Introduction DATA COMMUNICATION

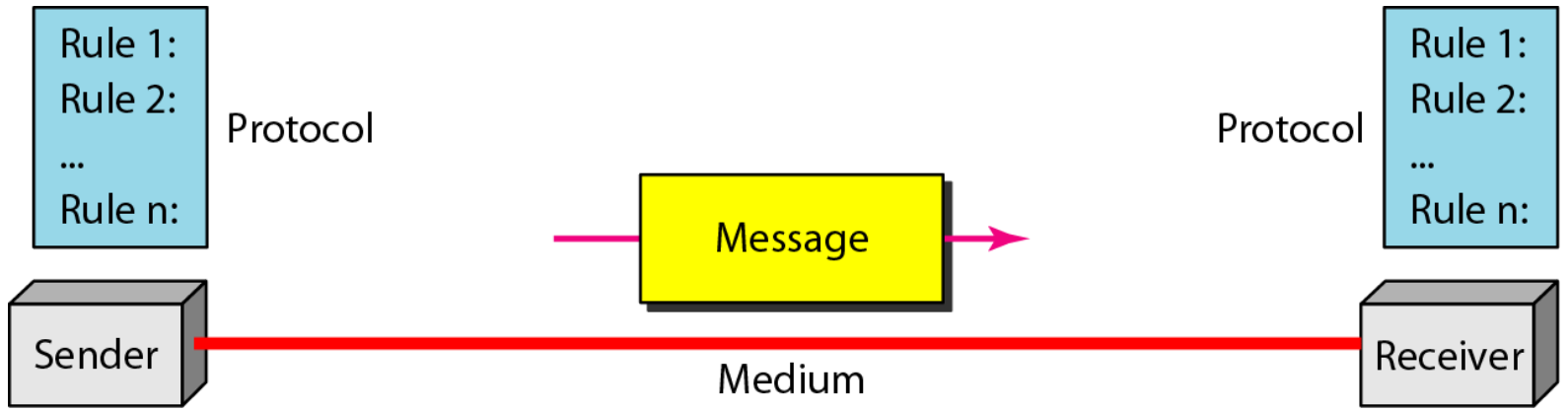
Data Communications

- 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.

Fundamental Characteristics of Data Communication

- Delivery
  - The system must deliver data to the correct destination.
- Accuracy
  - The system must deliver the data accurately.
- Timeliness
  - The system must deliver data in a timely manner. Data delivered late are useless.
- Jitter
  - Jitter refers to the variation in the packet arrival time.

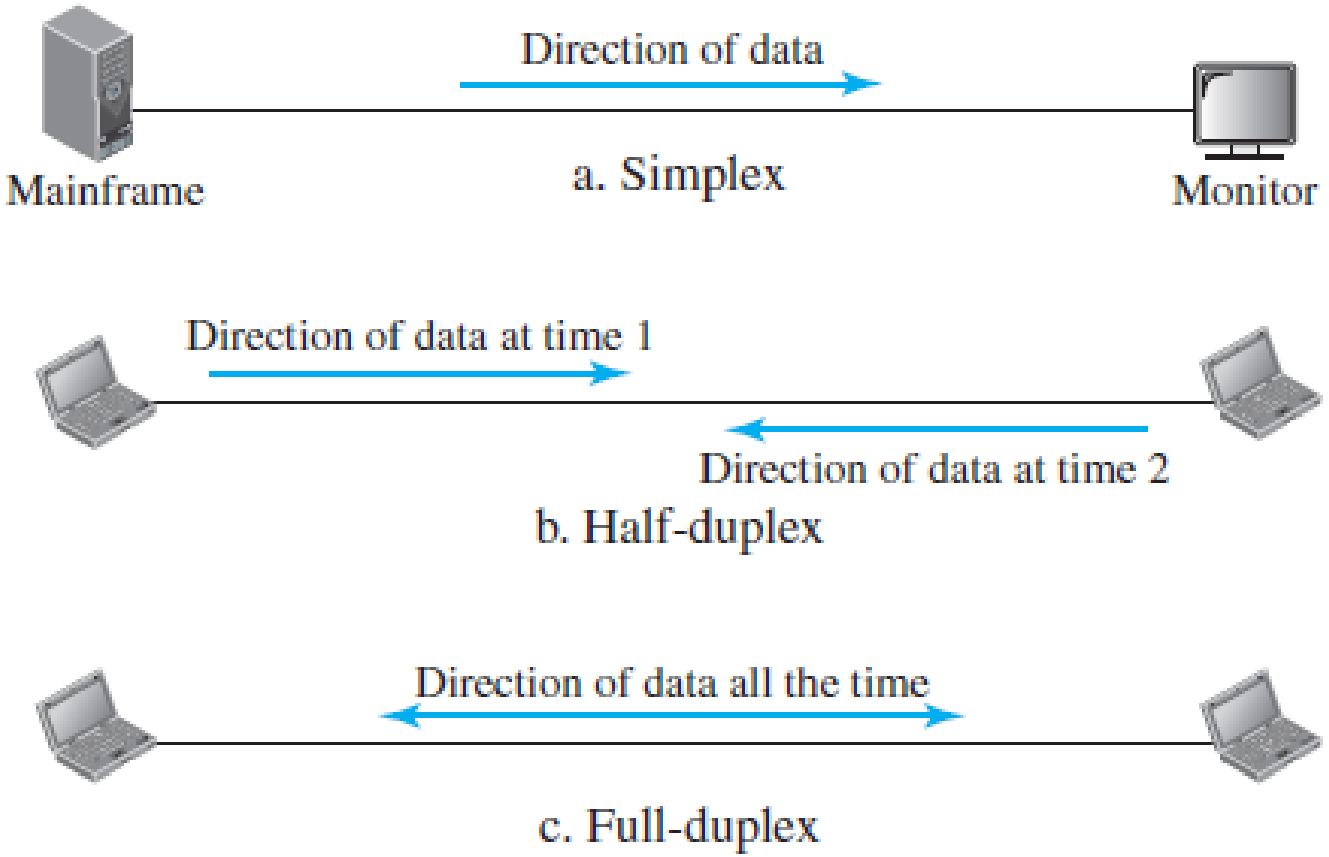
Components of a Data Communication System



Data Representation

- Text
  - ASCII, bit patterns
- Numbers
- Image
  - Pixel
  - RGB , YCM
- Audio
- Video

Data Flow


Direction of data
Mainframe
Monitor
a. Simplex
Direction of data at time 1
Direction of data at time 2
b. Half-duplex
Direction of data all the time
c. Full-duplex

Networks

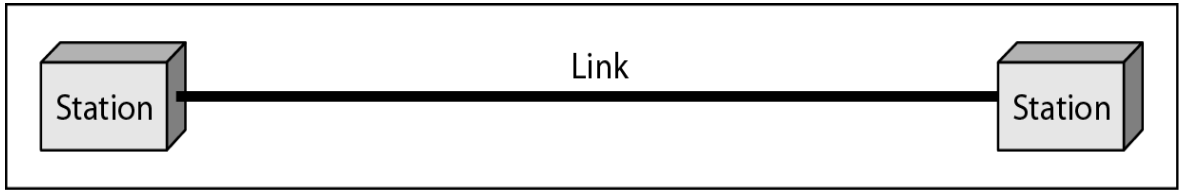
- A network is the interconnection of a set of devices capable of communication.
- A device can be a host (or an end system as it is sometimes called) such as a large computer, desktop, laptop, workstation, cellular phone.
- A device in this definition can also be a connecting device such as a router, switch, and modem.
- These devices in a network are connected using wired or wireless transmission media.

Network Criteria

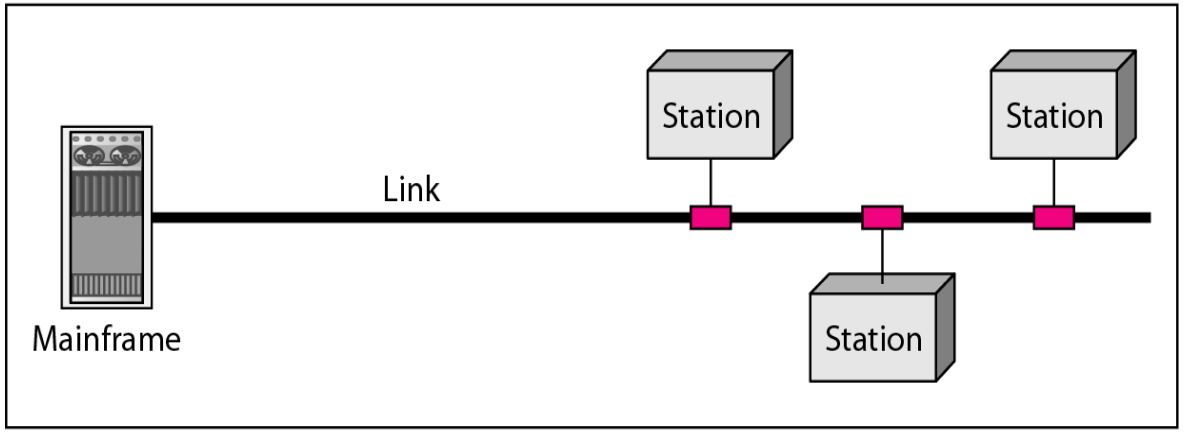
- **Performance**
  - Depends on Network Elements and factors such as users, transmission media , capabilities of H/W and efficiency of S/W.
  - Transit time and response time
  - Measured in terms of Delay and Throughput(contradictory)
- **Reliability**
  - Failure rate of network components
  - Measured 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, multicast, broadcast



a. Point-to-point

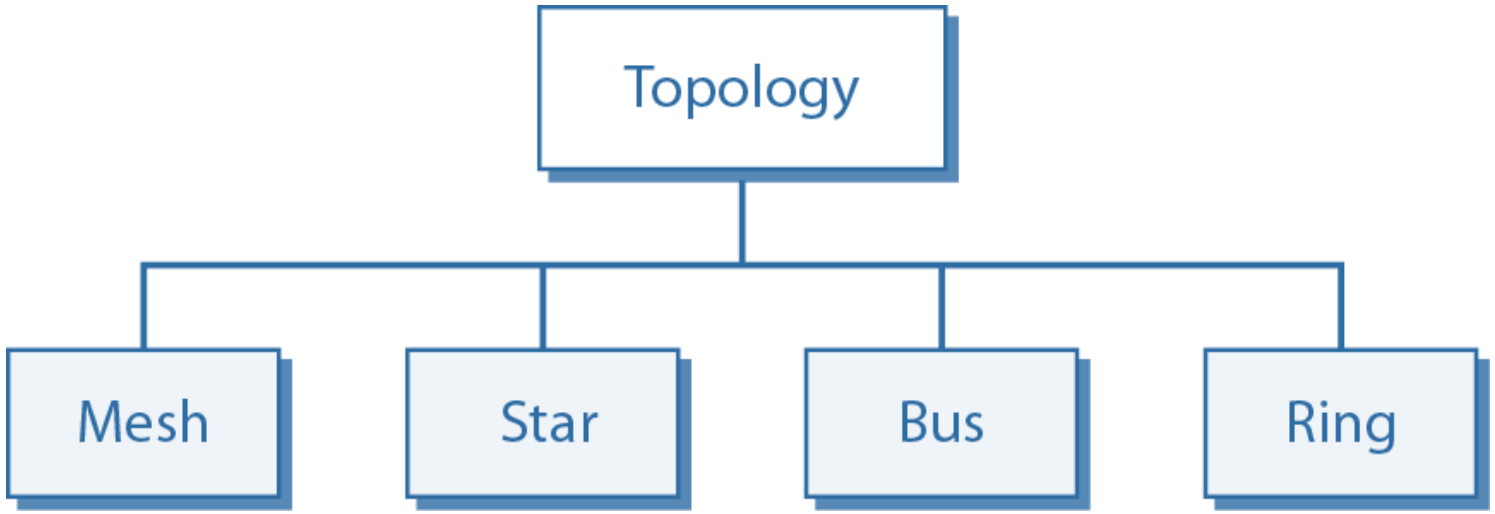


b. Multipoint

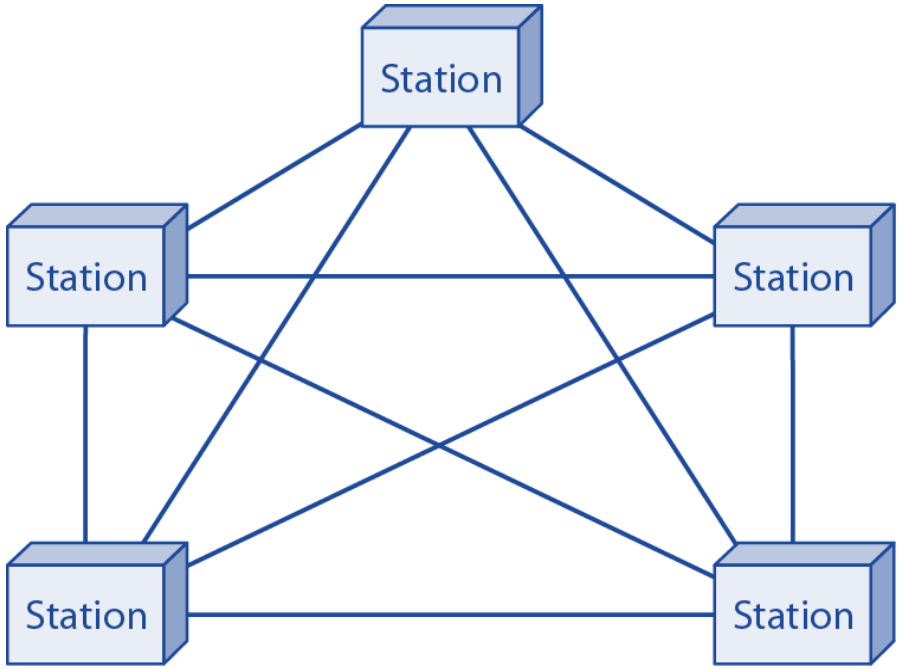
Physical Structures

Topology

- It refers to way in which a network is laid out physically
- The topology of a network is the geometric representation of the relationship of all the links and linking devices (usually called ***nodes***) to one another.



Mesh Topology



- Every device has a dedicated point to point link to every other device.
- n(n-1) connection for unidirectional
- n(n-1)/2 no of connection for bidirectional

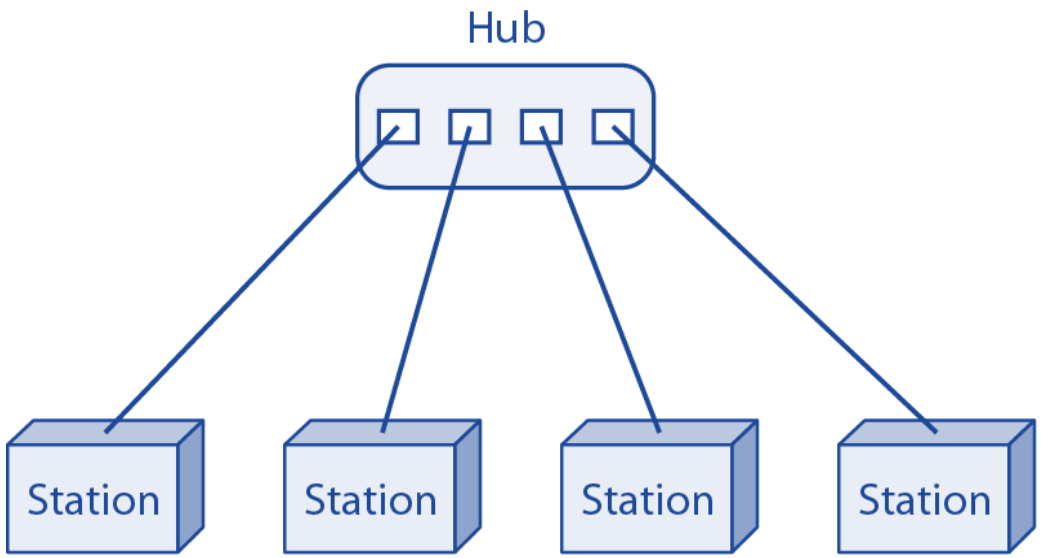
Advantages:

- Guarantees that each connection can carry its own data load, eliminates traffic problem.
- Robust
- Privacy and security
- Fault identification and isolation easy

Disadvantages:

- Amount of cabling and space requirement
- Expensive

Star Topology



- Each device has a dedicated point to point link to a central control device.
- Does not allow direct traffic between devices
- The controller acts as an exchange

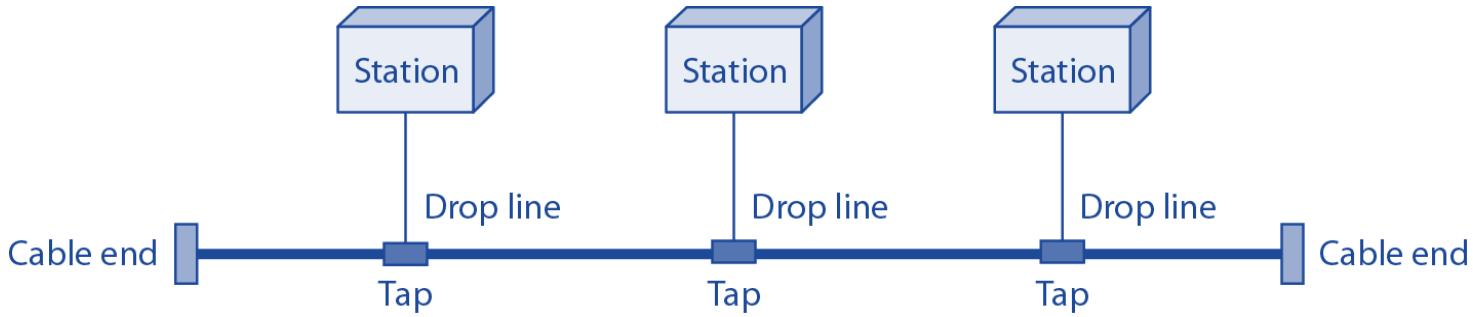
Advantages:

- Less expensive compare to mesh
- Easy installation and reconfigure.
- Robustness, if one link fails, only that link is affected . All other remain active

Disadvantages:

- Single point failure(Hub), whole system is dead

Bus Topology



- One long cable acts as Backbone to link all the device in network
- Nodes are connected to the bus cable by Taps and Drop lines
- Limits the number of Tabs in cable

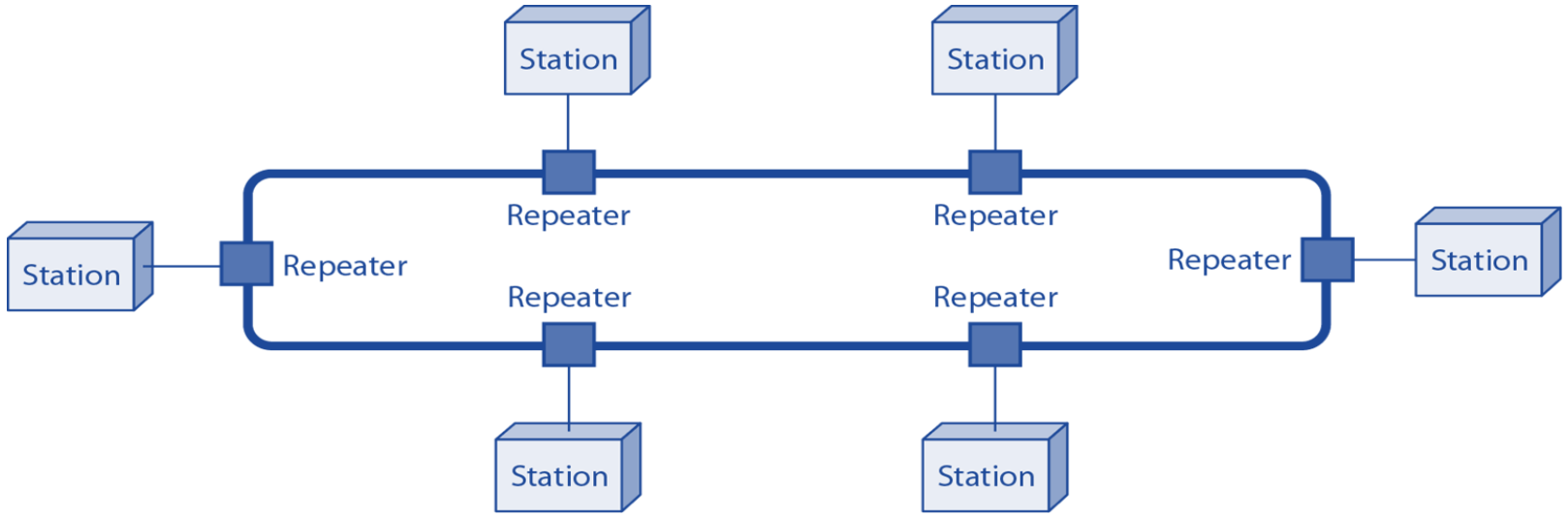
Advantages:

- Easy installation.
- Less cabling then Ring and Mesh topologies.

Disadvantages:

- Difficult reconnection and fault isolation
- Difficult to add new device
- Signal reflection at the tab can cause degradation in quality

Ring Topology



- Dedicated point-to-point connection with only the 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 incorporates a repeater.

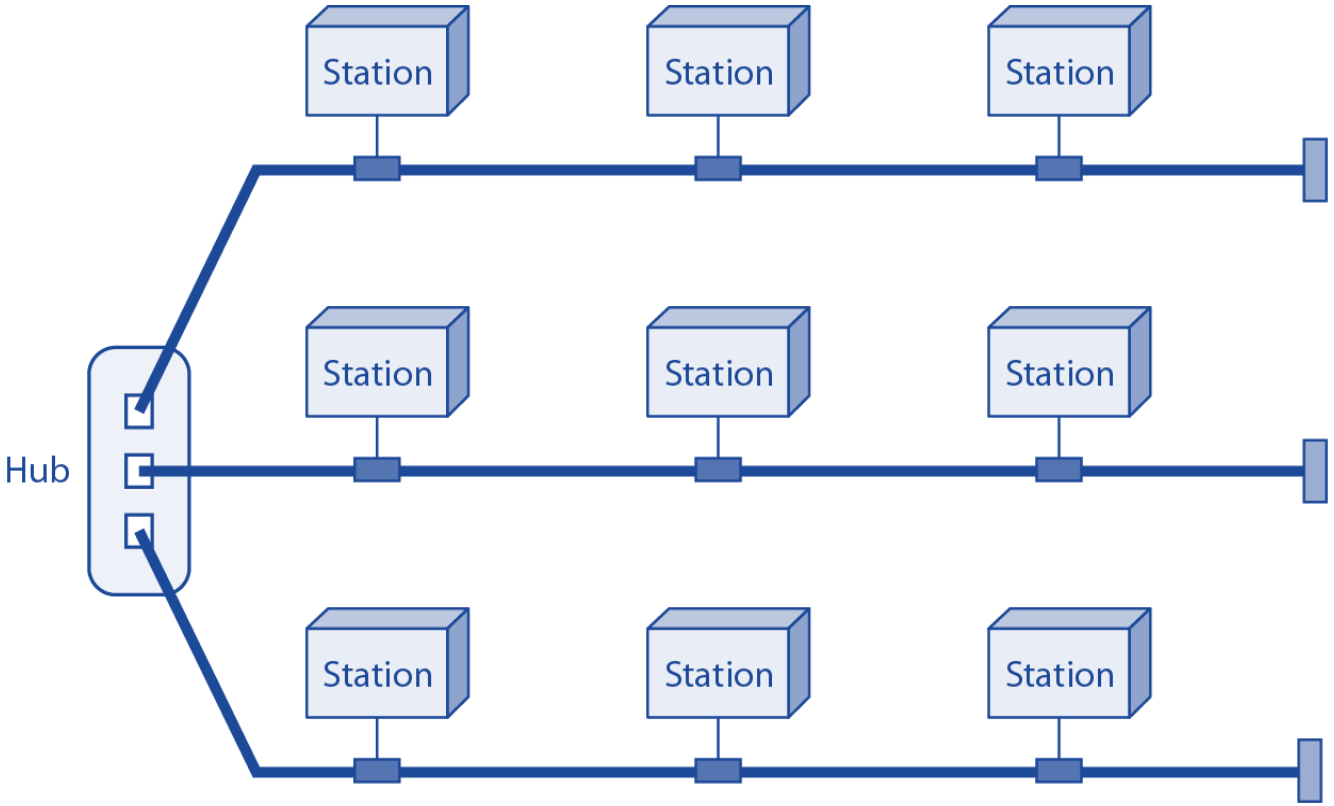
Advantages:

- Easy to install and reconfigure.
- To add and delete a device requires changing only two connection

Disadvantages:

- Unidirectional traffic
- A break in ring (such as a disabled station) can disable the entire network

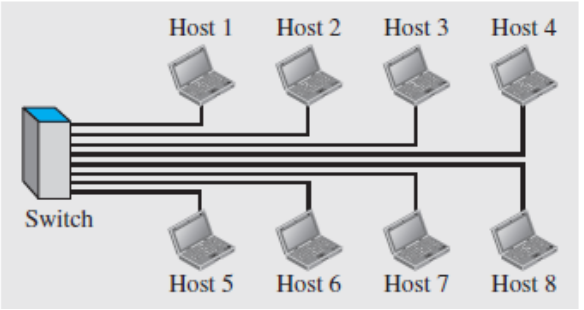
Hybrid Topology



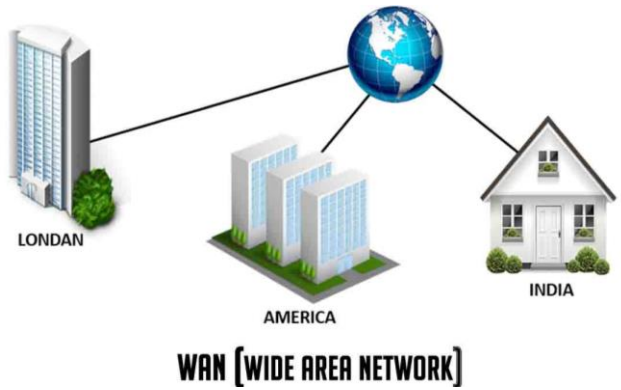
Star backbone with three bus networks

Network Types

- **Local Area Networks (LANs)**
  - Short distances
  - Designed to provide local interconnectivity



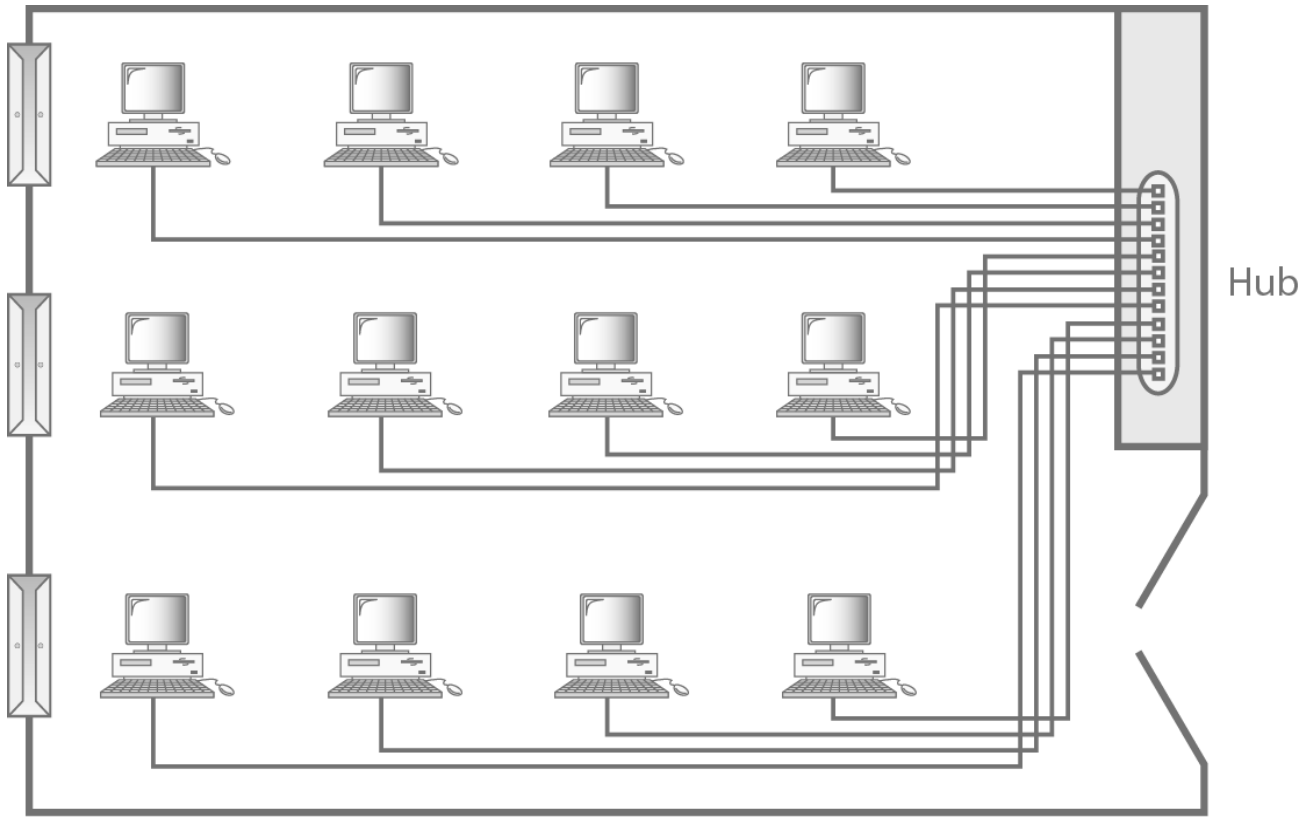
- **Wide Area Networks (WANs)**
  - Long distances
  - Provide connectivity over large areas



- **Metropolitan Area Networks (MANs)**
  - Provide connectivity over areas such as a city, a campus

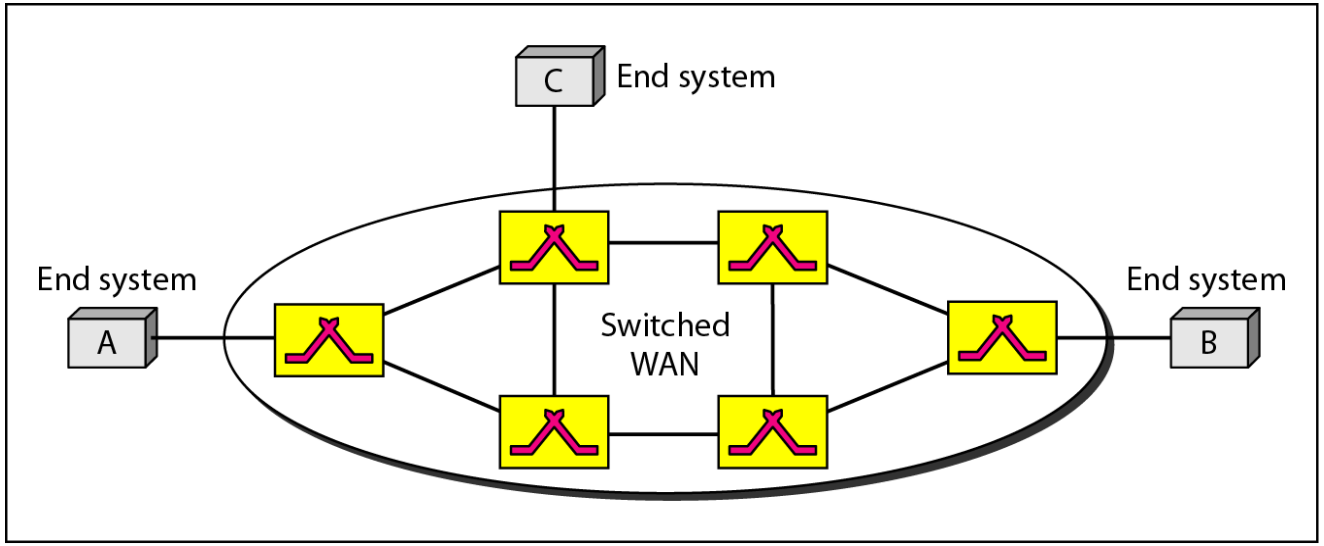
Network Types

- An Isolated LAN Connecting 12 Computers to hub

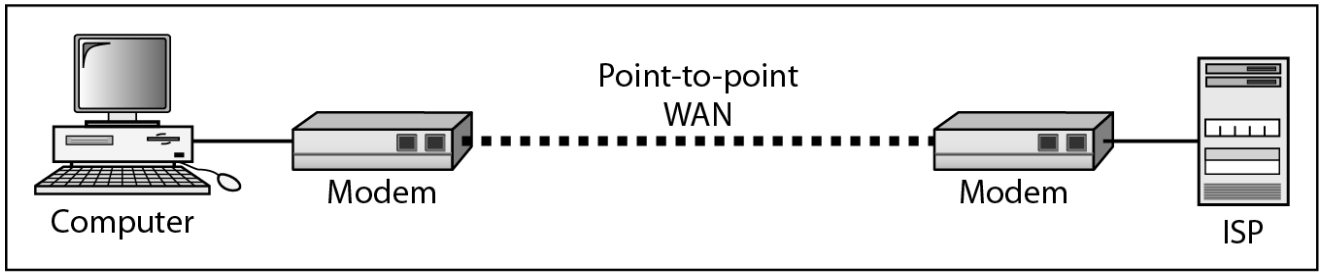


Network Types

- Switched WAN and a point to point WAN



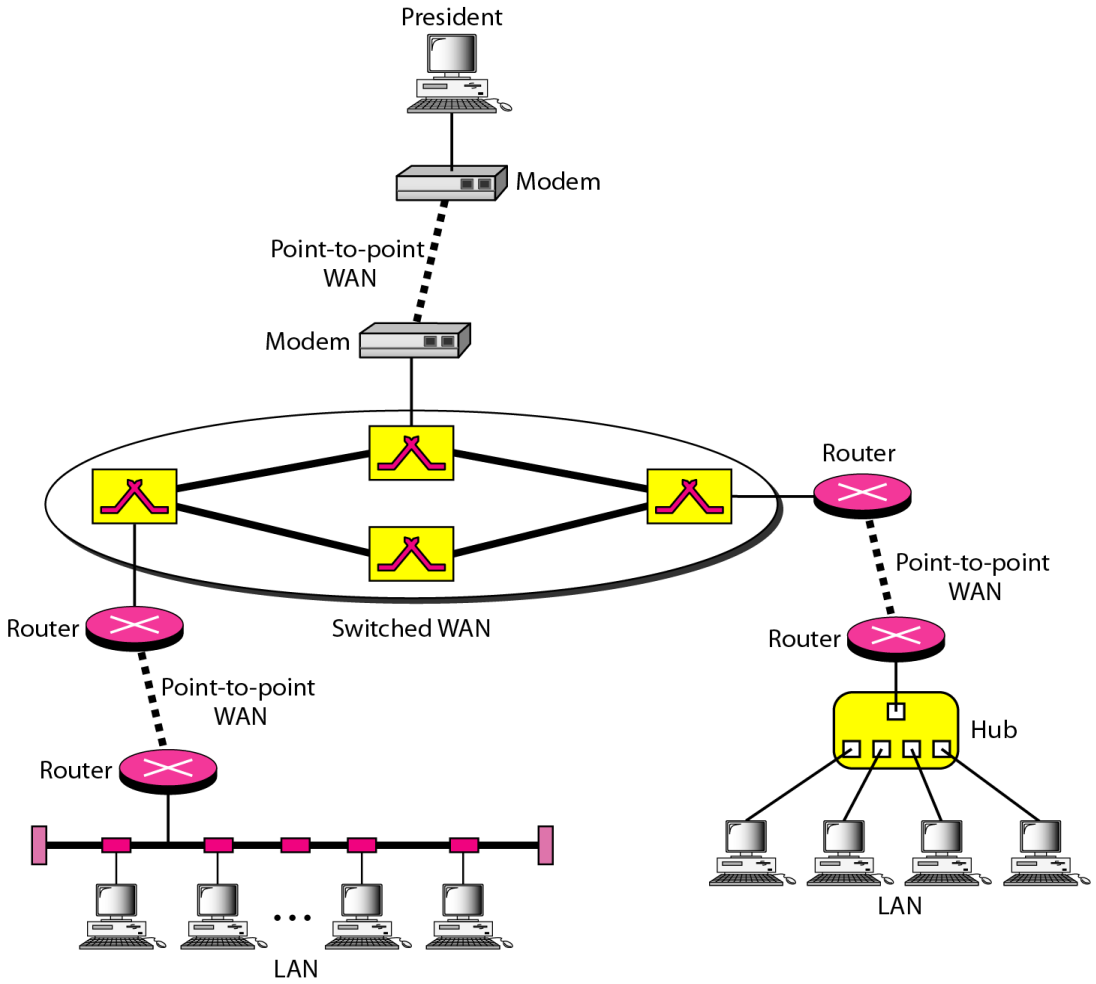
a. Switched WAN



b. Point-to-point WAN

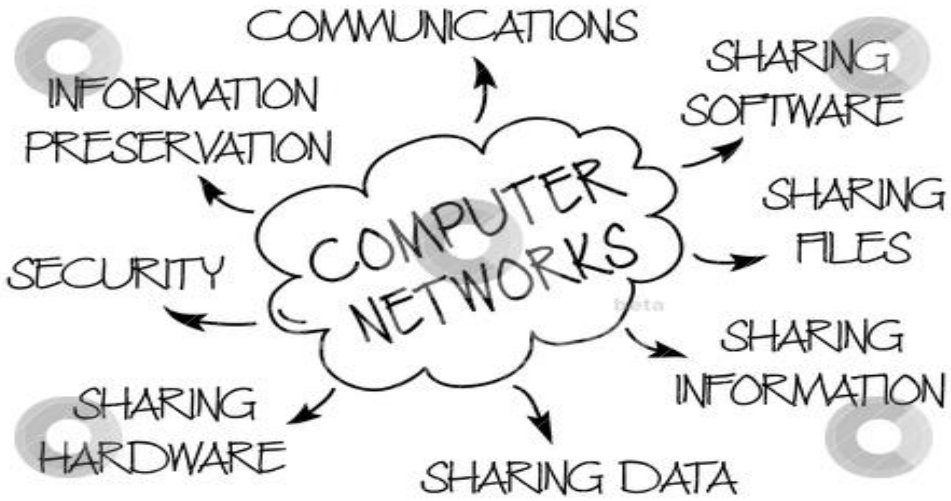
Network Types

- Heterogeneous network mode of four WANs and two LANs



Application of Networks

- **Business Applications of N/Ws**
  - Resource sharing in bank, finance, manufacturing plant, travel agency
  - E-mail
  - Video conferencing
  - Online shopping
  - Goods and services online “e-commerce”.

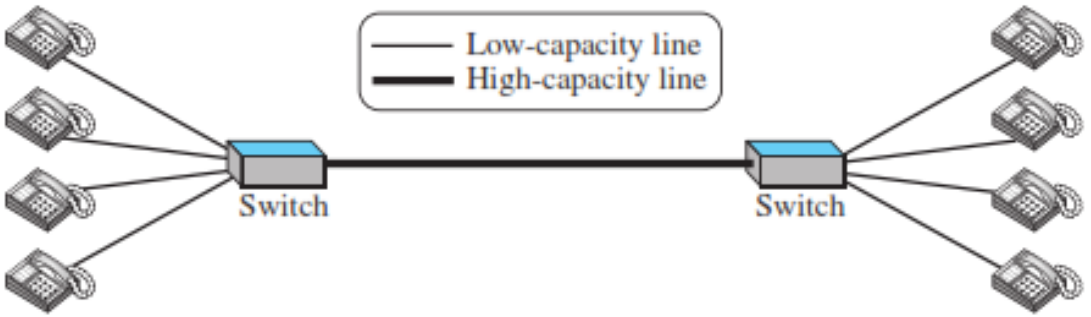


- **Home Network Applications**
  - Access to remote information
    - Surfing
    - Online newspaper, digital library..etc.
  - Person-to-person communication
    - Instant messaging, chatrooms, group communication
  - Interactive entertainment
  - Electronic commerce

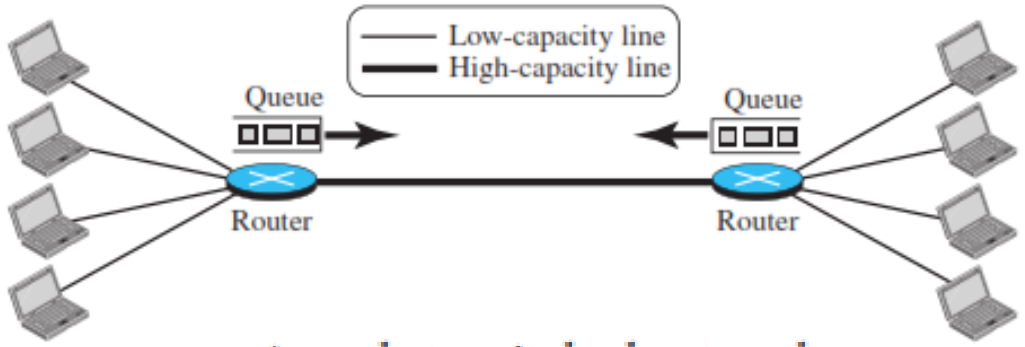
- **Distributed Processing**

Switching

- An Internet is a Switched networking in which a switch connects at least two links together.
- A Switch needs to forward data from a network to another network when required.
- Circuit-switched and Packet-switched networks



A circuit-switched network

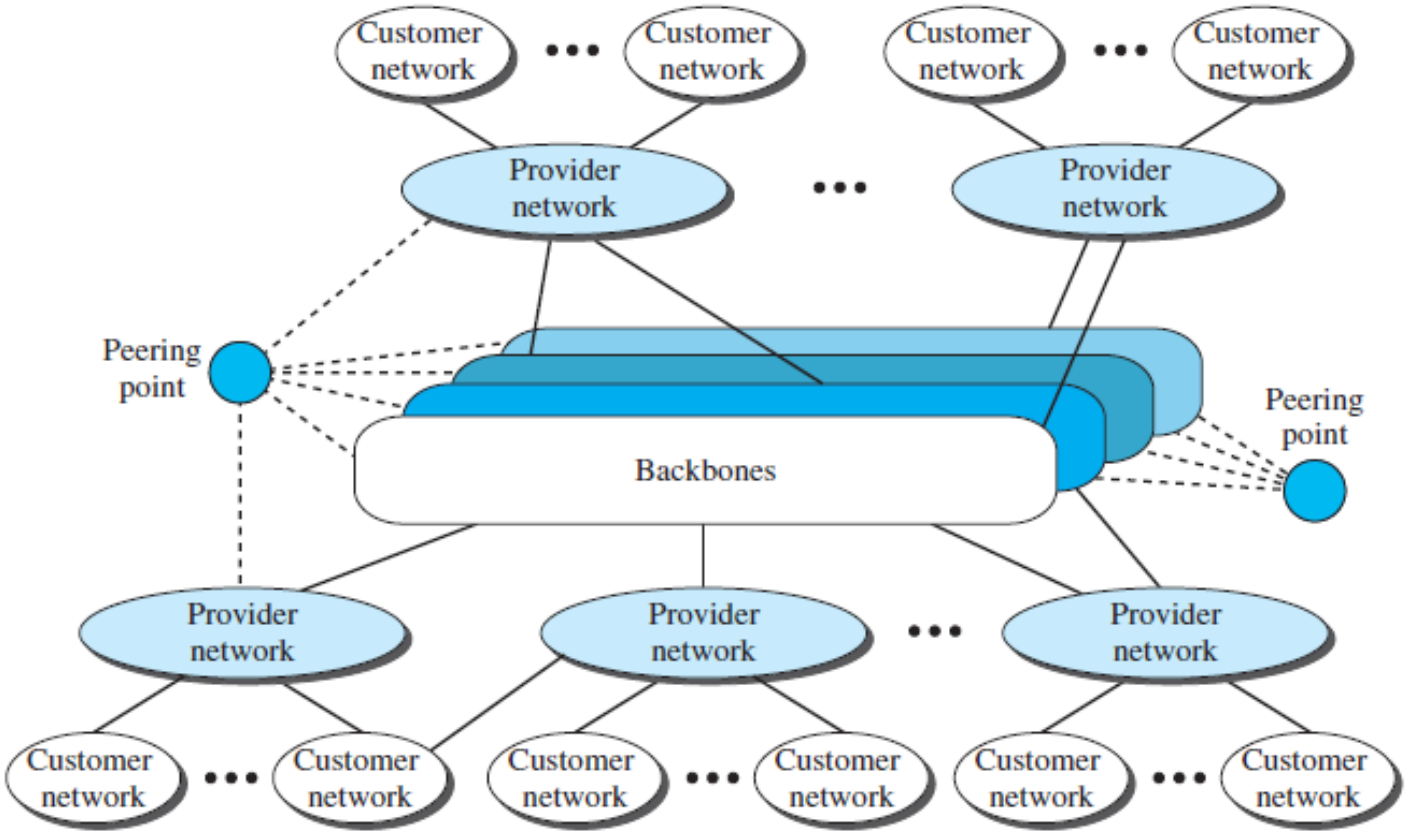


A packet-switched network

The Internet

- An internet (note the lowercase i) is two or more networks that can communicate with each other.
- The most notable internet is called the Internet (uppercase I), and is composed of thousands of interconnected networks.
- At the top level, the backbones are large networks owned by some communication companies such as Sprint, Verizon (MCI), AT&T, and NTT.
- The backbone networks are connected through some complex switching systems, called *peering points*
- At the second level, there are smaller networks, called provider networks
- The customer networks are networks at the edge of the Internet that actually use the services provided by the Internet. They pay fees to provider networks for receiving services.
- Backbones and provider networks are also called *Internet Service Providers (ISPs).*

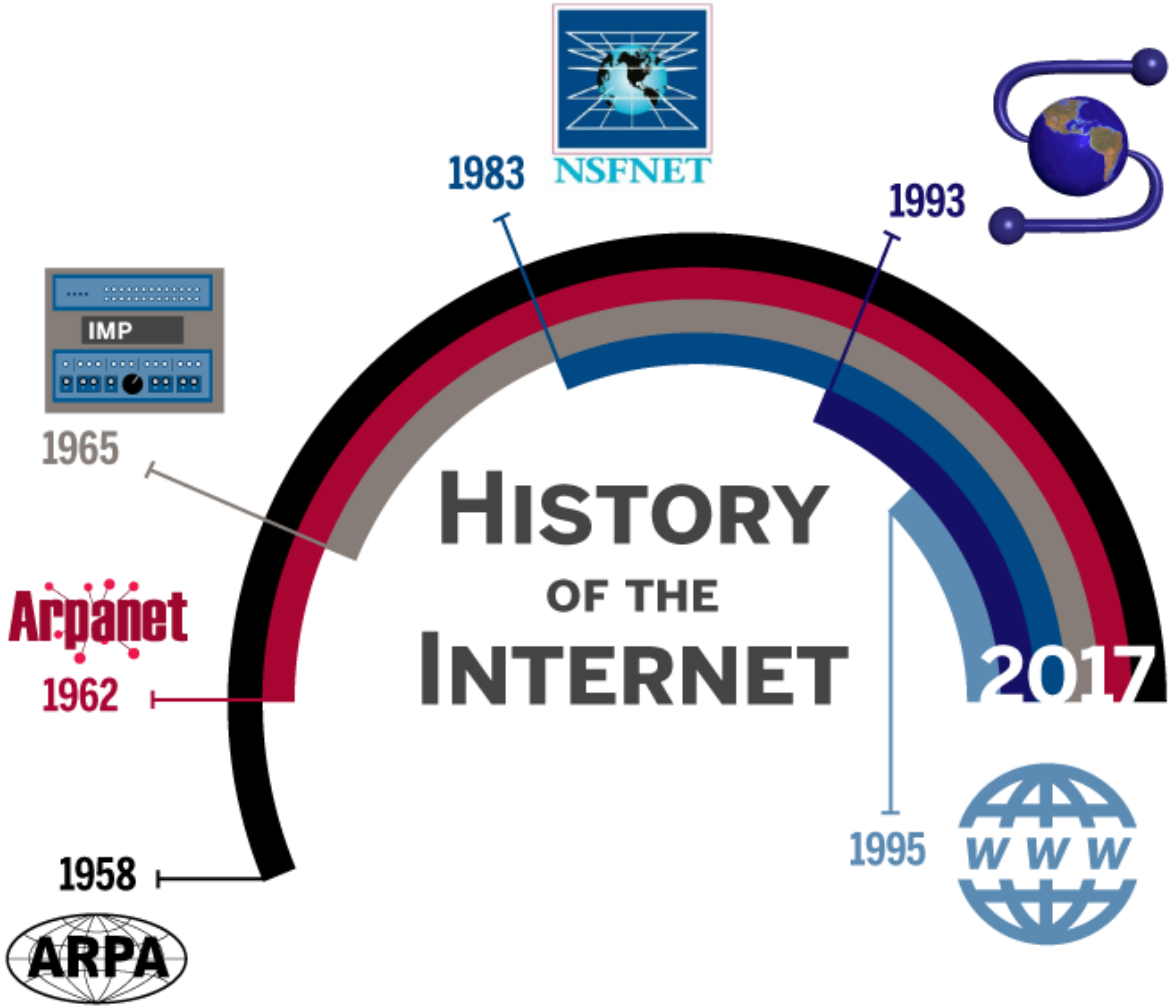
The Internet



Accessing the Internet

- Using Telephone Networks
  - Dial-up Service
  - DSL(Digital Subscriber Line) Service
- Using Cable Networks
- Using Wireless Networks
- Direct Connection to the Internet

Internet History



- ARPA: Advanced Research Projects Agency
- ARPANET: Advanced Research Projects Agency Network
- IMP: interface message processor
- NSFNET: National Science Foundation Network

Internet today

- Rapid growth both in the infrastructure and new applications
- World Wide Web
- Multimedia: VOIP, Video Over IP, View Sharing and Television over IP(PPLive)
- Peer to Peer Applications

Protocol

- 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 Protocol

Syntax

- Structure or format of the data
- Indicates how to read the bits - field delineation

Semantics

- Interprets the meaning of the bits
- Knows which fields define what action

Timing

- When data should be sent and what
- Speed at which data should be sent or speed at which it is being received.

Standards

- Standards are guaranteeing national and international interoperability of data and telecommunications technology and processes
- Its provide guidelines to manufacturers, vendors, government agencies.
- Request for Comment (RFC).
- Each RFC is edited, assigned a number, and made available to all interested parties
- Data Communication standards fall into two categories : *de facto* ("by fact" or "by convention")and *de jure* ("by low" or "by regulation")
- Standards Organizations
  - International Organization for Standardization(ISO)
  - International Telecommunication Union - Telecommunication standards Sector(ITU-T)
  - Consultative Committee for International Telegraphy and Telephony(CCITT)
  - American National Standards Institute (ANSI)
  - Institute of Electrical and Electronics Engineers (IEEE)
  - Electronic Industries Association (EIA)