Data Communications and Networking Fourth Edition

Forouzan

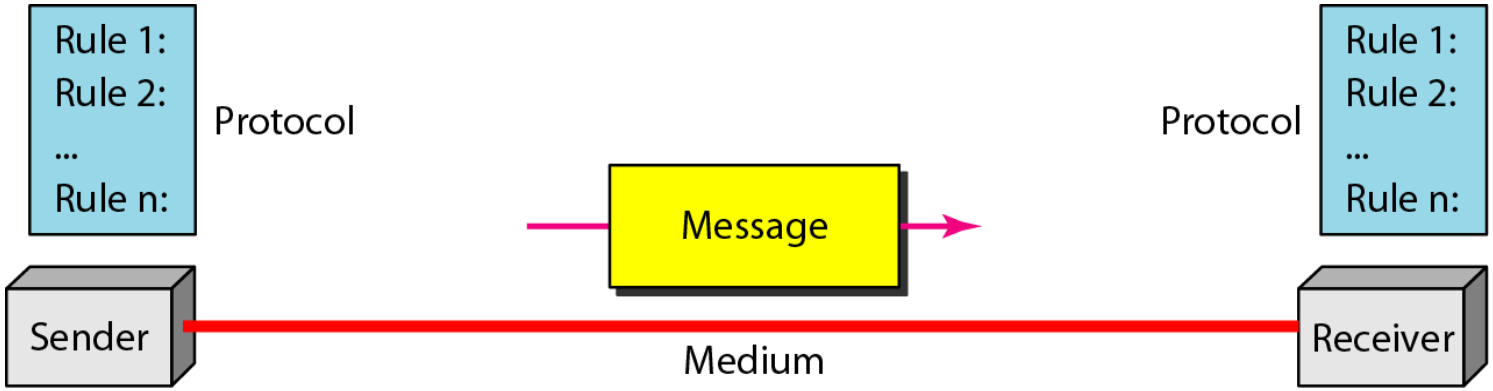
Chapter 1

Introduction

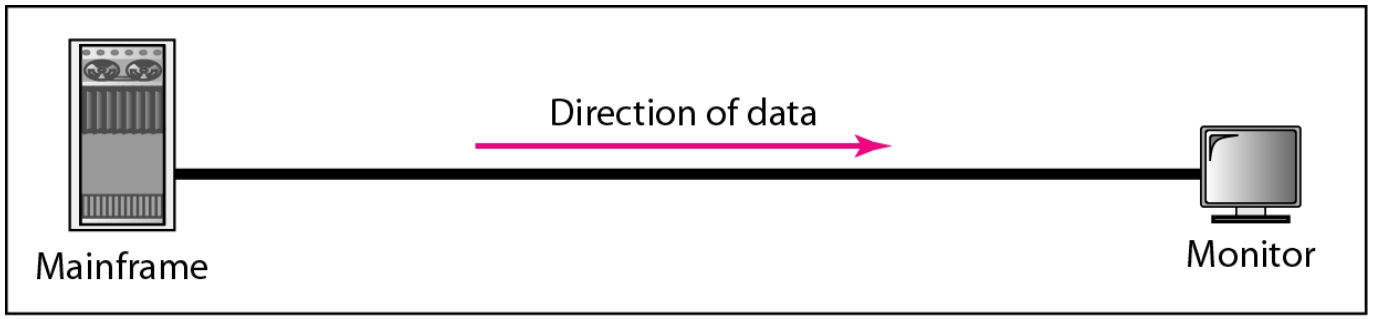
DATA COMMUNICATIONS

The term telecommunication means communication at a distance. The word data refers to information presented in whatever form is agreed upon by the parties creating and using the data. Data communications are the exchange of data between two devices via some form of transmission medium such as a wire cable.

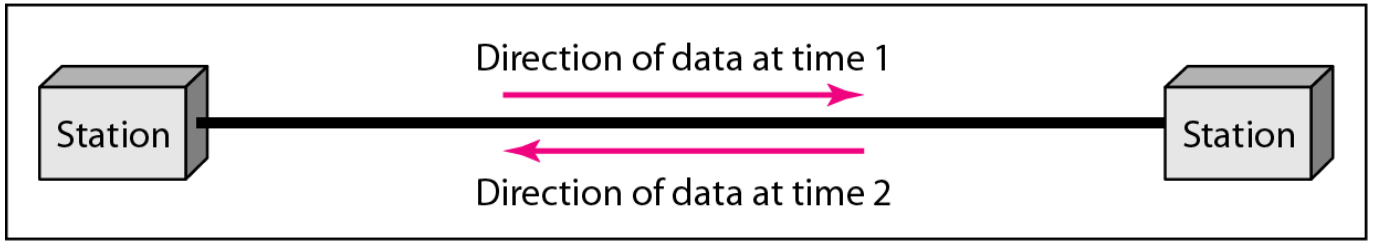
Components of a data communication system



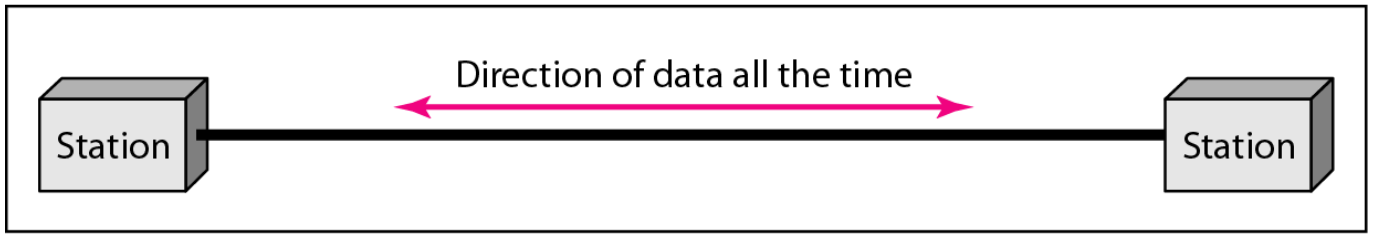
Data flow (simplex, half-duplex, and full-duplex)



a. Simplex



b. Half-duplex



c. Full-duplex

NETWORKS

A network is a set of devices (often referred to as nodes) connected by communication links. A node can be a computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network. A link can be a cable, air, optical fiber, or any medium which can transport a signal carrying information.

Network Criteria

- **Performance**
  - **Depends on Network Elements**
  - **Measured in terms of Delay and Throughput**
- **Reliability**
  - **Failure rate of network components**
  - **Measured in terms of availability/robustness**
- **Security**
  - **Data protection against corruption/loss of data due to:**
    - **Errors**
    - **Malicious users**

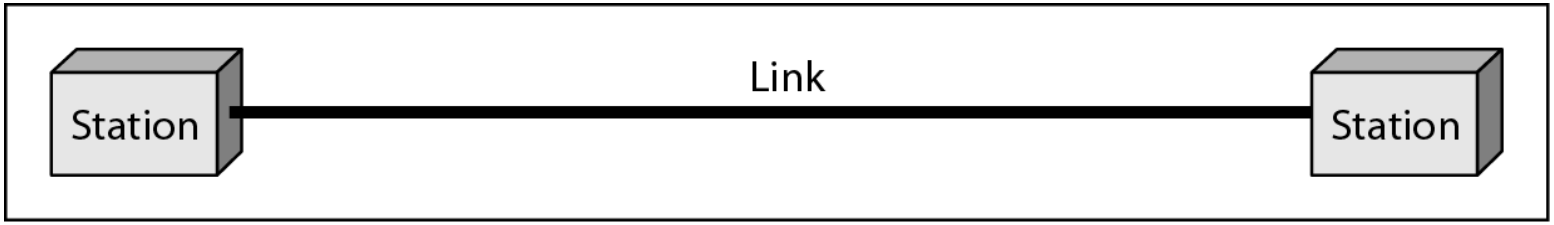
Physical Structures

- Type of Connection
  - Point to Point - single transmitter and receiver
  - Multipoint - multiple recipients of single transmission
- Physical Topology
  - Connection of devices
  - Type of transmission - unicast, mulitcast, broadcast

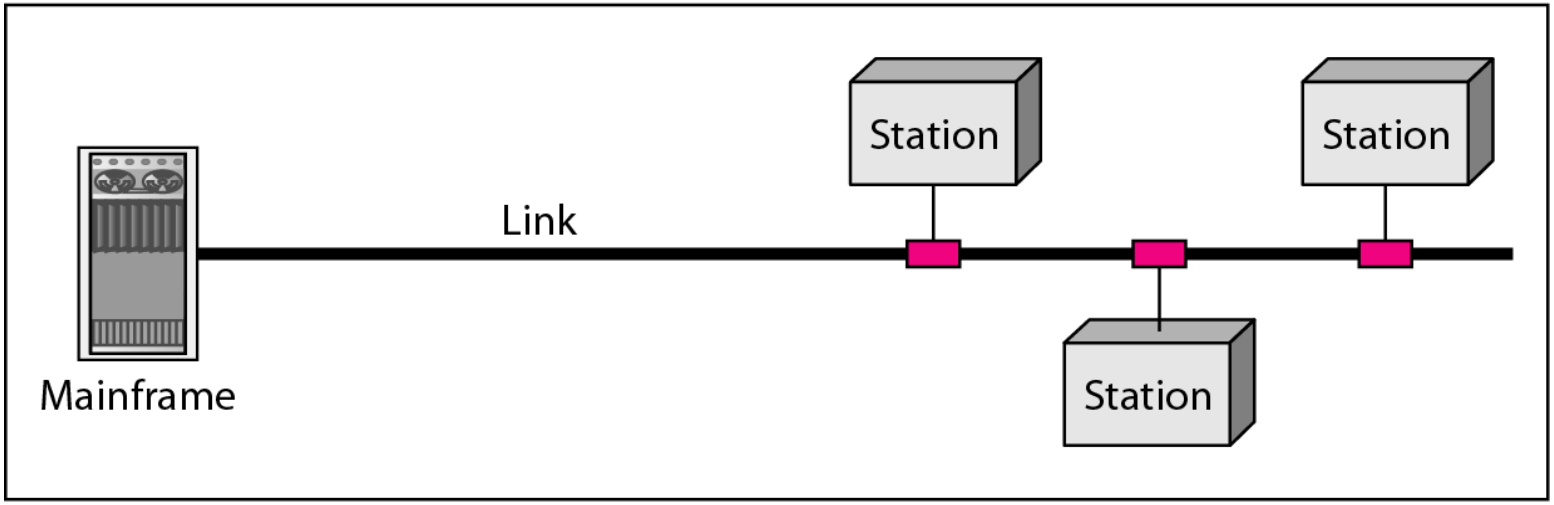
Types of connections: point-to-point and multipoint

Type of Connection:

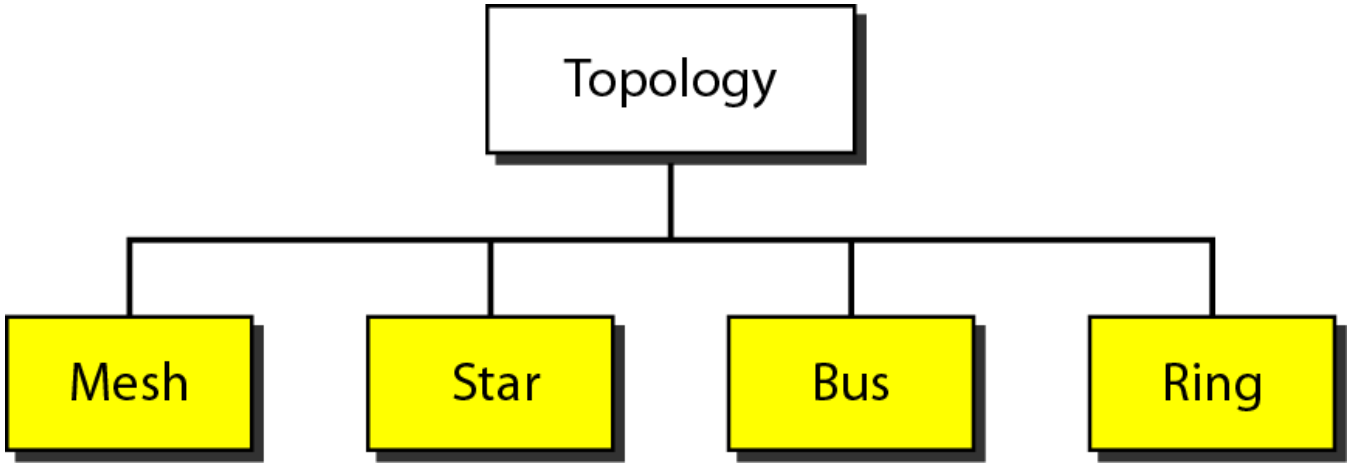
- Point to Point - single transmitter and receiver
- Multipoint - multiple recipients of single transmission



a. Point-to-point

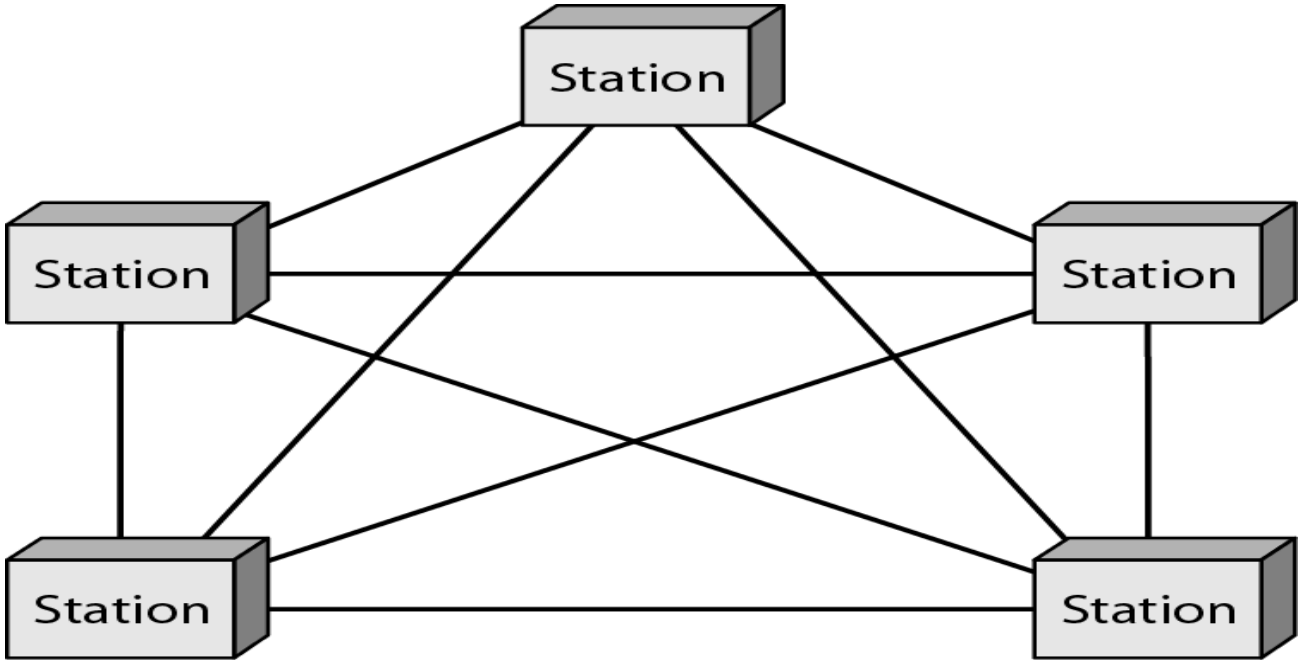


b. Multipoint



Network topology refers to the physical or logical layout of a network. It defines the way different nodes are placed and interconnected with each other. Alternately, network topology may describe how the data is transferred between these nodes.

A fully connected mesh topology (five devices)



Mesh Topology: Advantages & Disadvantages

A **mesh topology** is a network topology in which all the network nodes are individually connected to most of the other nodes. There is not a concept of a central switch, hub or computer which acts as a central point of communication to pass on the messages.

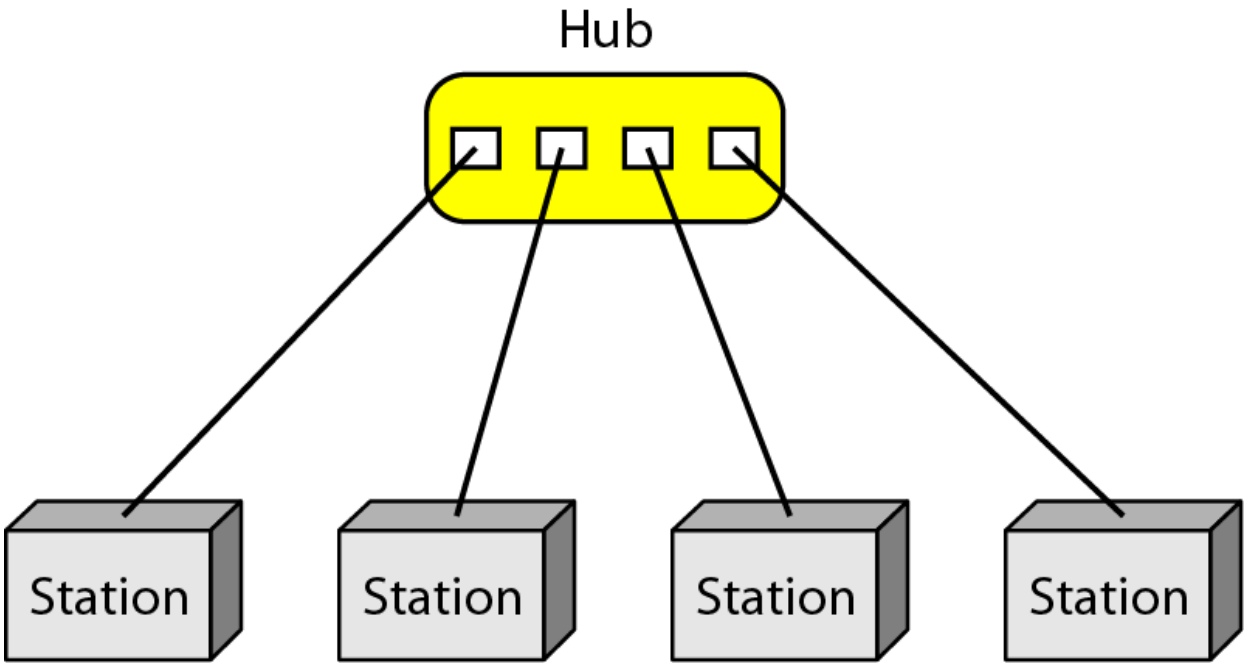
Advantages of mesh topology:

- Each connection can carry its own data load
- It is robust
- A fault is diagnosed easily
- Provides security and privacy

Disadvantages of mesh topology:

- Installation and configuration are difficult if the connectivity gets more
- Cabling cost is more and the most in case of a fully connected mesh topology
- Bulk wiring is required

A star topology connecting four stations



Star Topology: Advantages & Disadvantages

A **star topology** is designed with each node (like workstations, printers, laptops, servers etc.) connected directly to a central device called as a network switch. Each workstation has a cable that goes from its network card to a network switch. Most popular and widely used LAN technology Ethernet currently operates in Star topology.

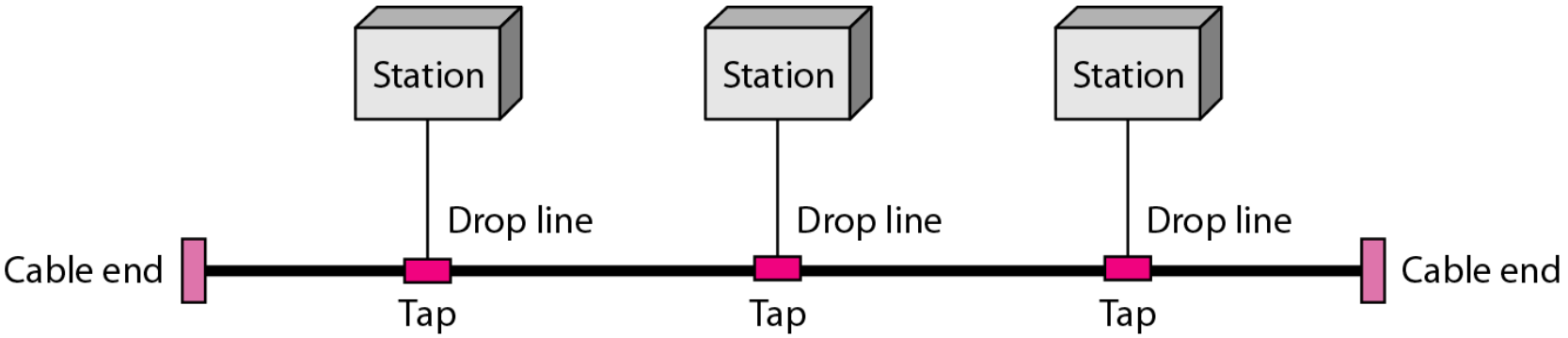
Advantages of Star Topology

- Easy to install and wire.
- No disruptions to the network when connecting or removing devices.
- Easy to detect faults and to remove parts.

Disadvantages of Star Topology

- Requires more cable length than a linear bus topology.
- If the connecting network device (network switch) fails, nodes attached are disabled and cannot participate in network communication.
- More expensive than linear bus topology because of the cost of the connecting devices (network switches).

A bus topology connecting three stations



Bus Topology: Advantages & Disadvantages

A **bus topology** consists of a main run of cable with a terminator at each end. All nodes like workstations, printers, laptops, servers etc., are connected to the linear cable. The terminator is used to absorb the signal when the signal reaches the end, preventing signal bounce. When using bus topology, when a computer sends out a signal, the signal travels the cable length in both directions from the sending computer. When the signal reaches the end of the cable length, it bounces back and returns in the direction it came from. This is known as signal bounce.

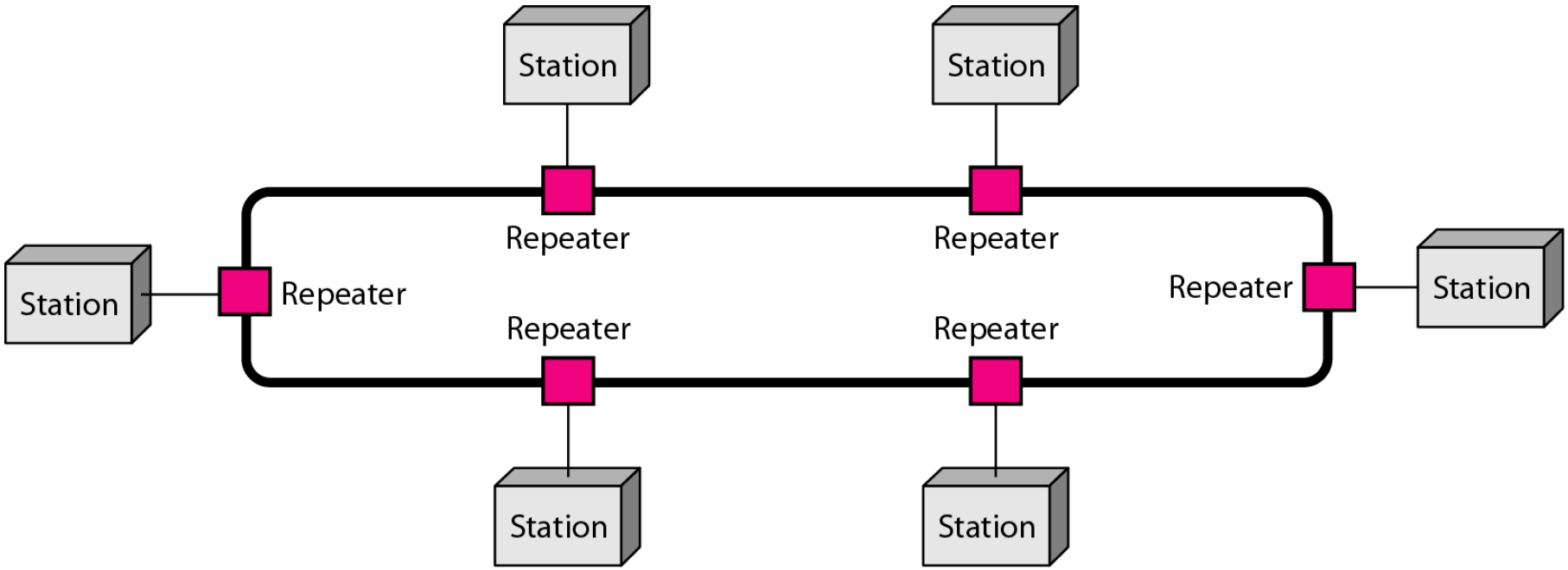
Advantages of Bus Topology

- Easy to connect a computer or peripheral to a linear bus.
- Requires less cable length than a star topology.

Disadvantages of Bus Topology

- Entire network shuts down if there is a break in the main cable.
- Terminators are required at both ends of the backbone cable.
- Difficult to identify the problem if the entire network shuts down.
- Not meant to be used as a stand-alone solution.

A ring topology connecting six stations



Ring Topology: Advantages & Disadvantages

In **Ring Topology**, all the nodes are connected to each-other in such a way that they make a closed loop. Each workstation is connected to two other components on either side, and it communicates with these two adjacent neighbors. Data travels around the network, in one direction. Sending and receiving of data takes place by the help of TOKEN.

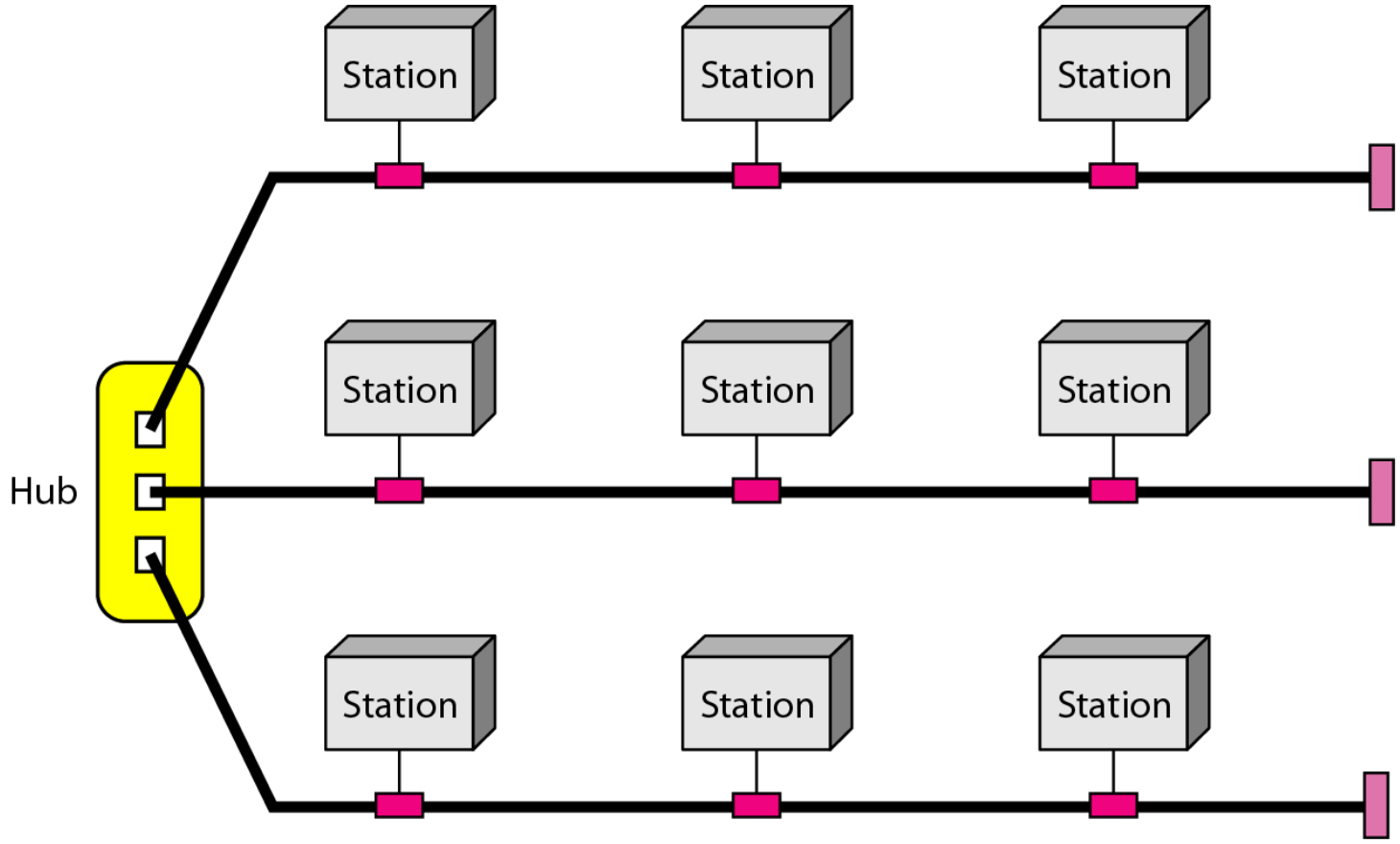
Advantages of Ring topology:

- Adding additional nodes is easy.
- All computers have equal access on network.

Disadvantages of Ring topology:

- Difficult to configure
- If Cable breaks, then whole Network will goes down.
- If any link goes down, then network will also goes down.
- Only one medium for Data Transmission so Transmission Speed is very slow.

A hybrid topology: a star backbone with three bus networks



The selection of a Network Topology

The selection of a Network Topology for a network can not be done in isolation as it affects the choice of media and the access method used. Because it determines the strategy used in wiring a building for a network and deserves some careful study.

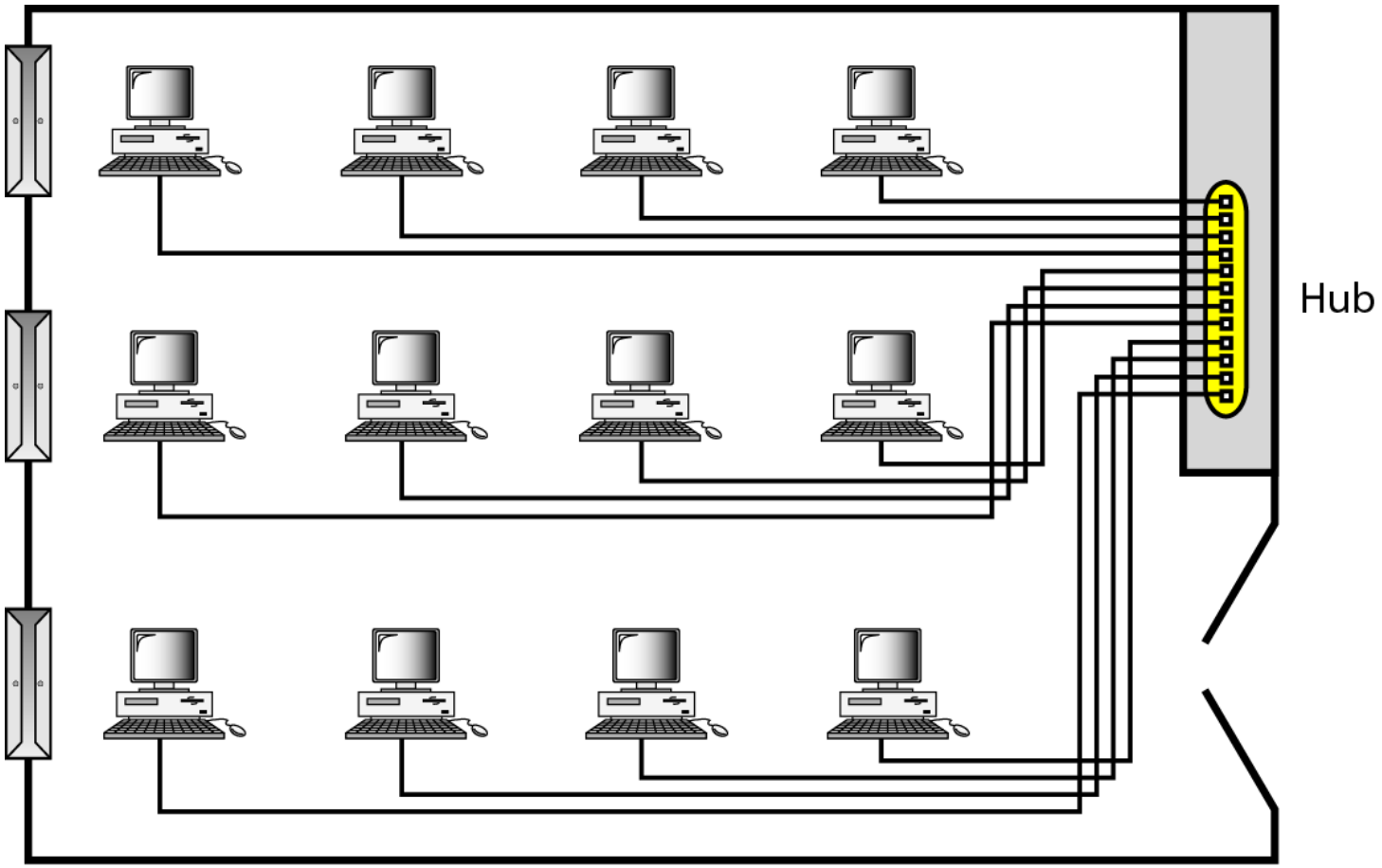
The following factors are considered while selecting a topology:

- Cost
- Reliability
- Scalability
- Bandwidth capacity
- Ease of installation
- Ease of troubleshooting
- Delay involved in routing information from one node to another

Categories of Networks

- Local Area Networks (LANs)
  - Short distances
  - Designed to provide local interconnectivity
- Wide Area Networks (WANs)
  - Long distances
  - Provide connectivity over large areas
- Metropolitan Area Networks (MANs)
  - Provide connectivity over areas such as a city, a campus

An isolated LAN connecting 12 computers to a hub in a closet



LAN (Local Area Network)

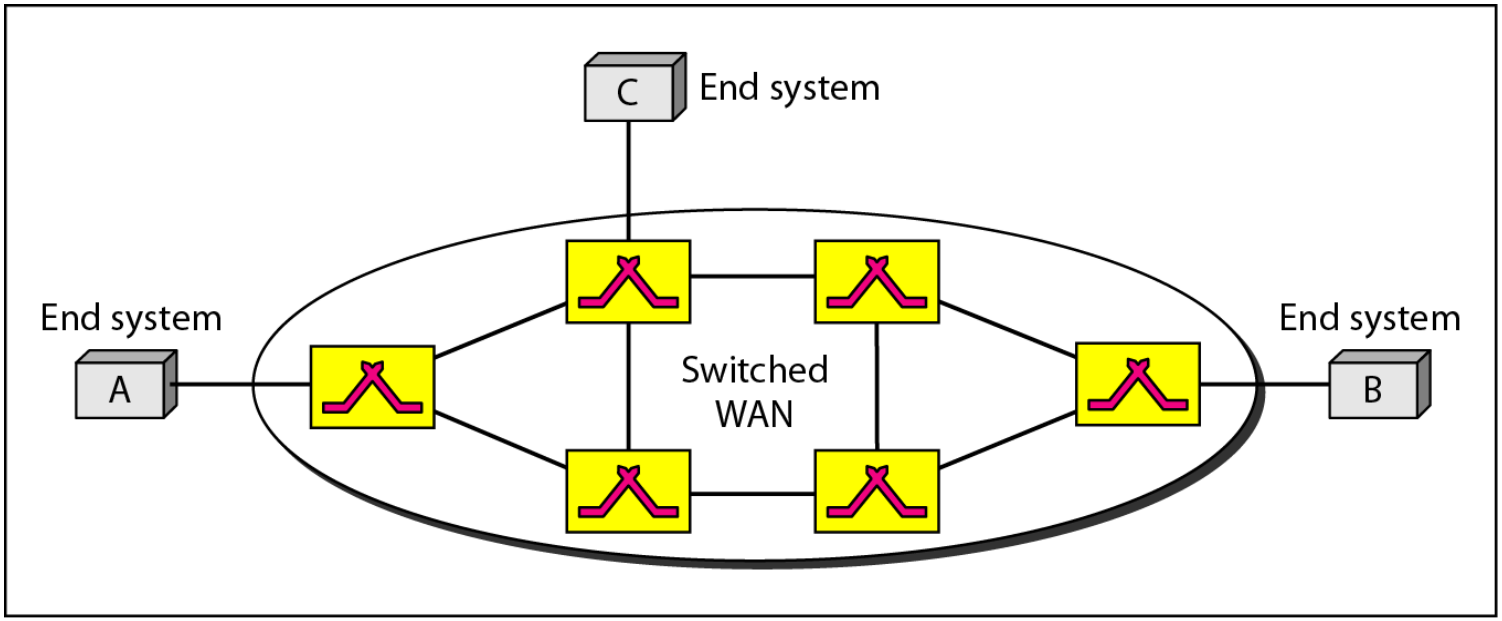
A local area network (LAN) is a group of computers and associated devices that share a common communications line or wireless link to a server. Typically, a LAN encompasses computers and peripherals connected to a server within a small geographic area such as an office building or home. Computers and other mobile devices can share resources such as a printer or network storage.

Ethernet and Wi-Fi are the two most commonly used LAN technologies.

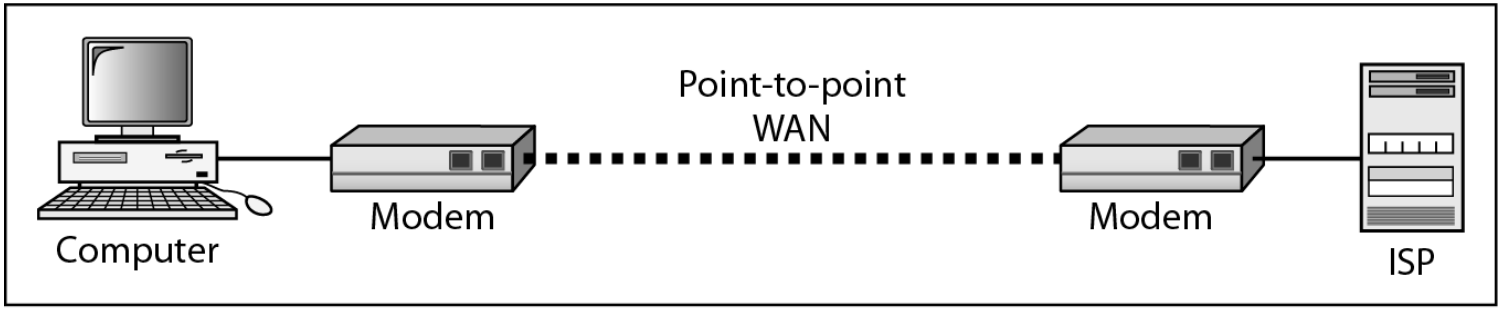
MAN (Metropolitan Area Network)

A metropolitan area network (MAN) is a network that interconnects users with computer resources in a geographic area or region larger than that covered by even a large local area network (LAN) but smaller than the area covered by a wide area network (WAN). The term is applied to the interconnection of networks in a city into a single larger network. It is also used to mean the interconnection of several local area networks by bridging them with backbone lines.

WANs: a switched WAN and a point-to-point WAN



a. Switched WAN

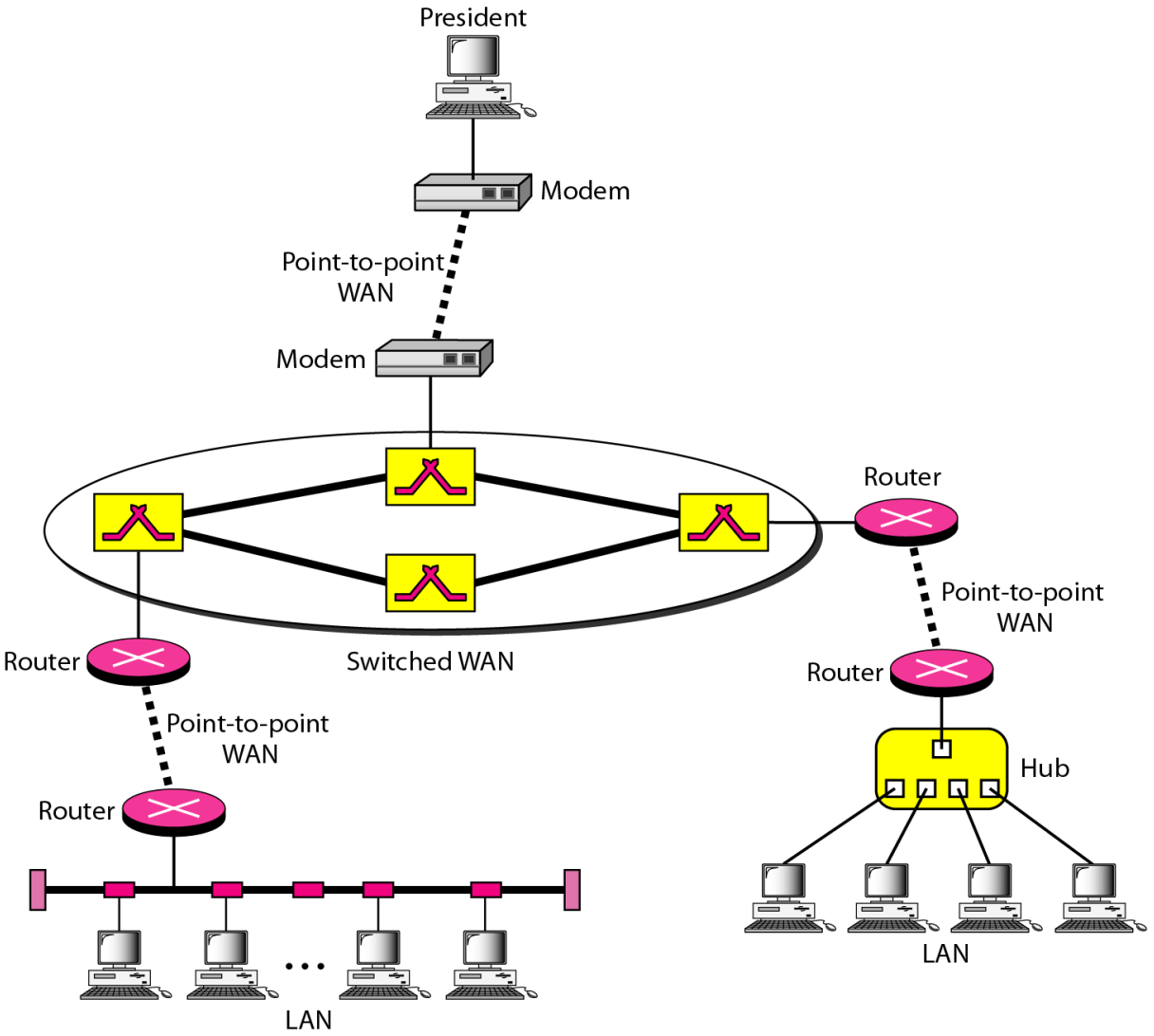


b. Point-to-point WAN

WAN (Wide Area Network)

A wide area network (WAN) is a network that exists over a large-scale geographical area. A WAN connects different smaller networks, including local area networks (LAN) and metropolitan area networks (MAN). This ensures that computers and users in one location can communicate with computers and users in other locations. WAN implementation can be done either with the help of the public transmission system or a private network.

Figure 1.12 *A heterogeneous network made of four WANs and two LANs*



THE INTERNET – Brief History

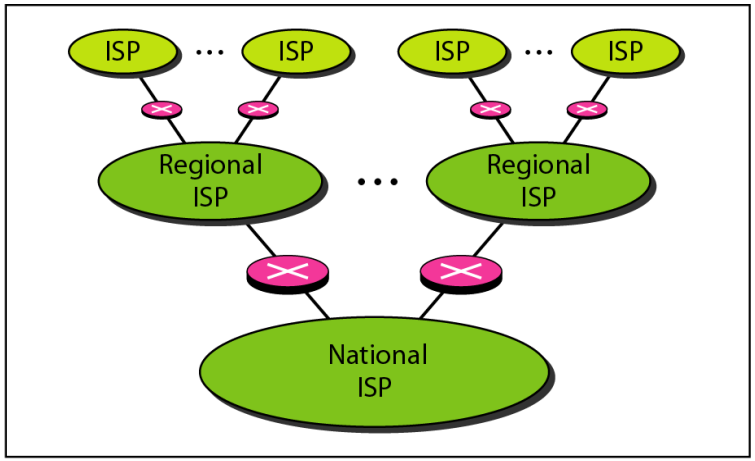
The Internet has revolutionized many aspects of our daily lives. It has affected the way we do business as well as the way we spend our leisure time. The Internet is a communication system that has brought a wealth of information to our fingertips and organized it for our use.

In 1967, the Advanced Research Projects Agency (ARPA) in the dept. of Defense presented ARPANET, a small network of connected computers

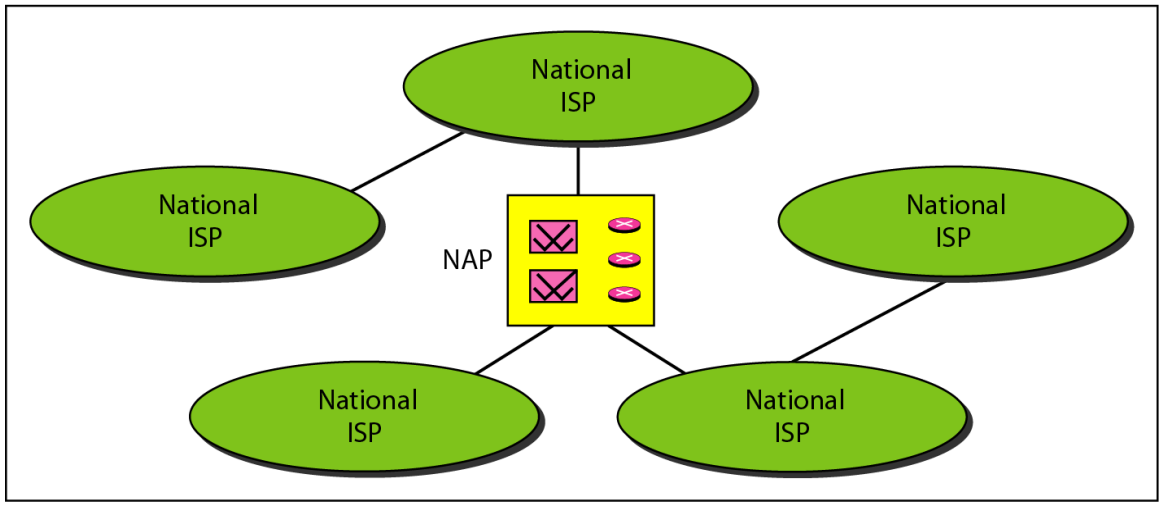
Things we do in Internet

- Learning and research
- Multimedia - Music, radio, videos, etc.
- Games and entertainment
- Improve yourself
- Shop - Online stores and Auctions
- Maps, and Geographic information
- Get fit, find a date, or locate a social event
- Keep up with current events
- Communicate - Chat, E-mail, Forums, blogs, and VoIP
- Surf and find popular pages

Hierarchical organization of the Internet



a. Structure of a national ISP



b. Interconnection of national ISPs

PROTOCOLS

A protocol is synonymous with rule. It consists of a set of rules that govern data communications. It determines what is communicated, how it is communicated and when it is communicated. The key elements of a protocol are syntax, semantics and timing

Elements of a Protocol

- **Syntax:** The term syntax refers to the structure or format of the data, meaning the order in which they are presented. For example, a simple protocol might expect the first 8 bits of data to be the address of the sender, the second 8 bits to be the address of the receiver, and the rest of the stream to be the message itself.

- **Semantics:** The word semantics refers to the meaning of each section of bits. How is a particular pattern to be interpreted, and what action is to be taken based on that interpretation? For example, does an address identify the route to be taken or the final destination of the message?

- **Timing:** The term timing refers to two characteristics: when data should be sent and how fast they can be sent. For example, if a sender produces data at 100 Mbps but the receiver can process data at only 1 Mbps, the transmission will overload the receiver and some data will be lost.