

# Data Communications

## Chapter 1: Introduction

---

NARZU TARANNUM (NTR)  
DEPT. OF CSE, BRAC UNIVERSITY

# Information of Course Teachers

---

Narzu Tarannum (NTR)  
 [<narzu.tarannum@bracu.ac.bd](mailto:narzu.tarannum@bracu.ac.bd)  
UB80609

# Recommended Text book

- 
1. Data Communications and Networking, 5th edition – By Behrouz A. Forouzan, ISBN 10: 1259064751 McGraw Hill
  2. Data and Computer Communications, 10<sup>th</sup> edition – By William Stallings, ISBN-10:0133506487 Pearson

# Marks Distribution

---

<b>Assessment Tools</b>	<b>Weightage (%)</b>
1. Participation in class	5 %
2. Quizzes/Class Tests	15%
3. Mid Term Examination	25 %
4. Assignments	15 %
5. Final	40 %

# Topic covered in the semester

---

- Topic 1: Introduction to elements of data communication, Network topology, Protocols and standards, Network models: OSI and TCP/IP model, Physical and logical addressing.
  - Topic 2: Basics concepts of signal: Analog and digital signal and their properties, Transmission impairment, Data rate limit calculation.
  - Topic 3: Digital to Digital conversion- Line coding, Block coding and Scrambling techniques.
  - Topic 4: Analog to Digital conversion techniques- PCM, DM.
- 
- Topic 5: Bandwidth utilization: Multiplexing and spreading, FDM, WDM, Synchronous Time-Division Multiplexing, FHSS and Direct sequence spread spectrum.
  - Topic 6: Major components of telephone network, Dial-Up modems and modem standards, Brief idea of DSL, Cable TV network for data transfer- Downstream and Upstream data band, Downstream and Upstream sharing, Guided and Unguided Medium- Twisted-Pair, Coaxial and fiber optic cable, radio and microwaves, wireless media.
  - Topic 7: Data link layer concepts, services and multi-access protocols: Channel Partitioning, Random Access and Taking Turns protocols.
  - Topic 8: Different types of error detection and correction mechanisms in the Data Link layer: Block coding, Hamming distance, CRC, Checksum.

# What is Data Communications

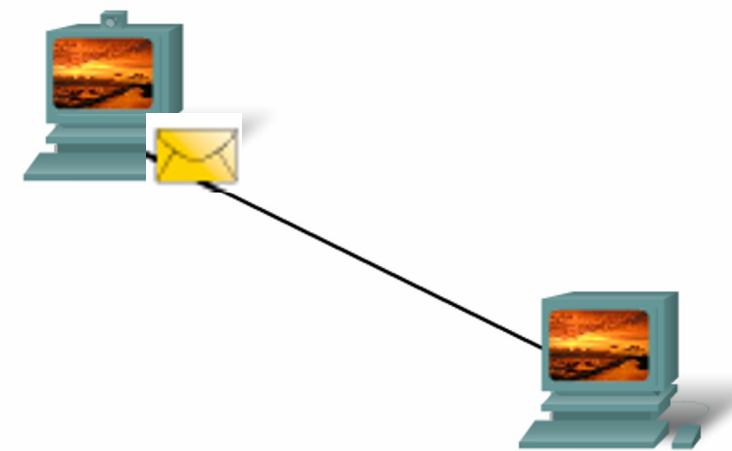
---

• **Data communications-** Data communications are exchange of data between two devices( usually sender and receiver) via some form of transmission medium

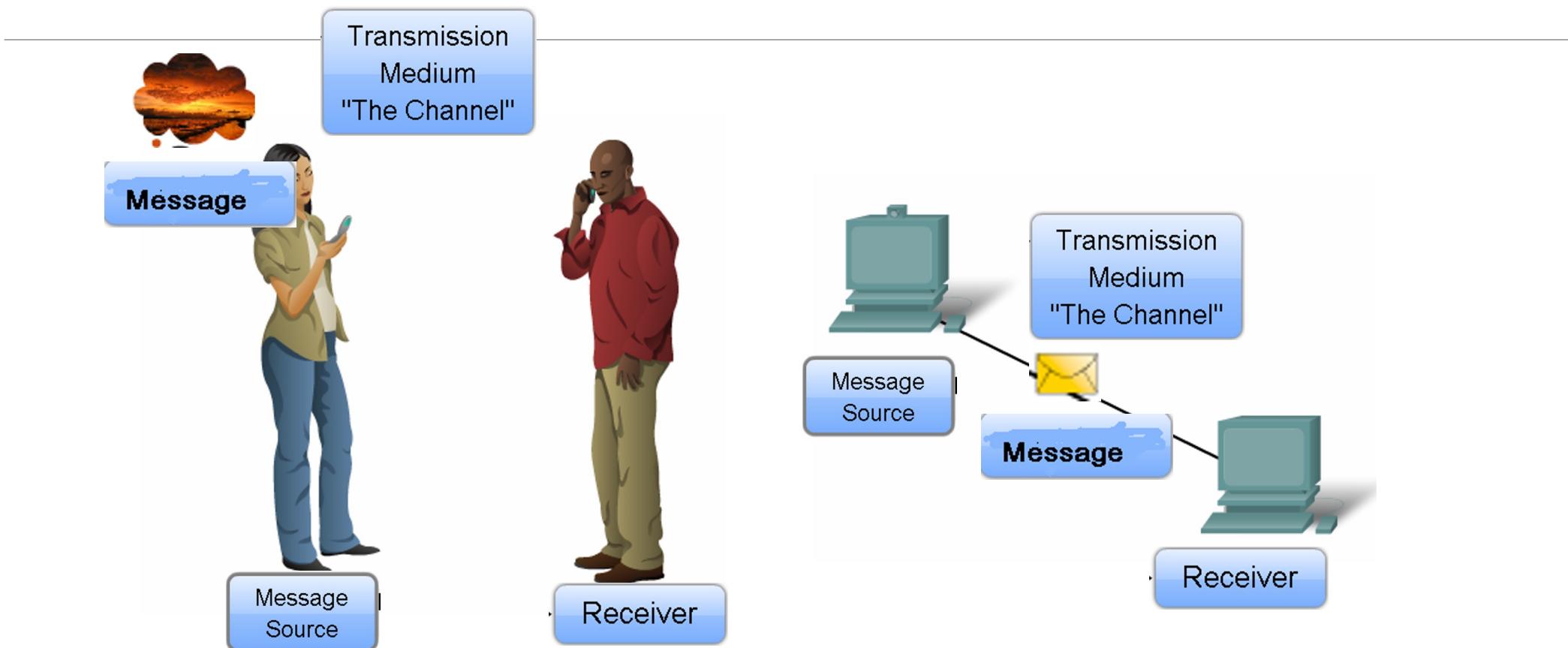
- Transmission medium can be wired or wireless
- Communication system- Hardware(physical equipment) and software(program)

# Elements/Components of Communication

---



# Elements/Components of Communication



# Components of Communication over Networks

---

- **Messages**

- Information(data) to be communicated

- **Devices (Sender/Receiver)**

- These are used to communicate with one another

- **Transmission Medium**

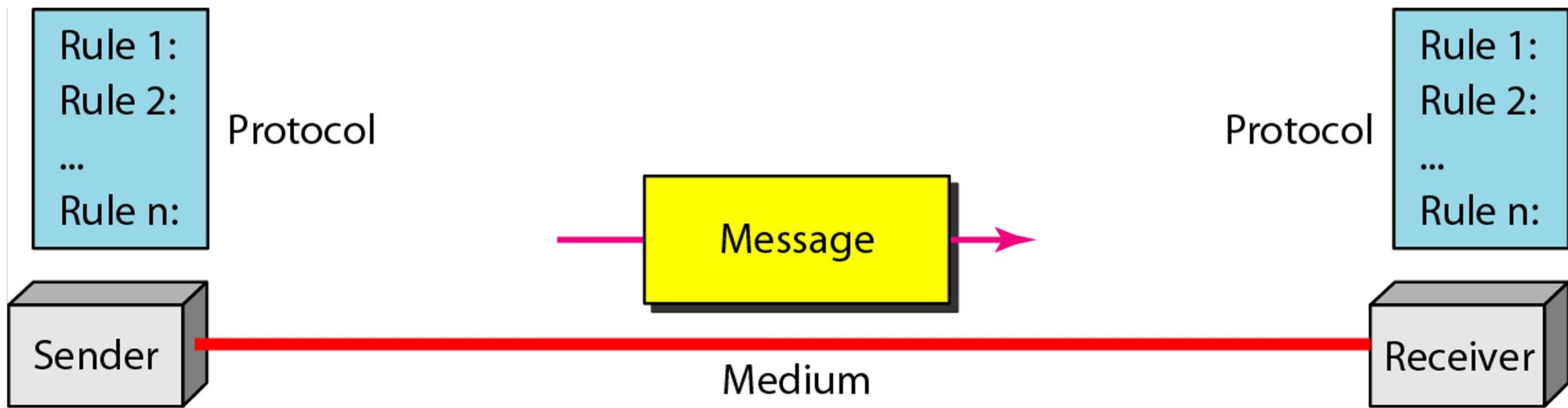
- The **transmission medium** is the physical path by which a message travels from sender to receiver

- **Rules/Protocols**

- Governs how messages flow across network

# Five elements/components of data communication

---



# 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.*

# Characteristics of effective data communication

---

- **Delivery** - The system must deliver data to the correct destination.
- **Accuracy** - The system must deliver the data accurately.
- **Timeliness** - The system must deliver data in a timely manner. In the case of video and audio, timely delivery means delivering data as they are produced, in the same order that they are produced, and without significant delay.
- **Jitter** - Jitter refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets.

*Perfect Stream*

*Rate: 3,75 Mbps*



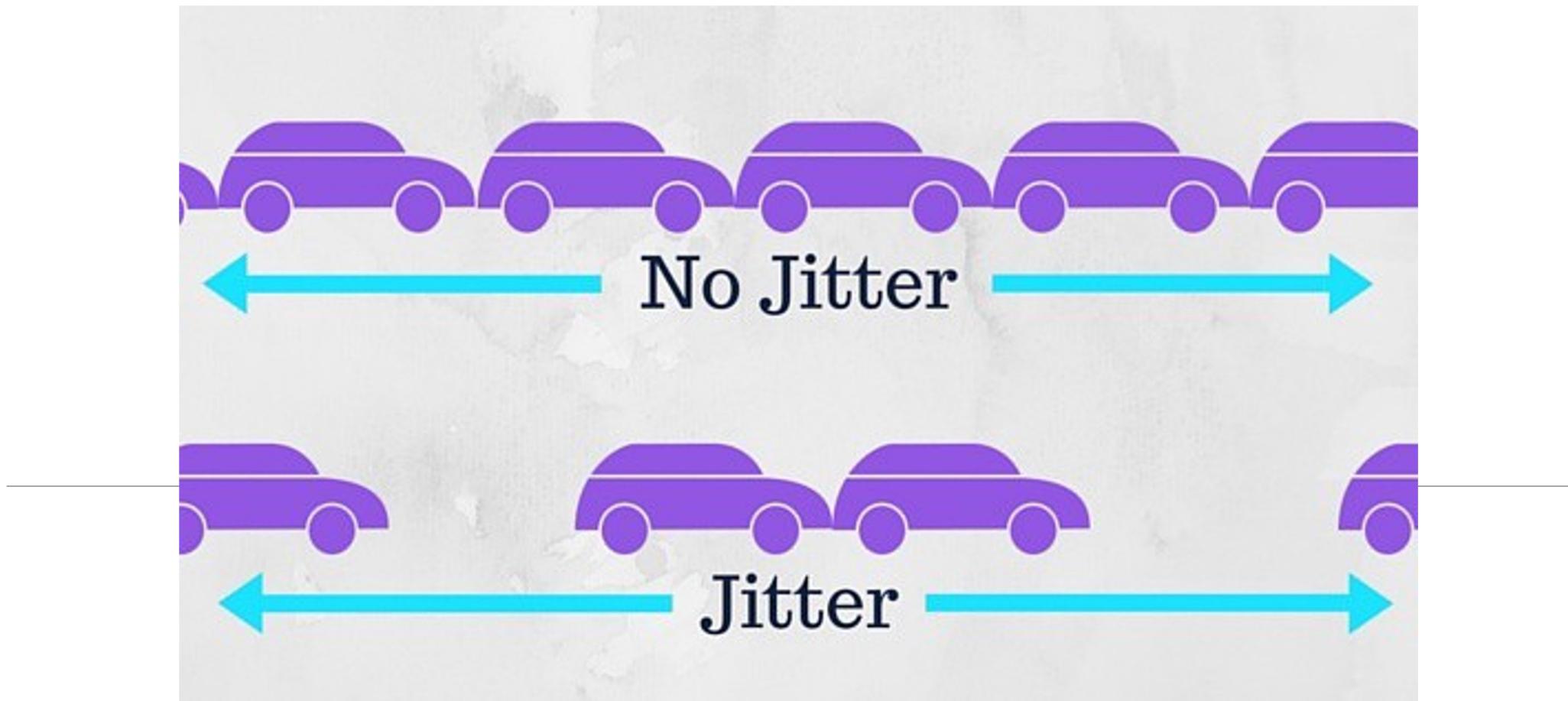
*Same stream with jitter*

*overflow*



→ *time*

→ *time*



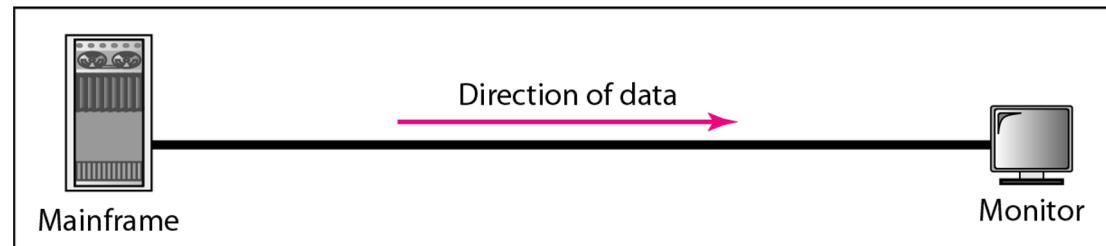
# Data Representation

- When we communicate we are sharing information- information is classified or organized data, which has some **meaningful** values for receiver.
- Data or information can be a form of- **text**( in data communications, text is represented as a bit pattern, sequence of 0's and 1's), **numbers**, **images**(e.g-RGB, CMY), **audio**, **video**

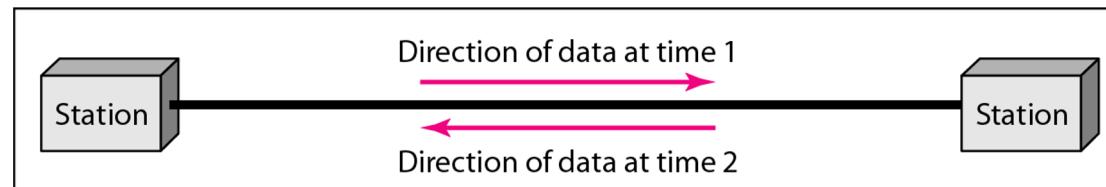
Type of Data	Standards
Alphanumeric	ASCII, Unicode
Image	JPEG, GIF, PCX, TIFF, BMP, etc
Motion picture	MPEG-2, Quick Time, MPEG-4, etc
Sound	Sound Blaster, WAV, AU, MP3, etc..
Outline graphics/fonts	PostScript, TrueType, PDF

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

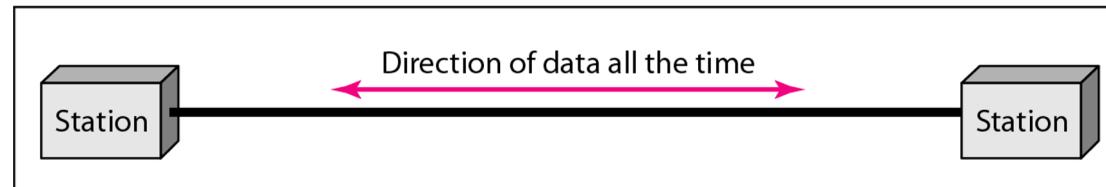
---



a. Simplex



b. Half-duplex



c. Full-duplex

# NETWORKS

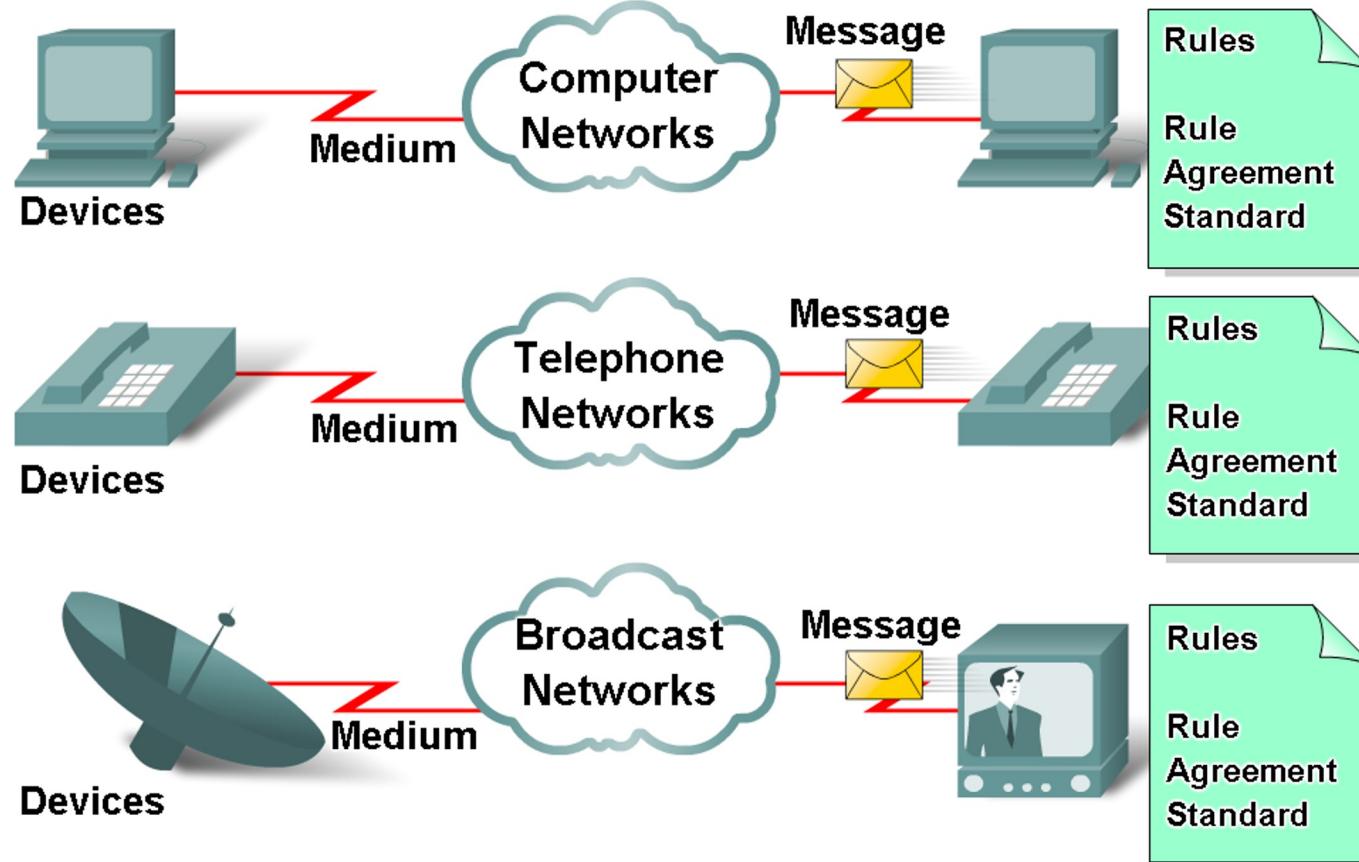
---

*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.*

## *Topics discussed in this section:*

- Network Criteria
- Physical Structures
- Categories of Networks

# Elements of Communication over Networks

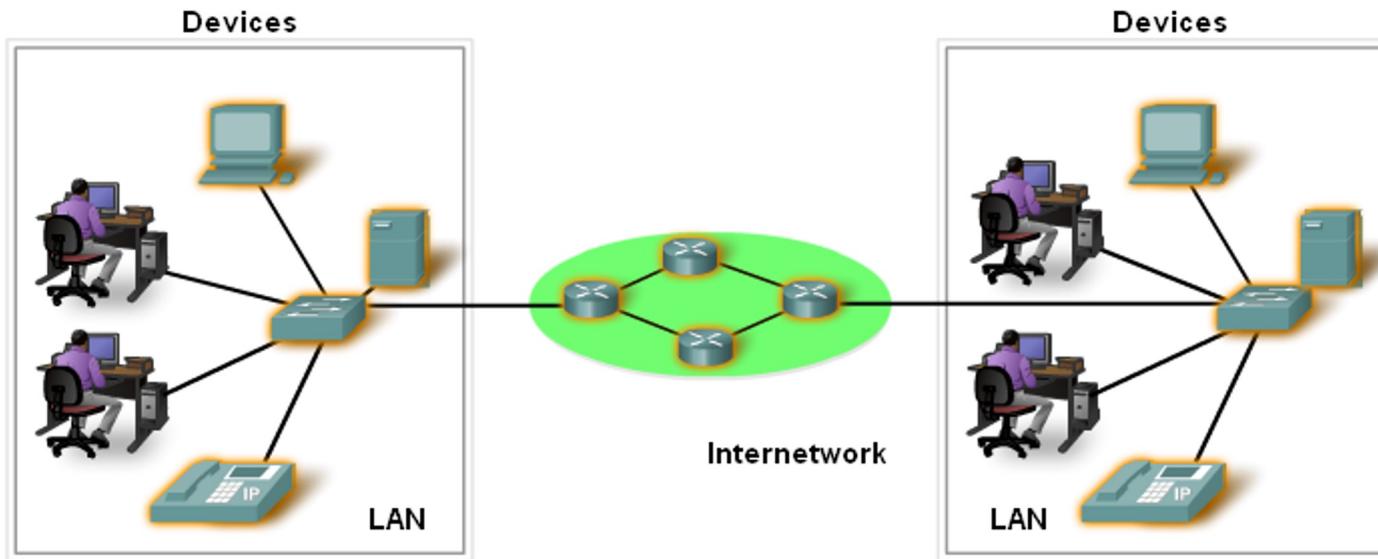


# Components of a computer Network

---

- Nodes
- Media
- Services

# Devices/Nodes

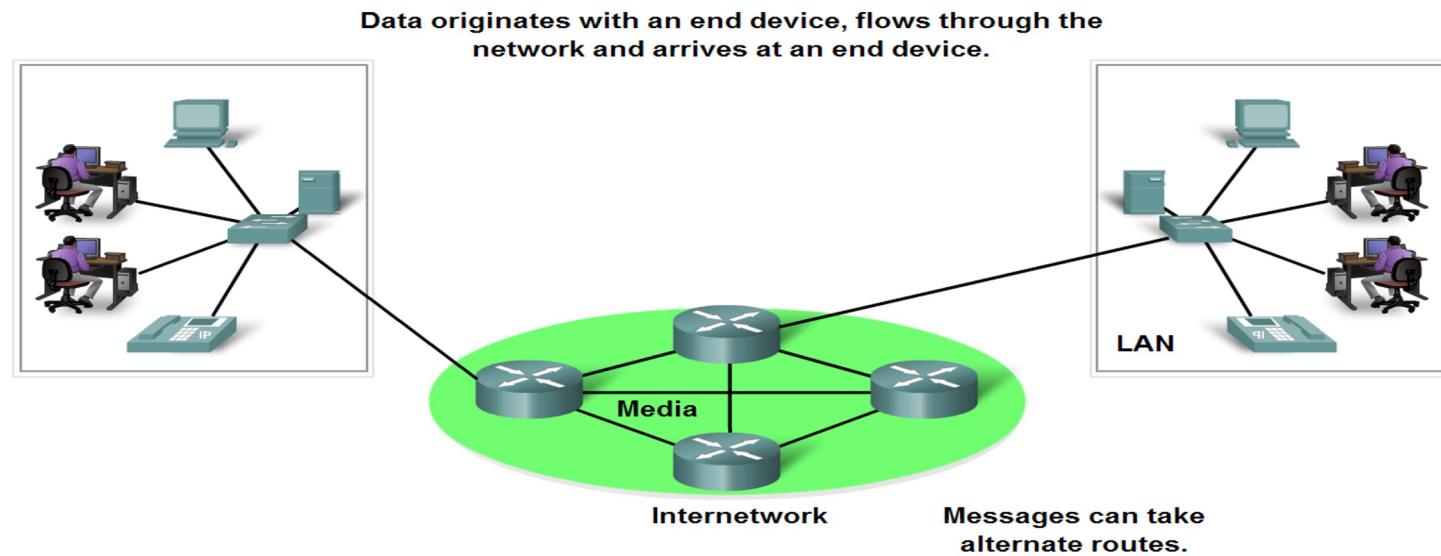


Two Types:

- End Devices
- Intermediary Devices

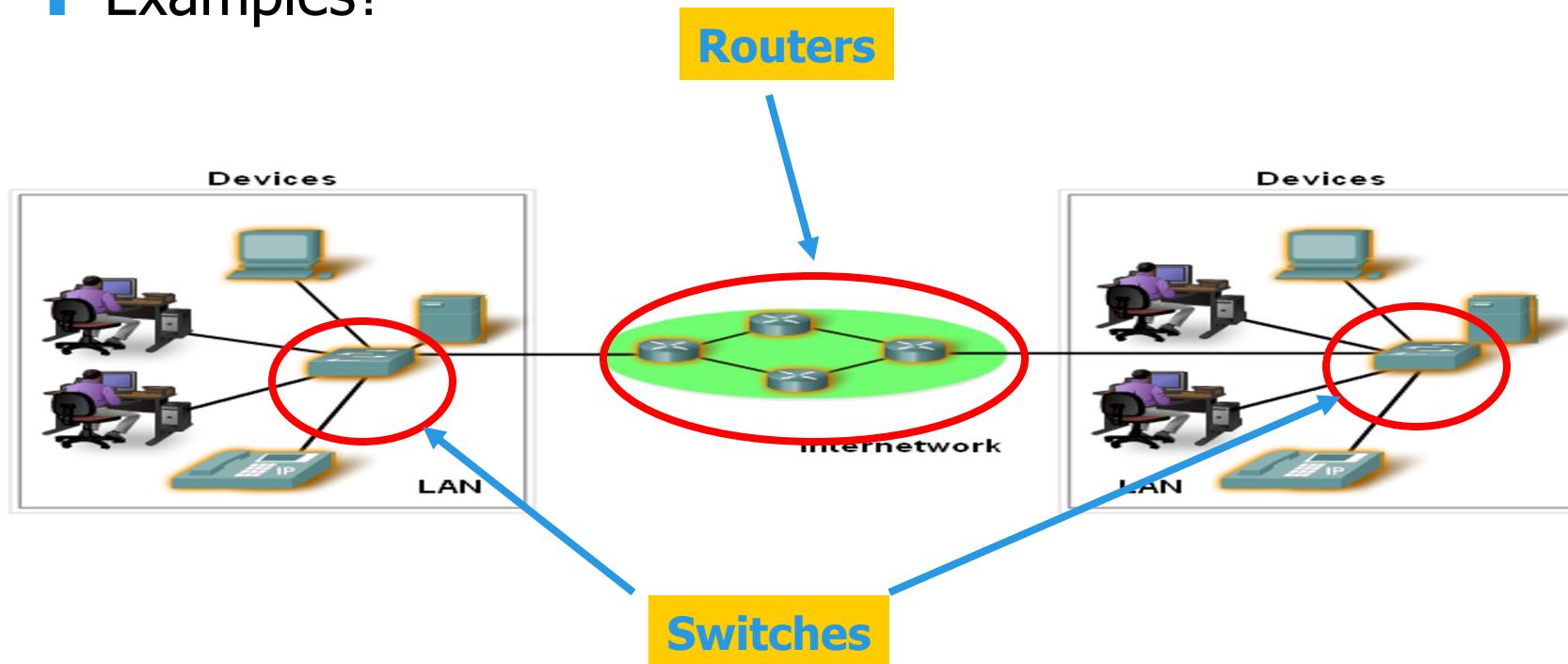
# End Devices and their Role

- End devices form interface with human network & communications network

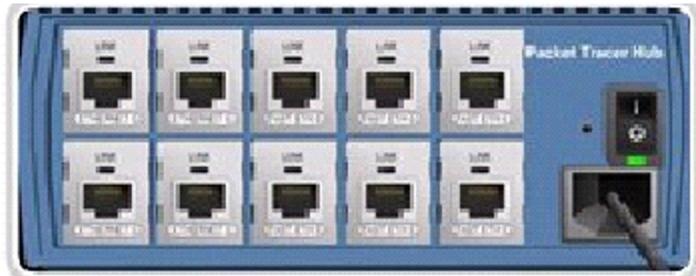


# Intermediary devices

- Provides connectivity between end devices.
- Manages data as it flows through the network.
- Examples?



# Intermediary devices



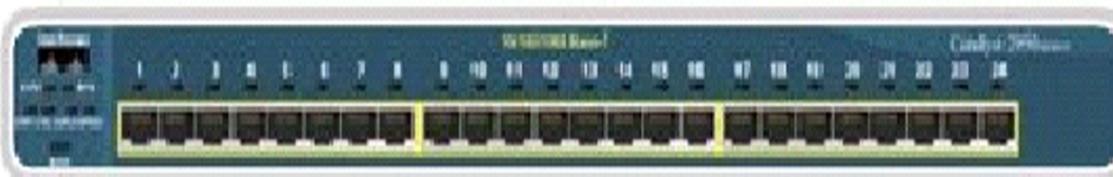
Hub



Wireless Router



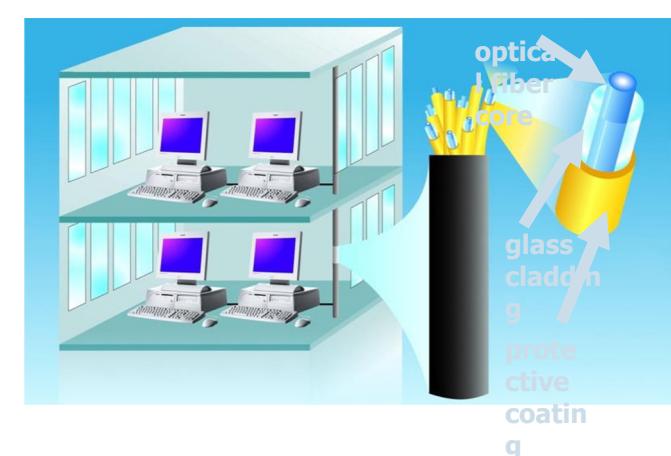
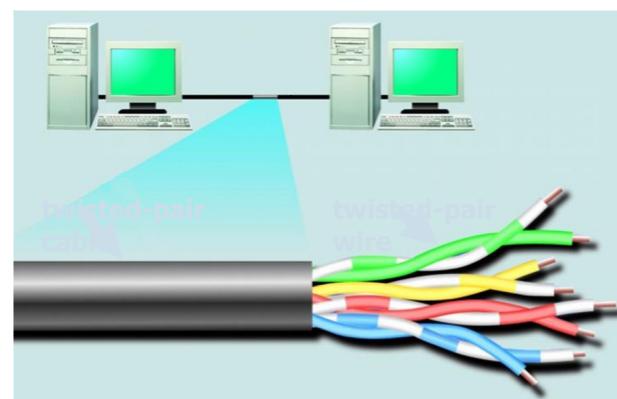
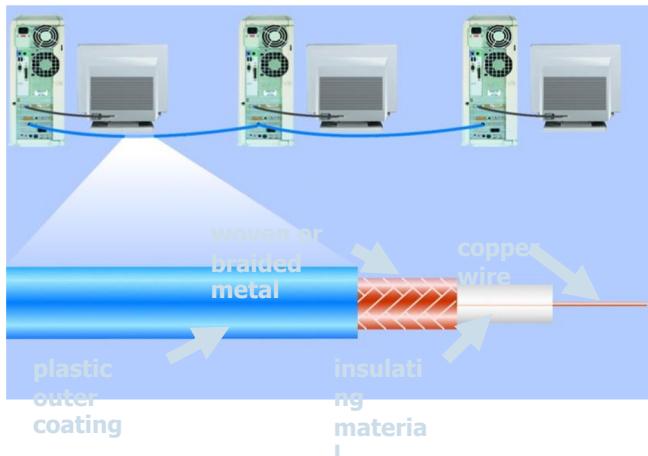
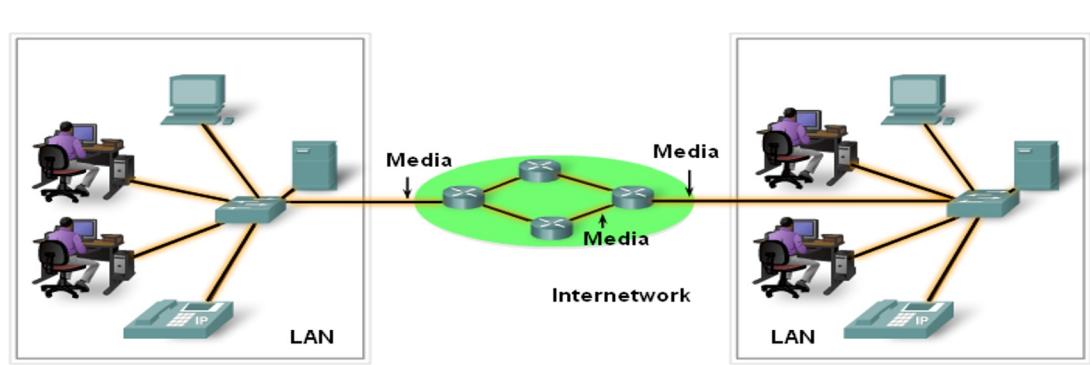
Router



Switch

# Media

- Wired Media
- Wireless Media



# Services

## ■ Services :

---

- provides information in response to a request(Instant Massing).
- For example e-mail hosting services and web hosting services.
- Storage Devices
- File Sharing
- Voice over IP
- Video Telephony
- World Wide Web
- Online Game

# 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

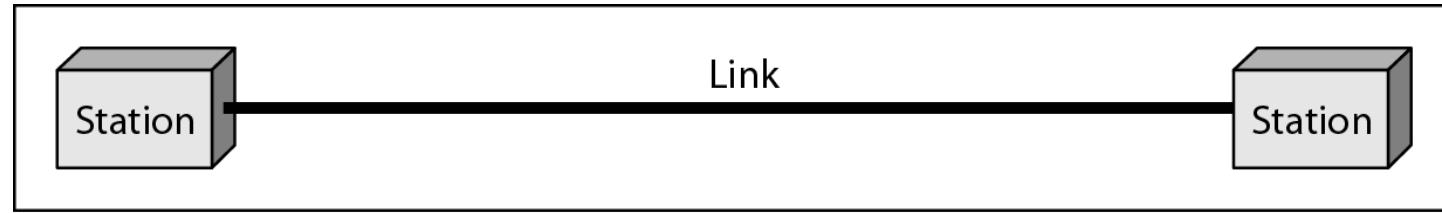
- Point to Point - single transmitter and receiver
- Multipoint - multiple recipients of single transmission

## Physical Topology

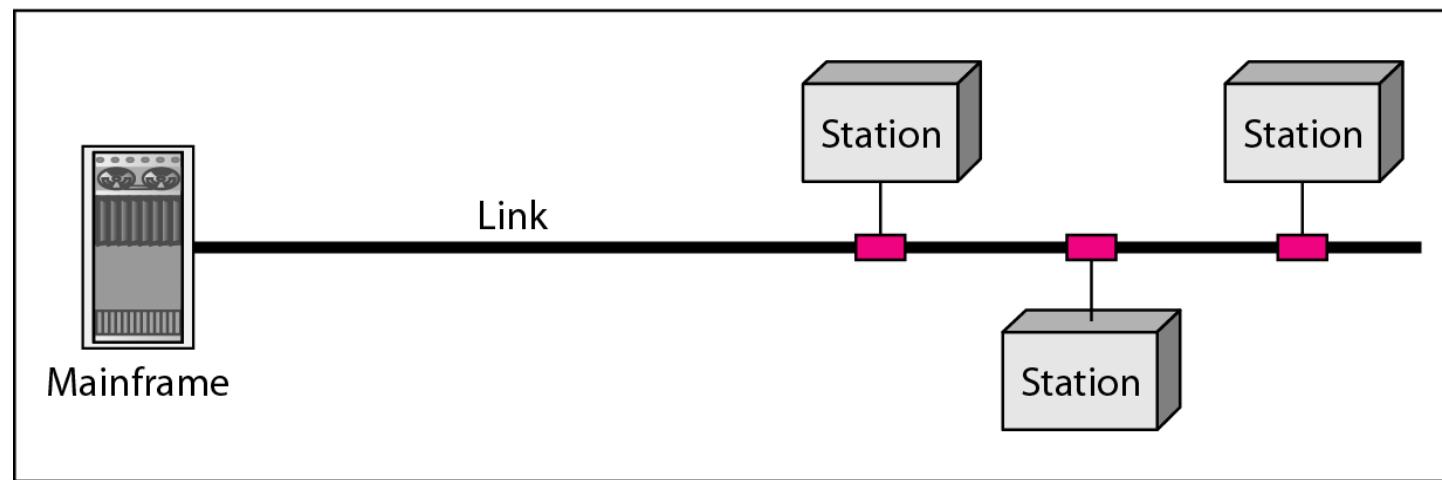
- Connection of devices
- Type of transmission - unicast, multicast, broadcast

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

---



a. Point-to-point

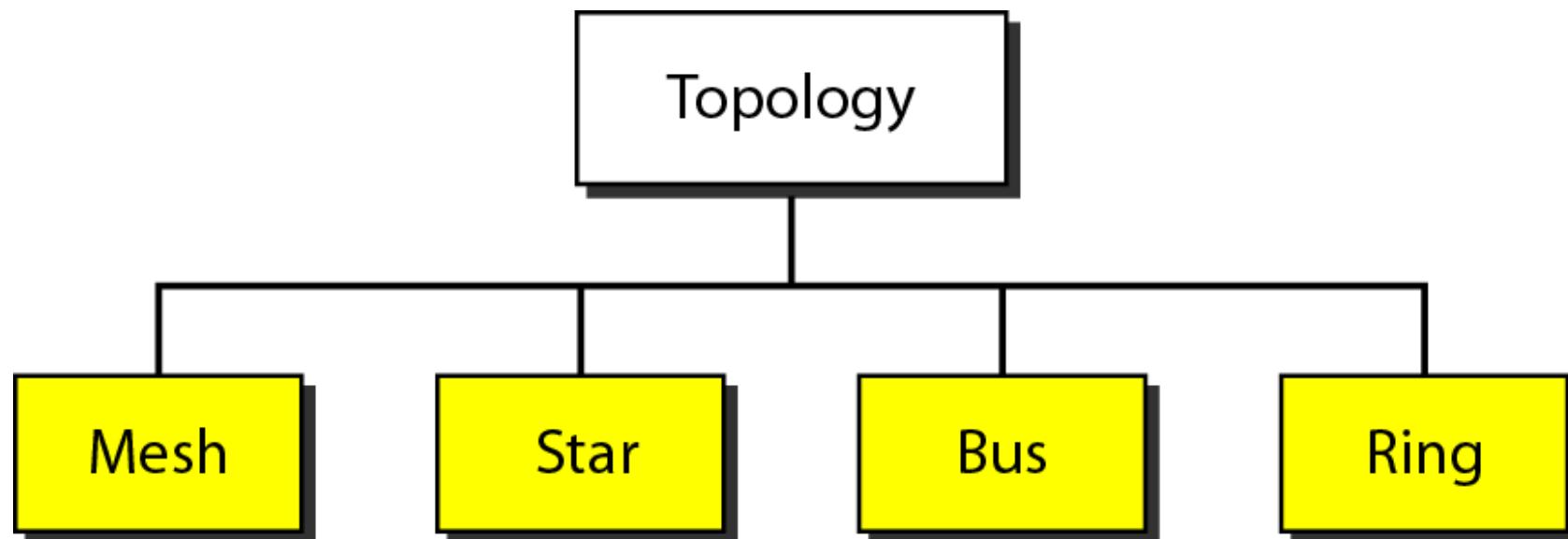


b. Multipoint

# Categories of topology

---

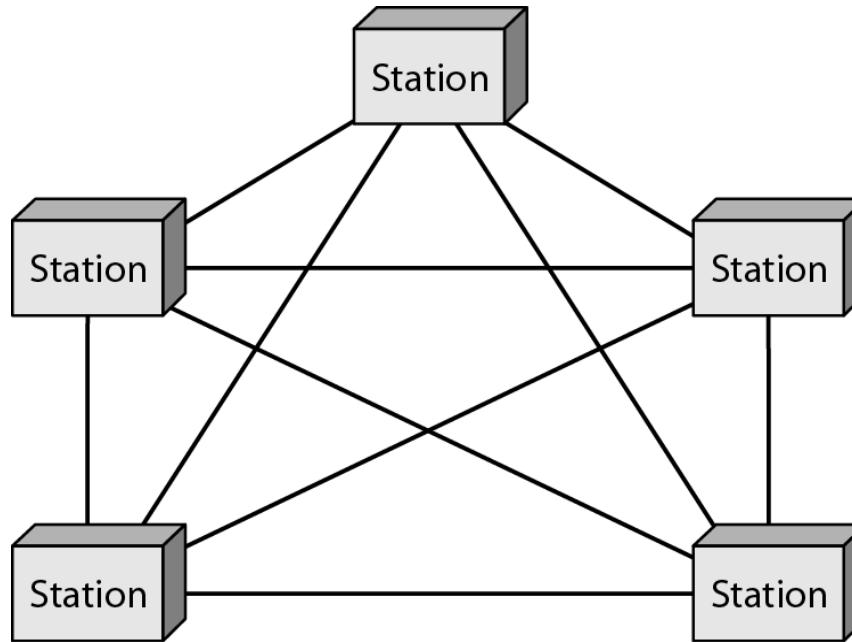
Network Topology is the schematic description of a network arrangement, connecting various nodes(sender and receiver) through lines of connection.



# A fully connected mesh topology (five devices)

---

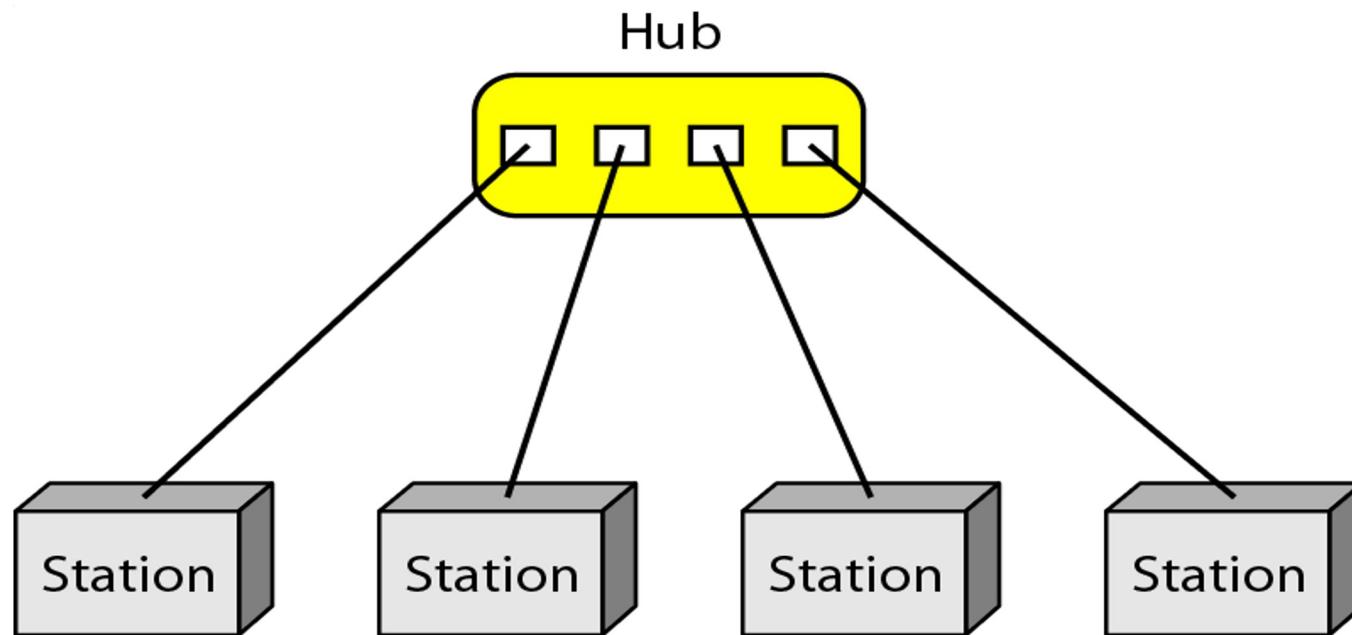
It is a point-to-point connection to other nodes or devices. All the network nodes are connected to each other. Mesh has  $n(n-1)/2$  physical channels to link  $n$  devices.



# A star topology connecting four stations

---

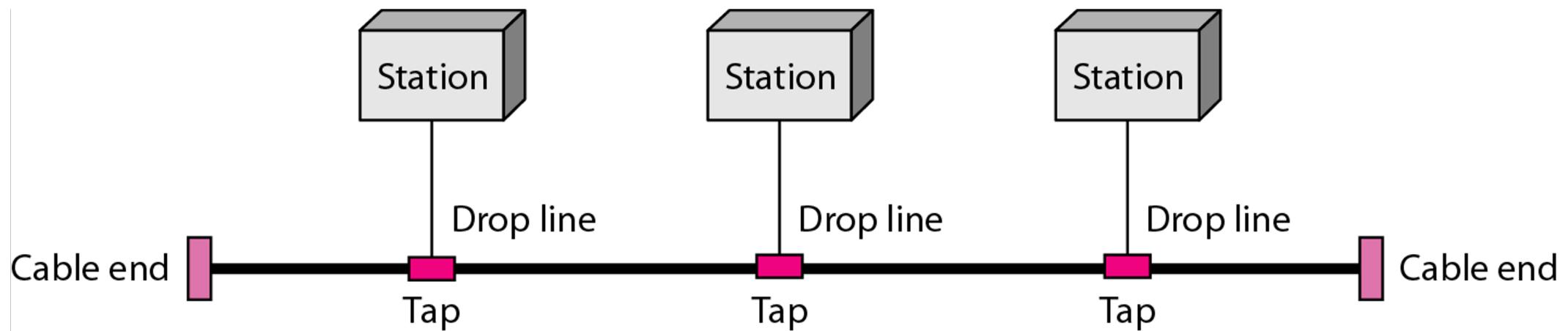
In this type of topology all the computers are connected to a single hub through a cable. This hub is the central node and all others nodes are connected to the central node. Hub acts as a repeater for data flow. Can be used with twisted pair, Optical Fiber or coaxial cable.



# A bus topology connecting three stations

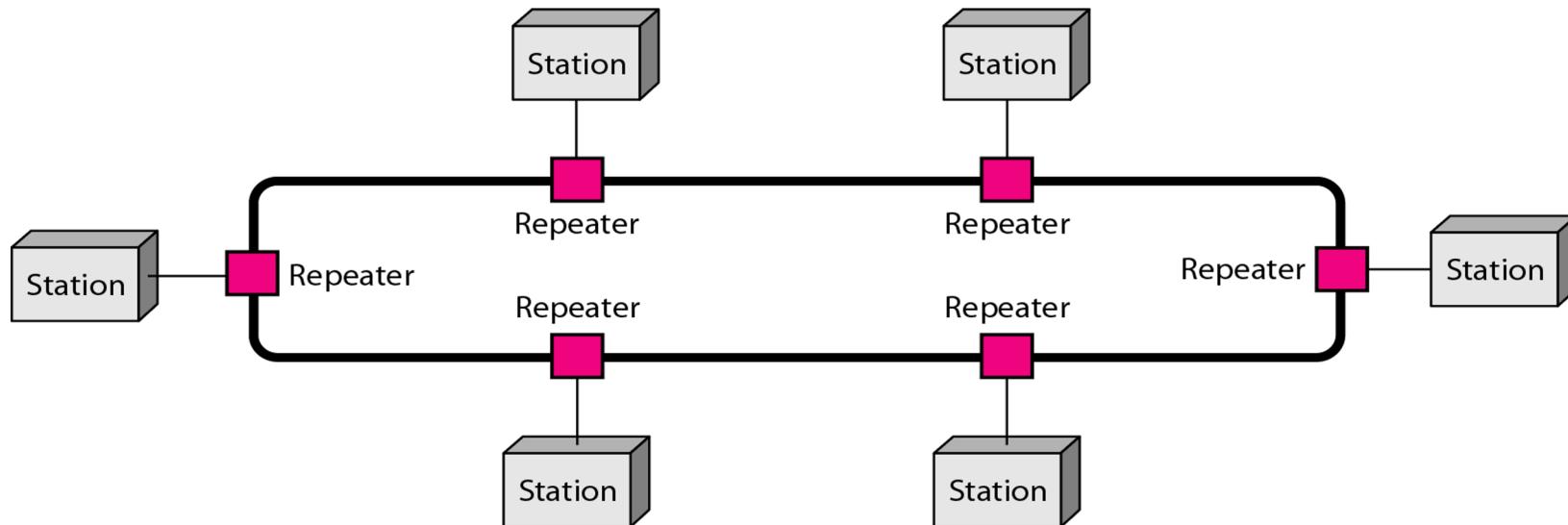
---

Bus topology is a network type in which every computer and network device is connected to single cable. When it has exactly two endpoints, then it is called Linear Bus topology.



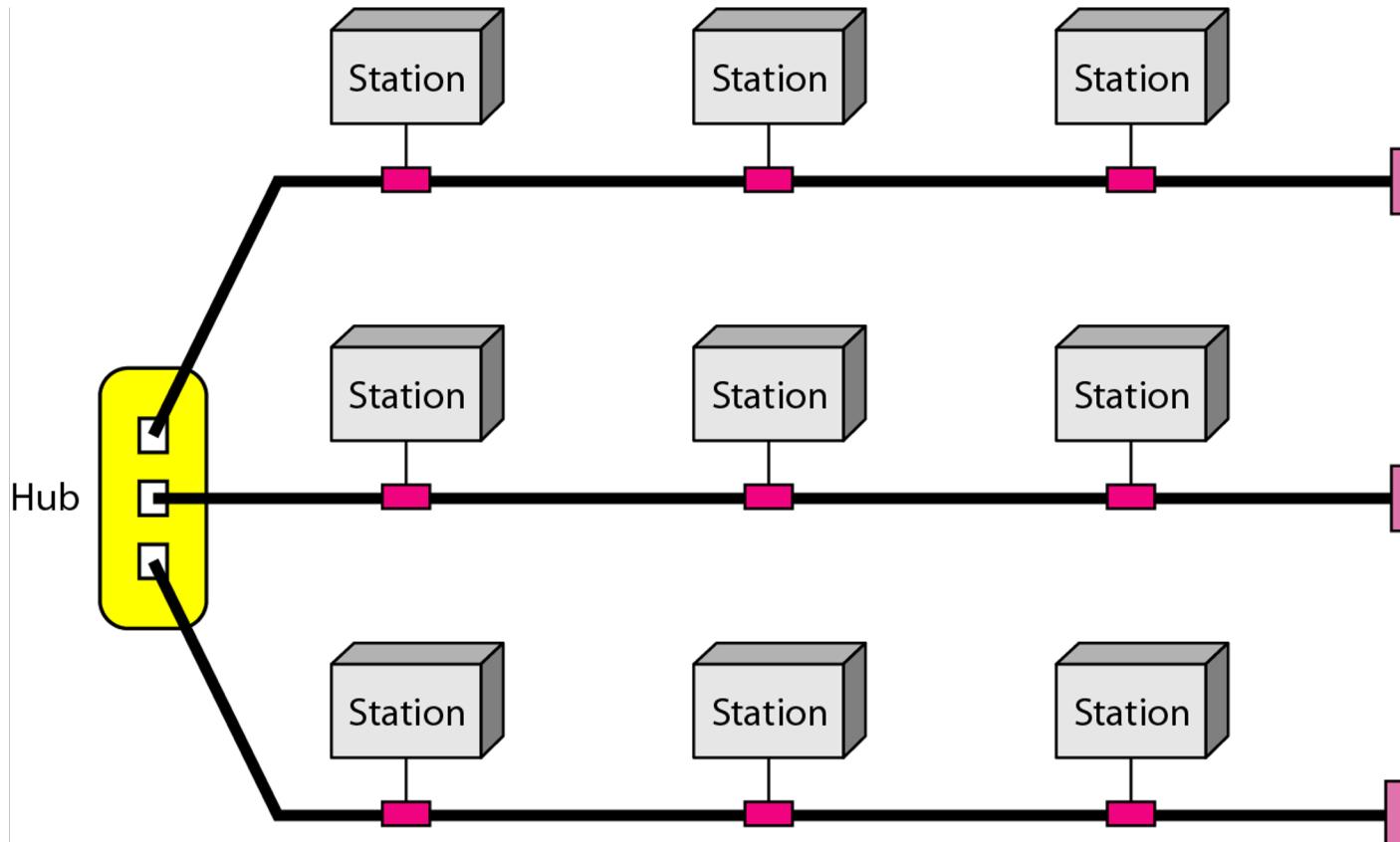
# A ring topology connecting six stations

Ring topology is a type of network topology in which each device is connected to two other devices on either side via an RJ-45 cable or coaxial cable. This forms a circular ring of connected devices which gives it its name. Data is commonly transferred in one direction along the ring. The transmission is unidirectional, but it can be made bidirectional by having 2 connections between each Network Node, it is called Dual Ring Topology. In Dual Ring Topology, two ring networks are formed, and data flow is in opposite direction in them. Also, if one ring fails, the second ring can act as a backup, to keep the network up.



# 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

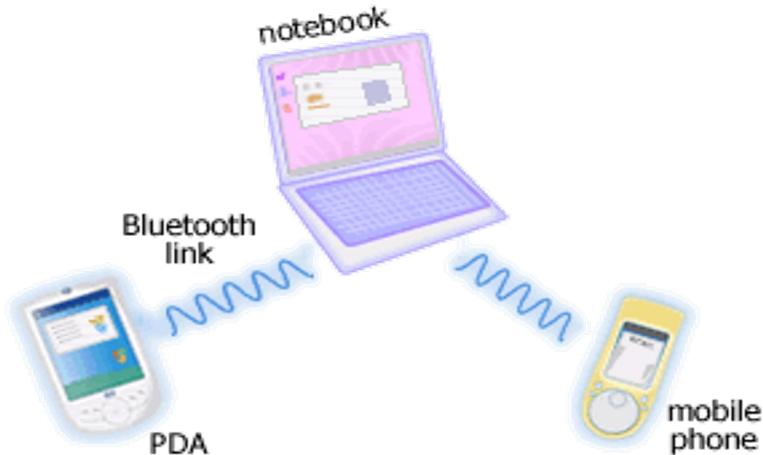
## Metropolitan Area Networks (MANs)

- Provide connectivity over areas such as a city, a campus

## Personal Area Networks (PAN)

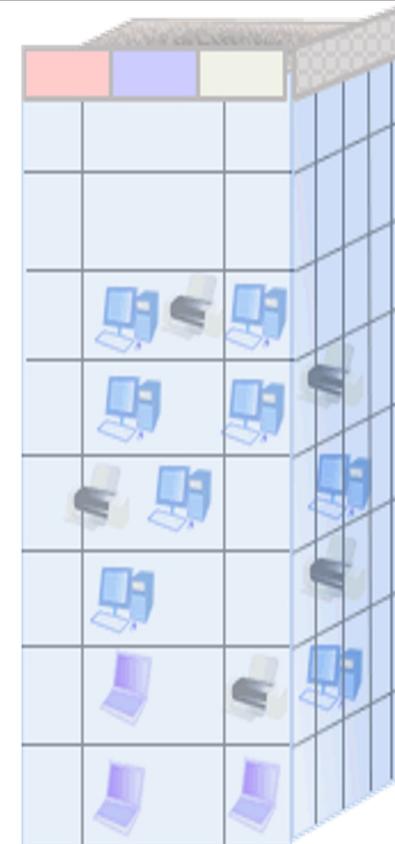
# Personal Area Networks (PAN)

- A personal area network (PAN) interconnects technology devices, typically within the range of a single user, which is approximately 10 meters or 33 feet.
- A network that connects computers, peripherals and other devices within a personal operating space. Such as a wireless mouse, a keyboard, and a computer.



# Local Area Networks (LAN)

- Connects computers, peripherals and other devices within a building (e.g. office, home) or in a limited area.
- Typical coverage 50 to 300 meters.
- Ex. Ethernet, Wireless LANs
  - Through this type of network, users can easily communicate with each other by sending and receiving messages.
  - LAN is generally used for connecting two or more personal computers through some medium such as twisted pair, coaxial cable etc.
  - Through the number of computers connected in a LAN is limited
  - The data is transferred at an extremely faster rate.



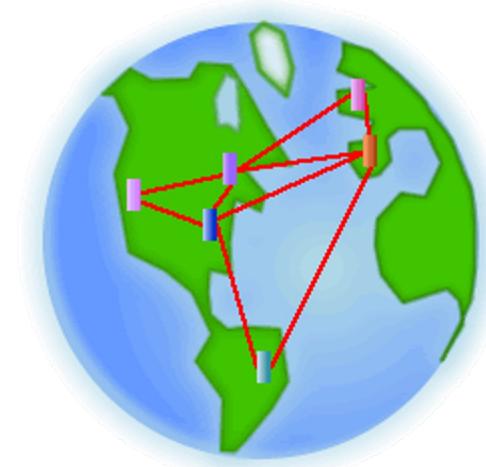
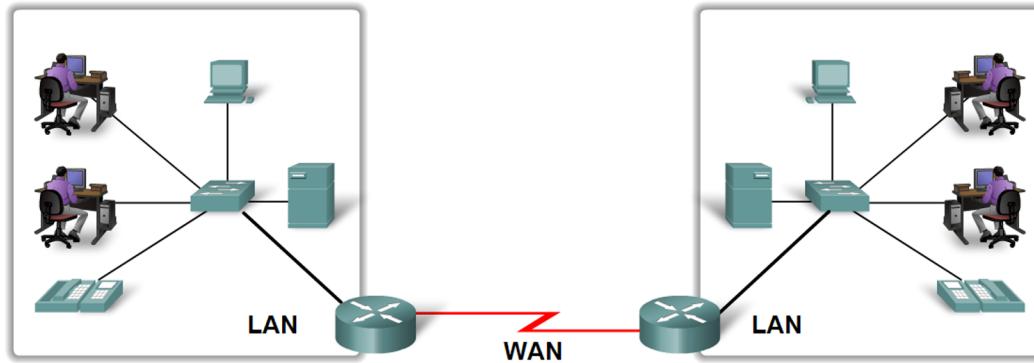
# Metropolitan Area Network (MAN)

- 
- MAN is a network of computers that covers a large area like city.
  - The size of the MAN generally lies between LAN and WAN, typically covering a distance of 5 km to 50 km.
  - The geographical area covered by MAN is comparatively larger than LAN but smaller than WAN.
  - MAN is generally owned by private organizations.
  - MAN is generally connected with the help of optical fibers, copper wires etc.



# Wide Area Networks (WANs)

- A network that spans larger geographical area.
- WAN is a group of computers that are connected in a large area such as continent, country, etc.
- WAN is generally used for connecting two or more LANs through some medium such as leased telephone lines, microwaves, etc.



# Switching

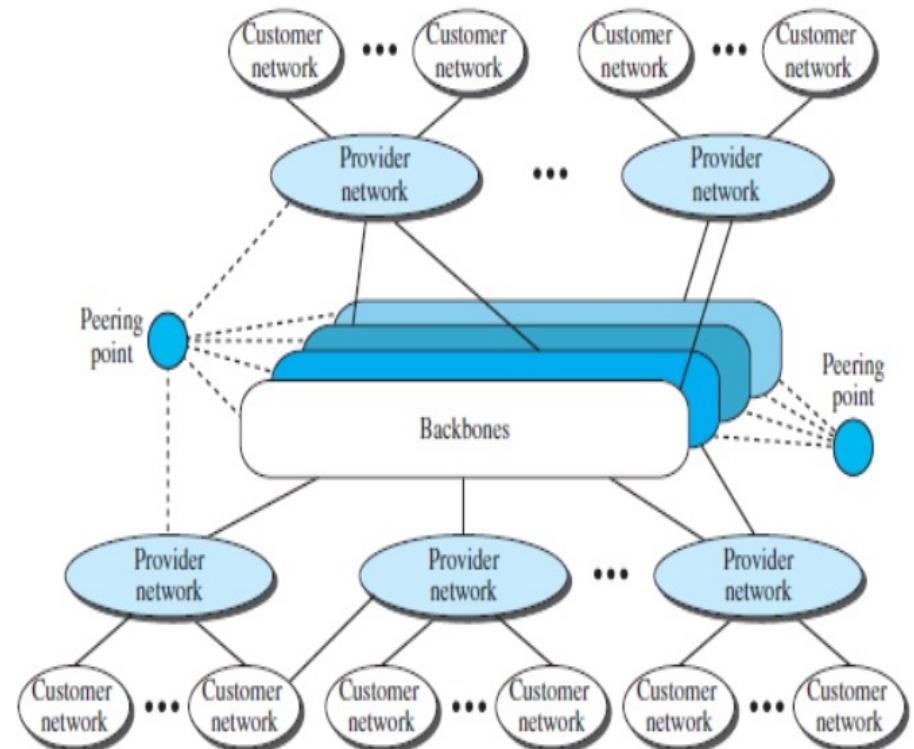
---

An internet is a **switched network** in which a switch connects at least two links together. A switch needs to forward data from a network to another network when required. The two most common types of switched networks are **circuit-switched** and **packet-switched** networks.

- In **circuit-switching** a dedicated path is established between the sender and receiver before data transfer.  
Example: Telephone network.
- **Packet-switching** use store and forward mechanism. This allows us to make the switches function for both storing and forwarding because a packet is an independent entity that can be stored and sent later.

# The Internet

- The internet is a network of networks in which users at any one computer can, if they have permission, get information from any other computer (and sometimes talk directly to users at other computers).
- The **Internet**, is a global system of interconnected computer networks that uses the Internet protocol suite (TCP/IP) to communicate between networks and devices.
- *It is a network of networks that consists of private, public, academic, business, and government networks of local to global scope, linked by a broad array of electronic, wireless, and optical networking technologies.*
- The Internet carries a vast range of information resources and services, such as the interlinked hypertext documents and applications of the World Wide Web (WWW), electronic mail, telephony, and file sharing.
- At the top level, the *backbones* are large networks owned by some communication companies such as Sprint, Verizon (MCI), AT&T, and NTT.



# 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.