Introduction to Computer Networks

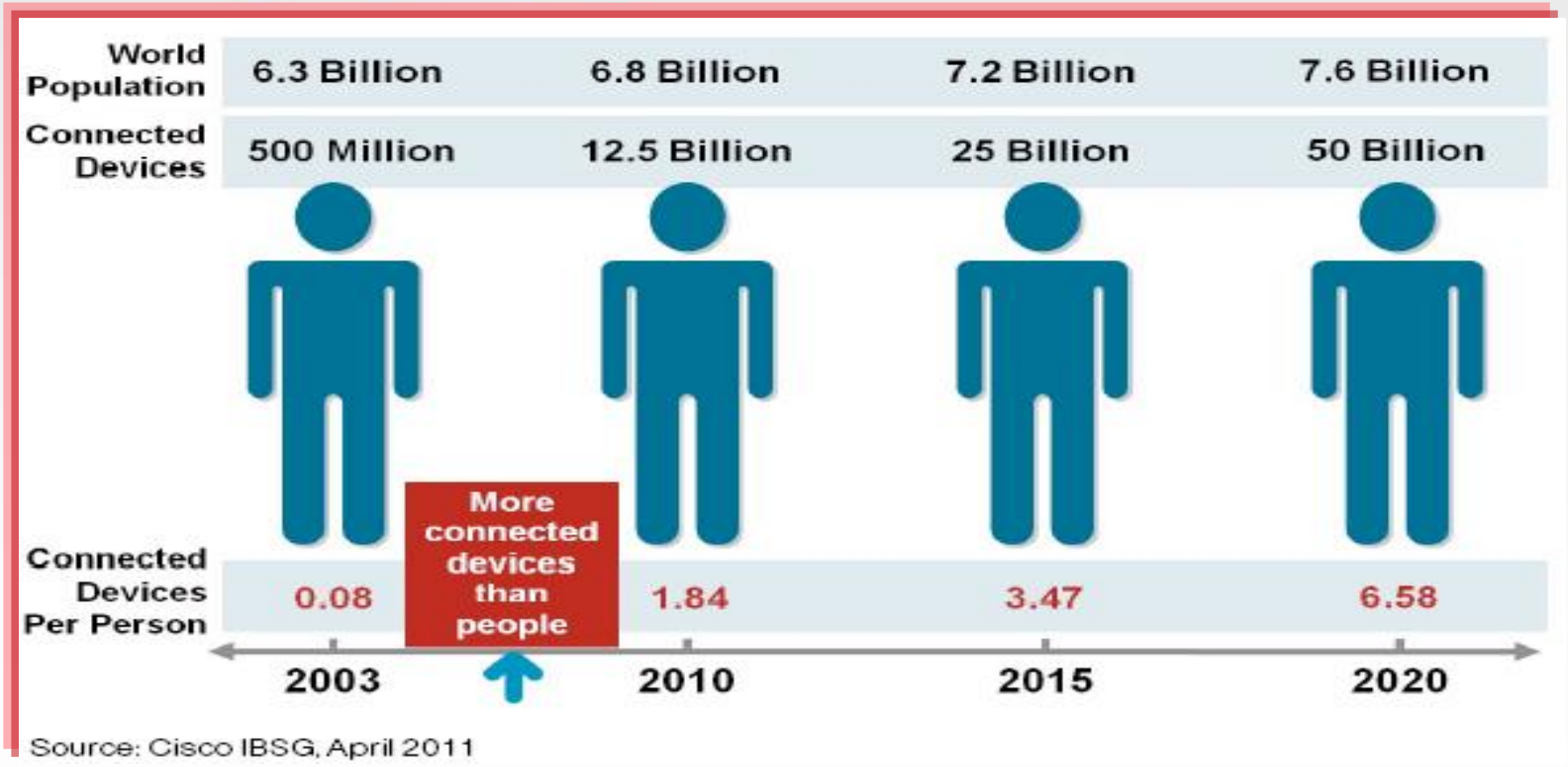
Current Scenario:

- Explosive Growth in the users of worldwide Communication
- Emergence of various communication Networks
- Usage of bandwidth hungry information's such as graphics, images, video, ….

Evolution in Internet :

- As per Ericsson, 29 billion connected devices by 2023
- As per HIS Markit, 125 billion connected devices by 2030

Connected Devices Per Person:



The number of devices connected to IP networks will be more than three times the global population by 2023

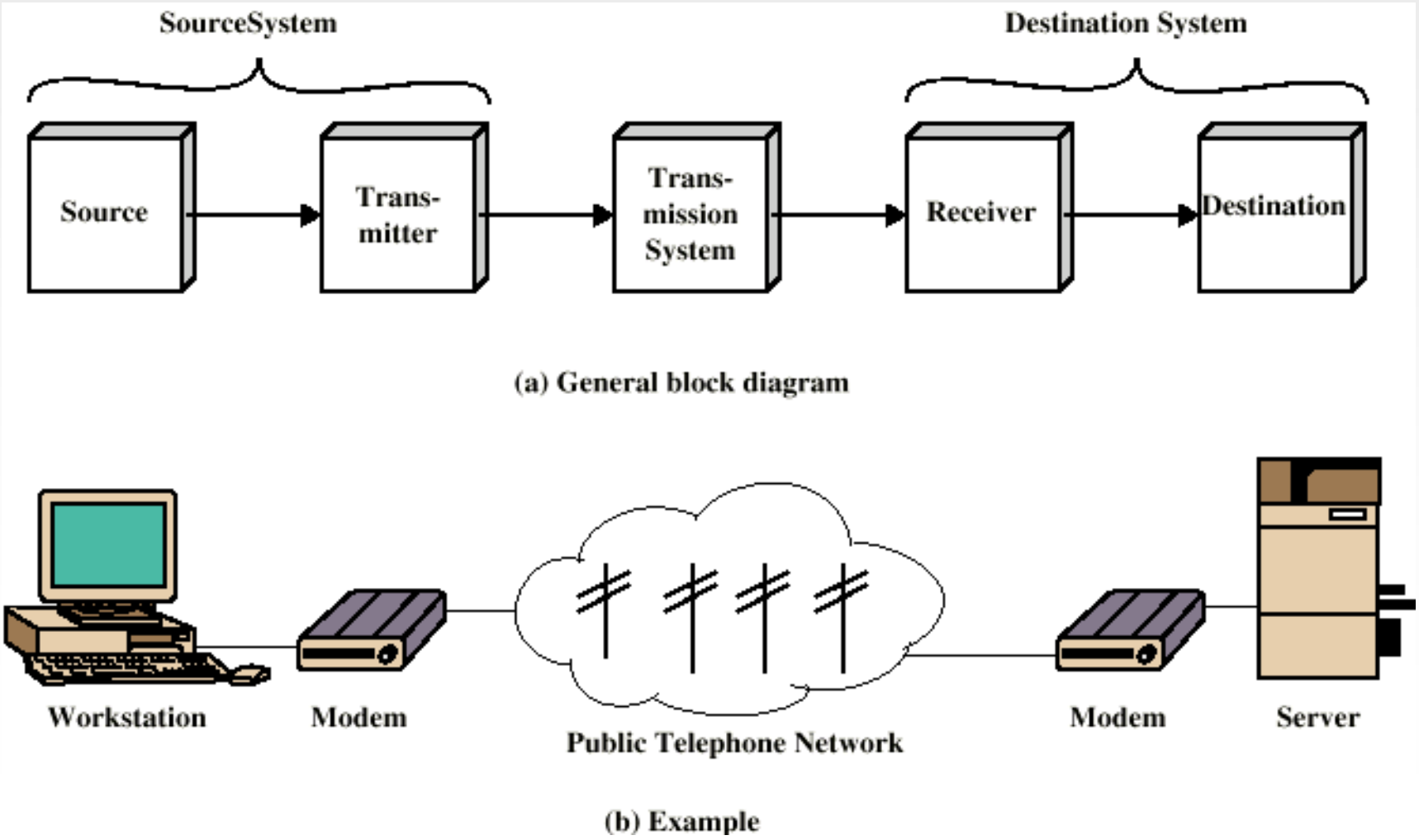
Current Scenario and Users Demands:

- Level of desired QoS is high: low latency
- Very high demand for channel bandwidth
- Broadband Applications such as video on demand, location based services, interactive multiparty gaming, IPTV and so many

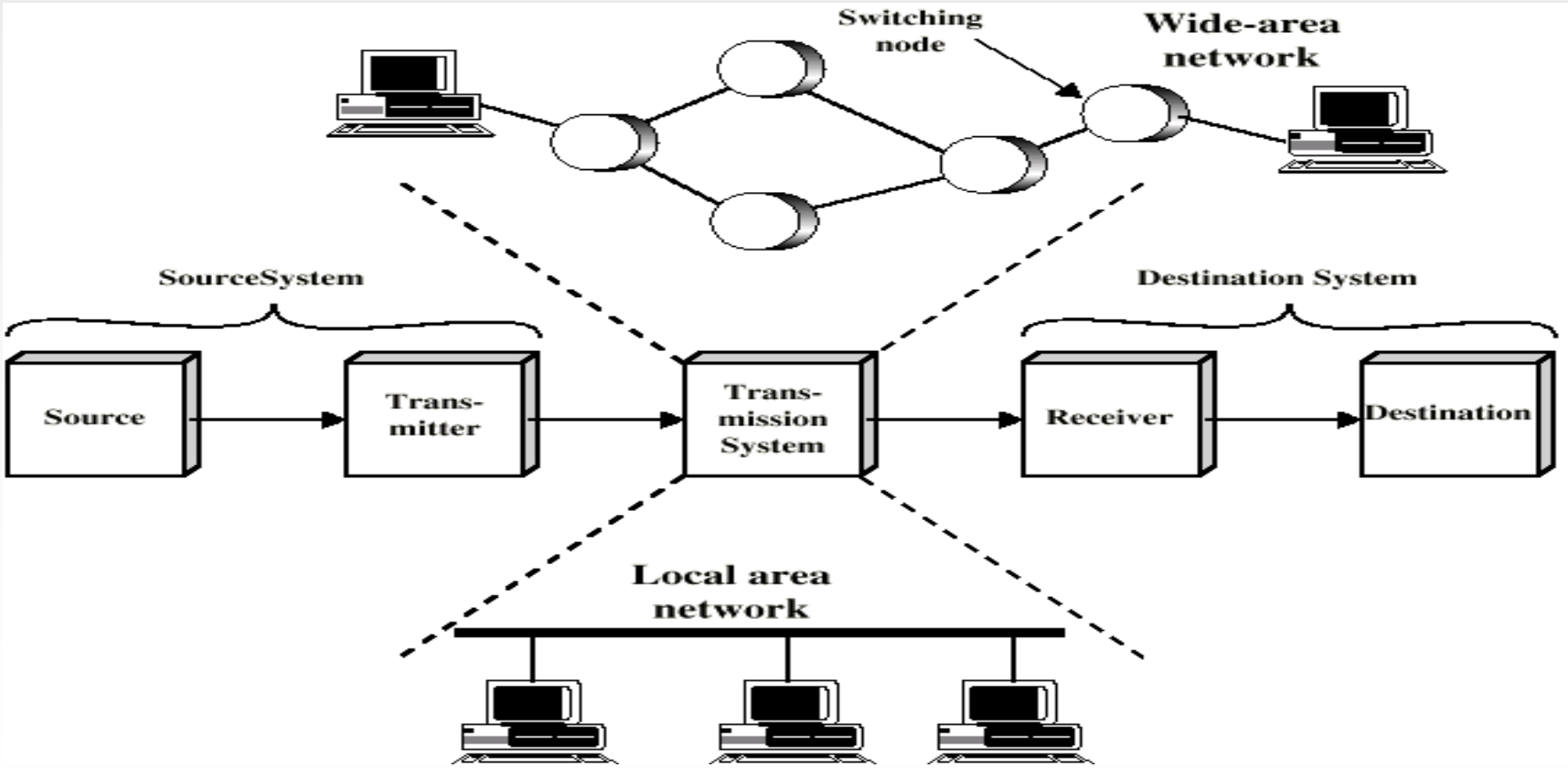
A Communications Model:

- Source
  - Generates data to be transmitted
- Transmitter
  - Converts data into transmittable signals
- Transmission System
  - Carries data
- Receiver
  - Converts received signal into data
- Destination
  - Takes incoming data

Simplified Communications Model:



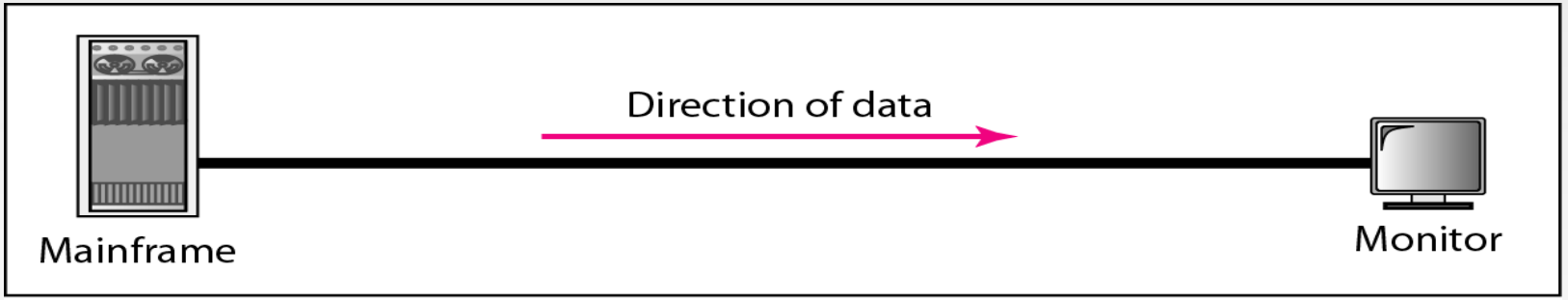
Simplified Network Model:



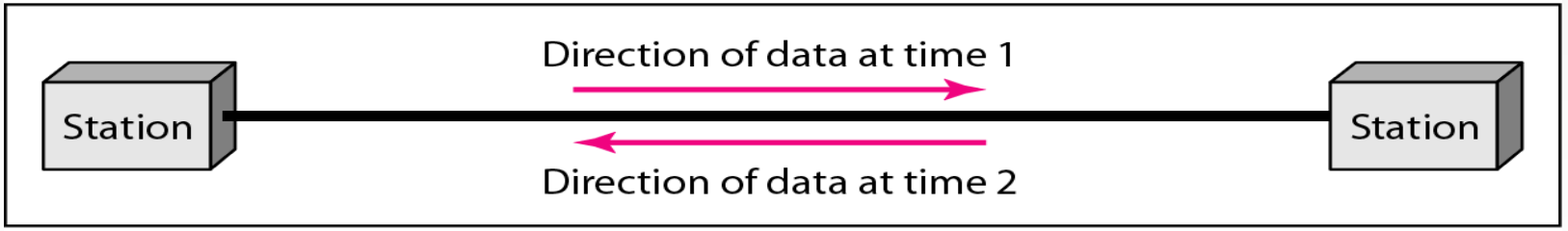
Important Tasks of Communications Systems:

- Transmission System Utilization
- Interfacing
- Signal Generation
- Synchronization
- Exchange Management
- Error Detection and Correction
- Addressing and Routing
- Recovery
- Message Formatting
- Security
- Network Management

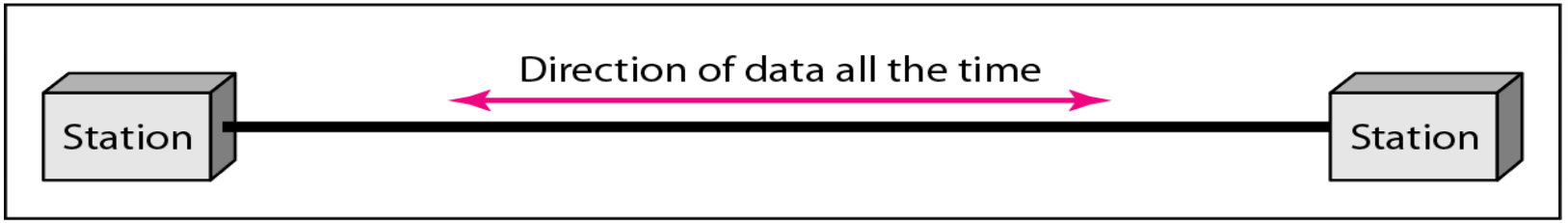
Direction of Data Flow



a. Simplex



b. Half-duplex

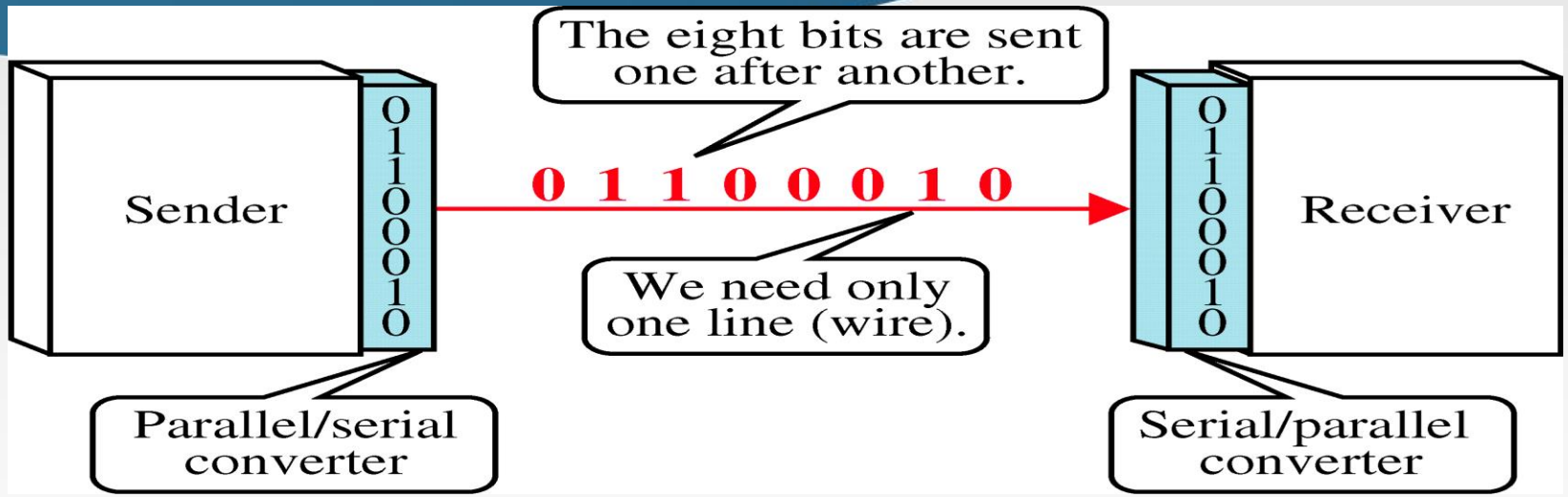


c. Full-duplex

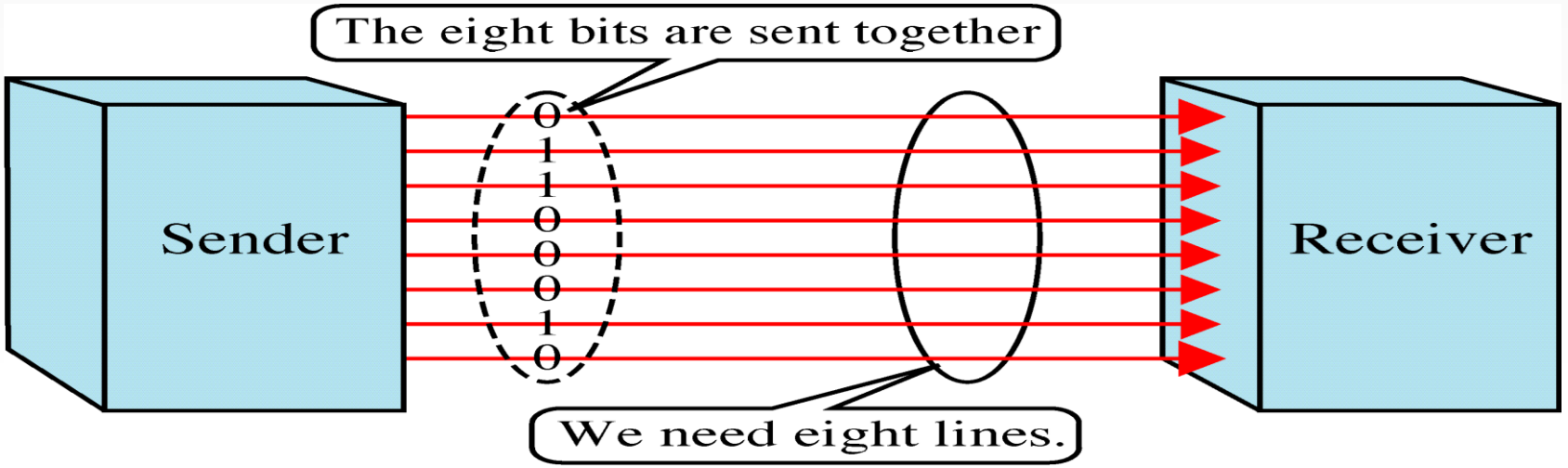
Data Flow

- Simplex
  - Unidirectional
  - As on a one-way street
- Half-duplex
  - Both can transmit and receive, but not at the same time
  - Like a one-lane road with two-directional traffic
  - Walkie-talkie
- Full-duplex
  - Transmit and receive simultaneously
  - Like a two-way street, telephone network
  - Channel capacity must be divided between two directions

Serial Transmission:



Parallel Transmission:



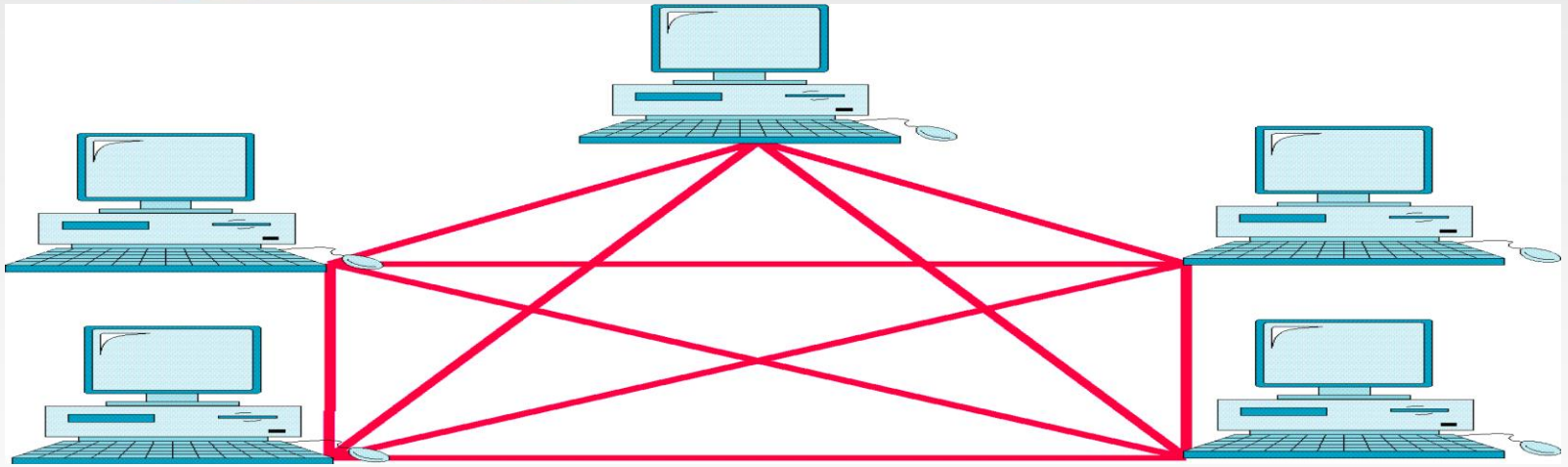
Networks:

- Point to point communication not usually practical
  - **Devices are too far apart**
  - **Large set of devices would need impractical number of connections**
  - **Multiplexing**
- Approaches for Communication:
  - **Broadcasting**
  - **Multicasting**
  - **Unicasting**

Networking Topologies:

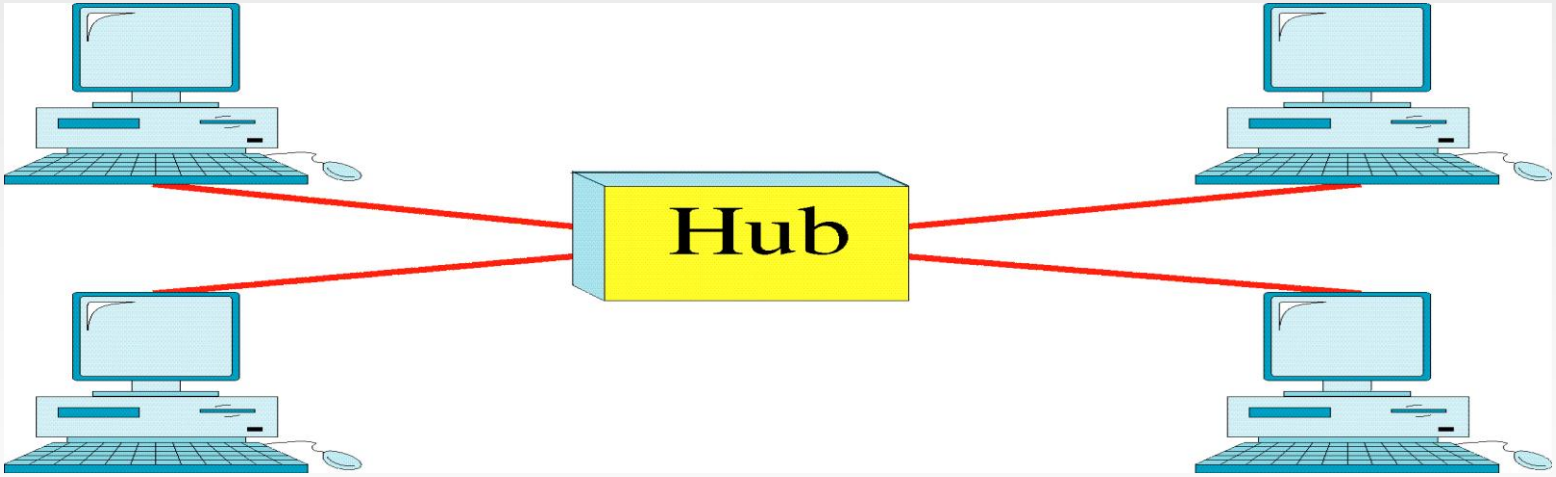
- Mesh
- Star
- Tree
- Bus
- Ring
- Hybrid

Mesh Topology:



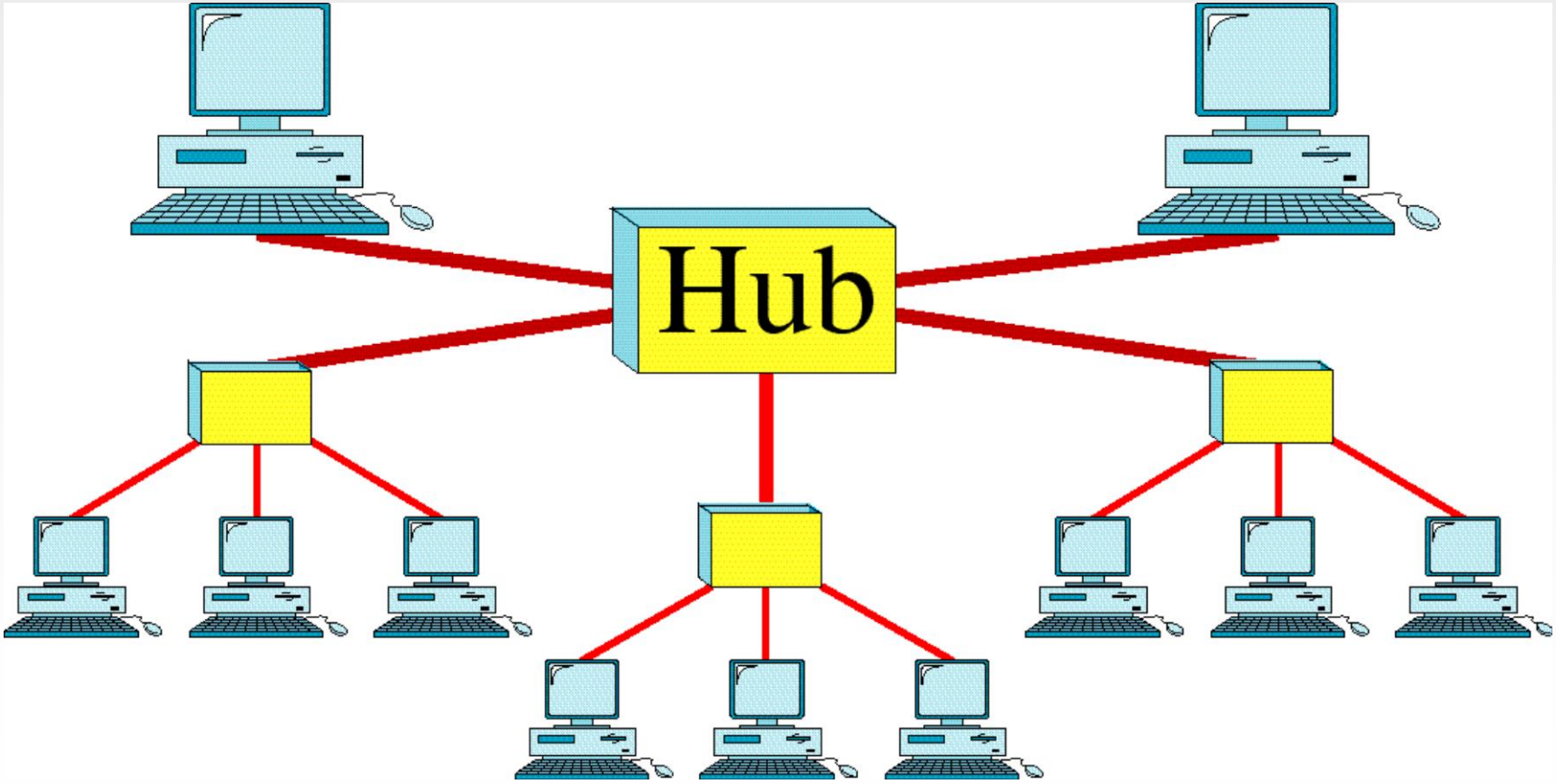
- Dedicated point-to-point link to every other nodes
- A mesh network with *n* nodes has *n(n-1)/2* links. A node has *n-1* I/O ports (links)
- Advantages: No traffic problems, robust, security, easy fault identification & isolation
- Disadvantages: Difficult installation/reconfiguration, space, cost, Hence, we go for multiplexing

Star Topology:

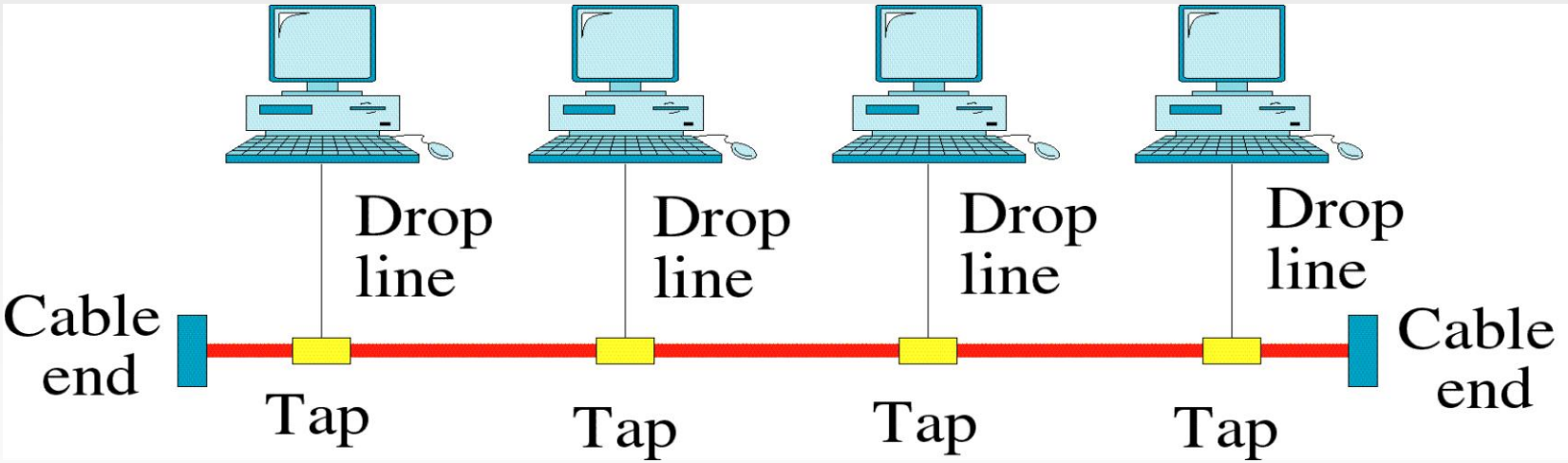


- Dedicated point-to-point link *only to* a central controller, called ***hub/switch***
- No direct traffic between devices
- Advantages: Less expensive, robust
- Disadvantages: dependency of the whole on one single point

Tree Topology:

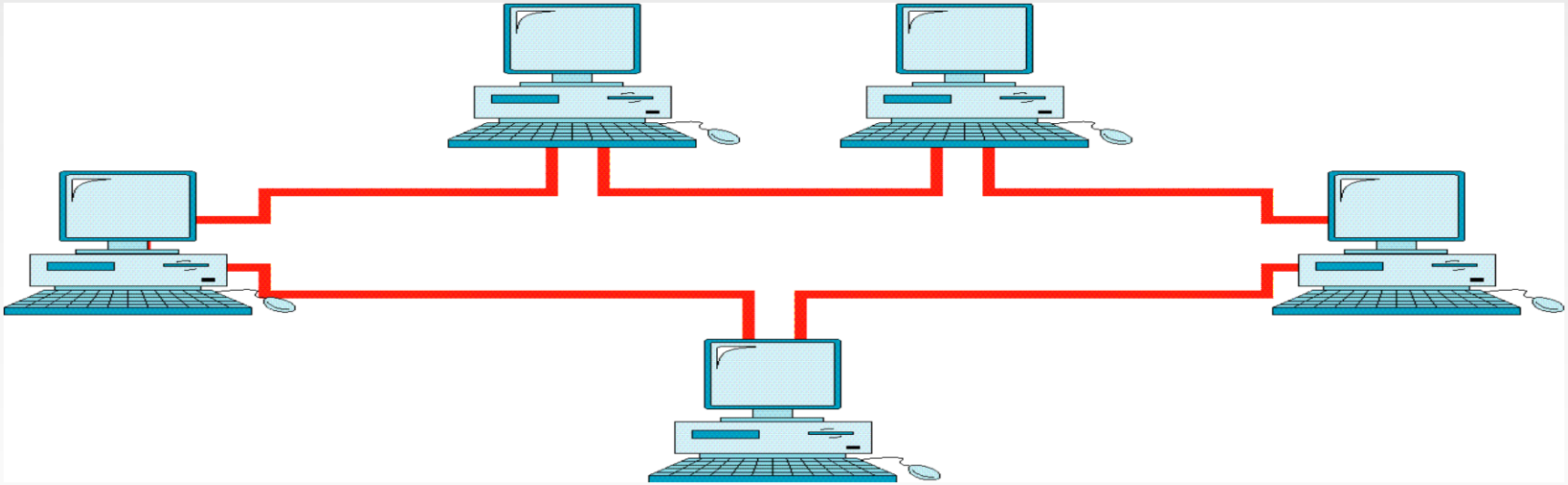


Bus Topology:



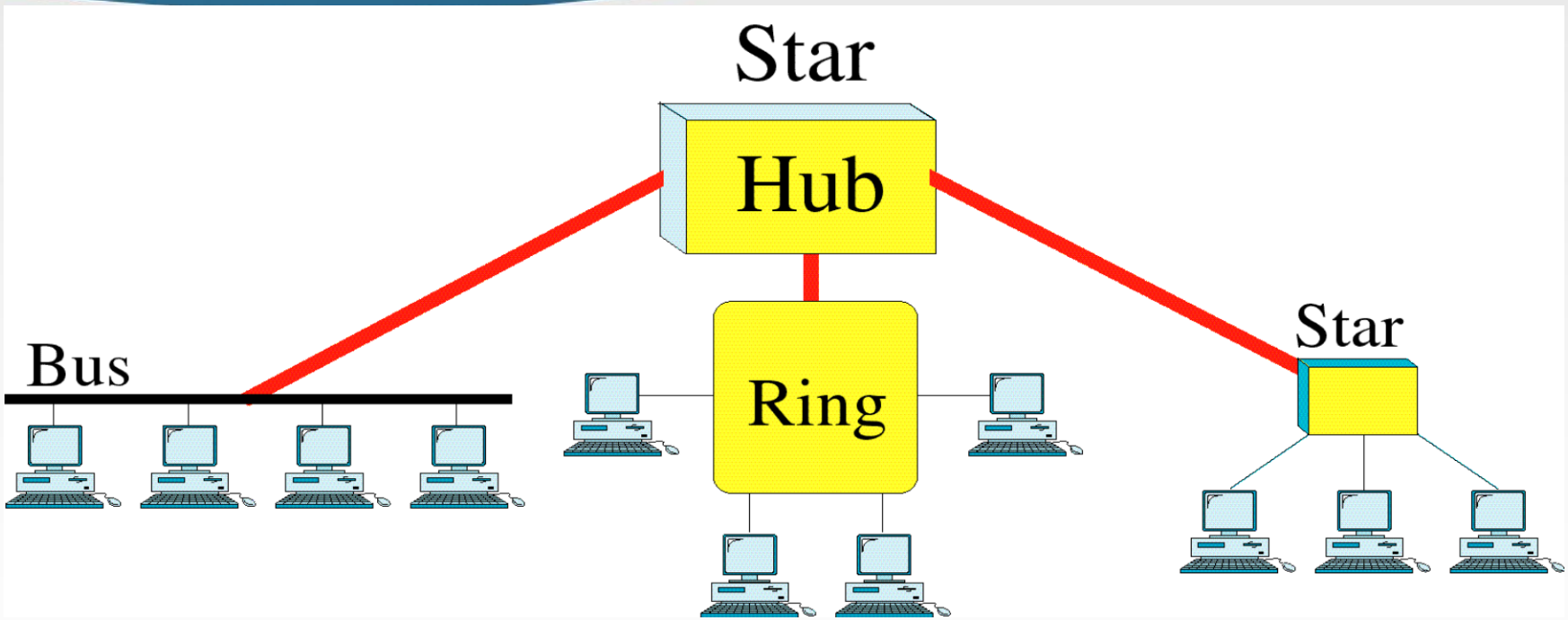
- One long cable that links all nodes
- Tap, drop line, cable end
- Limit on the number of devices, distance between nodes
- Advantages: Easy installation, cheap
- Disadvantages: Difficult reconfiguration, no fault isolation, a fault or break in the bus stops all transmission

Ring Topology:



- Dedicated point-to-point link only with the two nodes on each sides
- One direction, repeater
- Advantages: Easy reconfiguration, fault isolation
- Disadvantage: Unidirectional traffic, a break in the ring cab disable the entire network

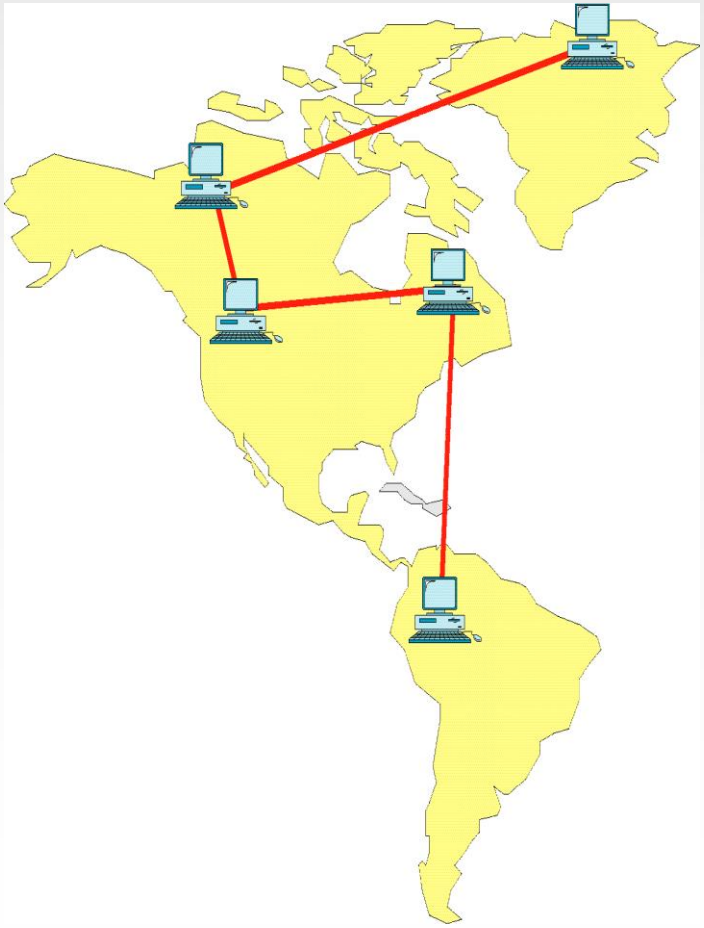
Hybrid Topology:



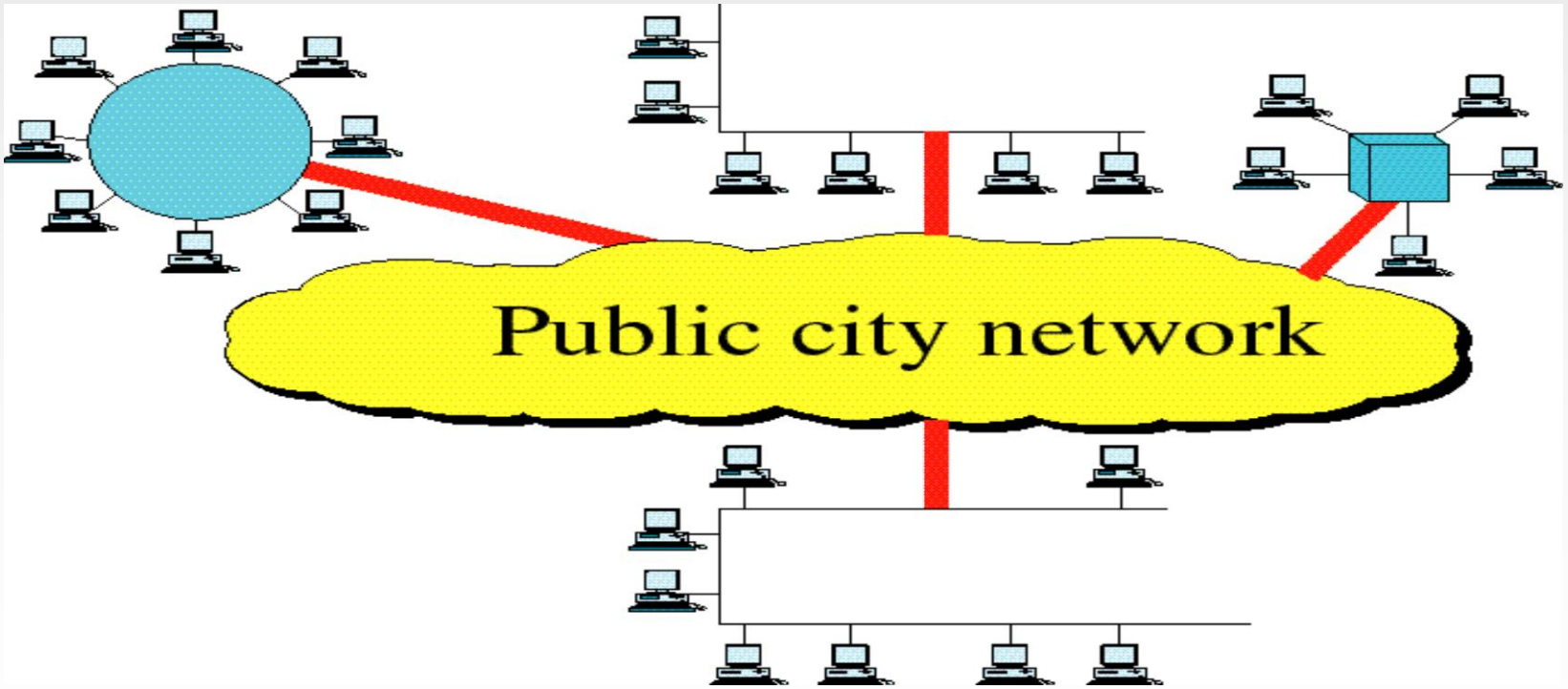
- Example: Main star topology with each branch connecting several stations in a bus topology
- To share the advantages from various topologies

Wide Area Networks:

- Large Geographical Area
- Consists of large number of Interconnected nodes
- Routing is required
- Technologies:
  - Circuit Switching
  - Packet Switching
  - Virtual Switching
    - Frame Relay
    - Asynchronous Transfer Mode (ATM)



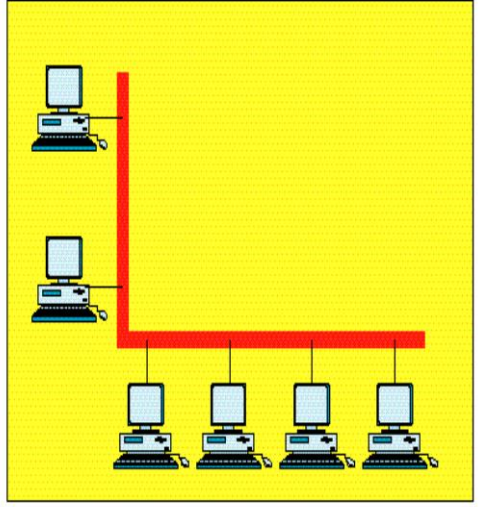
Metropolitan Area Network:



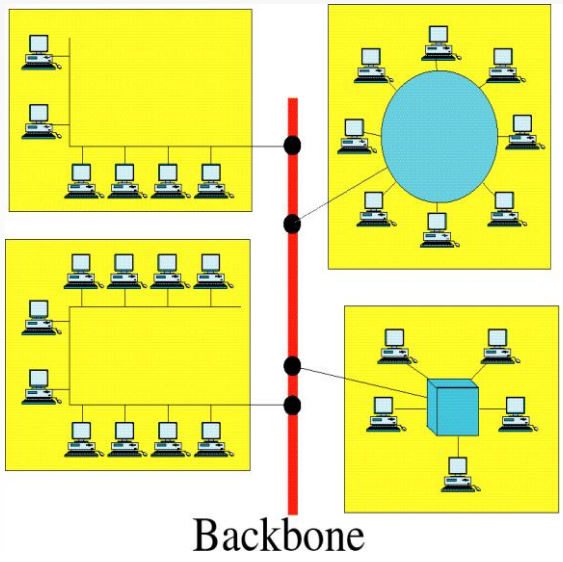
- Designed to extend to an entire city
- Cable TV network, a company's connected LANs
- Owned by a private or a public company

Local Area Network:

- Small Networks
  - Building or small campus
- Usually owned by same organization as attached devices
- Data rates much higher
- Usually broadcast systems



Single building LAN



Multiple building LAN

Circuit Switching:

- Dedicated communications path established for the duration of the conversation

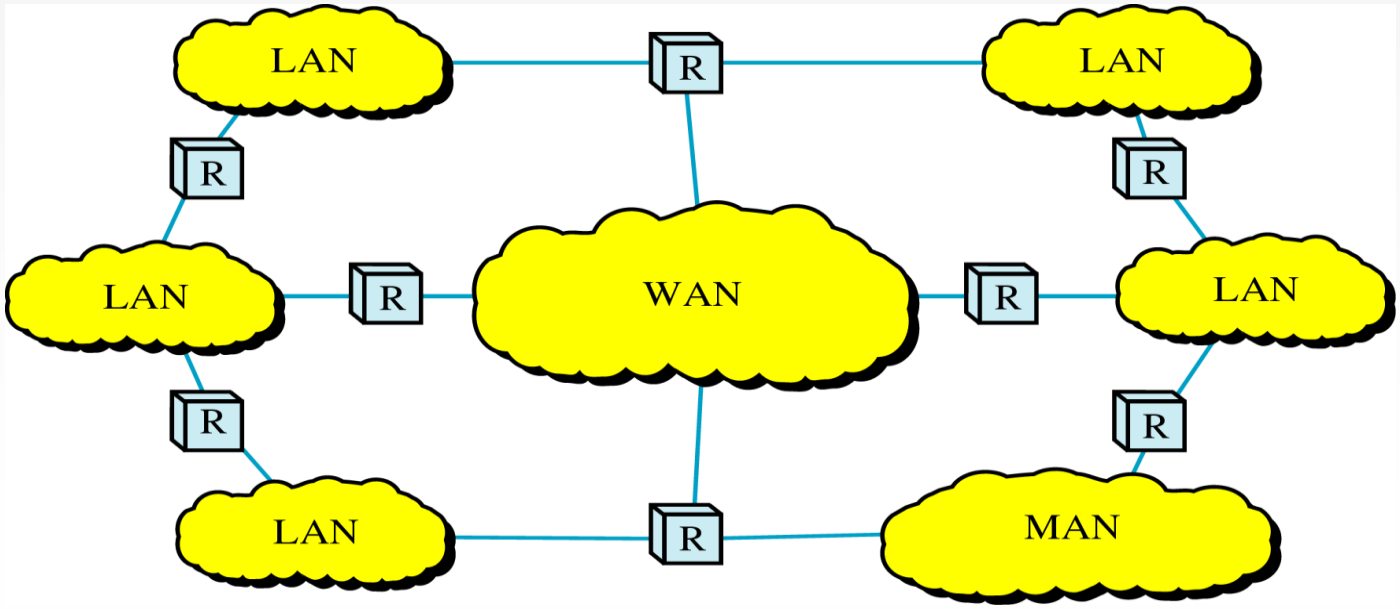
- e.g. telephone network

Packet Switching:

- Small chunk (packet) of data at a time
- Data packets sent out in a sequence
- Packets passed from node to node between source and destination

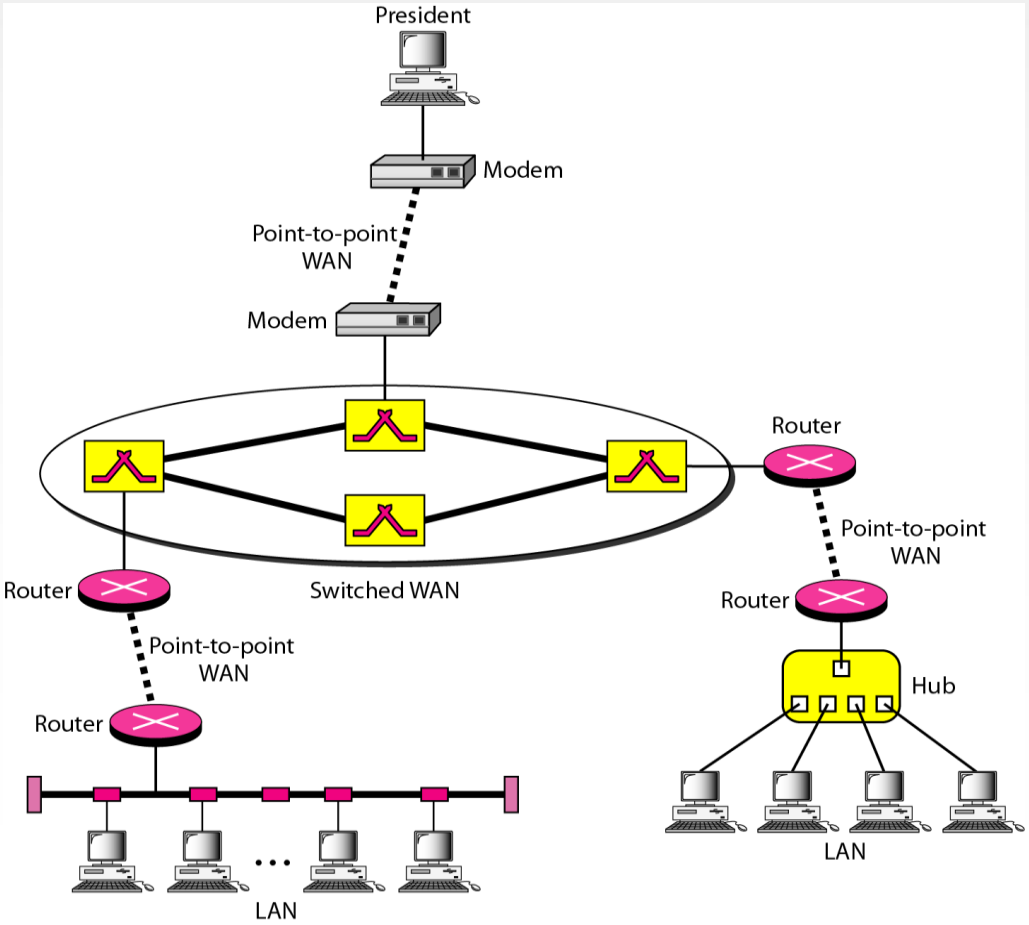
Inter Network (Internet):

- Two or more networks are connected by internetworking devices
- Internetworking Devices: Router, Gateway, etc.



Internetwork Example

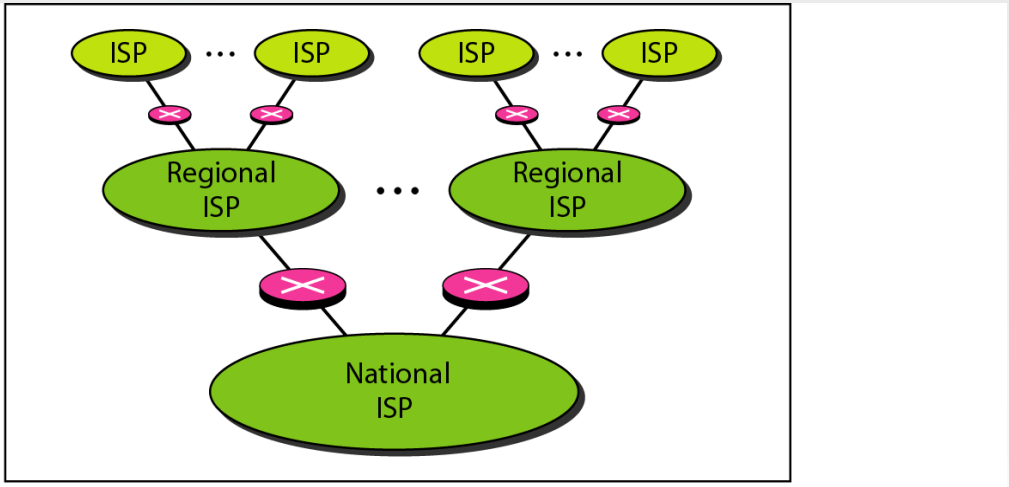
- A heterogeneous network : four WANs and two LANs



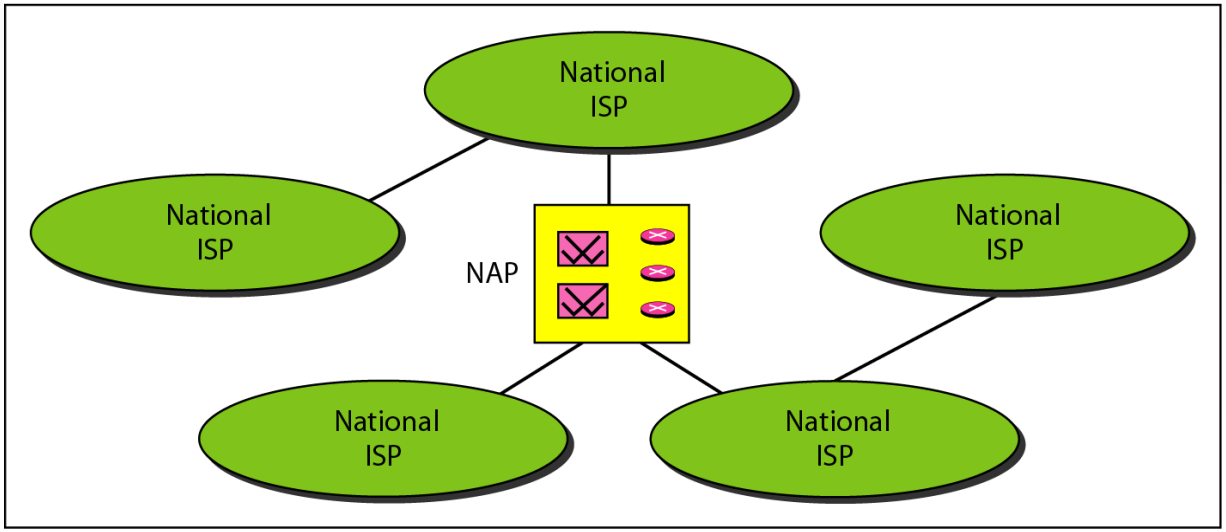
The Internet

- 1967: ARPANET proposed by DoD's ARPA(Advanced Research Project Agency)
- 1969: ARPANET in a reality: UCLA, UCSB, SRI, U. of Utah
- 1973: Vint Cerf and Bob Kahn proposed TCP
- Later, TCP was split into two protocols TCP and IP

Internet Today



a. Structure of a national ISP



b. Interconnection of national ISPs

Standards Organisations:

- **IEEE:** Institute of Electrical and Electronics Engineers
- **ANSI:** American National Standards Institute
- **ISO:** International Standards Organization
- **ITU-T:** International Telecommunications Union-Telecommunication
- EIA: Electronics Industry Association
- TIA: Telecommunications Industry Association
- Internet Advisory Board
- Frame Relay Forum
- ATM Forum
- IETF: Internet Engineering Task Force
- IRTF: Internet Research Task Force