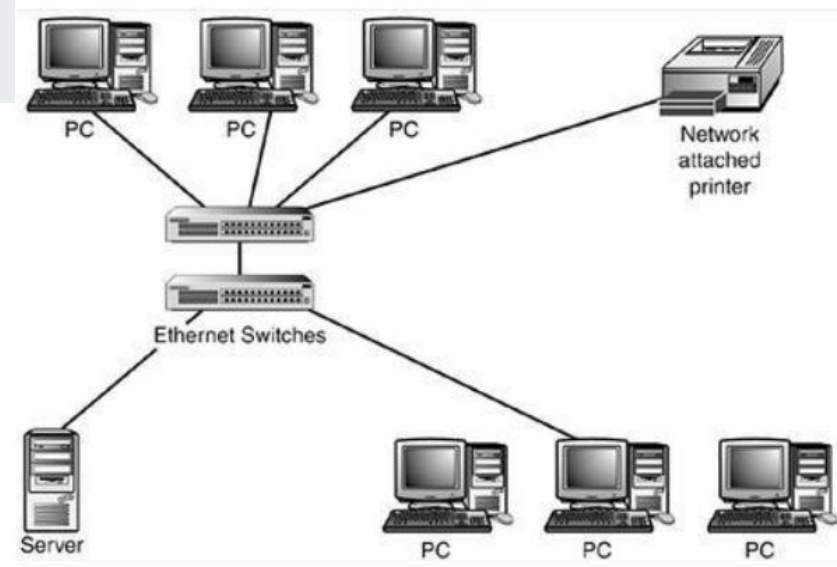


Network Categories

- LAN (Local Area Network)
- WLAN (Wireless Local Area Network)
- WAN (Wide Area Network)
- MAN (Metropolitan Area Network)
- Based on geographical scope

Local Area Networks (LAN)

- A LAN connects network devices over a relatively short distance.
- A networked office building, school, or home usually contains a single LAN, though sometimes one building will contain a few small LANs (perhaps one per room), and occasionally a LAN will span a group of nearby buildings.
- In TCP/IP networking, a LAN is often but not always implemented as a single IP subnet.
- In addition to operating in a limited space, LANs are also typically owned, controlled, and managed by a single person or organization.
- They also tend to use certain connectivity technologies, primarily Ethernet and Token Ring.



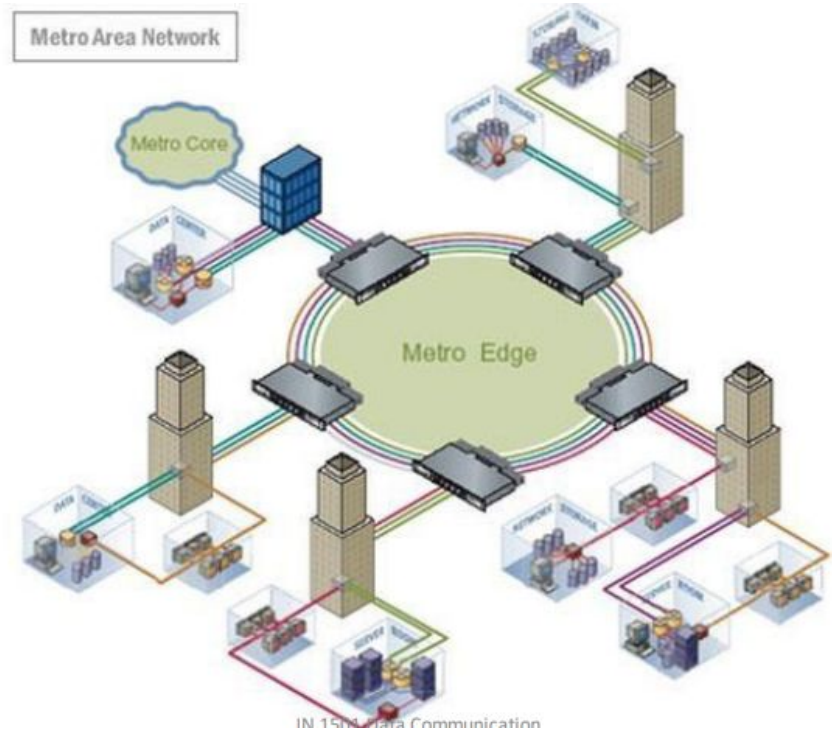
Wide Area Networks (WAN)

- Large geographical coverage
- Multiple LAN connections
- Router-based connectivity
- Distributed management
- Internet as largest example



Metropolitan Area Network

- A network spanning a physical area larger than a LAN but smaller than a WAN, such as a city.
- A MAN is typically owned and operated by a single entity such as a government body or large corporation.
- Example: Public city network



Internetworking

- Network interconnection
- Gateway usage
- Protocol standardization
- TCP/IP implementation
- Global connectivity solutions

