

# Data Communication Network

## DAY – 1

**Mrs.Akshita.S.Chanchlani**  
**[akshita.chanchlani@sunbeaminfo.com](mailto:akshita.chanchlani@sunbeaminfo.com)**



# Contents

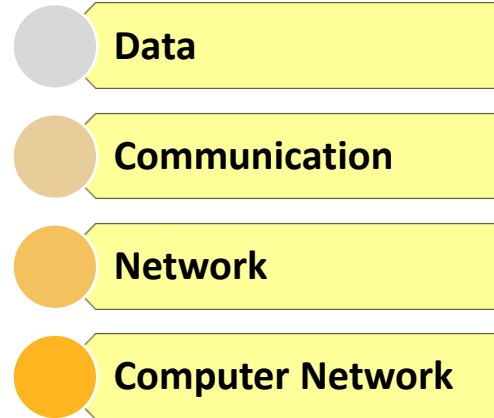
---

- Network Terminologies
- Need of Network
- Network Types
- Media (Transmission Medium)
- Switching
- Multiplexing
- Network Classification (LAN, MAN, WAN)
- ARP
- Network Classification by Component Role
- Network Physical Structure
  - Types of Connection
  - Physical Topology
- Network Devices



# Network Terminologies

•connecting multiple devices (computers) together to share the information group of devices/machines/IP addresses/hosts.



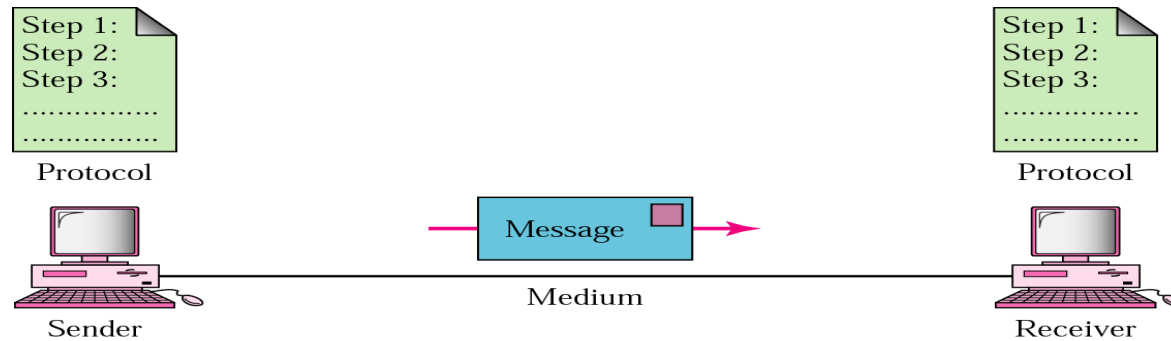
## *Node*

- any device connected to the network(a computer, a printer etc)

## *Network Interface Card (NIC)*

- is the circuit board that is used to connect computers to the network.
- In most cases, this is an *Ethernet* card plugged in a computer's motherboard

## Components of Data communication



**The effectiveness of a data communications system depends on four fundamental characteristics:**  
Delivery, Accuracy , Timeliness , Jitter



# Need of Network/ Applications of Network

**Information Sharing**

**Enhance communication**

**Share resources**

**Facilitate centralized management**

**Remote computing**



# Network Criteria

## Performance

- depends on a number of factors, including the number of users, the type of transmission medium, the capabilities of the connected hardware, and the efficiency of the software.
- Measured in terms of Delay and Throughput

## Reliability

- is measured by the frequency of failure, the time it takes a link to recover from a failure
- Measured in terms of availability/robustness

## Security

- Data protection against corruption/loss of data due to:
  - Errors
  - Malicious users



# Network Types

## Wired

### Medium

- Wire / Cable

### Cable Types

- co-axial
  - transfers the data in the form of electrical signals
- CAT Cable / Twisted Pair Cable (STP/UTP)
  - transfers the data in the form of electrical signals
- Fiber Optics
  - transfers the data in the form of light
  - Minimum 10gbps

### Types

- LAN , MAN , WAN

cat1 : - [it was used only for telephony network]

cat2 : 1 mbps

cat3 : 10 mbps

cat4 : 16 mbps

cat5 : 100 mbps

cat5e: 125 mbps

cat6 : 1000 mbps ~ 1 gbps

cat7 : 10000 mbps ~ 10 gbps

cat8 : 25000 mbps ~ 25 gbps

## Wireless

### Medium

- Air (EM Waves)

### Cable Types

- PAN
- WLAN
- WAN (GSM)

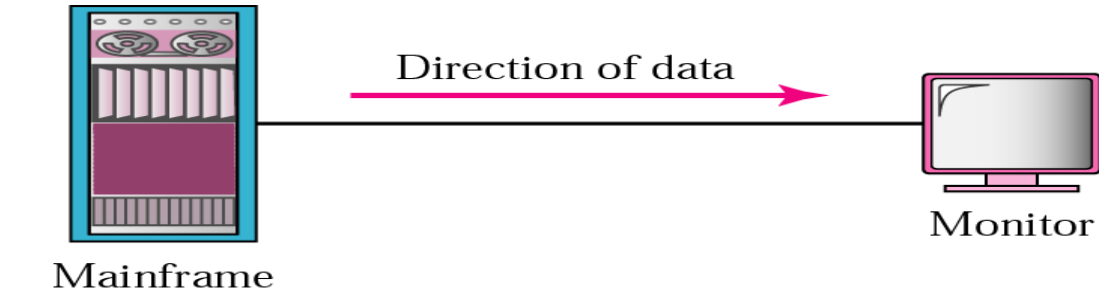


---

# Media (Transmission Medium)

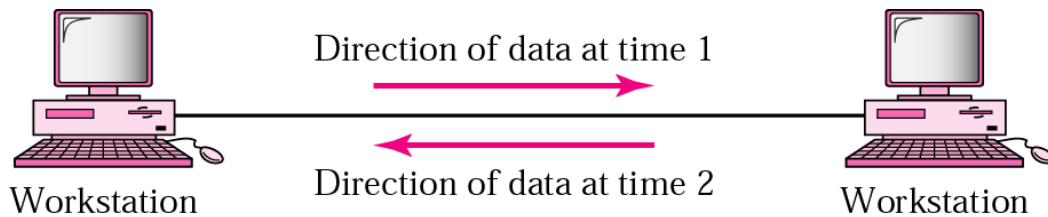


# Transmission Modes / Data Flow Direction



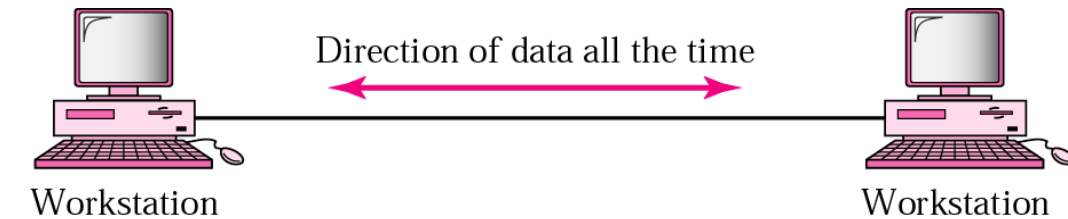
## Simplex Mode

- Example: Keyboard and traditional monitors.



## Half-Duplex Mode

- each station can both transmit and receive, but not at the same time.
- Example: Walkie- talkie



## Full-Duplex Mode

- Example: Telephone Network there is communication between two persons by a telephone line, through which both can talk and listen at the same time.





# Transmission Medium

- For any networking to be effective, raw stream of data is to be transmitted from one device to other over some medium.
- Various transmission media can be used for transfer of data.

## Types of Transmission Medium

### Guided

- Transmitted data travels through cabling system that has a fixed path.
- For example, copper wires, fibre optic wires, etc.

### Unguided

- Transmitted data travels through free space in form of electromagnetic signal.
- For example, radio waves, lasers, etc



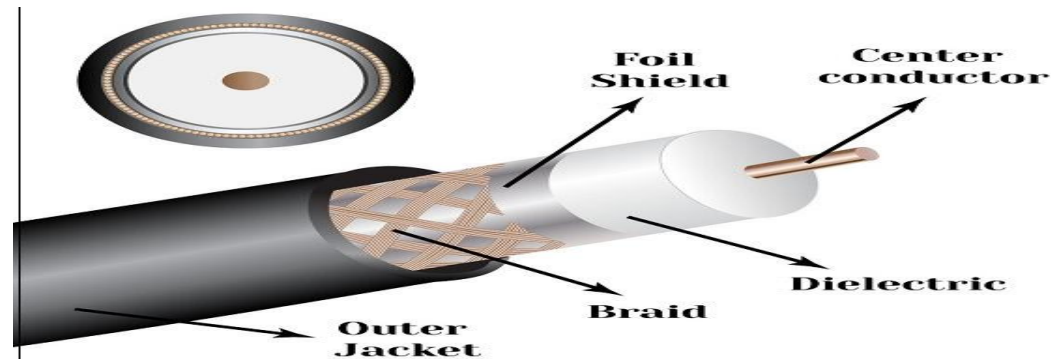
# Twisted Pair (maximum length of 100 meters)

- Most common wires used for transmitting signals
- To reduce this electromagnetic interference, pair of copper wires are twisted together.
- Shielding twisted pair cable
  - To counter the tendency of twisted pair cables to pick up noise signals, wires are shielded .
  - Such twisted pairs are called **shielded twisted pair (STP) cables**.
- The wires that are not shielded but simply bundled together in a protective sheath are called **unshielded twisted pair (UTP) cables**.



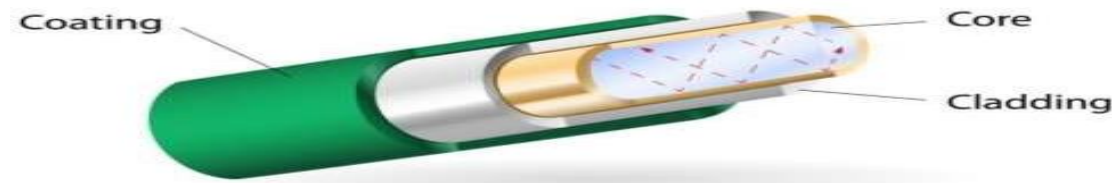
# Coaxial Cable

- Coaxial cables are widely used for **cable TV** connections and **LANs**.
- **Coaxial cables** are copper cables with better **shielding** than twisted pair cables.
- Transmitted signals may travel **longer distances** at higher speeds.
  - e.g. 1 to 2 Gbps for 1 Km cable
- Can be used for both analog and digital signals
- Inexpensive as compared to fiber optic cables
- Easy to install and maintain



# Optical Fiber

- Thin glass or plastic threads used to transmit data using light waves are called **optical fiber**.
- Signals carrying data can travel long distances without weakening
- Immune to electromagnetic interference , Suitable for industrial and noisy areas
- Three Layers:
  - **Core** made of high quality **silica glass** or **plastic**
  - **Cladding** made of high quality **silica glass** or **plastic**, with a lower refractive index than the core
  - Protective outer covering called **buffer**

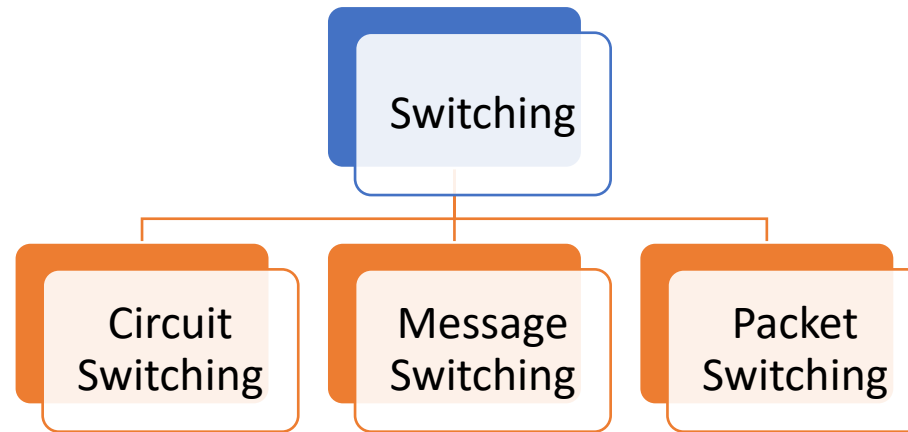


# Switching



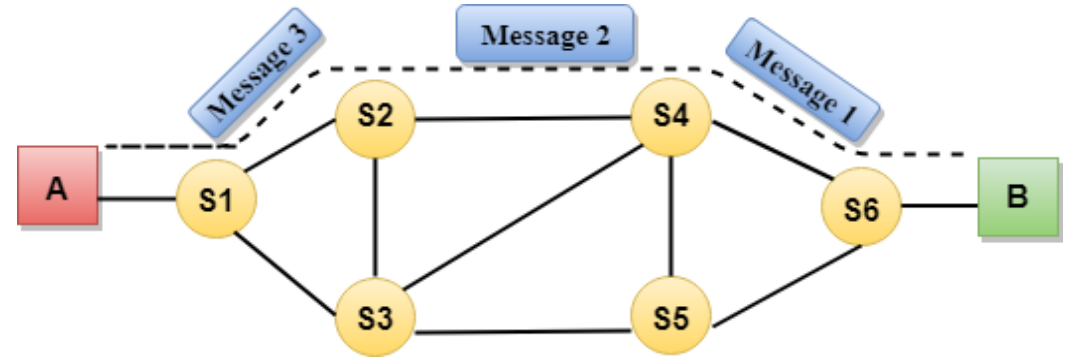
# Switching

- In large networks, there can be multiple paths from sender to receiver.
- The switching technique will decide the best route for data transmission.
- Switching technique is used to connect the systems for making one-to-one communication.
- The mechanism for exchange of information between different computer networks and network segments is called switching in Networking.



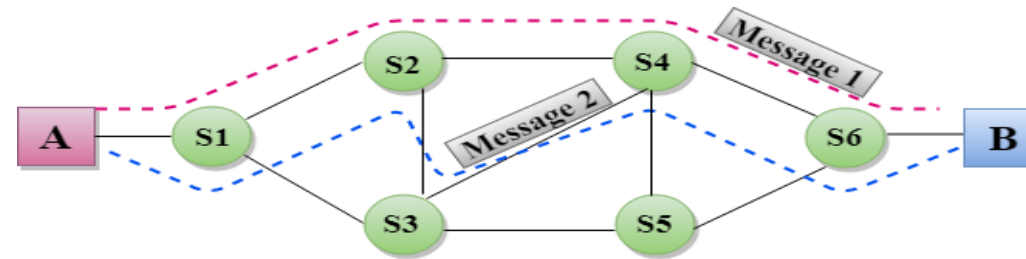
# Circuit Switching

- Establishes a dedicated path between sender and receiver.
- once the connection is established then the dedicated path will remain to exist until the connection is terminated.
- Operates in a similar way as the **telephone** works.
- when any user wants to send the data a request signal is sent to the receiver then the receiver sends back the acknowledgment to ensure the availability of the dedicated path. After receiving the acknowledgment, dedicated path transfers the data.
- Three Phases:
  - Circuit Establishment
  - Data Transfer
  - Circuit Disconnect



# Message Switching

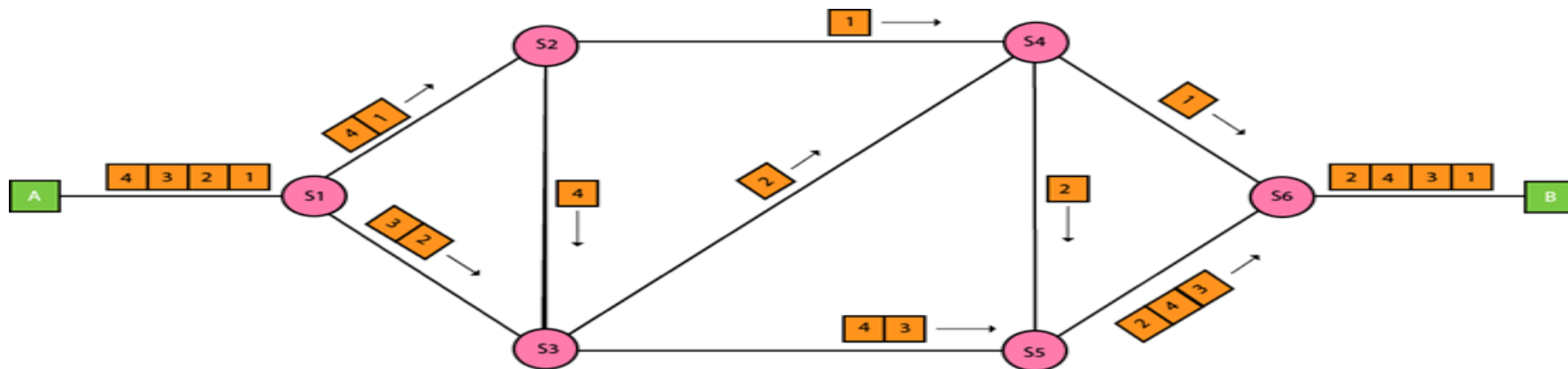
- There is no establishment of a dedicated path between the sender and receiver.
- The destination address is appended to the message.
- provides a dynamic routing as the message is routed through the intermediate nodes based on the information available in the message.
- they can provide the most efficient routes.
- Uses a method of **store and forward network**





# Packet Switching

- Message is divided in packets , packets are given a unique number to identify their order at the receiving end.
- Every packet contains some information in its headers such as source address, destination address and sequence number.
- Packets will travel across the network, taking the shortest path as possible.
- All the packets are reassembled at the receiving end in correct order.
- If any packet is missing or corrupted, then the message will be sent to resend the message.
- If the correct order of the packets is reached, then the acknowledgment message will be sent

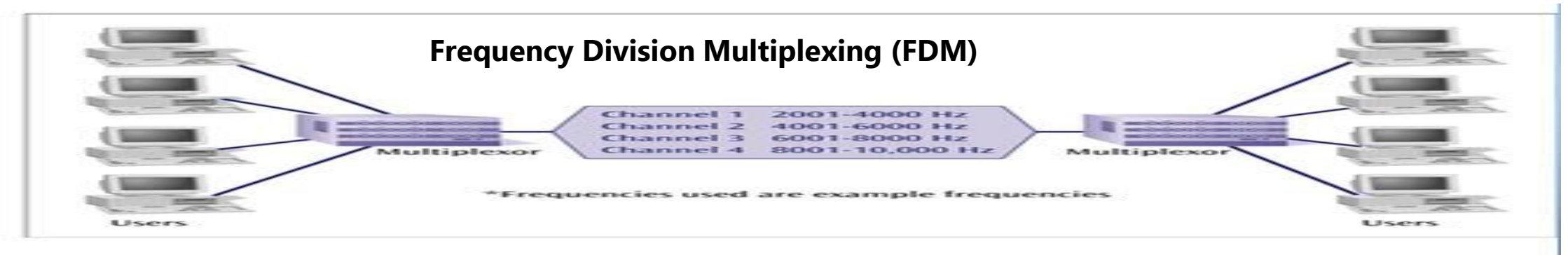


# Multiplexing



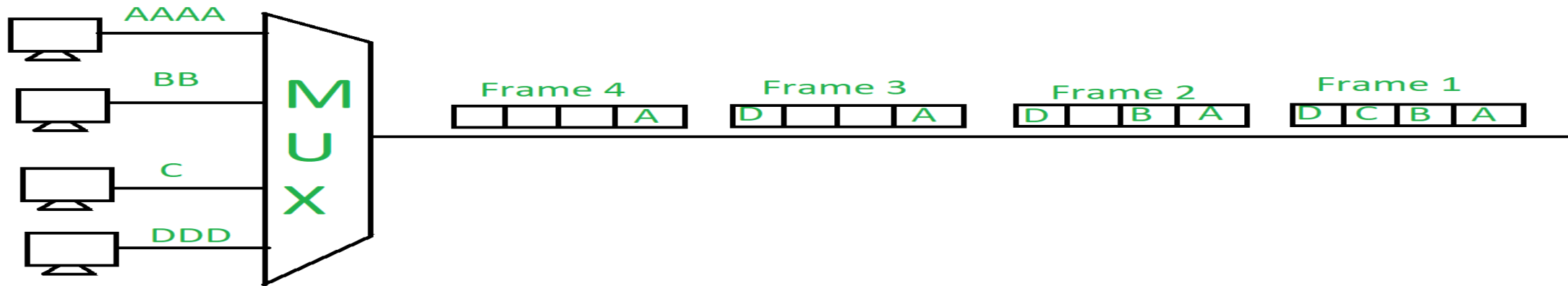
# Multiplexing

- A communication channel such as an optical fiber or coaxial cable can carry only one signal at any moment in time. **Wastage of Bandwidth**
- Multiplexing is the process of combining multiple signals into one, in such a manner that each individual signal can be retrieved at the destination.
- **Multiplexing** is used in the cases where the signals of lower bandwidth and the transmitting media is having higher bandwidth.
- Methods of Multiplexing;
  - FDM (Frequency Division Multiplexing)
  - TDM (Time Division Multiplexing)

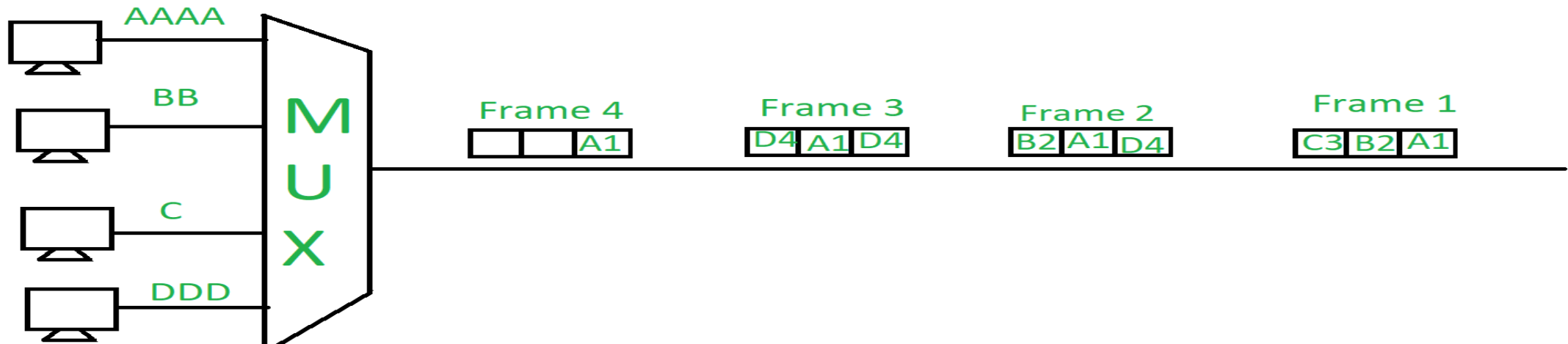


# Time Division Multiplexing (TDM)

## Synchronous TDM



## Asynchronous (or statistical) TDM



# TDM VS FDM

	<b>TDM (Time Division Multiplexing.)</b>	<b>FDM(Frequency Division Multiplexing)</b>
1	TDM works with digital signals as well as analog signals.	While FDM works with only analog signals.
2	TDM has low conflict.	While it has high conflict.
3	TDM is efficient.	While it is inefficient.
4	In TDM, time sharing takes place.	While in this, frequency sharing takes place.
5	Here synchronization pulse is necessary.	Here Guard band is necessary.
6	Framing bits (Sync Pulses) are used in TDM at the start of a frame in order to enable synchronization	FDM uses Guard bands to separate the signals and prevent its overlapping



---

# Network Classification



# Network Classification

## Classification by network geography

- according to the geographical boundaries spanned by the network itself
- LAN, WAN, MAN ,PAN, SAN( Major two are LAN and WAN)

## Classification by component roles

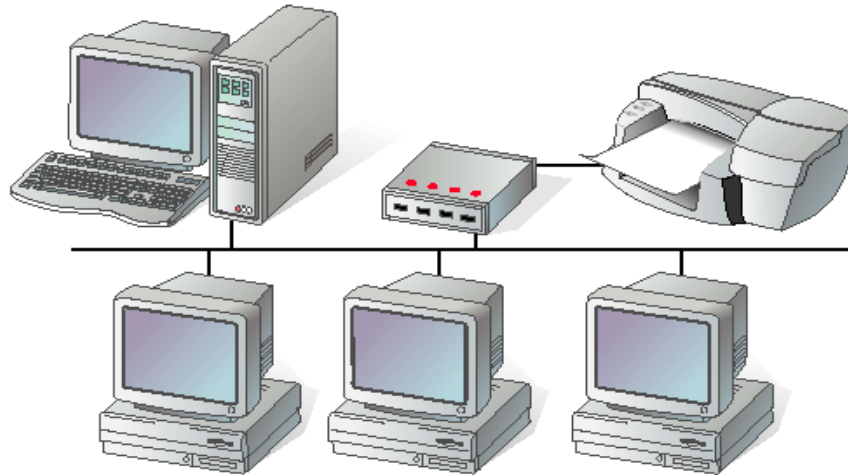
- according to the roles that the networked computers play in the network's operation
- Peer-to-peer, server-based, and client-based .

Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	
100 m	Building	Local area network
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet



# LAN (Local Area Network) : Wired Network

- Network in small geographical Area (Room, Building or a Campus)
- **Short distances (100 meters)**
- **Designed to provide local interconnectivity**
- LAN's can either be made wired or wireless. Twisted pair, coax or fiber optic cable can be used in wired LAN's
- a network that is used for communicating among computer devices, usually within an office building or home.





# Basic systems people use to set up wired networks

## An Ethernet system

- uses either a twisted copper-pair or coaxial-based transport system.
- The most commonly used cable for Ethernet is a **category 5 unshielded twisted pair (UTP)** cable

## A phone line

- simply uses existing phone wiring found in most homes

## Broadband systems

- provide cable Internet and use the same type of coaxial cable that gives us cable television



# Wired Network Designing

## Token Ring (Not used)

- Its copy write by IBM.
- It is a data link technology for local area networks (LANs) in which devices are connected in a star or ring topology.
- It was designed by only IBM PCs with 4mbps they increased upto 16mbps.

## Ethernet (Used World wide /Now a days)

- It belongs to IEEE
- Its autonomous
  - 10mbps (Ethernet),
  - 100mbps (fast Ethernet)
  - 1Gbps (Gigabit Ethernet)
  - 10gbps (10 gig Ethernet)
  - 100gbps (100 gig Ethernet)
  - LRE (Long Range Ethernet)



# Token Ring

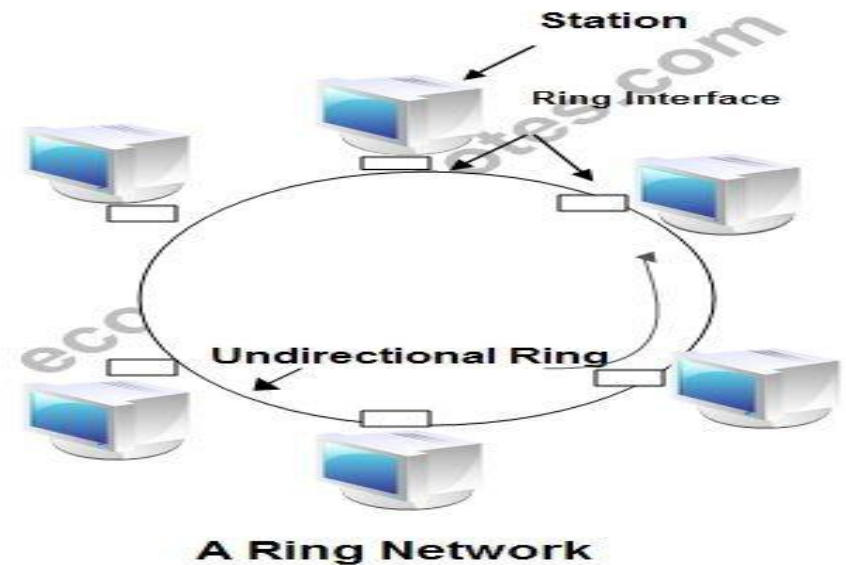
- The token ring LAN process is delineated by the following sequence of events:
  - A token continually circulates inside the token ring LAN
  - To transmit a message, a node inserts a message and destination address inside an empty token.
  - The token is examined by each successive node.  
The destination node copies the message data and returns the token to the source with the source address and a data receipt message.
  - The source receives the returned token, verifies copied and received data and empties the token.
  - The empty token now changes to circulation mode, and the process continues.

## Listen Mode

- The input bits are simply copied to output with a delay of 1-bit time.

## Transmit Mode

- The connection between input and output is broken by the interface so that it can insert its own data



# Ethernet Transfer speed 10 Mbps, 100 Mbps, or above

- Ethernet is the dominant cabling and low level data delivery technology used in Local Area Networks (LAN's).
- It was developed by Xerox corp. along with DEC and Intel.
- **Features:**
  1. Ethernet Addresses are 6 bytes( 48 bits) long.
  2. Ethernet supports networks built with twisted pair, thin and thick coaxial and fiber optic cabling.
  3. To prevent the loss of data, when two or more devices attempt to send packets at the same time, Ethernet detects collisions.

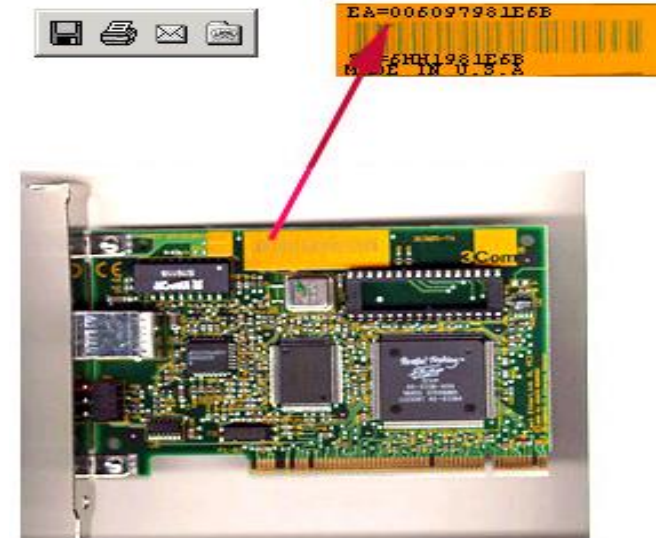


# Ethernet Address/ MAC Address

*Example: 47:20:1B:2E:08:EE*

- First three bytes from left specify the vendor.
- the last 24 bit should be created uniquely by the company

Cisco	00-00-0C
Dell	20-47-47
Sun	08-00-20
IBM	08-00-5A
Nokia	00-40-43



**Ipconfig/all : Ethernet adapter Ethernet(Physical Address)**

**A network interface card (NIC) / Ethernet Card is a piece of computer hardware designed to allow computers to communicate over a computer network.**



# Ethernet Frame Format/MAC Frame

Preamble	SFD	Destination MAC	Source MAC	Type	Data and Pad	FCS
7 Bytes	1 Byte	6 Bytes	6 Bytes	2 Bytes	46-1500 Bytes	4 Bytes

## Preamble

- informs the receiving system that a frame is starting and enables synchronization. In IEEE 802.3, eighth byte is start of frame (10101011)

## SFD (Start Frame Delimiter)

- signifies that the Destination MAC Address field begins with the next byte.

## Destination MAC

- identifies the receiving system.

## Source MAC

- identifies the sending system.

## Type

- defines the type of protocol inside the frame, for example IPv4 or IPv6.

## Data and Pad

- contains the payload data.
- Padding data is added to meet the minimum length requirement for this field (46 bytes).

## FCS (Frame Check Sequence)

- contains a 32-bit Cyclic Redundancy Check (CRC) which allows detection of corrupted data.



# How to determine the type of destination addresses

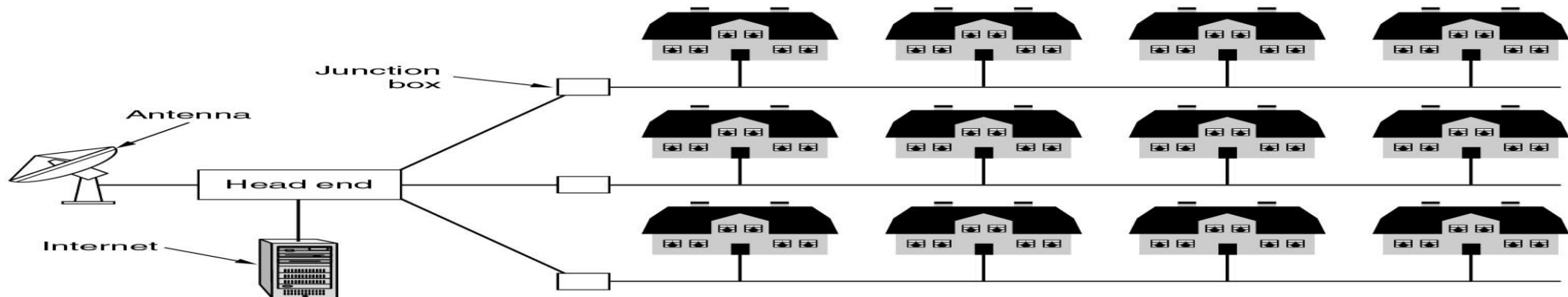
- To find the type of the address, we need to look at the **second hexadecimal digit** from the left. If it is **even**, the address is **unicast**. If it is **odd**, the address is **multicast**.
- *Define the type of the following destination addresses:*
  - a) 4A:30:10:21:10:1A
  - b) 47:20:1B:2E:08:EE
  - c) FF:FF:FF:FF:FF:FF

## ***Solution:***

- a) *This is a unicast address because A in binary is 1010.*
- b) *This is a multicast address because 7 in binary is 0111.*
- c) *This is a broadcast address because all digits are F's.*

# MAN

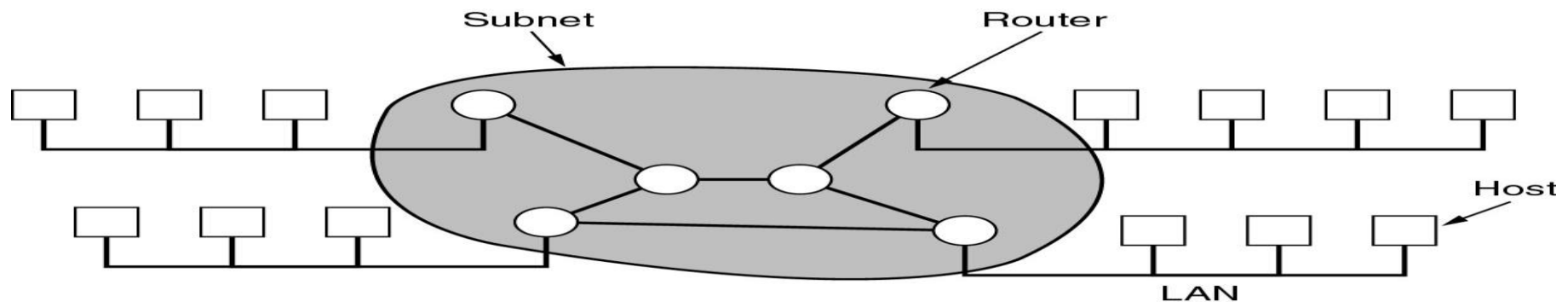
- A MAN spans the distance of a typical metropolitan city.
- The cost of installation and operation is higher.
- MANs use high-speed connections such as fiber optics to achieve higher speeds.
- Provide connectivity over areas such as a city, a campus
- More than 100m , Designed to handle data communication for multiple organizations in a city and nearby cities as well
- e.g. cable television network





# WAN

- Network spread geographically (Country or across Globe)
- WANs consist of two distinct components:
  - transmission lines (copper, fiber, microwave) and switches (electronics, optics)
  - Store-and-forward or packet-switched subnet
- WANs span a larger area than a single city.
- These use long distance telecommunication networks for connection, thereby increasing the cost.
- The Internet is a good example of a WAN.
- More than 1000m long distance, Provide connectivity over large areas



# Address Resolution Protocol (ARP)



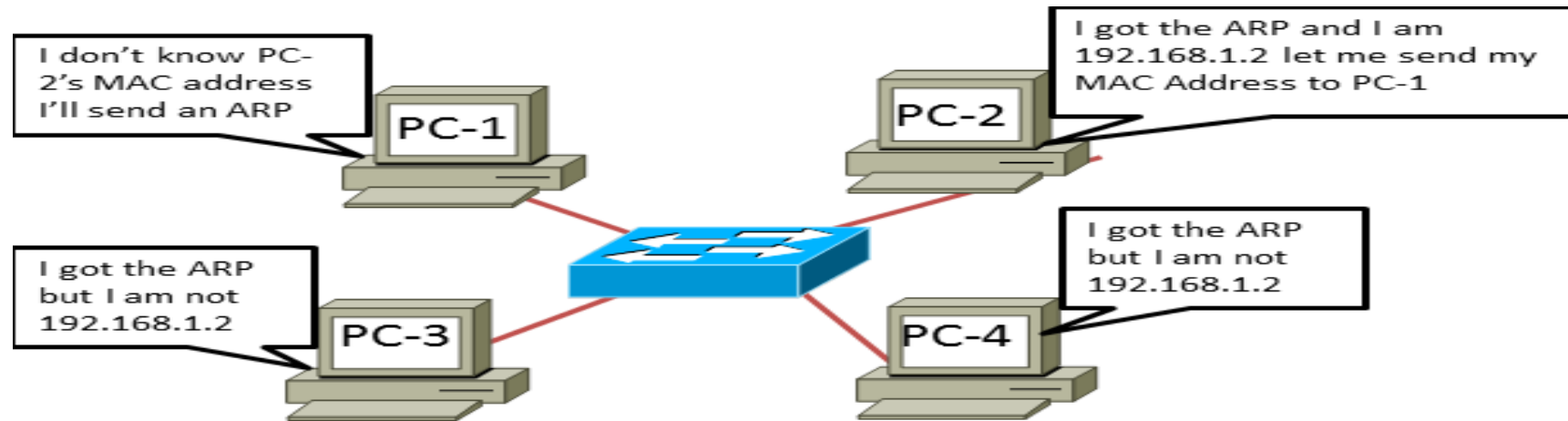
# ARP

- Address resolution refers to the process of finding an address of a computer in a network.
- The address is "resolved" using a protocol in which a piece of information is sent by a client process executing on the local computer to a server process executing on a remote computer.
- The address resolution procedure is completed when the client receives a response from the server containing the required address.
- The job of the ARP is essentially to translate 32-bit addresses to 48-bit addresses and vice-versa



# ARP

- Step1 : ARP Broadcast
    - Note: Broadcast is received by everyone and processed by everyone.
  - Step 2: ARP Reply
  - Step 3 : Actual Data Transfer
- 
- Router creates an ARP Request message to be sent to all hosts on the subnet.
  - Address resolution protocol message asks "Who has specified IP address ?"
  - Passes ARP request to data link layer process for delivery



---

# Thank You

