

Module 1

Introduction to networking

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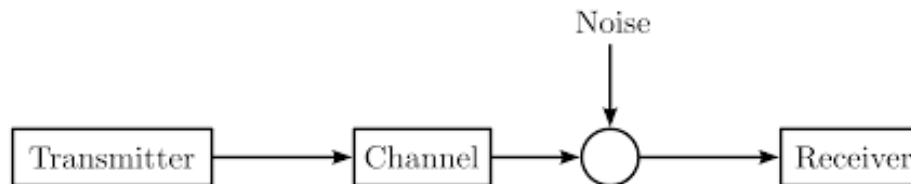
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Syllabus Contents

1. Data Communication basics
2. Types of Networks: LAN, WAN, MAN; Network Topology (types)
3. Network Software: Protocol hierarchy, Design Issues for layers, Connection oriented and connectionless services, Reliable and Un-reliable services
4. OSI and TCP/IP reference model, Comparison of OSI and TCP/IP reference model
5. Overview of connecting devices- NIC, Repeater, Hub, Switch, Router, Gateway
6. Self learning: Guided and unguided transmission

Communication

- Exchange of ideas/ information
 - Verbal and non-verbal
- Long distance communication historical form- Smoke/fire, Sound (drum beats), Pigeons, Mail etc.
- Electronic Communication- Transfer of information from one place to other through electronic signal
- Types: Wired/ Wireless
- Components of Communication System
 - Sender, Receiver, Message, Channel; (noise)



1-1 DATA COMMUNICATIONS

- **Telecommunication** means communication at a distance
- **Data** refers to information presented in whatever form
- *Data communication* refers to *exchange of data between two devices via some form of transmission medium such as a wire cable or radio signal*

Topics discussed in this section:

Components

Data Representation

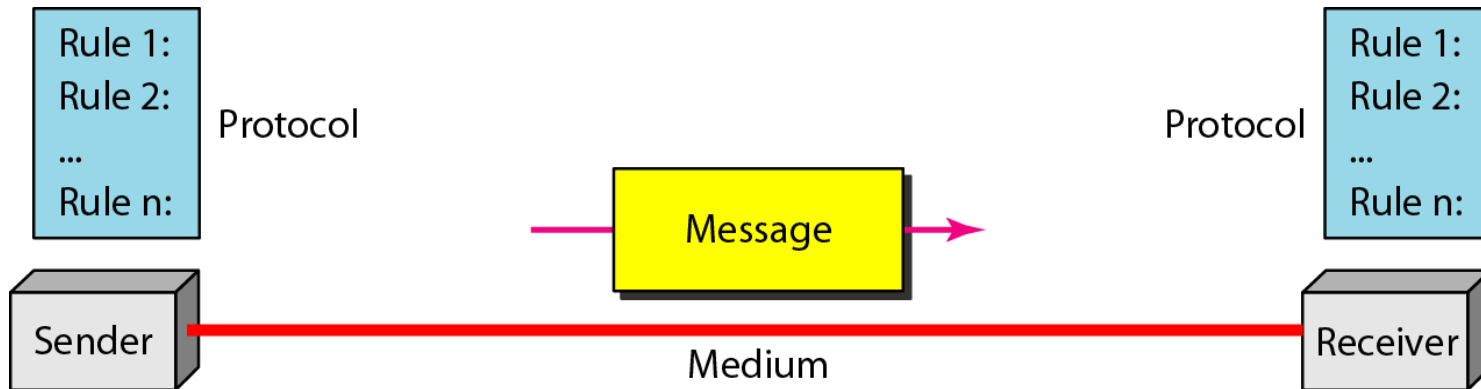
Data Flow

Data Representation

- Different forms of Information/Data
 - Text- Unicode (32 bits), ASCII
 - Numbers- numbering systems
 - Images- pixels; gray scale, colour (RGB etc)
 - Audio- sound / music; continuous not discrete
 - Video- continuous or discrete entity

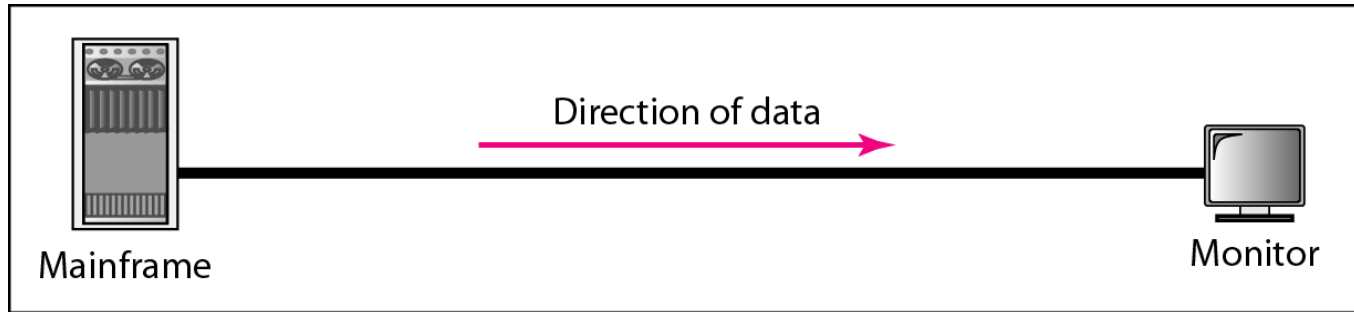
Figure 1.1 *Five components of data communication*

- Sender, Receiver, Medium, Message and Protocol

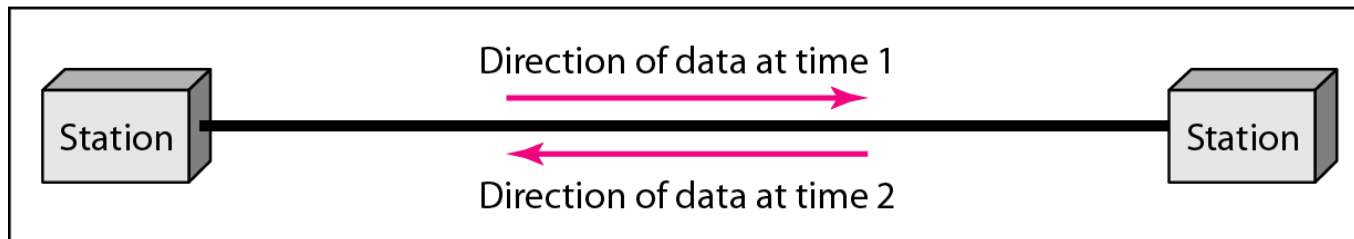


- Protocol is a set of rules that govern data communication
 - agreement between the communicating devices
 - without a protocol, two devices may be connected but not communicating

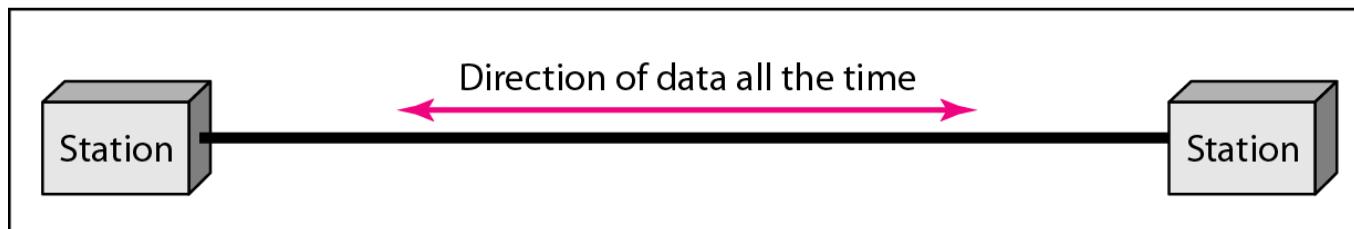
Data flow: Simplex (one way), half-duplex (two way communication but not simultaneously) and full duplex (2 way)



a. Simplex



b. Half-duplex



c. Full-duplex

1-2 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

Topics discussed in this section:

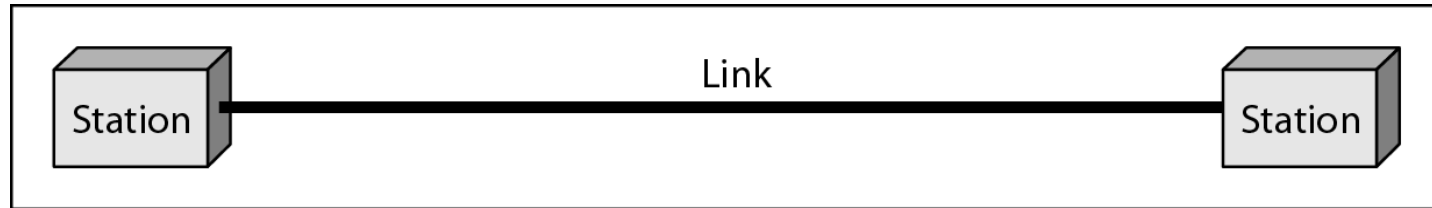
Physical Structures

Network Models

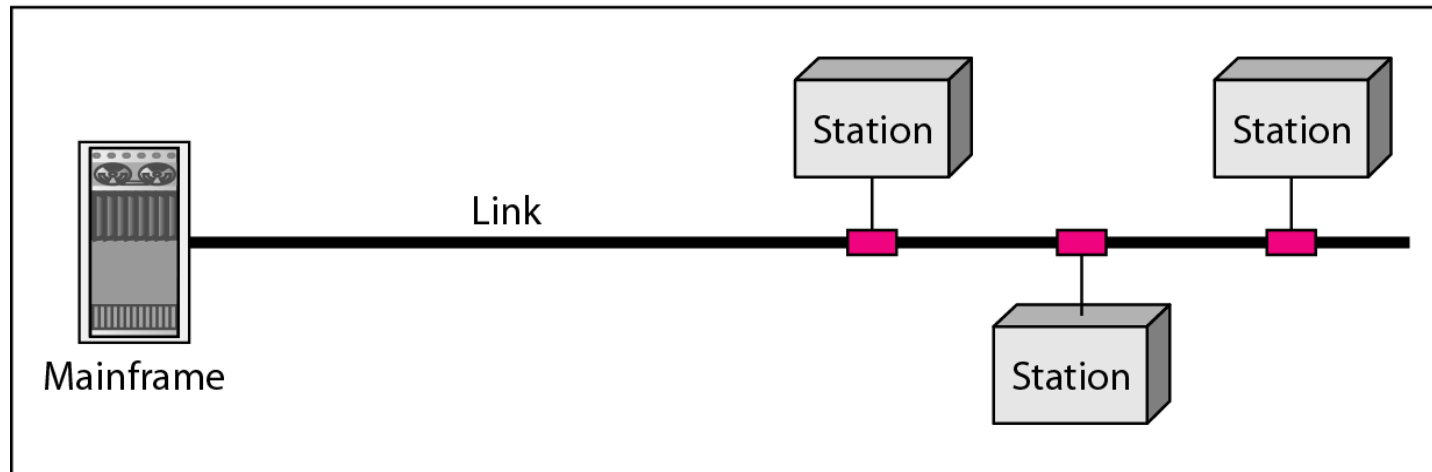
Categories of Networks

Interconnection of Networks: Internetwork

Figure 1.3 *Types of connections: point-to-point and multipoint*



a. Point-to-point



b. Multipoint

Types of connection/link (*Point-to-point and multipoint*)

- Point-to-point- dedicated link between two devices
 - Capacity reserved only for these devices
 - Dedicated wire cable or microwave links, IR etc.
- Multipoint- More than two devices share a single link
 - Capacity of the channel is shared spatially or temporally

Physical Topology:

*-Refers to the way in which a network is laid physically;
Geometric representation of the relationship of all the links and devices (nodes) to one another*

Figure 1.4 *Categories of topology*

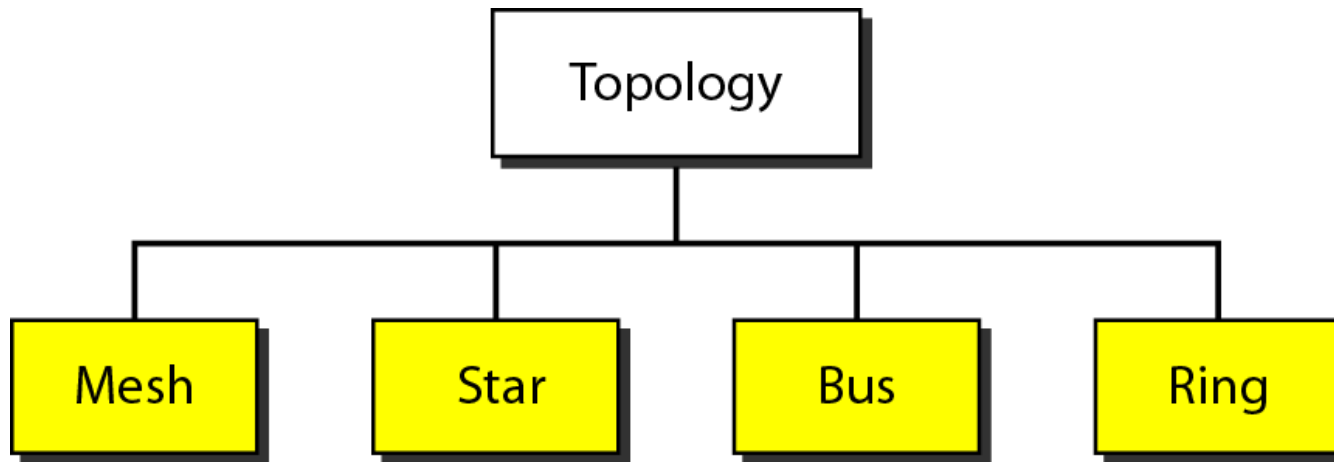
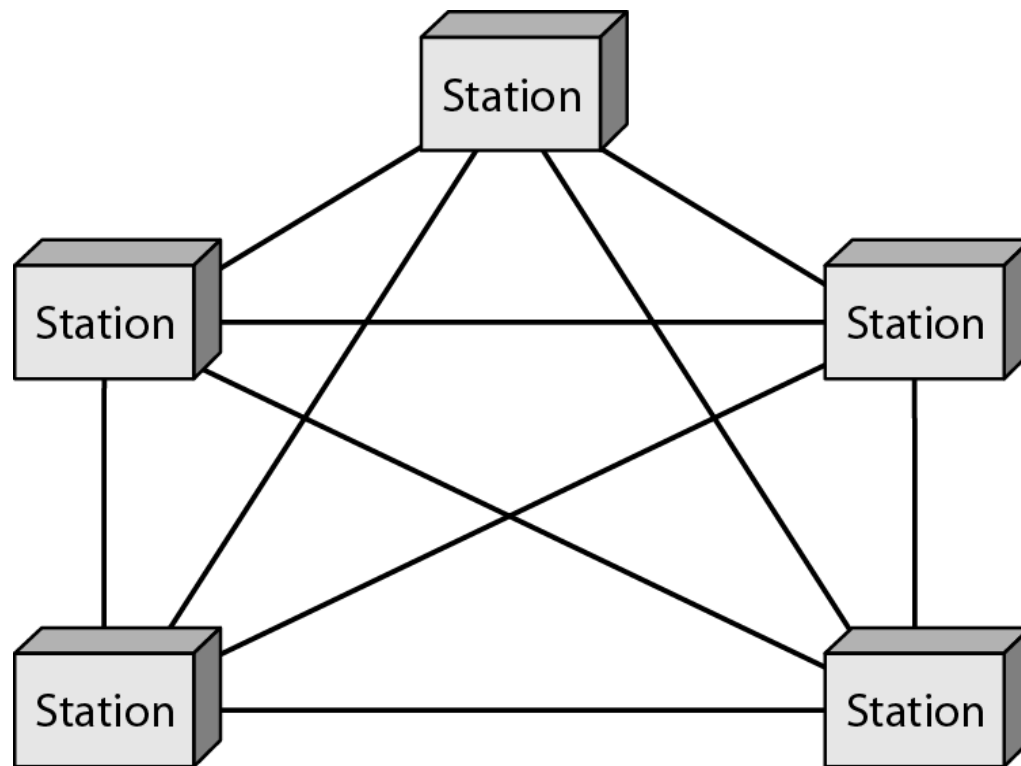


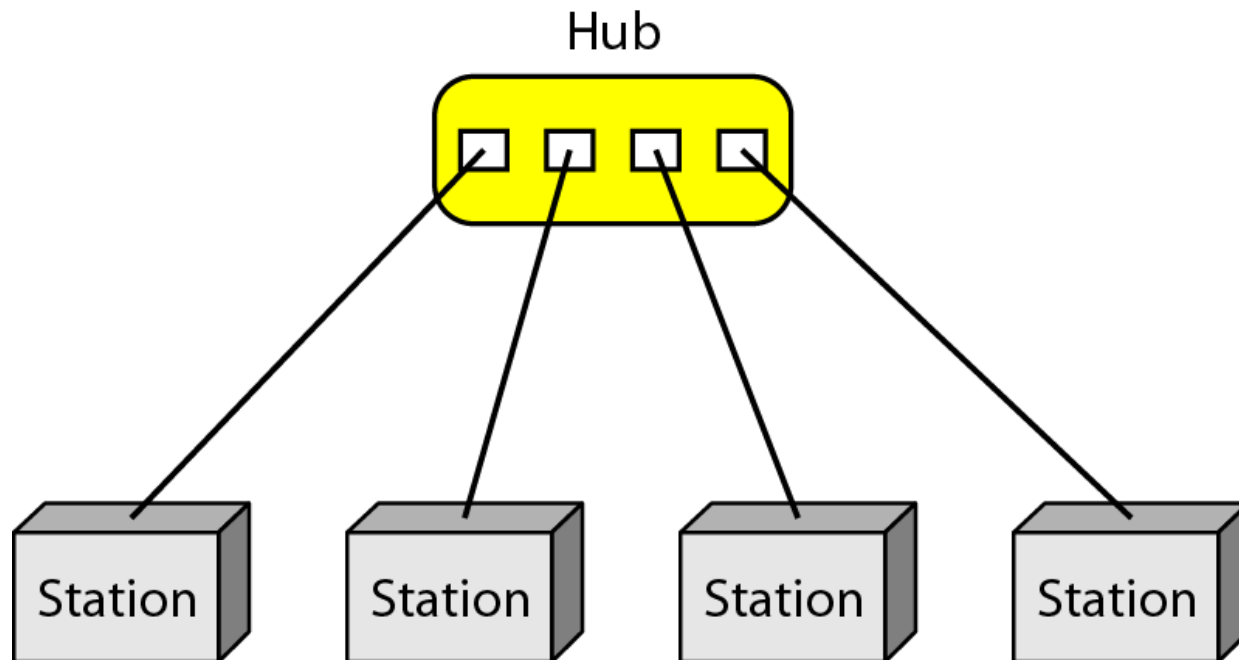
Figure 1.5 *A fully connected mesh topology (five devices)*



MESH Topology

- Every device has dedicated point-to-point link to every other device
- For network consisting of ' n ' nodes, $n(n-1)$ links are required
 - $(n-1)$ I/O ports required
 - Robust; easy fault identification and isolation
 - Privacy & Security
 - Large amount of cabling reqd → large space, expensive
 - Ex. Backbone networks; connecting Telephone regional offices

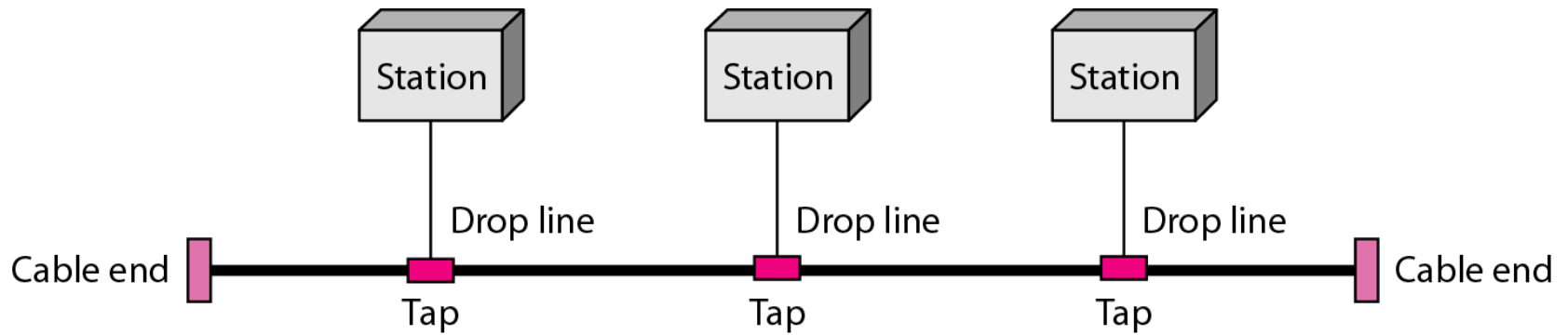
Figure 1.6 *A star topology connecting four stations*



STAR Topology

- Each device has a dedicated point-to-point link only to a central controller → Hub
 - Does not allow direct communication between devices
 - Less expensive than Mesh
 - If one link fails only that node is affected; others can communicate
 - Less cabling reqd; in-expensive
 - Not as Robust as Mesh; Hub is single point of failure
 - Ex. LAN

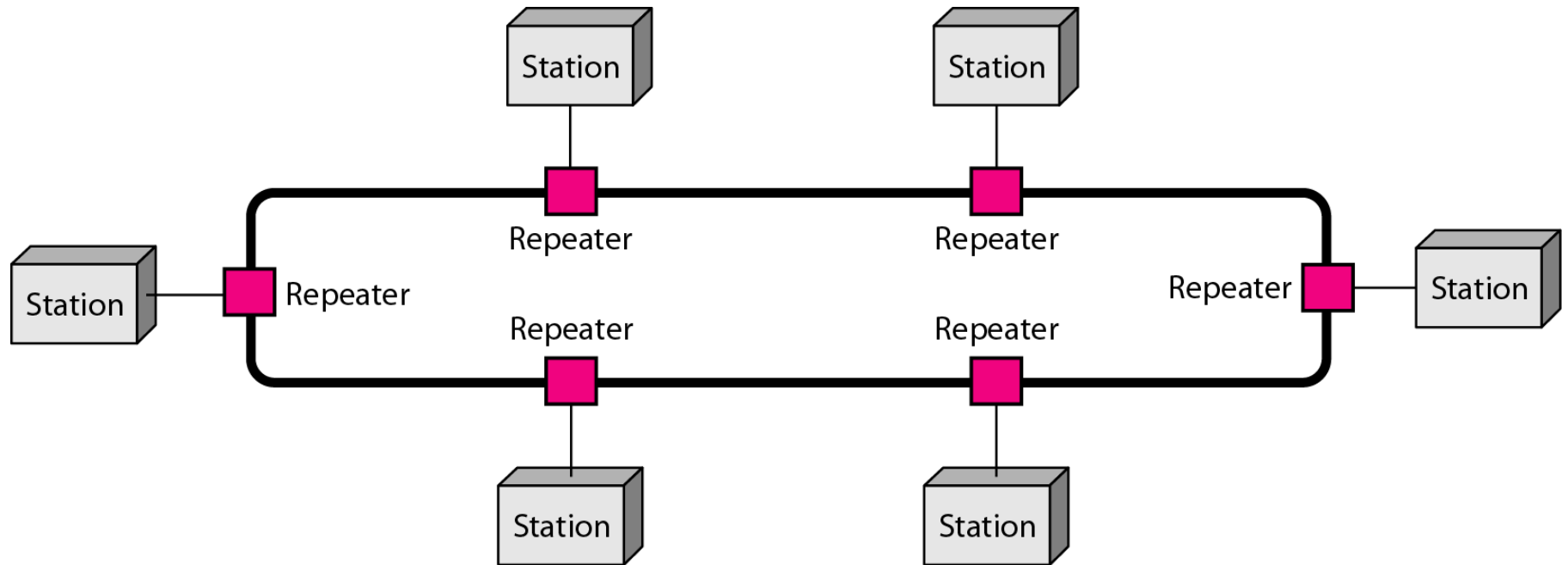
Figure 1.7 *A bus topology connecting three stations*



BUS Topology

- Multipoint topology
- one long cable acts as a **backbone** to which all devices are connected with the help of drop lines and taps
 - Least cabling hence inexpensive than other topologies
 - Signal becomes weaker as it travels farther
 - Difficult fault isolation and reconnection; break in cable stops communication
 - Ex. Early Ethernet LANs, now obsolete

Figure 1.8 *A ring topology connecting six stations*



Ring Topology

- Each device has a dedicated point-to-point connection to only two devices on either side of it
- Each device incorporates a repeater
- Signal passed along the ring in one direction
 - Easy to install and reconfigure; Less expensive than Mesh
 - Easy fault isolation
 - In simple ring (simplex links), break in ring/disabled station can disable entire network
 - Solved using dual ring with switching capability
 - Ex. Token Ring LAN

Figure *A dual-ring topology connecting six stations*

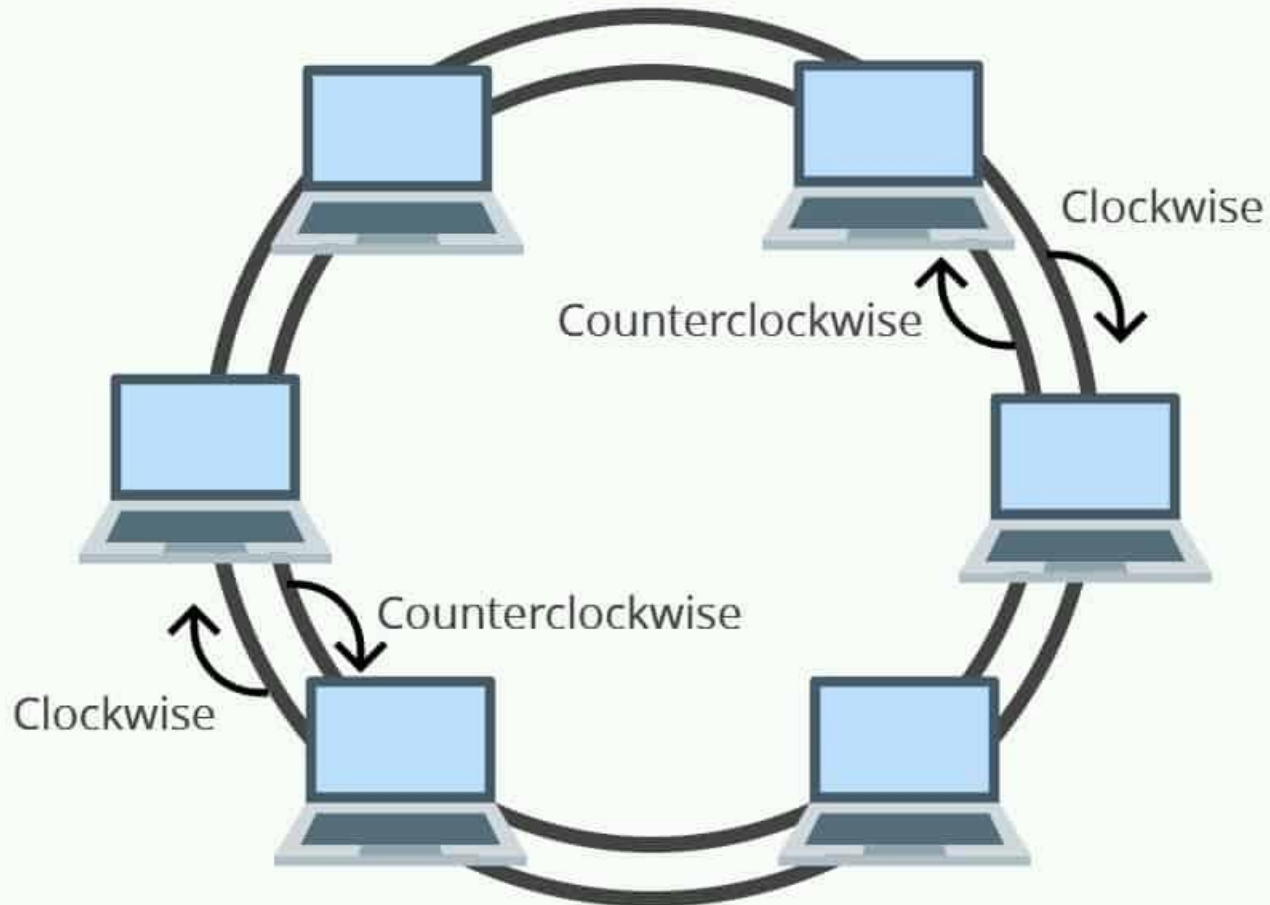
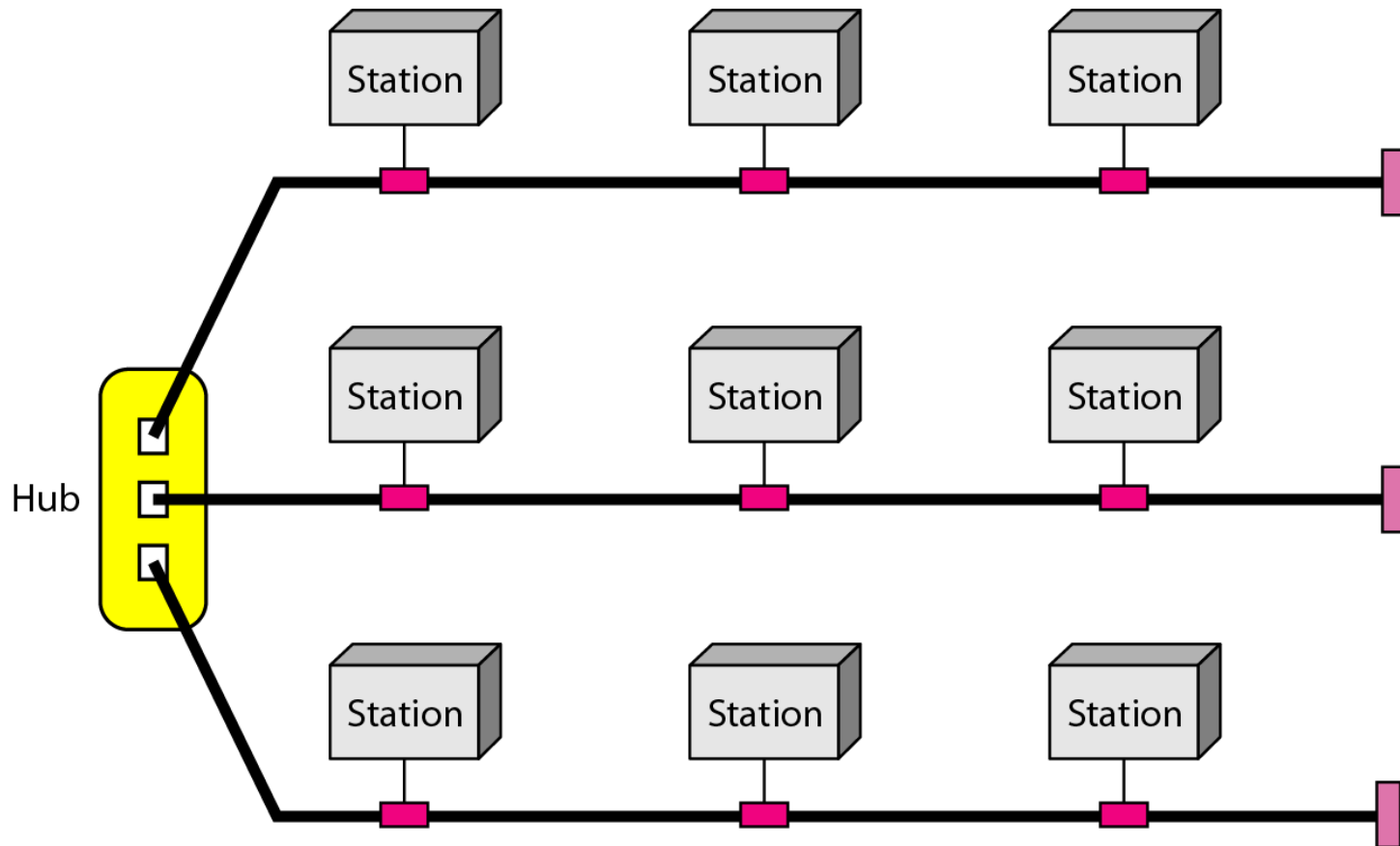


Figure 1.9 *A hybrid topology: a star backbone with three bus networks*

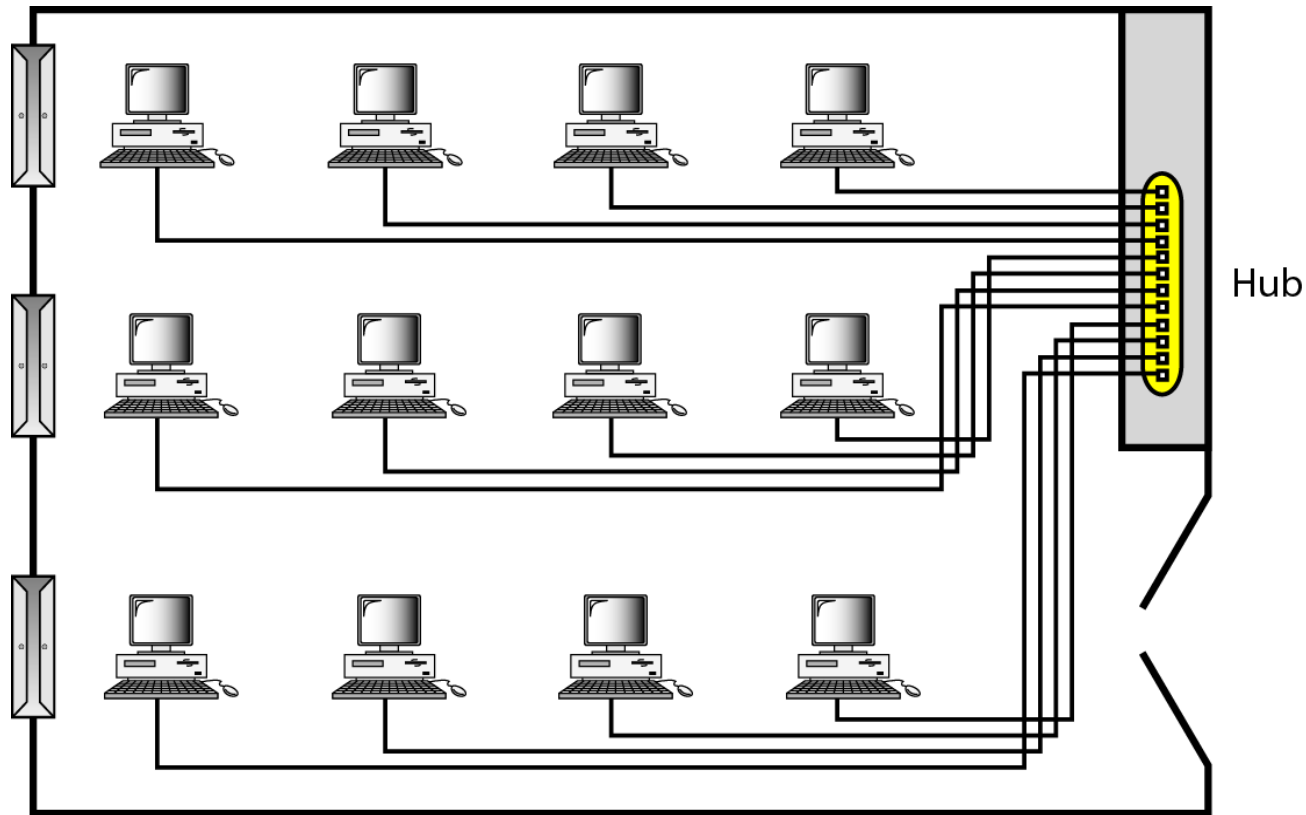


Types of Networks: LAN, MAN, WAN

■ LAN- Local Area Network

- Privately owned; allows resources to be shared among computers
- Linking the devices in a single office, building or campus;
- High capacity device acts as a Server; clients use the resources (storage, files, software etc.) available on server
- Topologies: Star, Bus and Ring
- LAN size/Area Restricted to few kms
- Data Rate: 10 to 1000Mbps

Figure 1.10 *An isolated LAN connecting 12 computers to a hub in a closet*

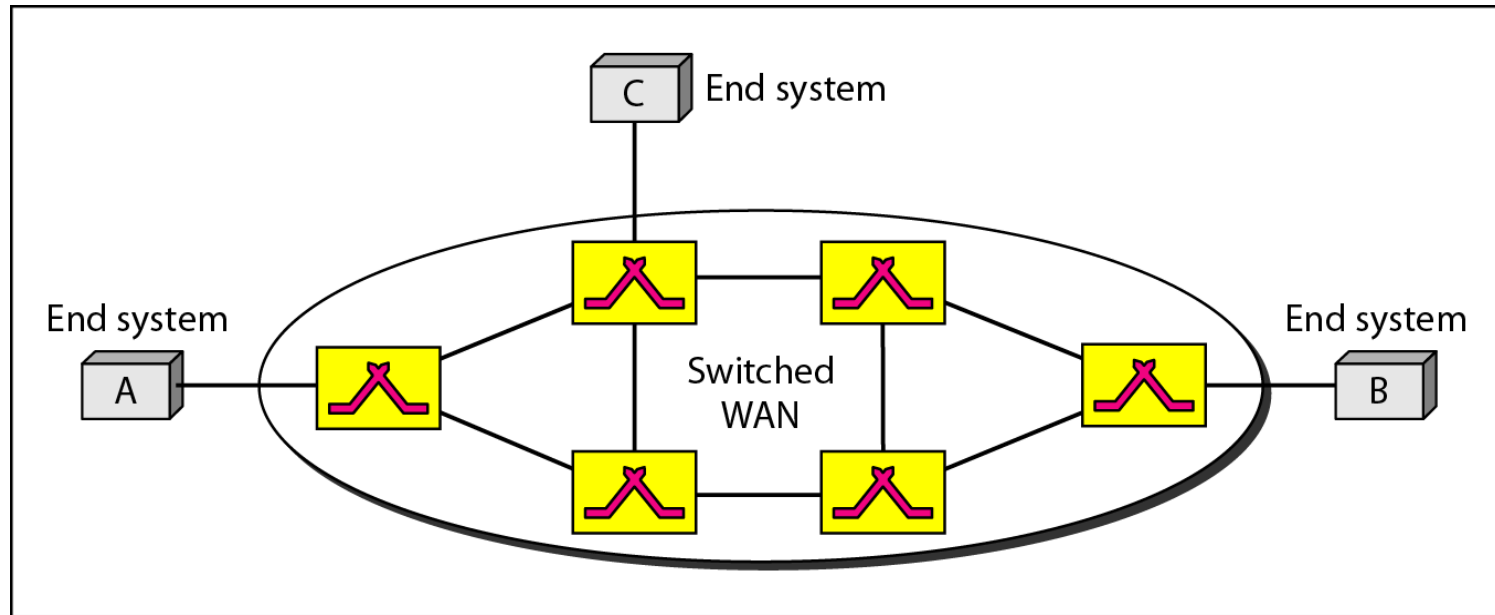


Types of Networks: LAN, MAN, WAN

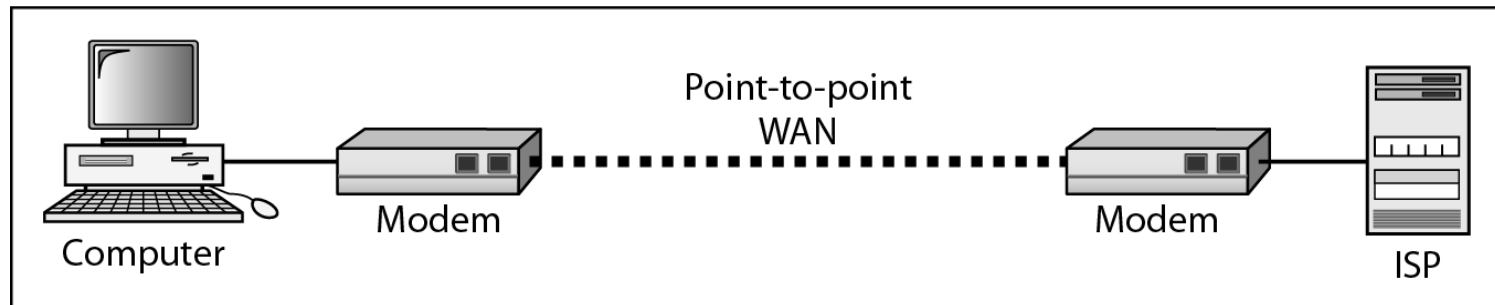
■ WAN- Wide Area Network

- Provides long distance transmission of data
- spans large geographical area that may comprise a country, a continent or entire globe
- Types- Switched, Point-to-Point
- Switched WAN- connects the end systems, which comprise a Router that connects to another LAN or WAN
 - X.25, Frame relay, ATM, wireless WAN
- Point-to-Point WAN- Home computer/LAN connected to Internet Service Provider (ISP) via Dialup/Leased line or cable TV network

Figure 1.11 *WANs: a switched WAN and a point-to-point WAN*



a. Switched WAN



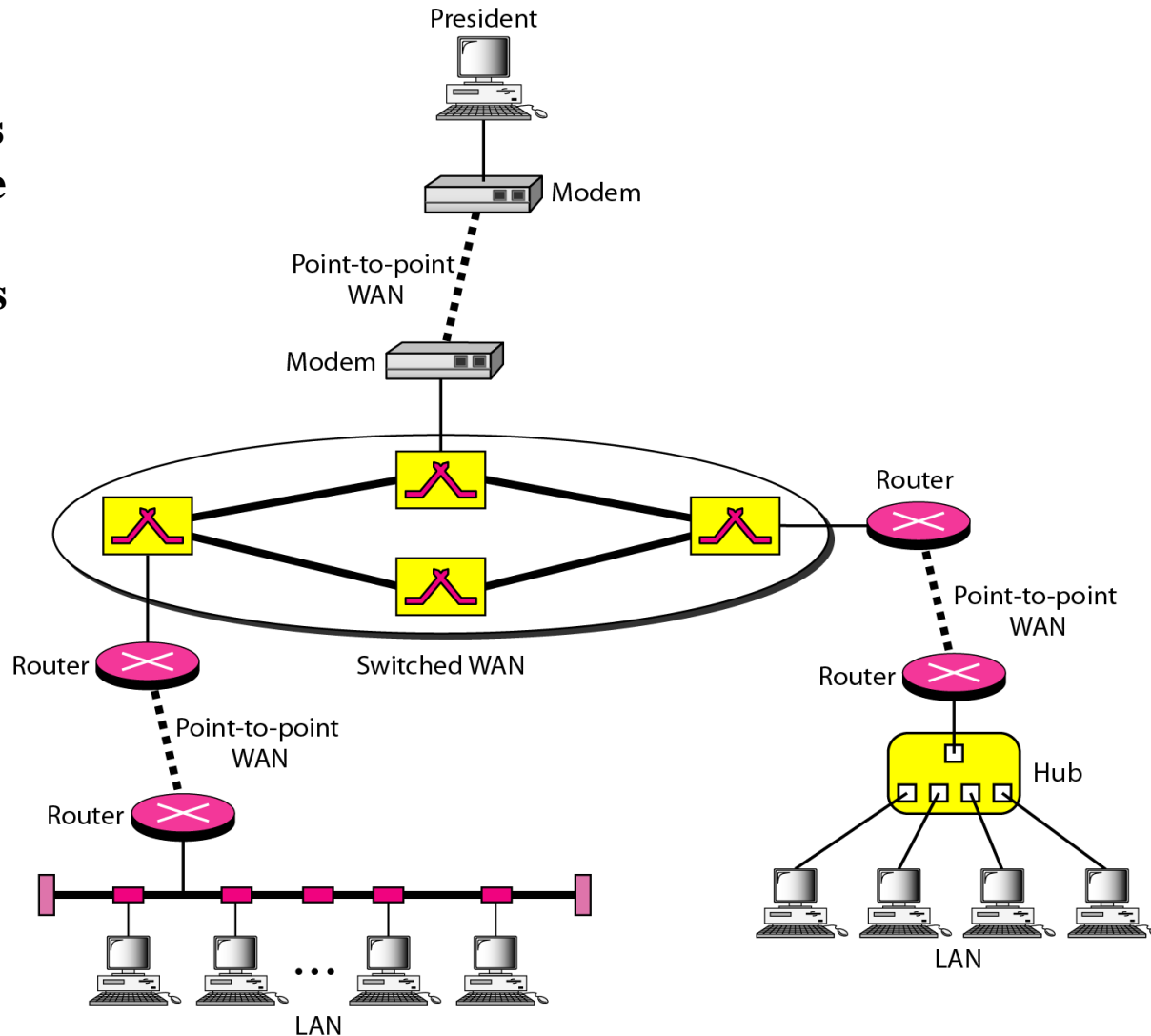
b. Point-to-point WAN

Types of Networks: LAN, MAN, WAN

- **MAN- Metropolitan Area Network**
 - Fits between LAN and WAN; covers region/area within a city restricted to few tens of kms
 - Designed for customers who need high speed connectivity; offices spanning over the city
 - E.g. Telephone company network that provides high-speed DSL line to customers

Internetwork: interconnection of networks

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



1-3 THE INTERNET

- An *internet* comprises of two or more networks that can communicate with each other
- *Internet* is a collaboration of more than hundreds of thousands of interconnected networks
- *Internet* has revolutionized many aspects of our lives
- *Changed the way* we do *business* as well as the way we spend our *leisure time*
- *It is a communication system* that has brought a *wealth of information* to our *fingertips* and *organized it for our use*

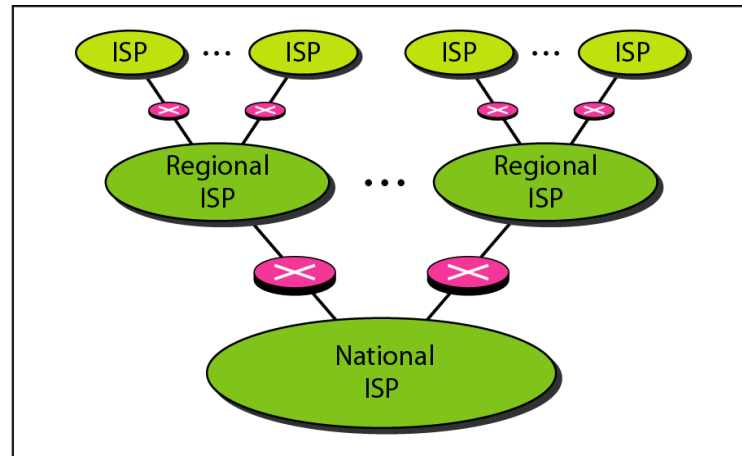
History

- First network/internet- **ARPANET**- 1969
 - Advanced Research Projects Agency (ARPA), Dept. of Defense
 - Small network of connected computers; each host computer attached through specialized computer called **IMP** (interface message processor)
 - 4 nodes at the University of California at Los Angeles (UCLA), University of California at Santa Barbara (UCSB), Stanford Research Institute (SRI) and University of Utah connected via IMP
 - **Network Control Protocol (NCP)** provided communication between the hosts
 - 1973- **V. Cerf and B. Kahn-TCP** (Transmission Control Protocol); later split into TCP and IP

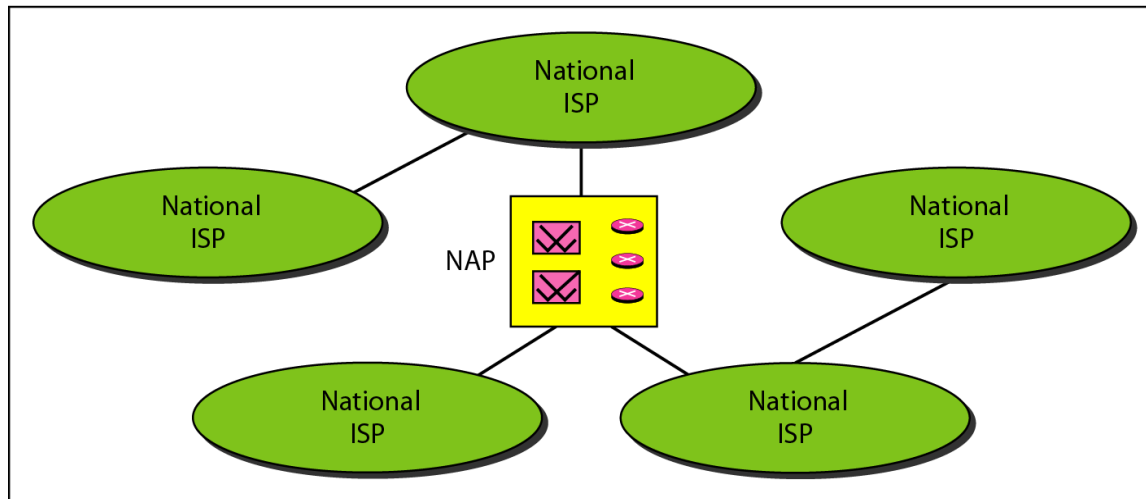
Internet Service Providers (ISPs)

- For connecting to Internet, end users use the service of Internet Service Providers (ISPs)
 - Types: International service providers, national service providers, regional service providers and local service providers
- Local ISPs- provide direct service to end users and are connected to regional ISPs or national ISPs
 - Can be a company providing Internet services, corporation or a non profit organization e.g college/University, civic body...
- Regional ISPs are connected to one or more national ISPs
- National ISPs- backbone networks created and maintained by specialized companies
 - interconnected by switching stations called Network Access Points
- International ISPs- connect National ISPs together

Figure 1.13 *Hierarchical organization of the Internet*



a. Structure of a national ISP



b. Interconnection of national ISPs

1-4 PROTOCOLS AND STANDARDS

Jargon terms: *Protocols and Standards*

- *Protocol* is synonymous with rule
- *Standards* are agreed-upon rules

Topics discussed in this section:

Protocols

Standards

Standards Organizations

Internet Standards

Connection oriented and connectionless services

Protocols

- Set of rules that govern data communication
 - Defines what is communicated, how it is communicated and when it is communicated
- Key elements- Syntax, Semantics and Timing
- Syntax- structure or format of data; order in which data is presented
 - E.g. first 48 bits sender address, next 48 bits receiver address and remaining bits the message/user data
- Semantics- meaning of each section of bits
 - How a bit pattern is to be interpreted and what action be taken
- Timing- refers to what data to be sent and how fast be sent
 - Useful for matching the sending rate of sender with the capability of receiver

Standards

- Provide **guidelines** to manufacturers, vendors, government agencies, and other service providers
- **Essential** for **guaranteeing national** and **international interoperability** (of technology and processes)
- **Developed** through **cooperation** of **standards creation committees**, forums and **regulatory agencies**
- Two categories: **De facto** and **De jure**
 - **De facto (by fact)**- standards **not been approved** by a **standardisation** body but have been **adopted through widespread use**
 - **De jure (by regulation)**- standards that have been **legislated** by an **officially recognized body** (e.g. IEEE)

Standards Organizations

- ISO: International Organization for Standardization
- ITU-T: International Telecommunication Union-
Telecommunication Standards Sector
- ANSI: American National Standards Institute
- IEEE: Institute of Electrical and Electronics Engineers
- EIA: Electronic Industries Association

- Special Interest Groups/ **Forums**- representatives from various corporations
 - work with universities and users, test and evaluate new technologies
- Regulatory Agencies - Govt. agencies to protect public interest (e.g. TRAI, FCC)
 - Regulate radio, TV, wire/cable communication

Connection Oriented and Connectionless Services

■ Connection Oriented Services

- Requires prior session connection between sender and receiver
- Sets up virtual links between the end systems through a network
- Reliable network service
- Suitable for Long messages
- High overhead, thus greater BW demand
- Example: Telephone call

Connection Oriented and Connectionless Services

■ Connection Less Services

- No prior connection between sender and receiver required
- Less overhead
- Suitable for Short messages, real-time traffic
- No reliability
- Does not maintain state information
- Example: email, SMS

Reliable and Unreliable Services

■ Reliable Services

- Assured delivery of message from sender to receiver
- Requires acknowledgement from the receiver about receipt of message
- Large Overhead; unsuitable for real-time applications like Voice/video i.e multimedia
- Example: TCP

Reliable and Unreliable Services

■ Unreliable Services

- Time-bound delivery of message; No guarantee
- Less Overhead; suitable for real-time applications like Voice/video i.e multimedia
- Example: UDP