Course Code: CSE 233
Course Title:
Data Communication

Course Instructor

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Recommended book

Text Book:

- Data Communications and Networking

  Behrouz A. Forouzan,

  4th EditionMcGraw-Hill

Reference Books:

- Data and Computer Communications (8th Edition), William Stallings.

- Computer Networks (5th Edition), Andrew S. Tanenbaum.

Syllabus

Chapter 1 Introduction

Chapter 2 Network Models

Chapter 3 Data and Signals

Chapter 4 Digital Transmission

Chapter 5 Analog Transmission

Chapter 6 Multiplexing

Chapter 7 Transmission Media

Chapter 10 Error Handling

Chapter 1. Introduction

1. Data communications
2. Networks
3. The Internet
4. Protocols and standards

Data Communications

- Data
  - Information presented in whatever form is agreed upon by the parties creating and using the data
- Data communication
  - Exchange of data between two devices
  - Via some form of transmission medium
- Fundamental characteristics of data communication
  - Delivery
  - Accuracy
  - Timeliness
  - Jitter : Variation in the packet arrival time

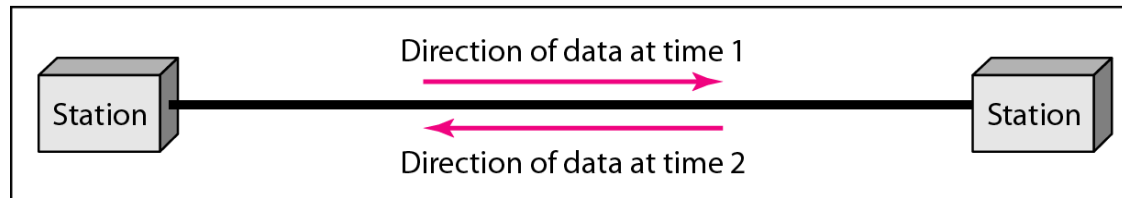# Five Components of Data Communication

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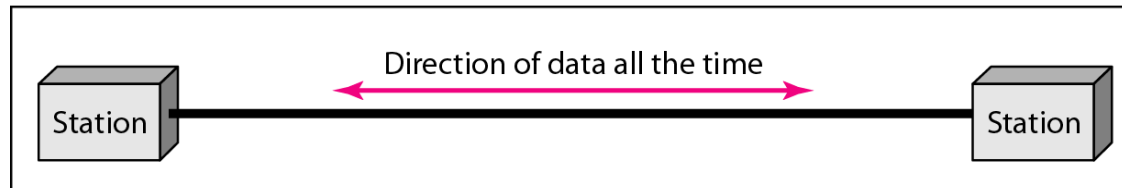- Protocol: A set of rules that govern data communication
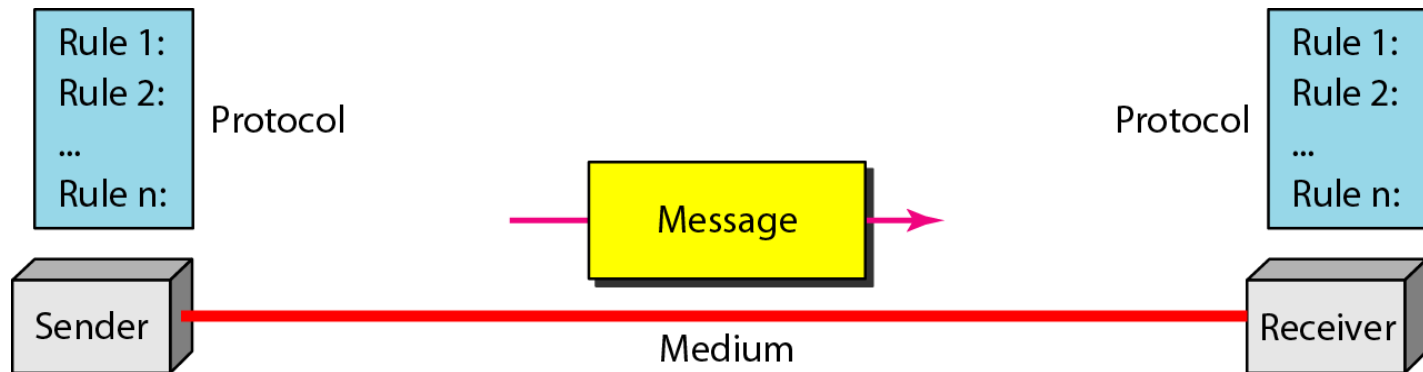
Direction of Data Flow
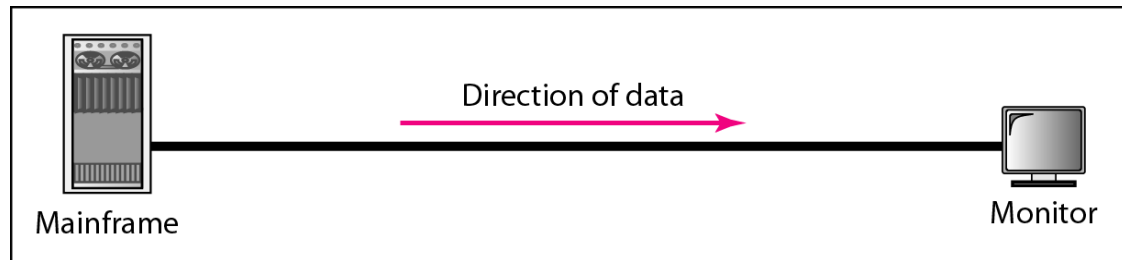
a. Simplex
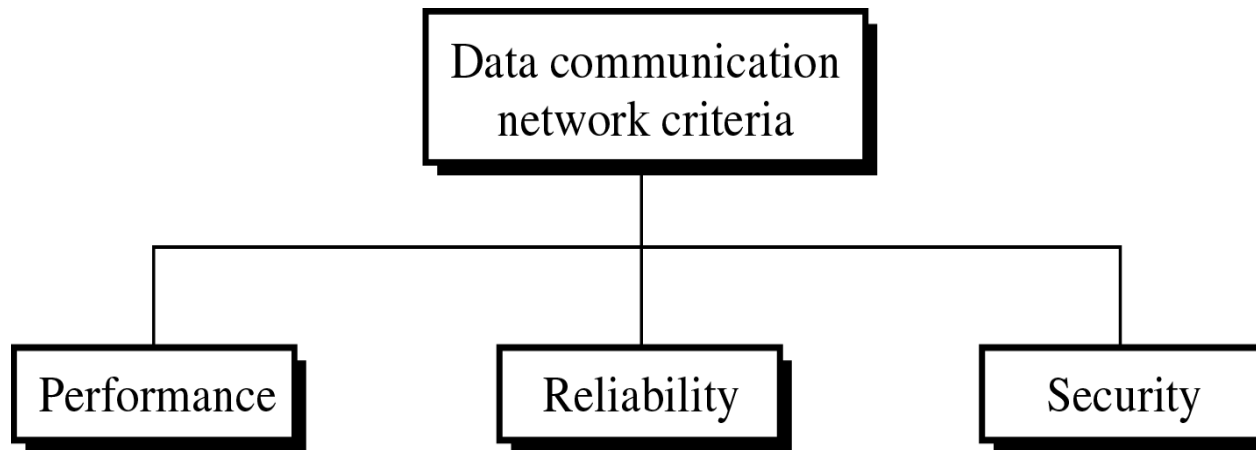

b. Half-duplex

c. Full-duplex

Data Flow

- Simplex
  - Unidirectional
  - As on a one-way street
- Half-duplex
  - Both 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
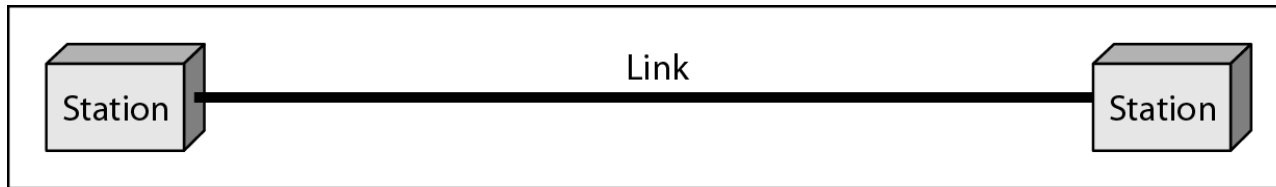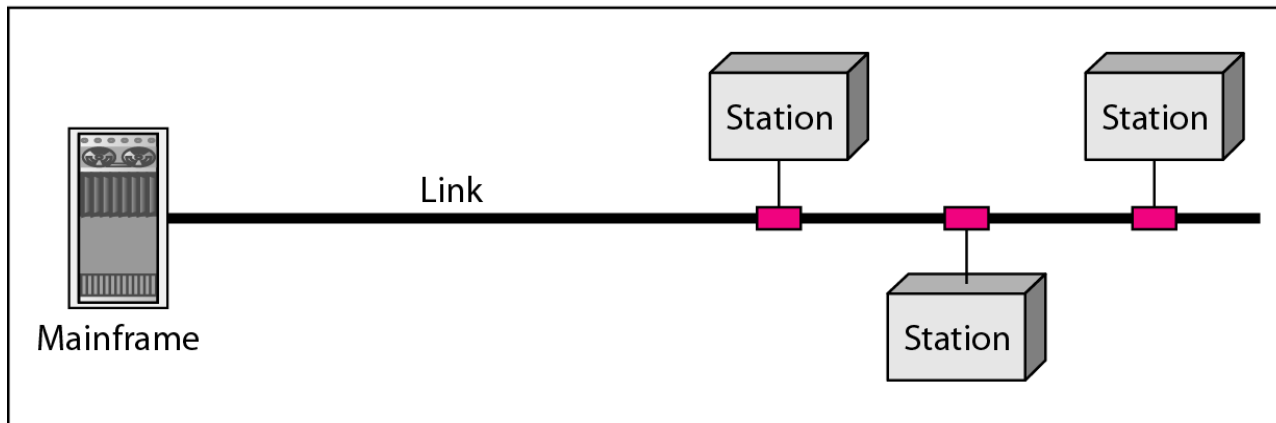 - Channel capacity must be divided between two directions

Network

- Network: A set of devices (nodes) connected by communication links
- Node: Computer, printer, or any device capable of sending and/or receiving data
- To be considered effective and efficient, a network must meet a number of criteria

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        ┌─────────────────────┐
        │  Data communication │
        │  network criteria   │
        └─────────────────────┘
                   │
      ┌────────────┼────────────┐
      │            │            │
┌───────────┐ ┌───────────┐ ┌──────────┐
│Performance│ │Reliability│ │ Security │
└───────────┘ └───────────┘ └──────────┘
```

# Type of Connection

a. Point-to-point

b. Multipoint

Type of Connection

- Point-to-point
  - Dedicated link between two devices
  - The entire capacity of the channel is reserved
  - Ex) 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
    - *Timeshare*: Users take turns
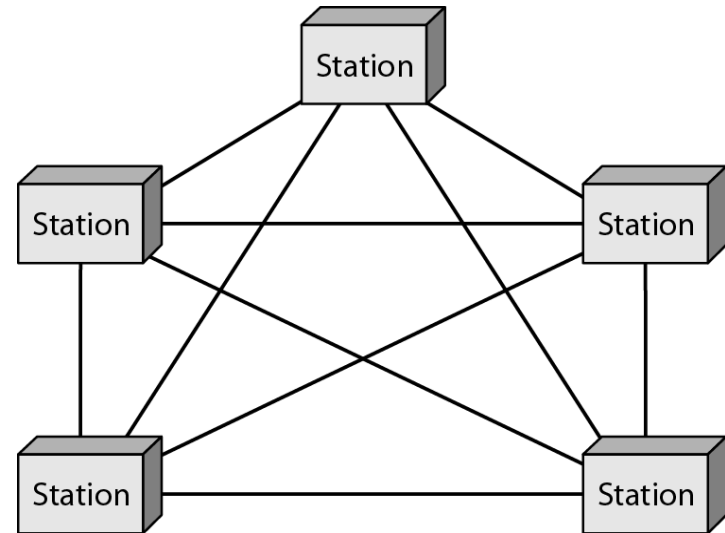
Physical Topology
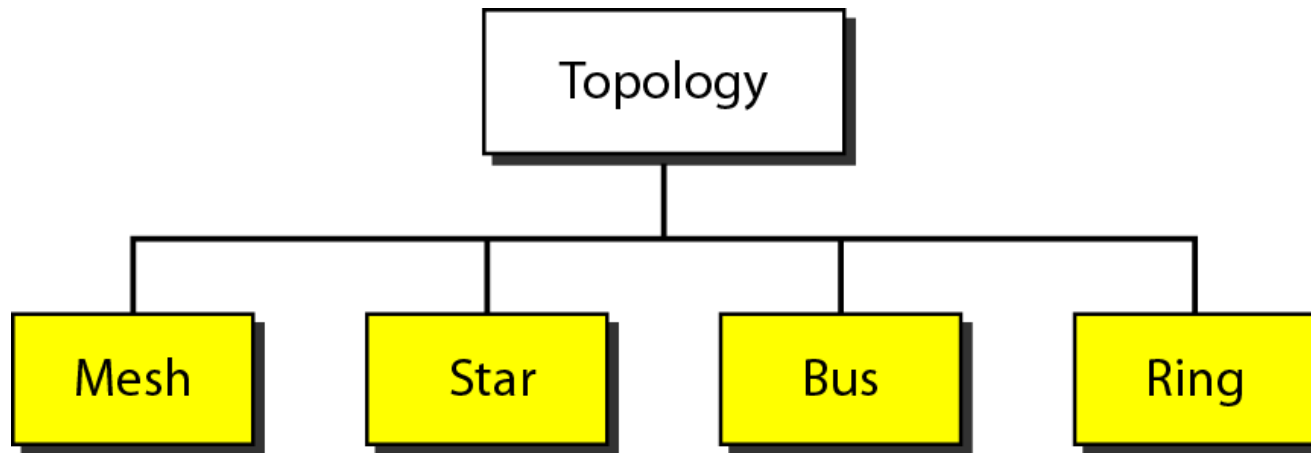
Mesh Topology

- 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 (links)

- 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

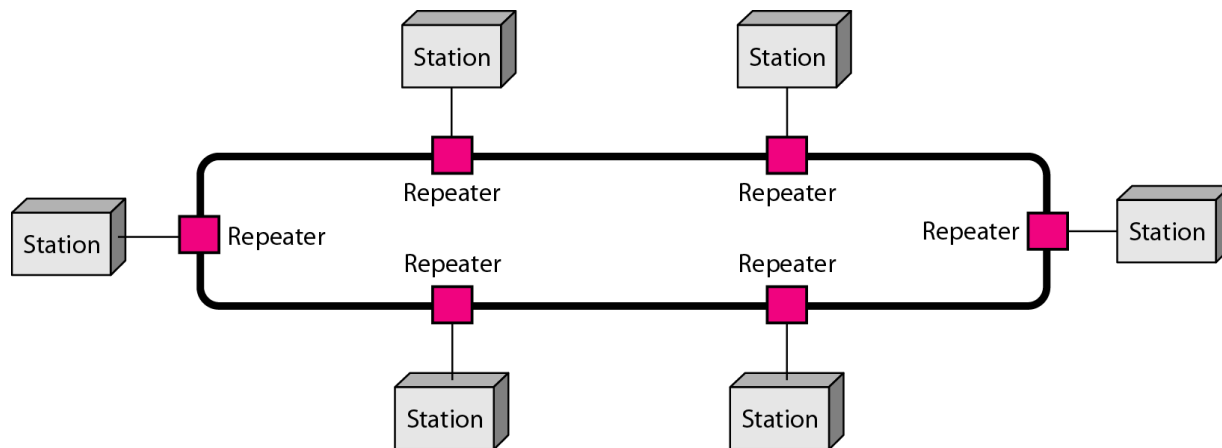Station   Station   Station   Station
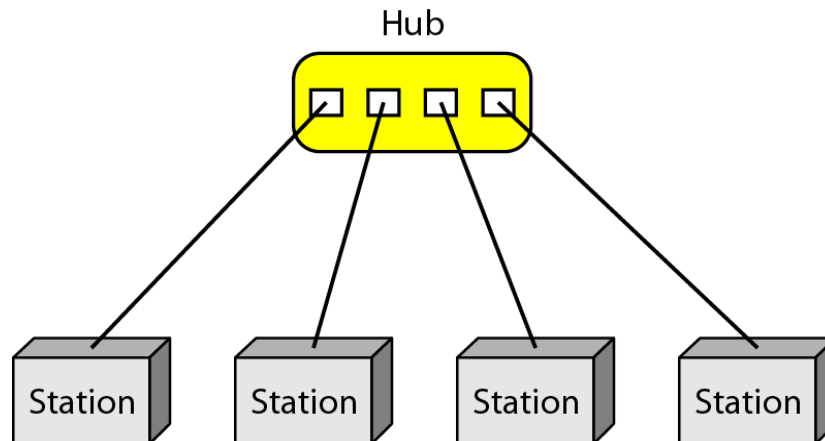
Bus Topology

- One long cable that links all nodes
- tap, drop line, cable end
- limit on the # 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
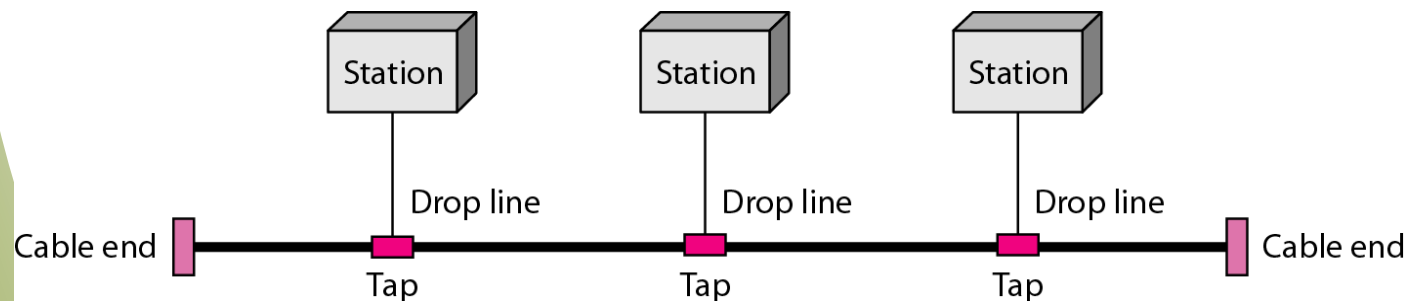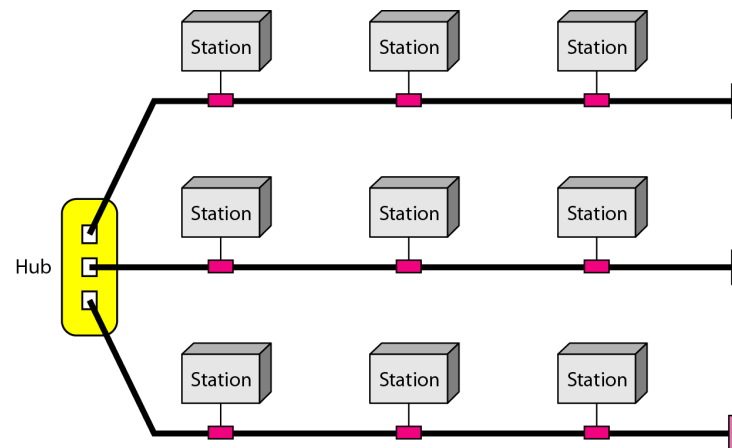
Ring Topology

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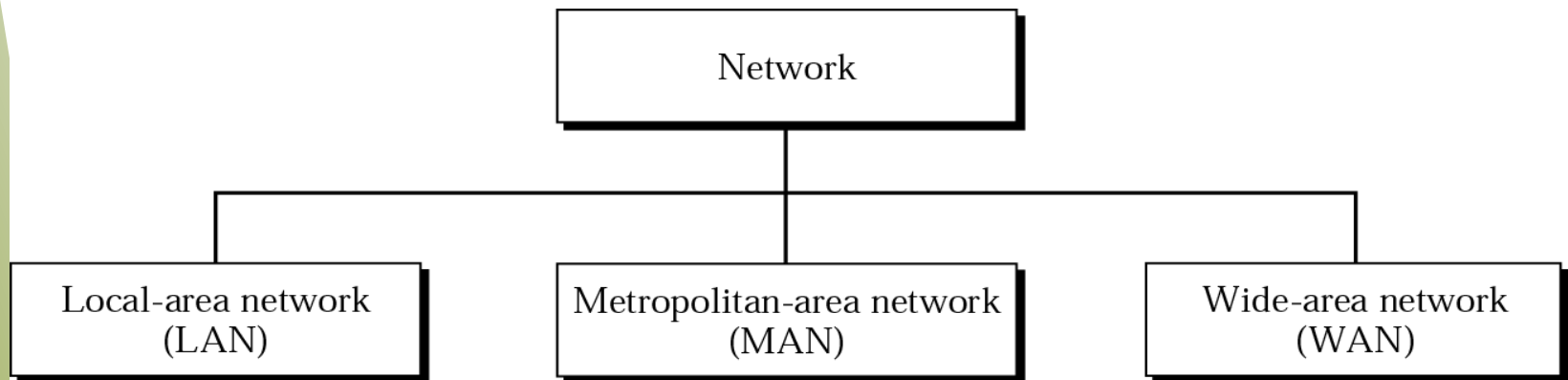- Disadvantage: Unidirectional traffic, a break in the ring cab disable the entire network

Hybrid Topology

- Example: Main star topology with each branch connecting several stations in a bus topology

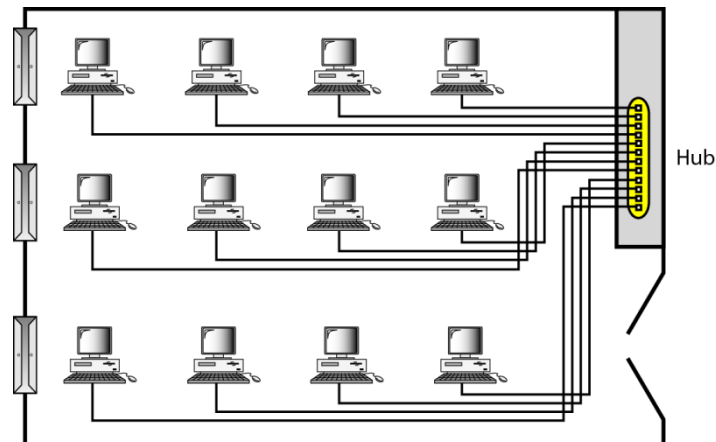- To share the advantages from various topologies

Categories of Networks

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                        ┌──────────────────┐
                        │     Network      │
                        └──────────────────┘
                                 │
        ┌────────────────────────┼────────────────────────┐
        │                        │                        │
┌────────────────┐    ┌──────────────────────┐    ┌─────────────────┐
│ Local-area     │    │ Metropolitan-area    │    │ Wide-area       │
│ network        │    │ network              │    │ network         │
│ (LAN)          │    │ (MAN)                │    │ (WAN)           │
└────────────────┘    └──────────────────────┘    └─────────────────┘
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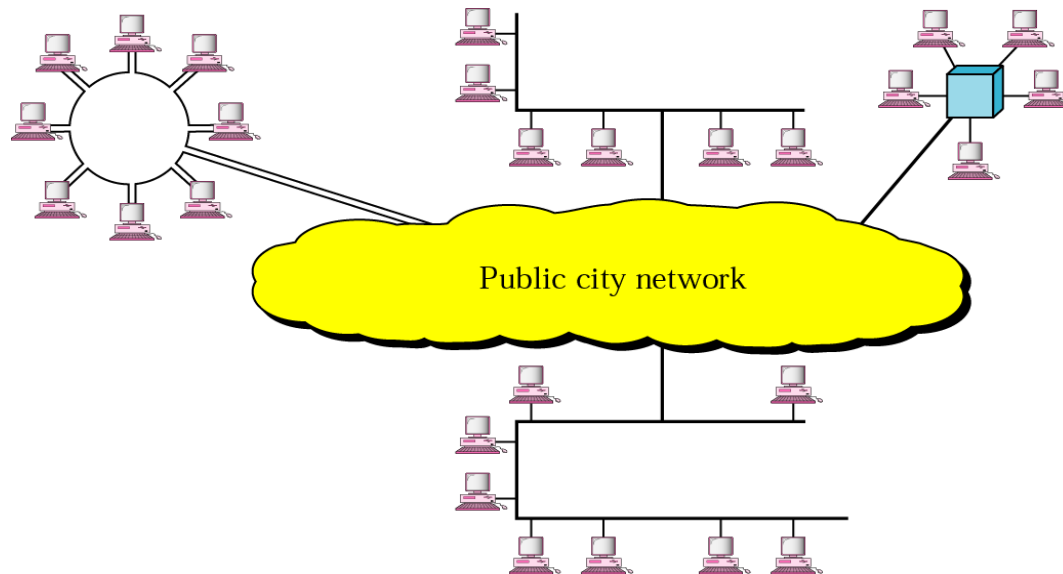
LAN

- Usually privately owned
- A network for a single office, building, or campus $\leq$ a few Km
- Common LAN topologies: bus, ring, star
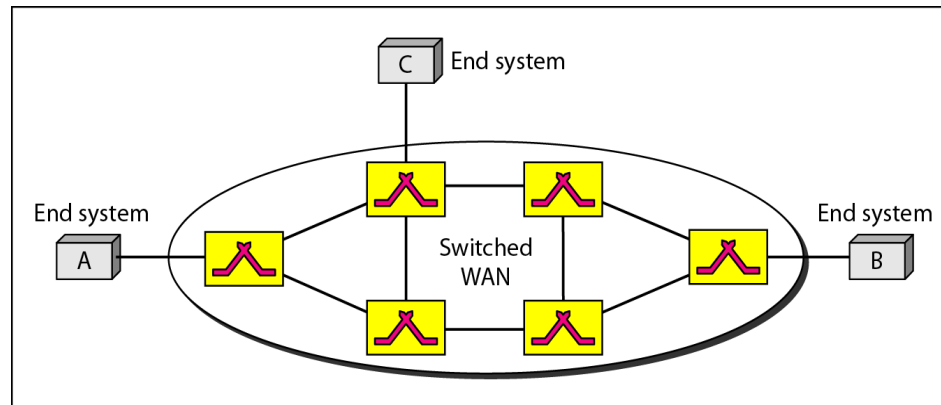- An isolated LAN connecting 12 computers to a hub in a closet

MAN

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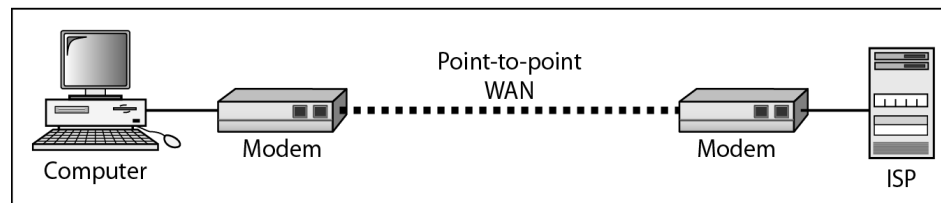- Owned by a private or a public company

WAN

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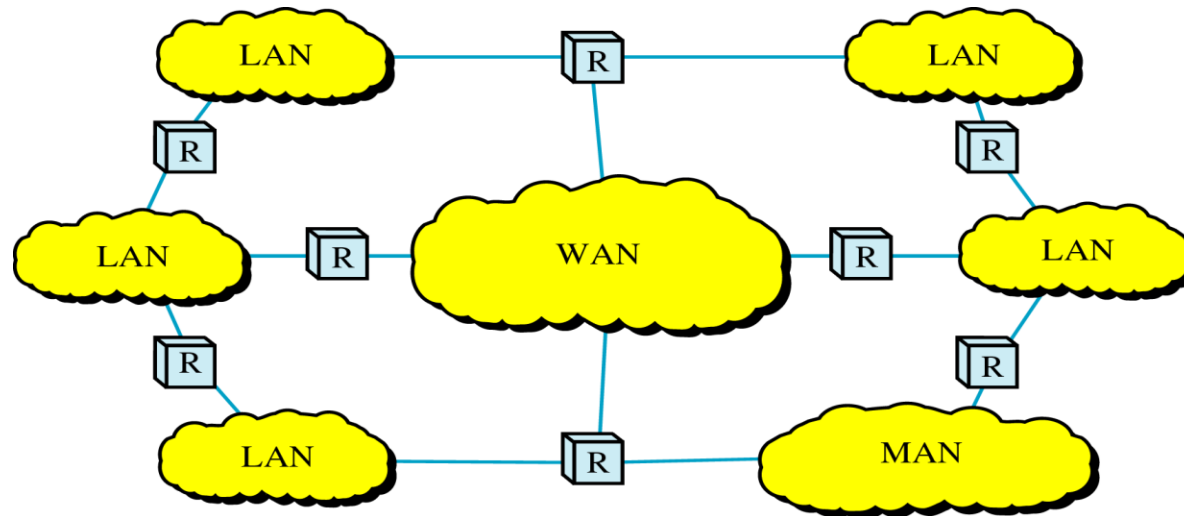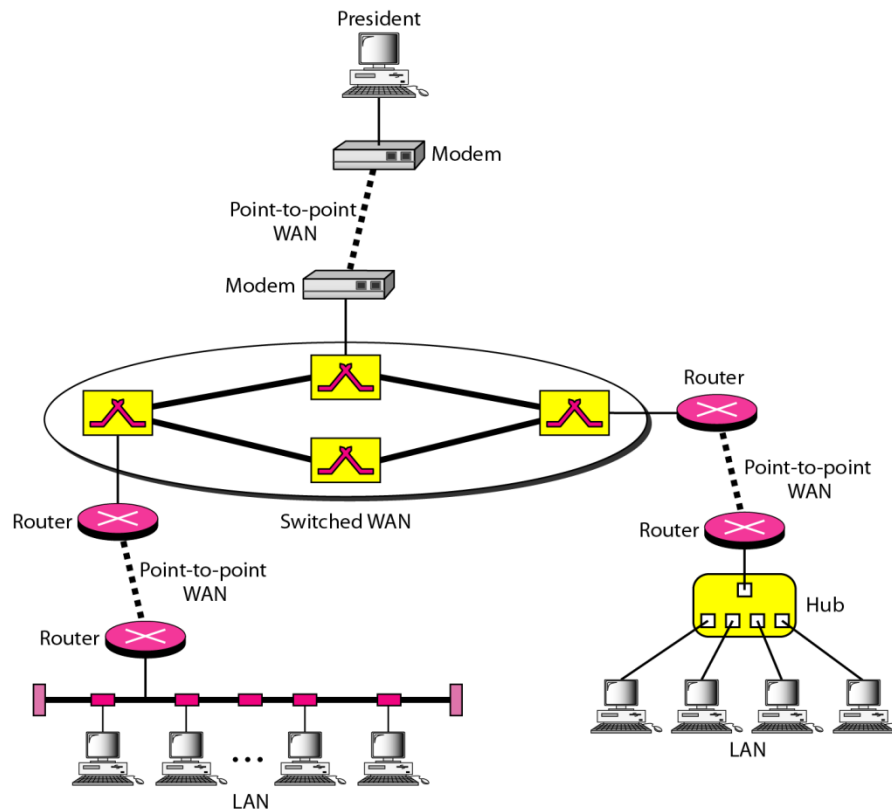

a. Switched WAN

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, U. of Utah

- 1973: Vint Cerf and Bob Kahn propose TCP,

- To split TCP into two protocols TCP and IP

Internet Today

- ISP (Internet service providers)
- NISP (national ISP)
- NAP (network access point)
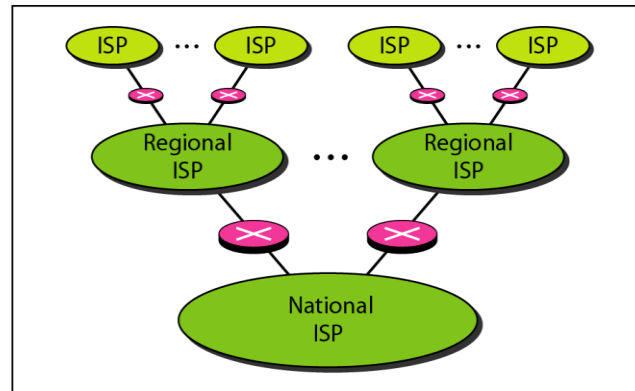
a. Structure of a national ISP
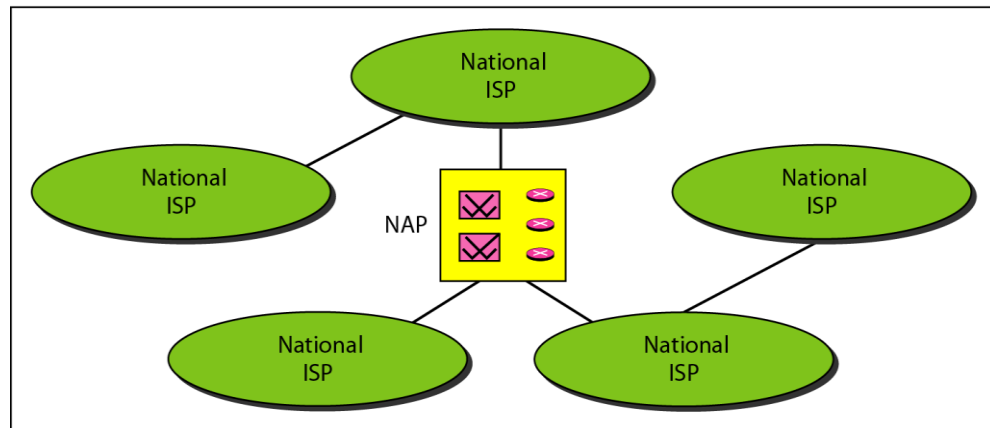
b. Interconnection of national ISPs

Protocols

- Protocol : rule
  - A set of rules that govern data communication
  - For communication to occur, entities must agree upon a protocol
- Key elements of a protocol
  - Syntax: structure or format of data
  - Semantics: meaning of each section in the structure
  - Timing: *when* and *how fast* data should be sent

Standards: agreed-upon rules

- Standards is essential in
  - Creating/maintaining open and competitive markets
  - Guaranteeing national/international interoperability
- Two categories
  - De jure ("by law" or "by regulation') standards
  - De facto ("by fact" or 'by convention') standards
    - Proprietary standards: closed standards
    - Nonproprietary standards: open standards

Standards Organizations

- Standards are developed by
  - Standards creation committees
  - Forums
  - Regulatory agencies
- Standards committees & forums
  - Standards committees are slow moving
  - Forums are made up of interested corporations
  - Forum are able to speed acceptance of a particular technology

Standards Committees

- ISO
  - Voluntary international organization
- ITU-T
  - Formerly, CCITT formed by UN
- ANSI
  - Private non-profit corporation in the US
- IEEE
  - The largest engineering society in the world
- EIA
  - Non-profit organization in the US

Internet Standards

- IETF (Internet Engineering Task Force)

- Internet Draft
  - working document with no official status
  - with a 6-month lifetime

- RFC (Request for Comment)
  - Edited, assigned a number, and made available to all interested parties

Assignments

❖ Problems – 15, 16, 17, 19, 20, 22, 23, 24, 25, 28, 29