Computer Communication and Networks

Lecture 1

Overview

- **Data Communications**
  - Components of a data communications system
  - Data flow
- **Networks**
  - Physical structure (Types of connection, Topologies)
  - Categories of networks
- **Internet**
  - ISPs
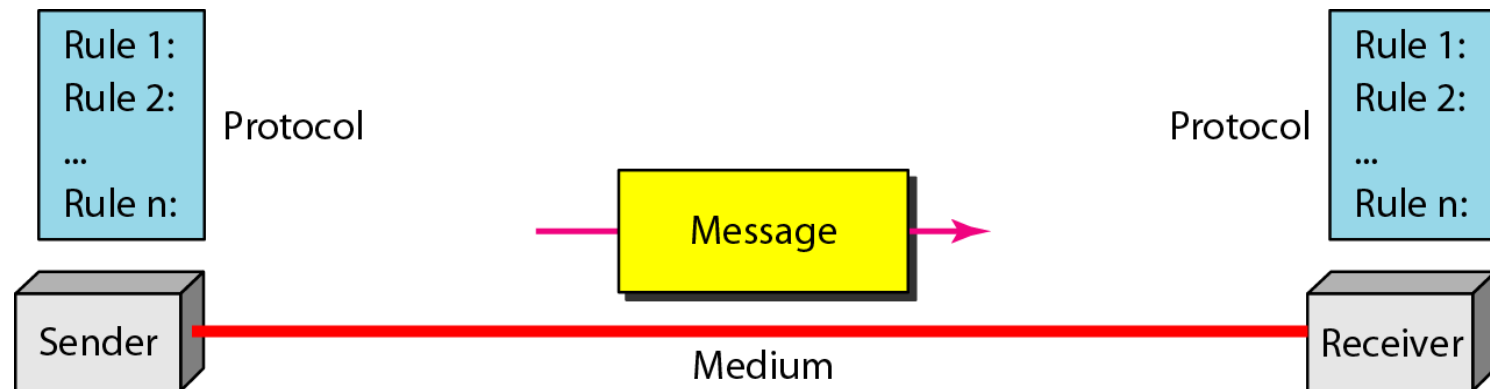- **Protocols**

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.*
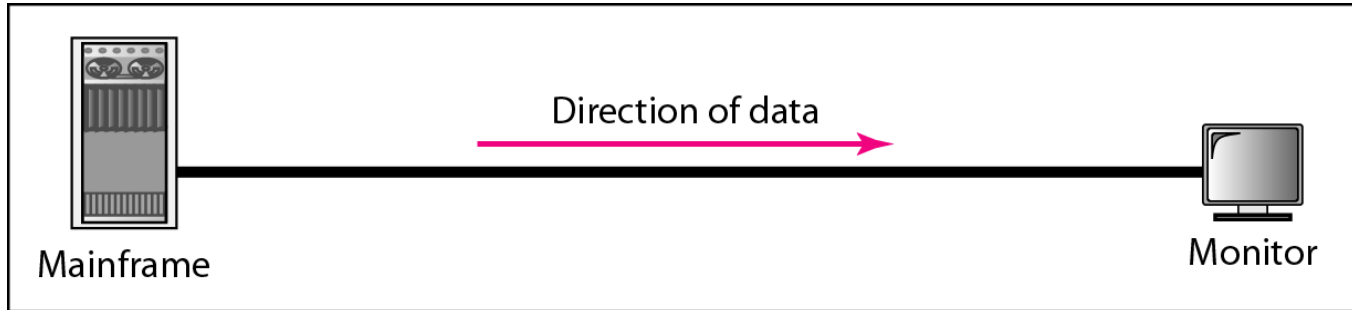
Further:

- **Components of a data communications system**
- **Data Flow**
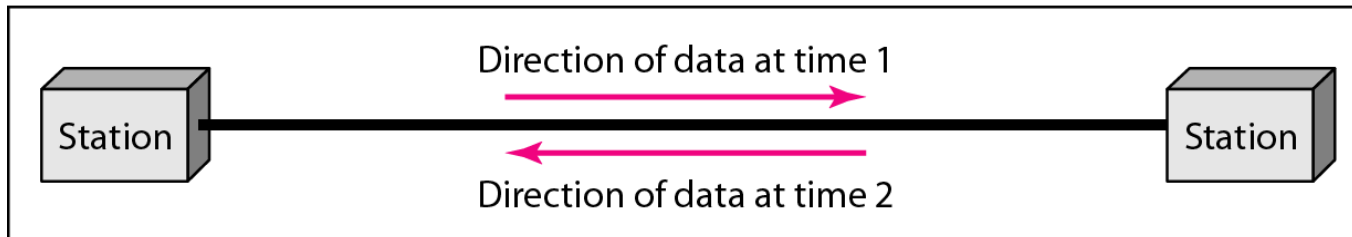
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Components of a data communication system

- **Message**: Information(data) to be communicated
- **Sender**
- **Receiver**
- **Transmission medium**: Physical path by which a message travels
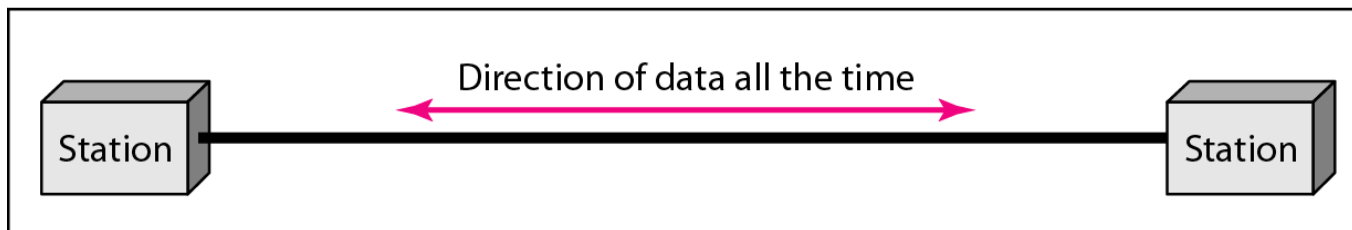- **Protocol**: A set of rules that govern data communication

Data flow

Direction of data

Mainframe

Monitor

a. Simplex

Direction of data at time 1

Station

Station

Direction of data at time 2

b. Half-duplex

Direction of data all the time

Station

Station

c. Full-duplex

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Data flow

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

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.

Further:

- **Network Criteria**
- **Physical Structures**
- **Categories of Networks**

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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
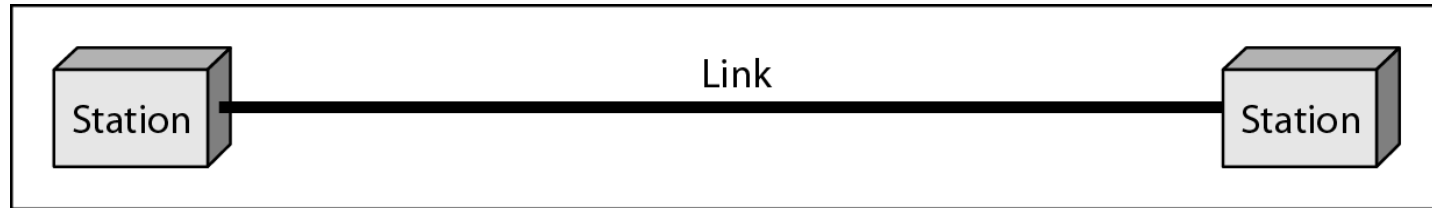
Physical Structures

- **Type of Connection**
  - **Point to Point** - single transmitter and receiver
  - **Multipoint** - multiple recipients of single transmission
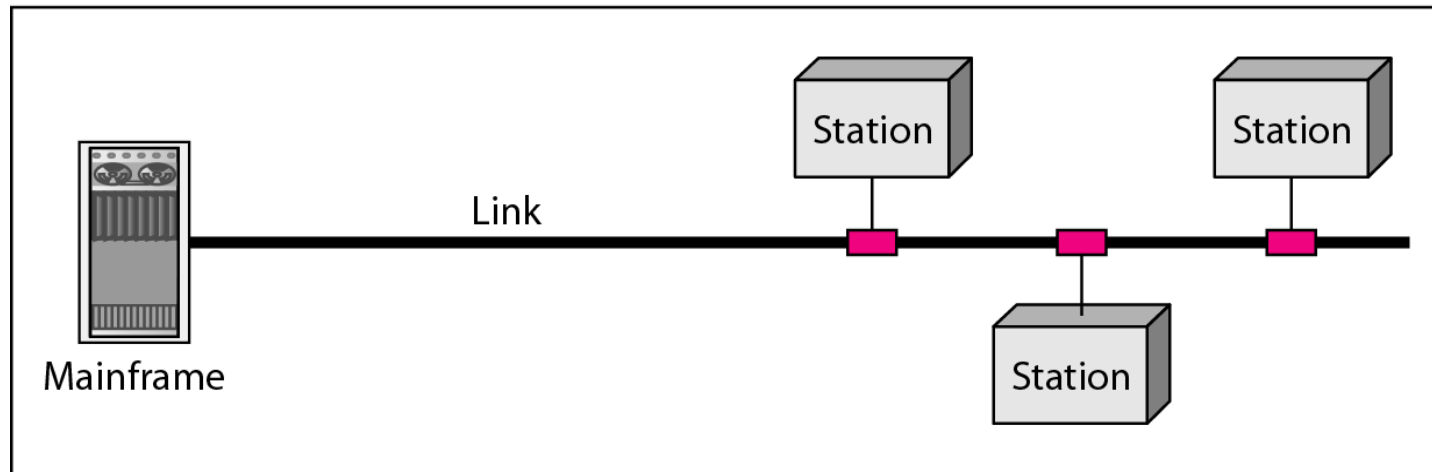
- **Physical Topology**
  - **Connection of devices**: Mesh, Star, Bus, Ring
  - **Type of transmission** - unicast, multicast, broadcast

Types of connections: point-to-point and multipoint

a. Point-to-point

b. Multipoint

# *Types of connections: point-to-point and multipoint*

- ## Point-to-point
  - Dedicated link between two devices
  - The entire capacity of the channel is reserved
  - Examples: Microwave link, TV remote control

- ## Multipoint
  - More than two devices share a single link
  - Capacity of the channel is either
    - **Spatially shared:** Devices can use the link simultaneously
    - **Timeshared:** Users take turns

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Categories of topology
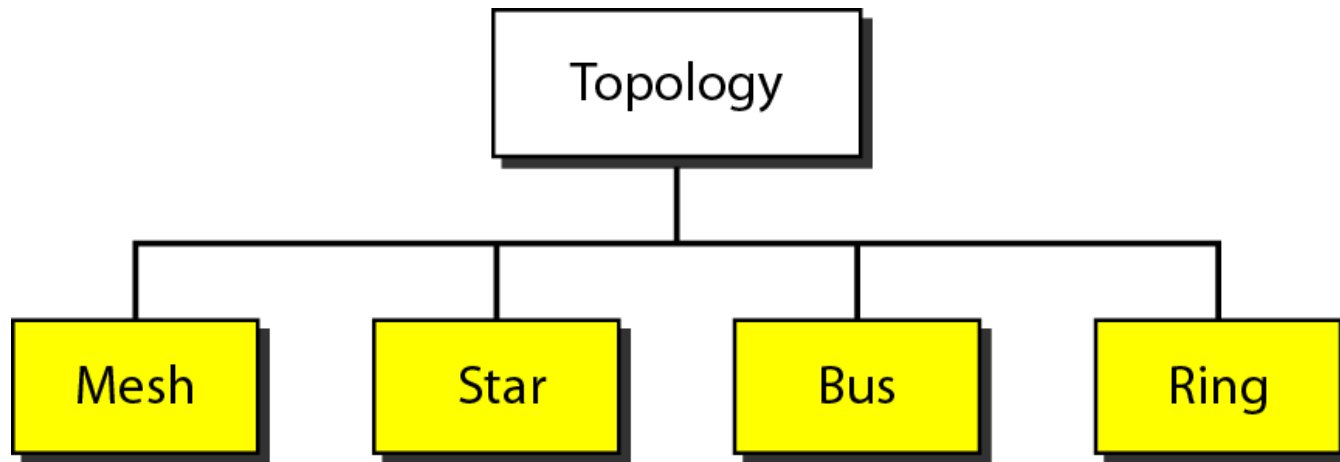
Mesh topology

- 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
- **Advantages**: No traffic problems, robust, security, easy fault identification & isolation
- **Disadvantages**: Difficult installation/reconfiguration, space, cost
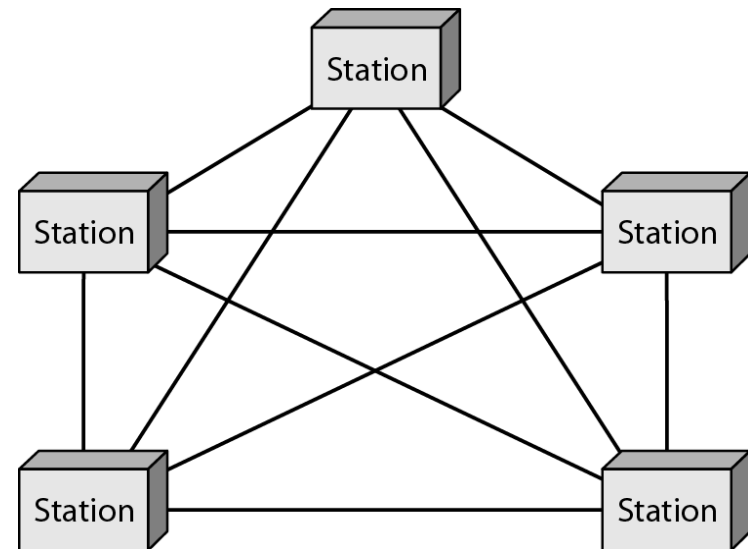
Star topology

- Dedicated point-to-point link *only to* a central controller, called a *hub*
- Hub acts as an exchange: No direct traffic between devices
- **Advantages**: Less expensive, robust
- **Disadvantages**: Dependency of the whole on one single point, the hub

Hub

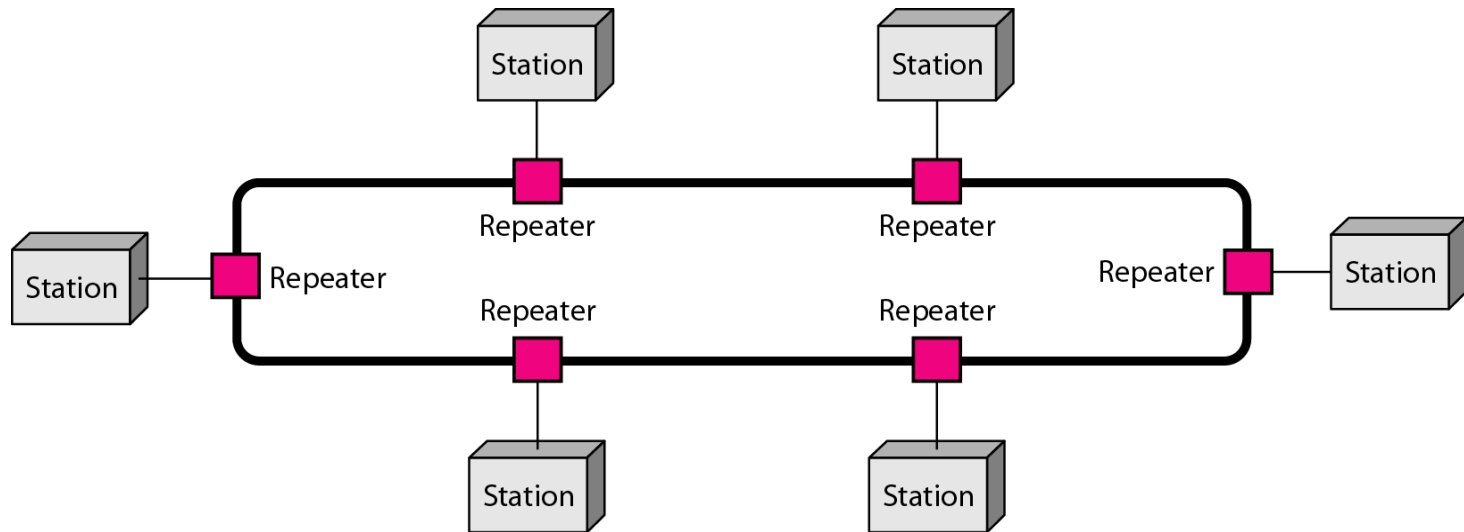Station   Station   Station   Station
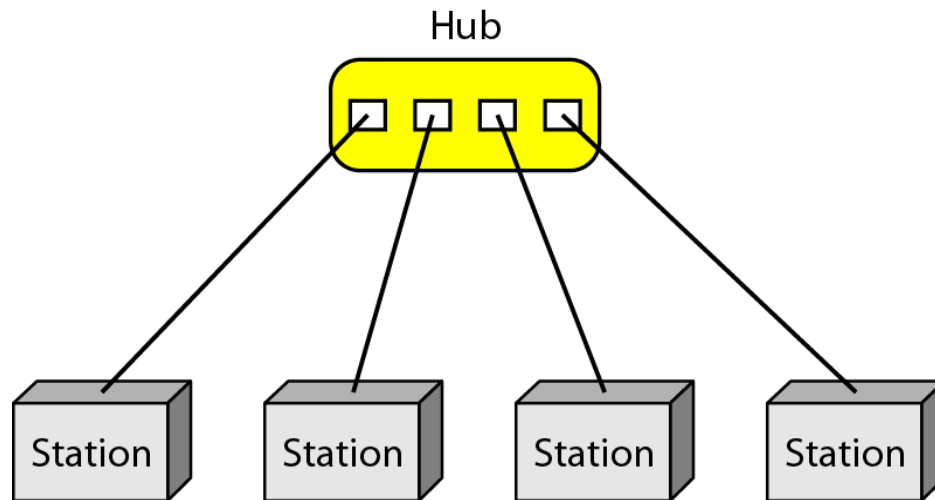
Bus topology

- 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
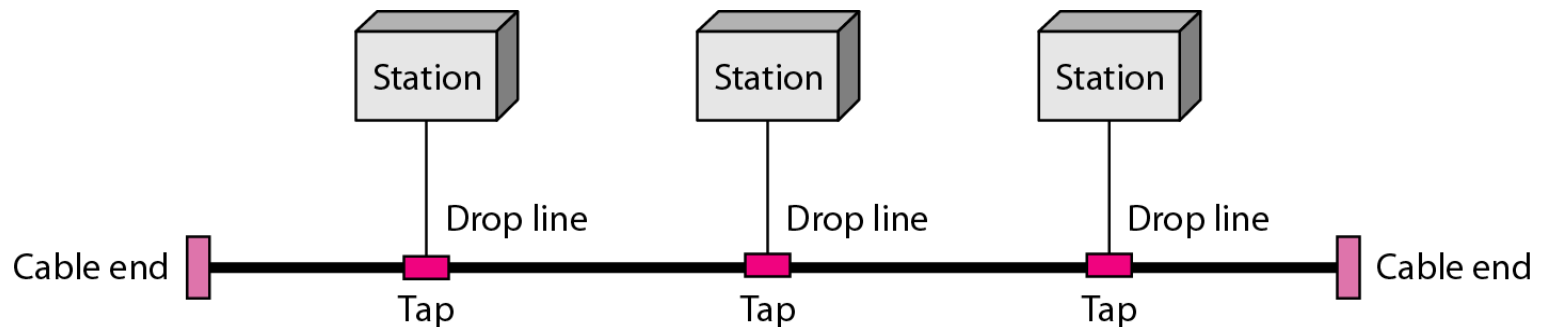
Ring topology

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

Hybrid topology: a star backbone with three bus networks

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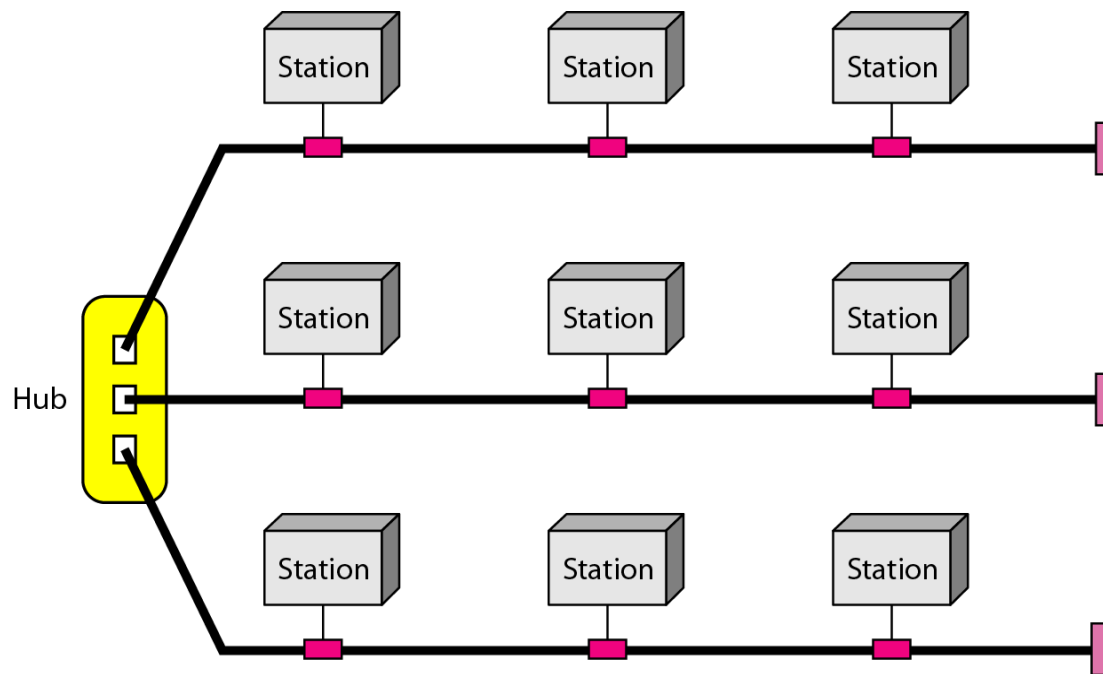
Categories of Networks

- **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

Local Area Networks

- Usually privately owned

- A network for a single office, building, or campus $\leq$ a few Km

- Common LAN topologies: bus, ring, star

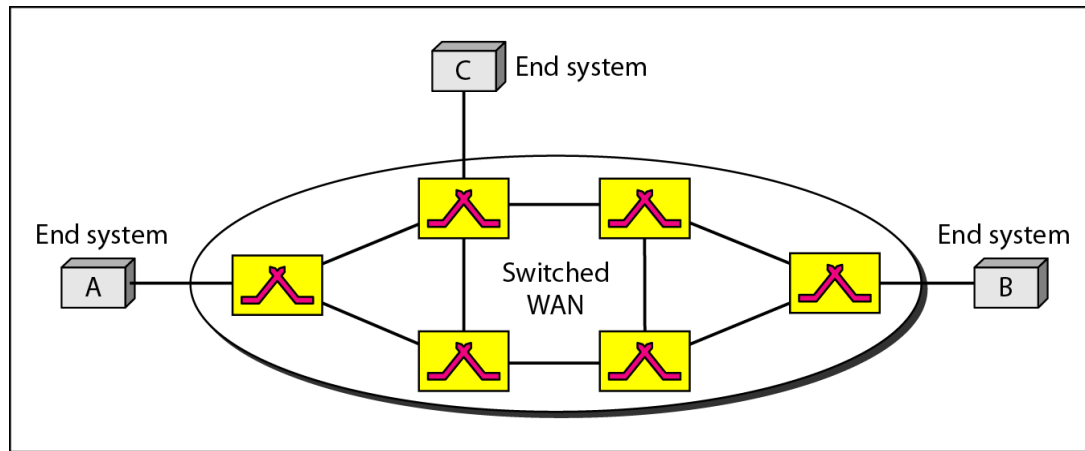- Example: An isolated LAN connecting 12 computers to a hub in a closet
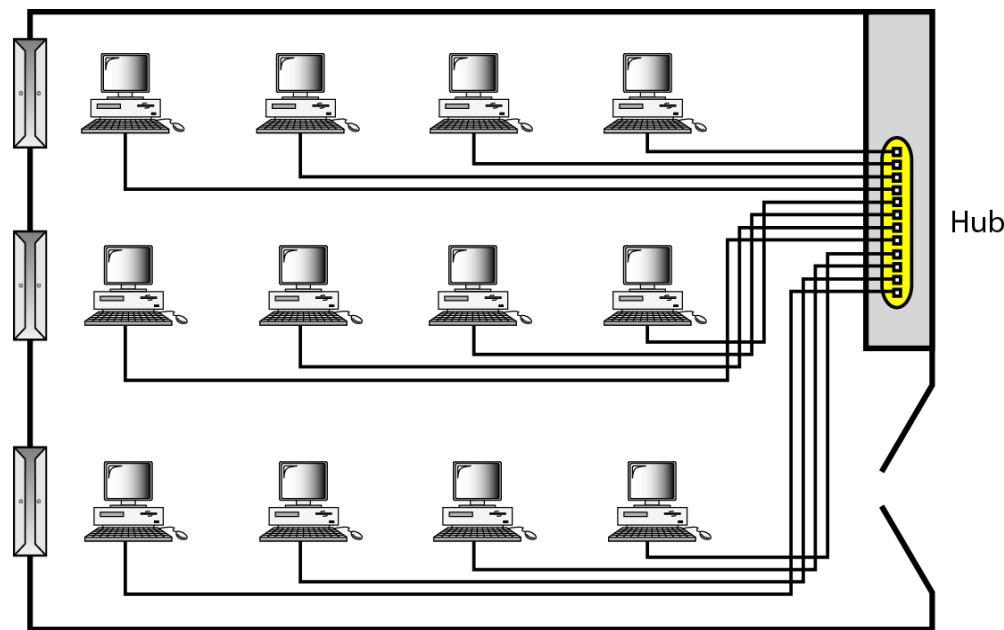
Metropolitan Area Networks

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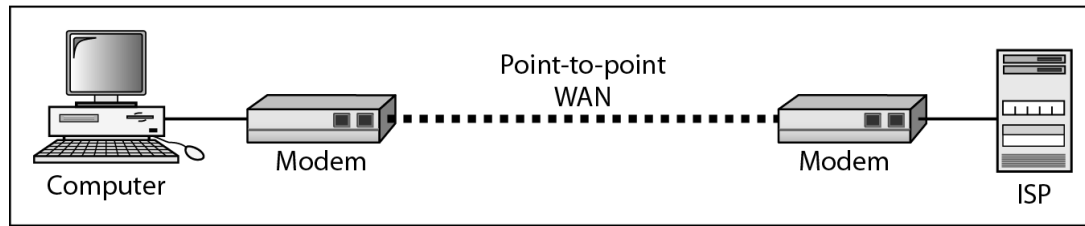

Public city network
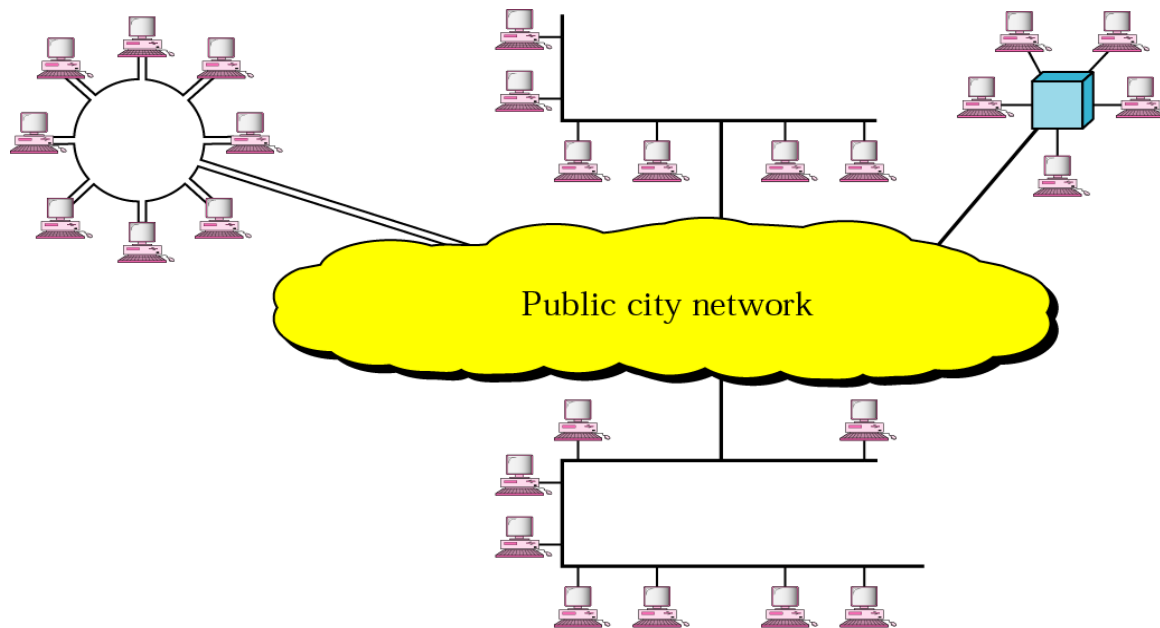
Wide Area Networks

- Long distance transmission, e.g., a country, a continent, the world
- Enterprise network: A WAN that is owned and used by one company

C End system

End system

A

End system

B

Switched
WAN

a. Switched WAN

Computer

Modem

Point-to-point
WAN

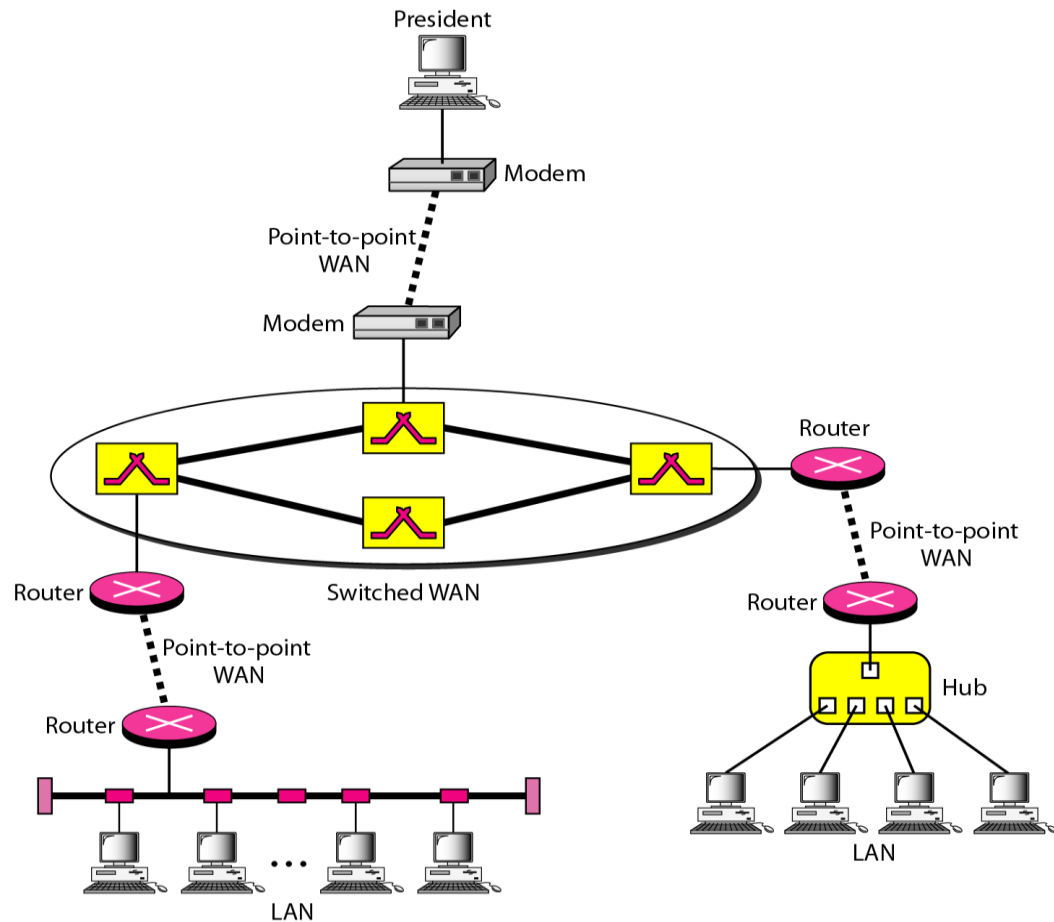Modem

ISP

b. Point-to-point WAN

Internetwork

- **Internetwork (internet)** : two or more networks are connected by internetworking devices
- **Internetworking devices**: router, gateway, etc.
- **The Internet**: a specific worldwide network
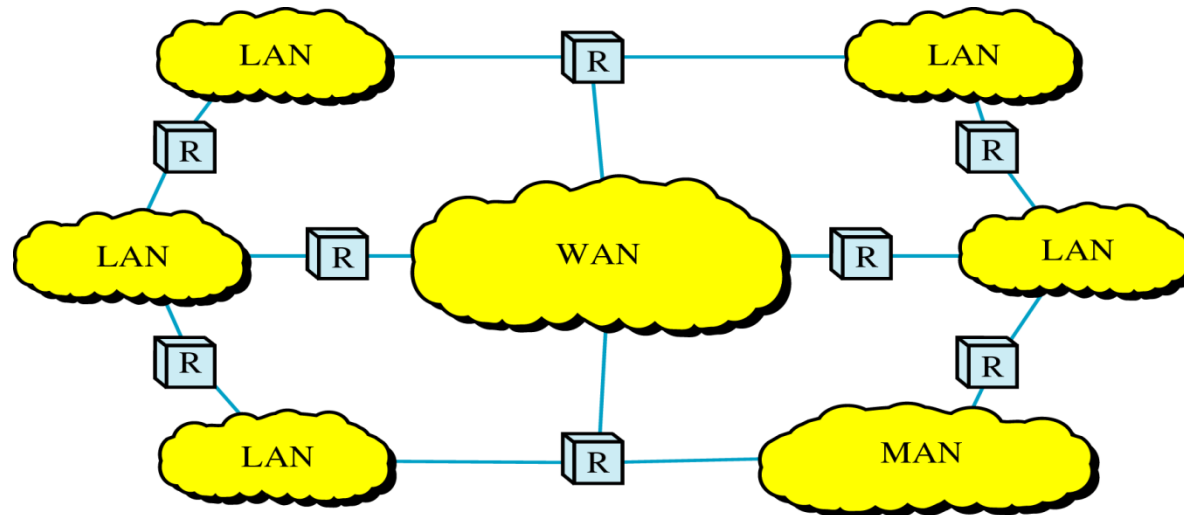
Internetwork example

- A heterogeneous network : four WANs and two LANs

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.*

1967: ARPANET proposed by DoD's ARPA(Advanced Research Project Agency)
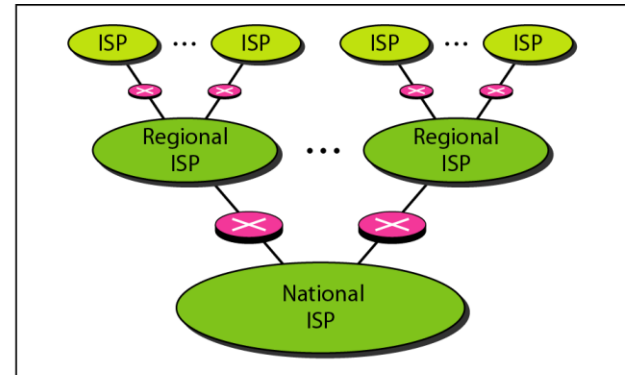**1969: ARPANET in a reality: UCLA, UCSB, SRI, Uni. of Utah**
1973: Vint Cerf and Bob Kahn propose TCP
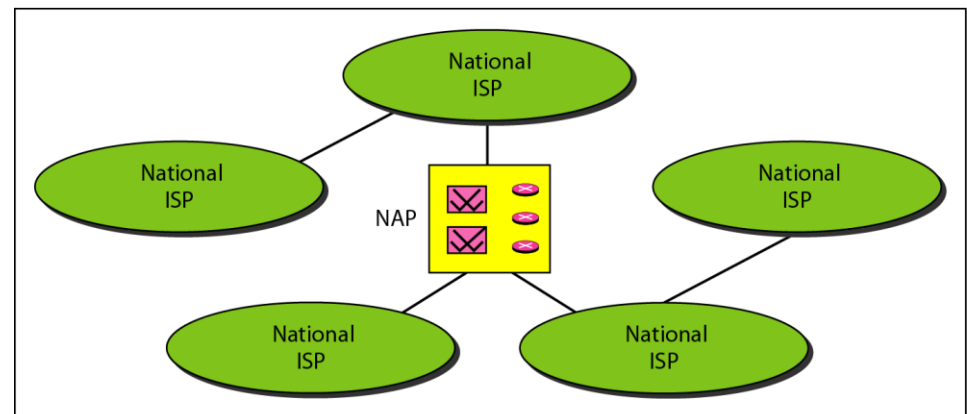**and …………**

Further:

- **Organization of Internet**
- **Internet Service Providers (ISPs)**

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Hierarchical organization of the Internet

- ISP (Internet service providers)
- NISP (national ISP)
- NAP (network access point)

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.

Further:

- **Elements of a protocol**

Elements of a Protocol

- **Syntax**
  - Structure or format of the data
  - Indicates how to read the bits

- **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

References

❑ Chapter 1,

"Data Communications and Networking" by
Behrouz A. Forouzan, Fifth Edition

Recap

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  - ISPs
- **Protocols**

Questions and Discussion