

Computer Network

Introduction

- Communication:
 - Sharing of information either in local or remote
 - Local communication usually either face-to-face whereas remote communication takes place over distance
 - Telephone, television, telegraphy etc.
- Data:
 - Refers to information presented in whatever form is agreed upon by the parties creating and using the data.

Introduction

- **Data Communication:**
 - *Exchange of data between two devices via some form of transmission medium*
 - *Ex: Wire cable, fiber optic cable*
 - Though data communication may be possible in wireless medium also
- For data communication to occur, the communication devices must be part of the communication system.
 - Here devices means both hardware and software

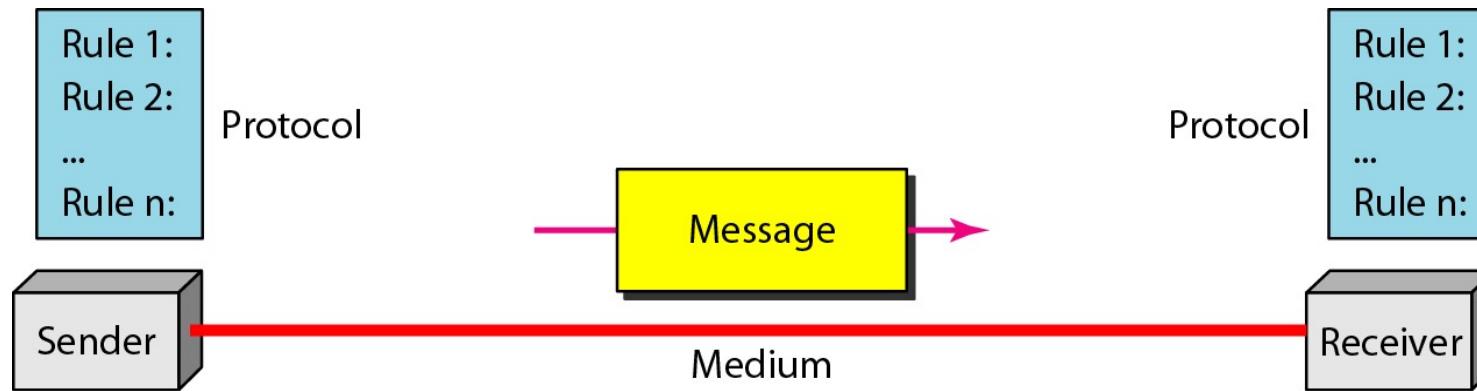
Characteristics of Communication Systems

- Effective communication depends on following properties:
 - **Delivery:**
 - Must deliver data to correct destination
 - Data must be received by the intended device or user and only by that device or user
 - **Accuracy:**
 - Must deliver data accurately
 - Data that have been altered in transmission and left uncorrected are unusable.
 - **Timeliness:**
 - The system must deliver data in timely manner
 - Delivery should be in real time communication
 - **Jitter:**
 - Refers to the variation in the packet arrival time

Components of a Data Communication System

- **Five components:**
 - **Message:** The information (data) to be communicated
 - Ex: Text, images, audio, video, numbers etc.
 - **Sender:** The device that send the message
 - Ex: Computer, workstation, telephone handset, video camera etc.
 - **Receiver:** The device that receives the message
 - Ex: Computer, workstation, telephone handset, television etc.
 - **Transmission medium:** The physical path by which a message travels from sender to receiver
 - Ex: twisted pair cable, coaxial cable, fiber optic cable and radio waves etc.
 - **Protocol:** Set of rules that govern data communication
 - It represents an agreement between the communication devices.
 - Ex: Two persons speaking in same language

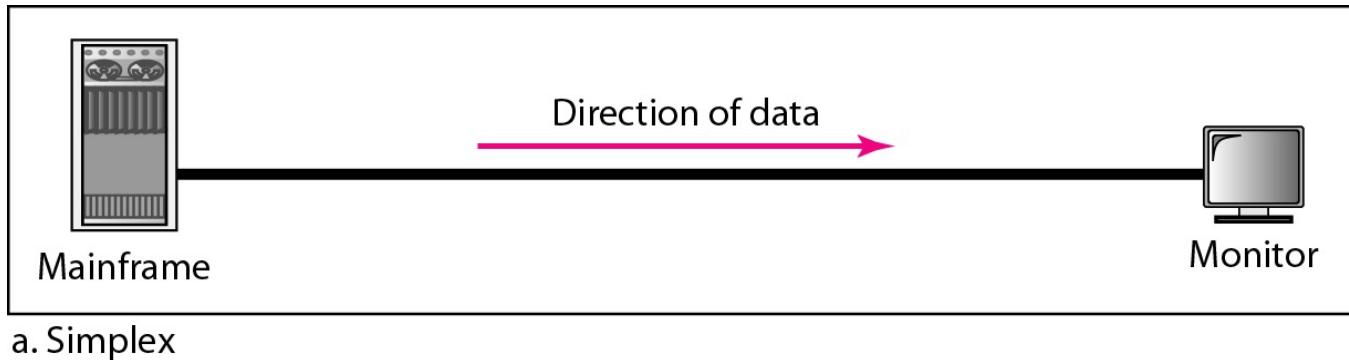
Components of a Data Communication System



Data Representation

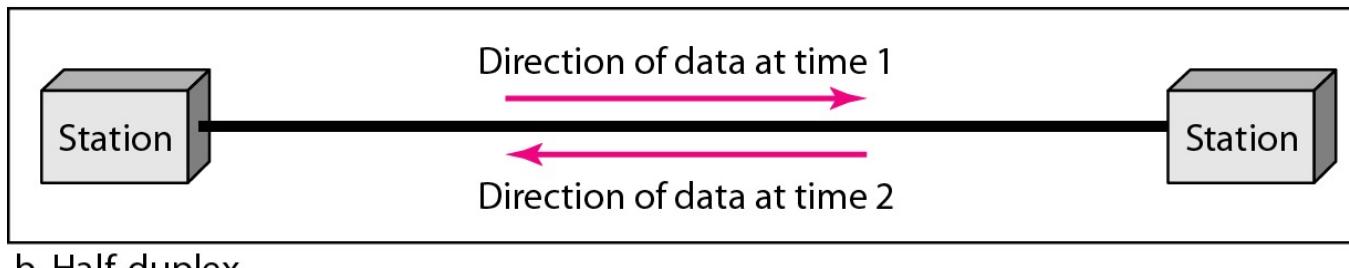
- Bit patterns are used to represent data
 - Text data: Unicode representation of text symbols.
 - Numbers: Binary representation of numbers
 - Image data: Pixels values are in numbers
 - Video data: Combination of images
 - Audio data: Signals

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



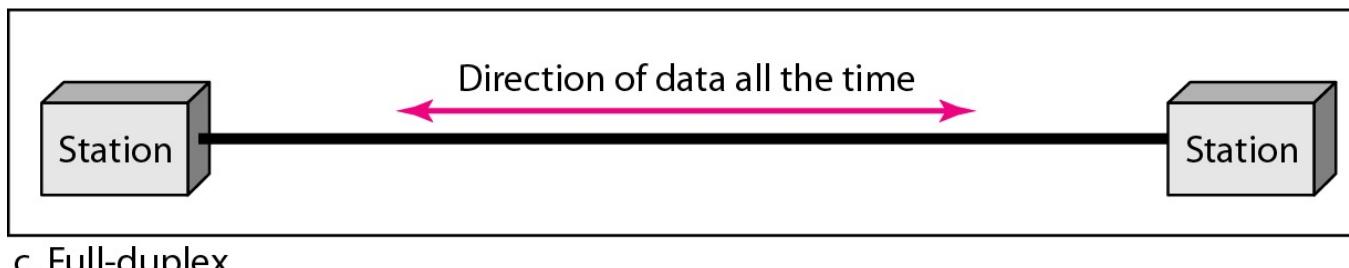
a. Simplex

* Ex: Keyboard, Monitor



b. Half-duplex

*Ex: Walki-talkies, citizen band radios



c. Full-duplex

*Ex: Telephone network

Network

- 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.
- A node can be a computer, laptop, router, switch, modem considered as a connecting device.

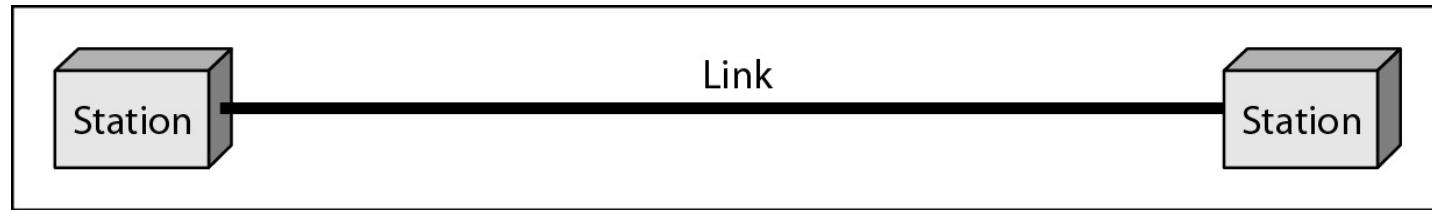
Network Criteria

- **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

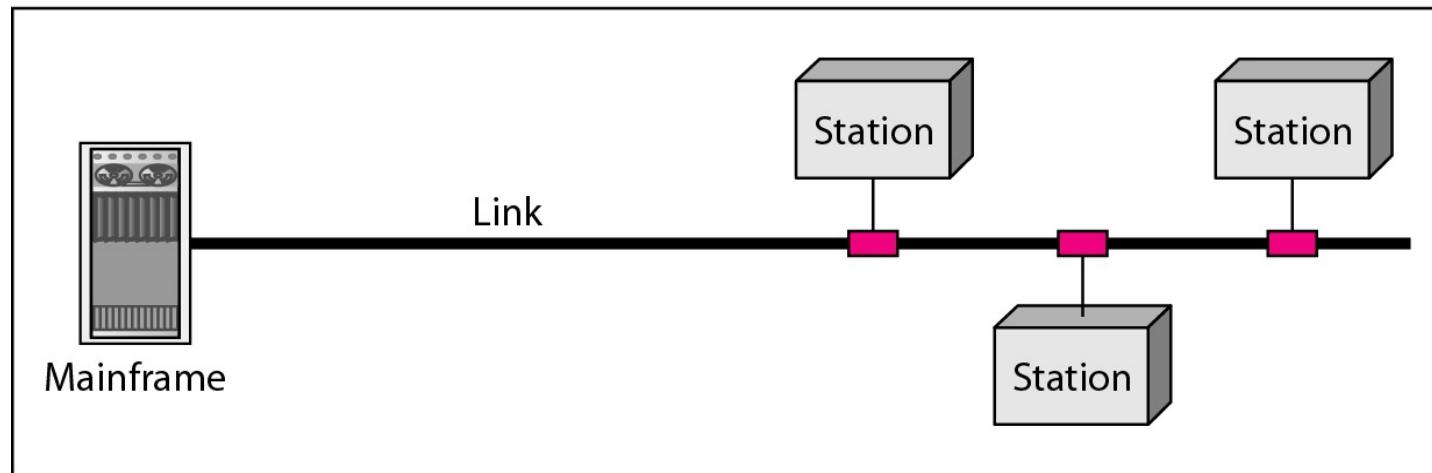
- Network attributes
 - Type of Connection
 - Point to Point - single transmitter and receiver
 - Multipoint - multiple recipients of single transmission
 - Physical Topology
 - The way in which a network is laid out physically
 - Two or more connection of devices to a network
 - Two or more links form a topology
 - Type of transmission - *unicast, multicast, broadcast*

Types of connections: point-to-point and multipoint



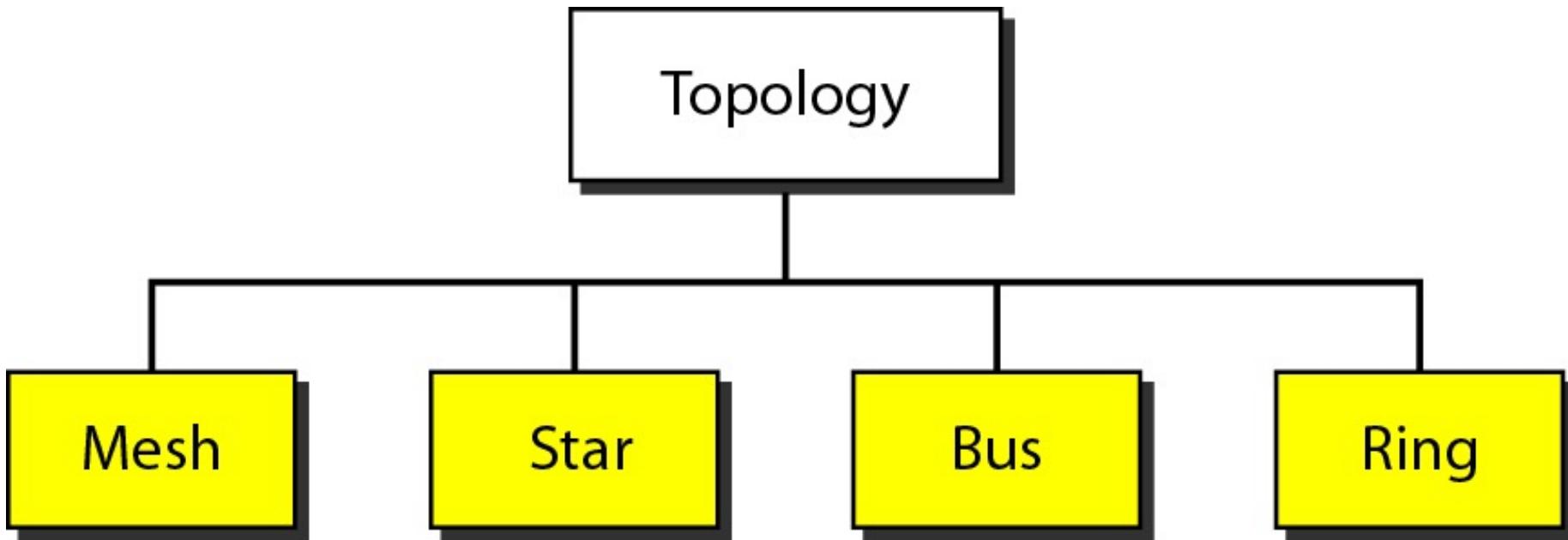
a. Point-to-point

Ex: Remote control of a TV

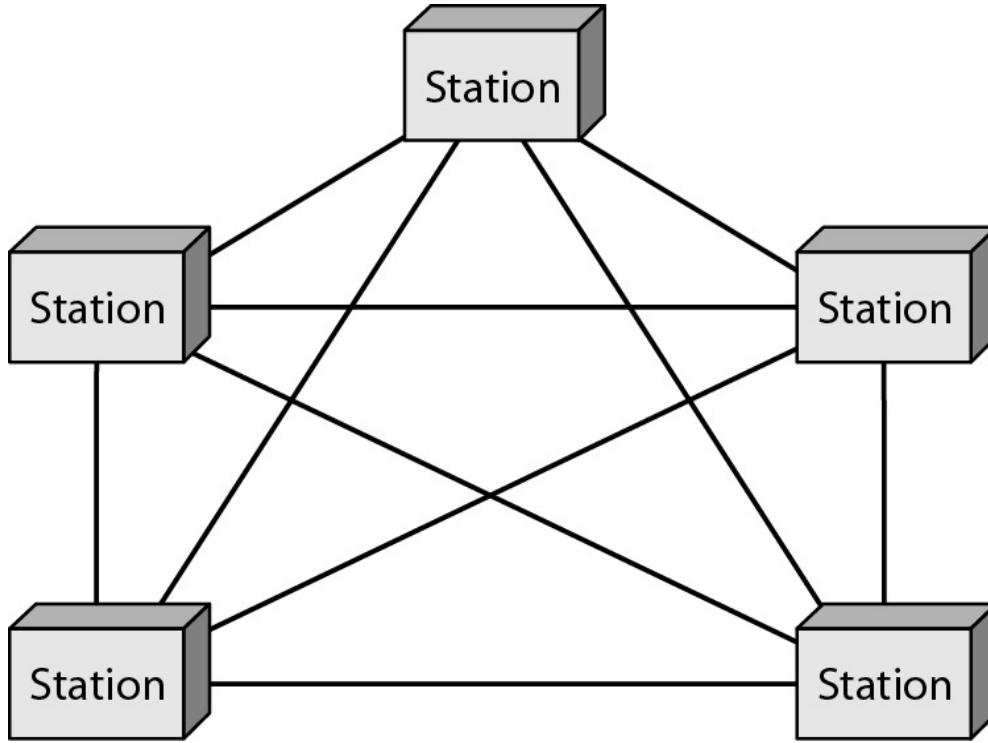


b. Multipoint

Categories of topology



A fully connected mesh topology (five devices)



Properties:

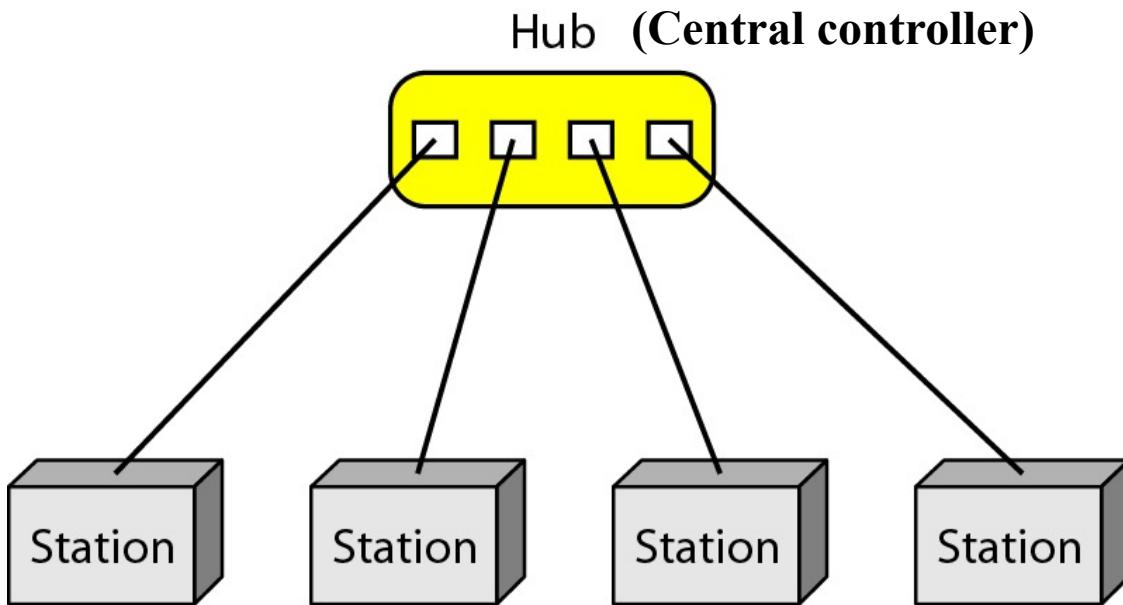
- Every device has a dedicated link to every other device
- So it carries traffic in between the devices only

Advantages:

- Carry its own data load
- Robust
- Advantage of privacy or security
- Fault identification and fault isolation easy

- Example: Connection of regional telephone exchanges

A star topology connecting four stations



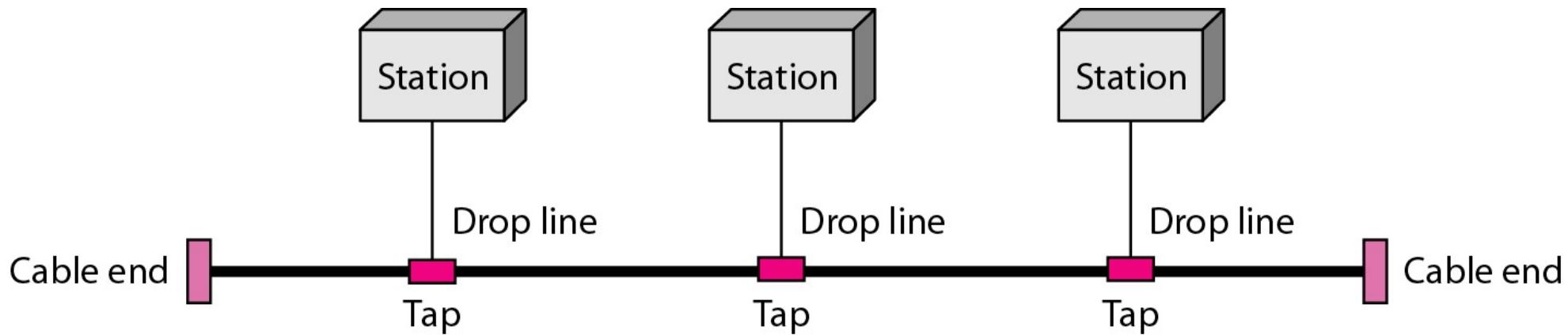
Advantages:

- Less expensive than a mesh topology
- Each device needs only one link and one I/O port to connect it to any number of others
- Easy to install and reconfigure

Disadvantages:

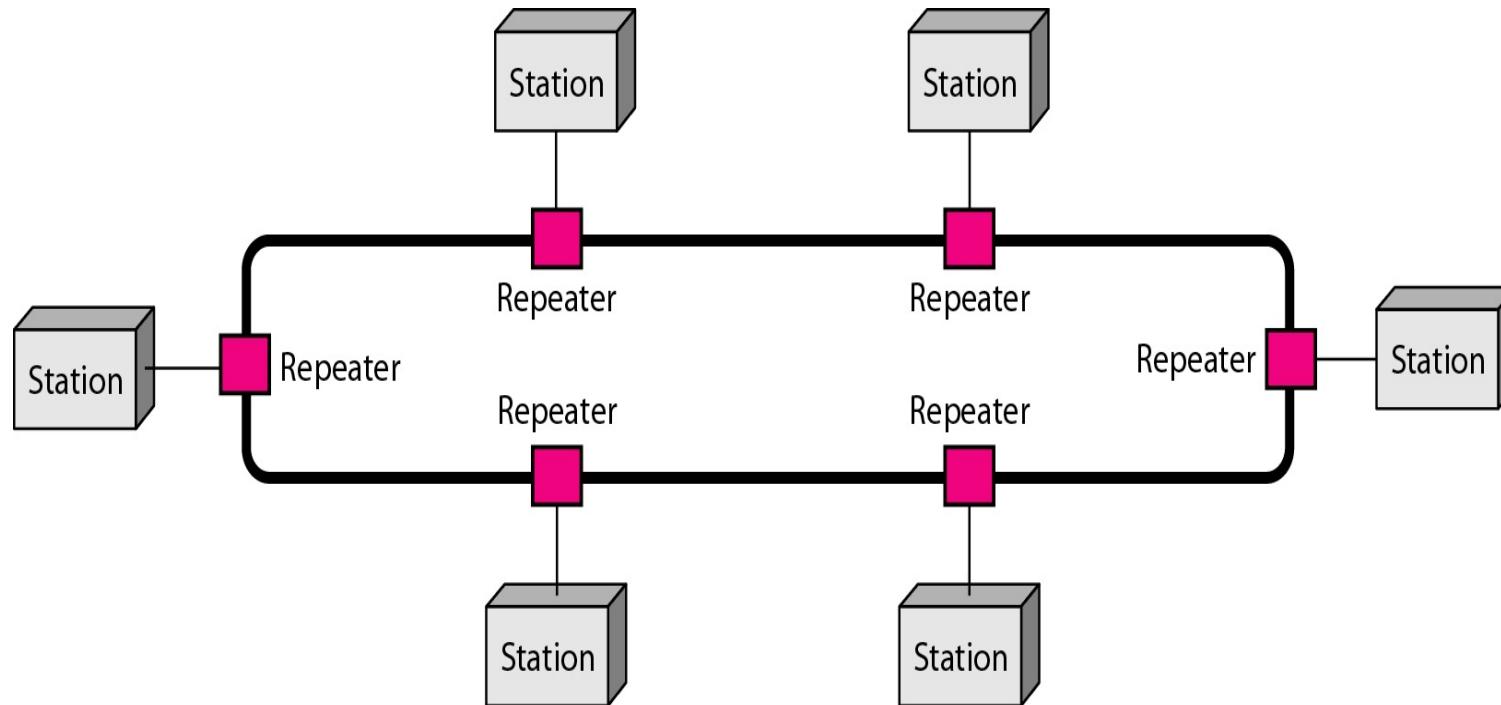
- Dependency of the whole topology on one single point, the hub

A bus topology connecting three stations



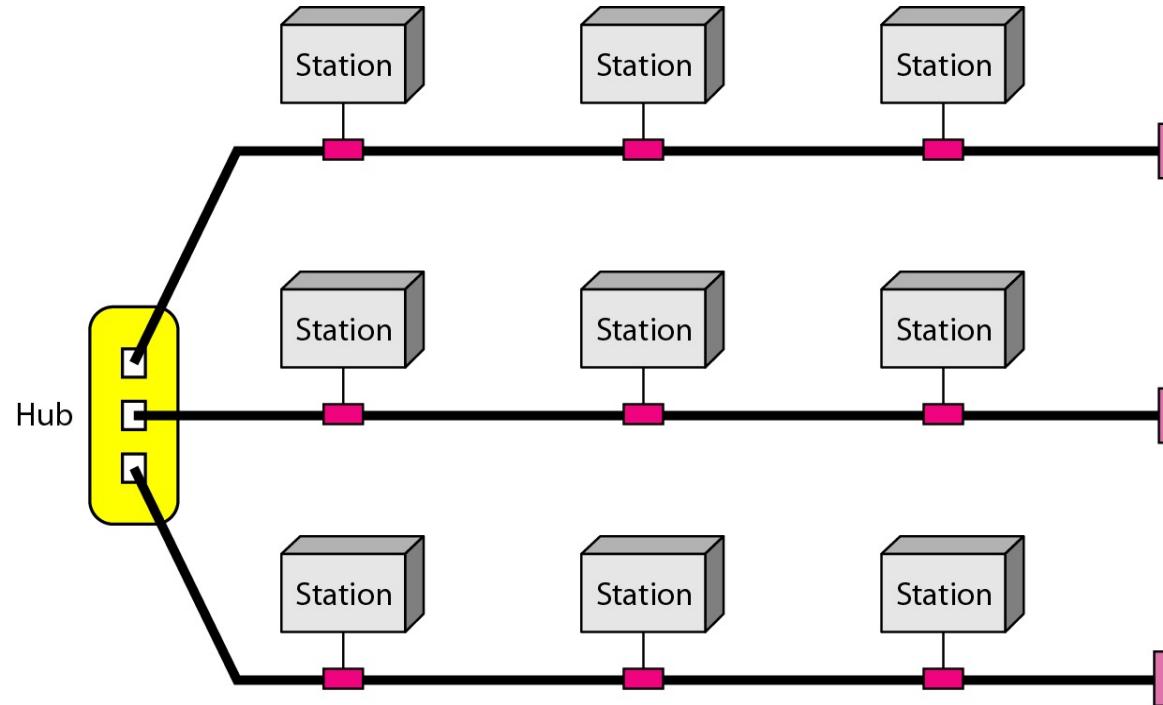
- Long cable acts as a backbone to connect all the devices in a network
- A tap is a connector that either splices into main cable or punctures the sheathing of a cable to create a connect with the metallic core.
- The travelled signal is weaker as it travels through the backbone.
 - So number of taps are limited
- **Advantages:**
 - Ease of installation
 - Less cabling than mesh or star
- **Disadvantages:**
 - Difficult reconnection and fault isolation
 - Addition of new device is difficult

A ring topology connecting six stations



- **Advantages:**
 - Easy to install and reconfigure
 - Each device is linked to only its immediate neighbors
 - Fault isolation is easy
- **Disadvantage:**
 - Media and traffic considerations (maximum ring length and number of devices)
 - A break in ring can disable the entire network

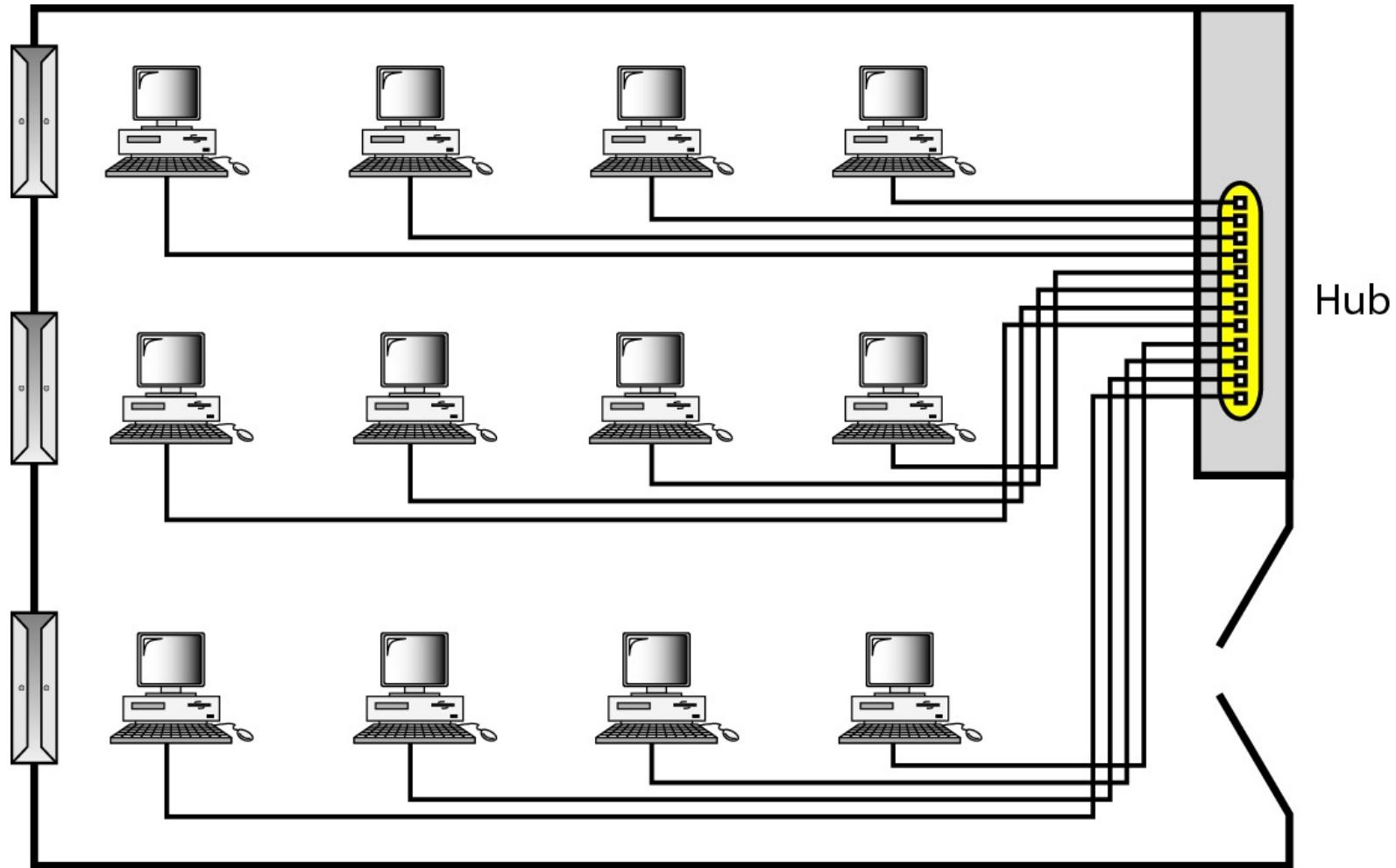
A hybrid topology: a star backbone with three bus networks



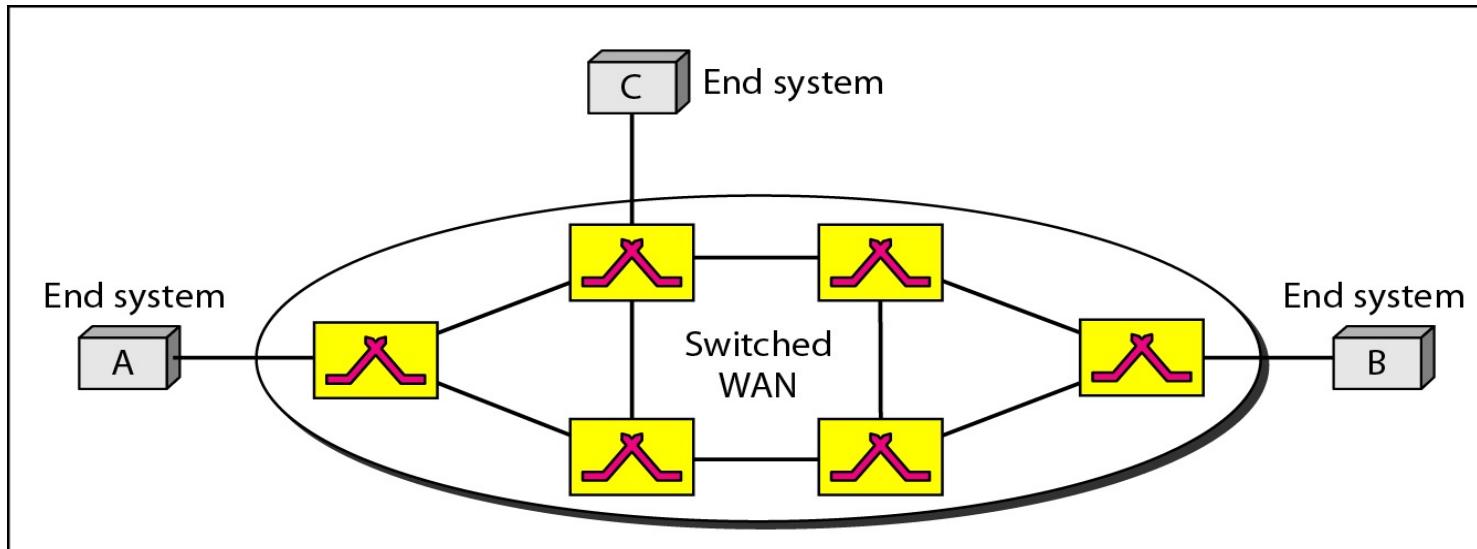
Categories of Networks

- **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

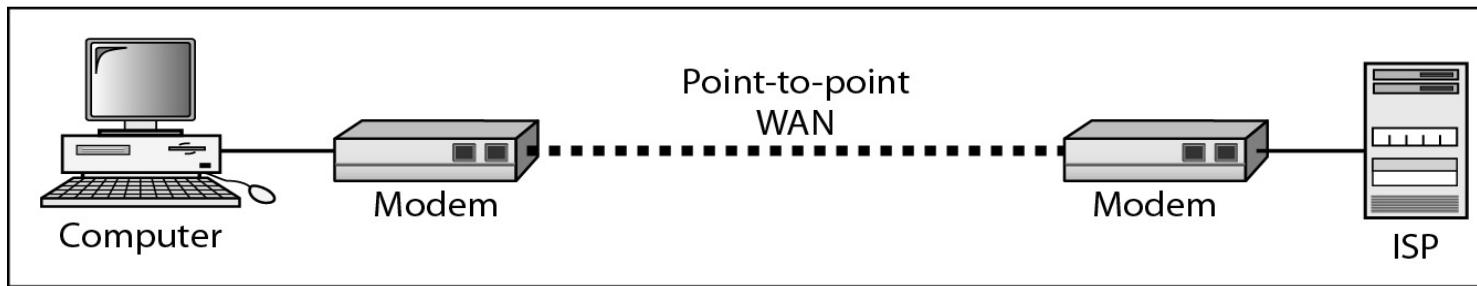
An isolated LAN connecting 12 computers to a hub in a closet



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

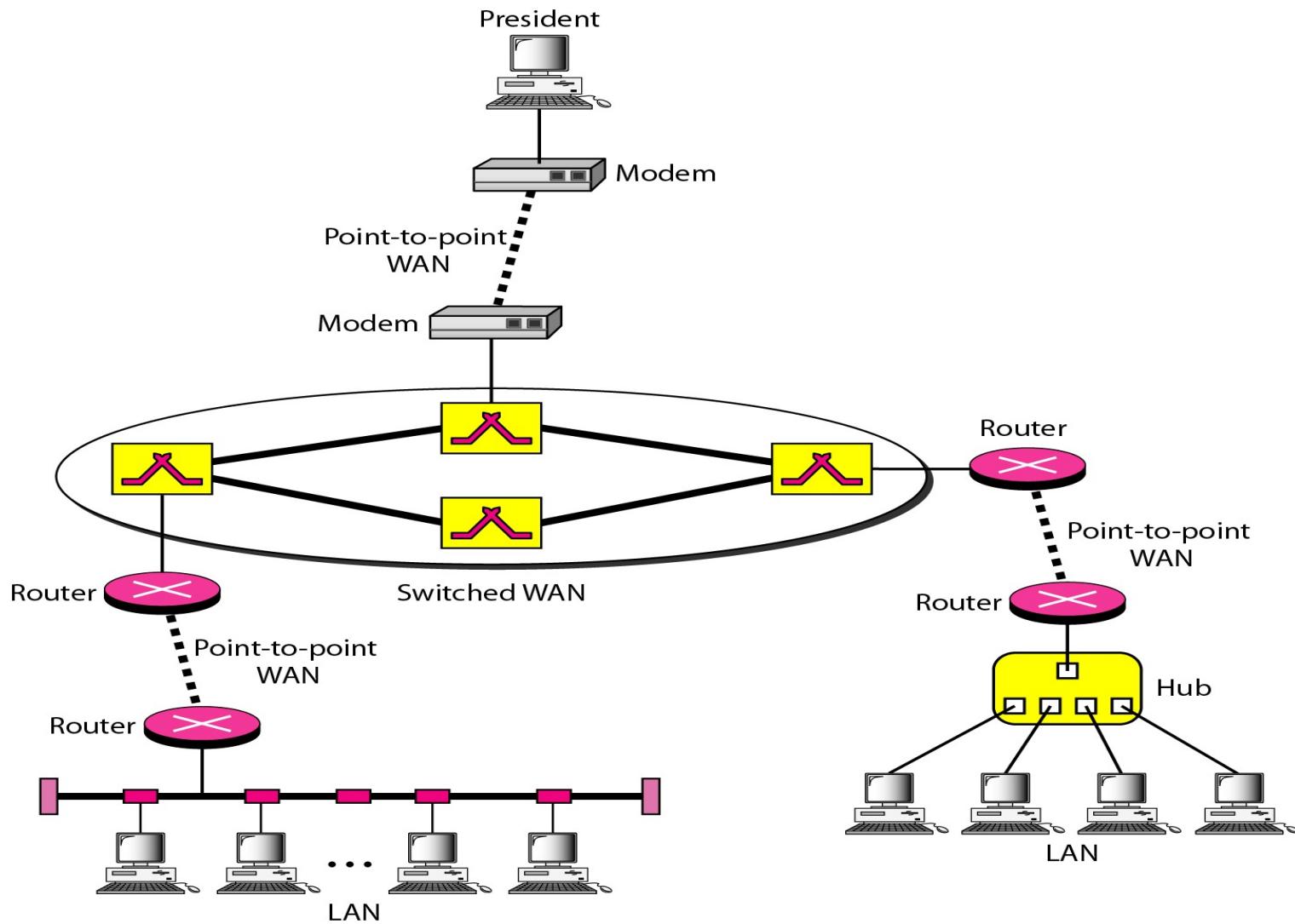


a. Switched WAN



b. Point-to-point WAN

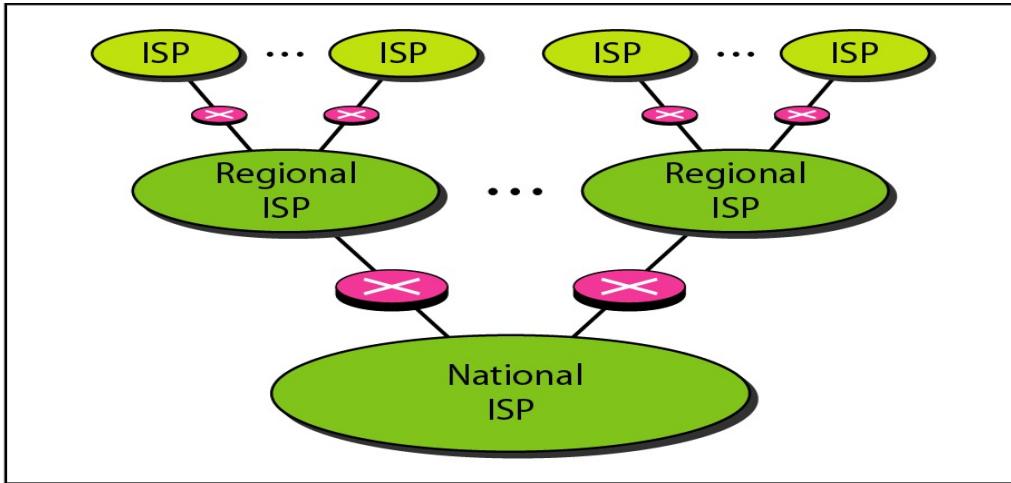
A heterogeneous network made of four WANs



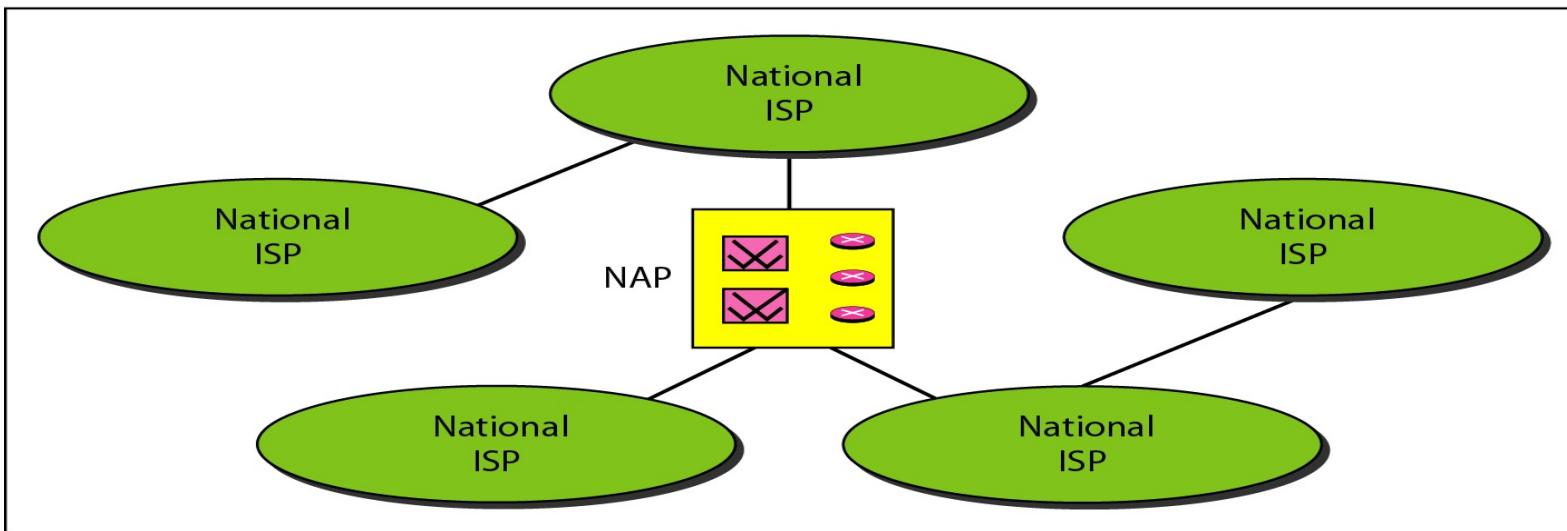
The Internet

- 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.

Hierarchical organization of the Internet



a. Structure of a national ISP



NAP: Network-Access-Point

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**
 - 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.