

# Computer Communication

## and Networks

INTRO :

Data Communications:

Data communications are the exchange of data between two devices via same form of transmission medium such as a wire cable. (also may be "wireless").

Characteristics of data communication system

The effectiveness of a data communications system depends upon four fundamental characteristics.

Delivery, accuracy, timeliness, jitter.

1 - Delivery:

The system must deliver data to the correct destination. Data must be received by the intended device or user and only by that device or user.

## 2- Accuracy:

The system must deliver the data accurately. Data that have been altered in transmission and left uncorrected ~~and~~ is unusable.

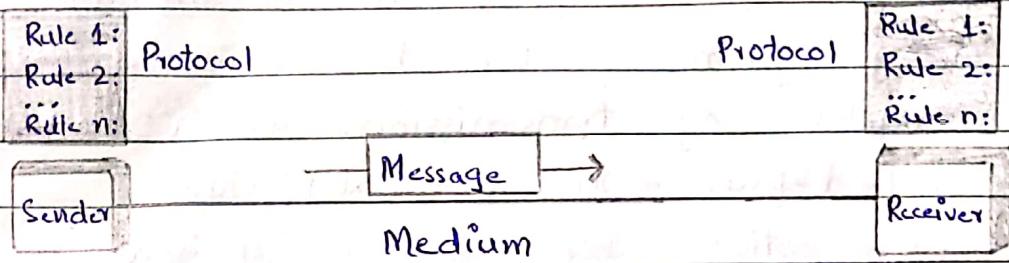
## 3- Timeliness:

The system must deliver data in a timely manner. Data delivered late are useless. 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. This kind of delivery is called real-time transmission.

## 4- Jitter:

Jitter refers to the variation in the packet arrival time. (Every message like audio, video, text or any other is transferred from one device to another in packets, 1 packet is 24KB). It is uneven delay in the delivery of audio or video packets).

## Five Components of Data Communication:



### 1. Message:

The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio and video.

### 2. Sender:

The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.

### 3. Receiver:

The receiver is the device that receives the message. It can be computer, workstation, telephone handset, television, and so on.

#### 4- Transmission medium :

The transmission medium is the physical path by which a message travels from sender to receiver. Some examples of transmission media include twisted-pair wire, coaxial cable, fibre-optic cable and radio waves.

#### 5- Protocol :

A protocol is a set of rules that govern data communications. It represents an agreement between the communication devices. Without a protocol, two devices may be connected but not communicating, just as a

person speaking French cannot be understood by a person who speaks only Japanese.

## Data Flow : /Communication modes : (simplex, half-duplex, and full-duplex)

### a) Simplex :

In simplex data flow is one-directional data flow in which sender only can send data (can't receive) and receiver only can receive (can't send) data.

### b) Half-duplex :

Half-duplex is two-directional data flow in which both devices have ability to send and receive data but not at the same time. (not parallelly or simultaneously).

### c) Full-duplex :

Full-duplex is also two-directional data flow like half-duplex but unlike half-duplex in full-duplex data can be sent and received by both devices at the same time. (parallelly or simultaneously).

## Network :

- Network is interconnection between two devices in order to share data on internet, and devices.
- 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 network is formed for sharing resources and to reduce cost of operation.

## Networks :

### ⇒ Distributed processing :

Most networks use distributed processing, in which a task is divided among multiple computers. Instead of one single large machine being responsible for all aspects of a process, separate computers (usually a personal computer or workstation) handle a subset.

=> Network Criteria:

A network must be able to meet a certain number of criteria. The most important of these are performance, reliability, and security.

### Performance :

- Performance can be measured in many ways, including transit time and response time.
- Transit time is the amount of time required for a message to travel from one device to another.
- Response time is the elapsed time between an inquiry and response.
- The performance of a network 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.
- Performance is often evaluated by two networking metrics, throughput and delay.
- We often need more throughput and less delay. However, these two criteria are often contradictory.

• If we try to send more data to the network, we may increase throughput, but we increase the delay because of traffic congestion in the network.

⇒ Reliability :

In addition to accuracy of delivery, network reliability is measured by the frequency of failure, the time it takes a link to recover from a failure.

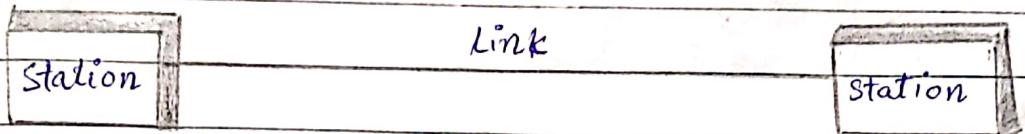
⇒ Security :

Network security issues include protecting data from unauthorized access, protecting data from damage and development, and implementing policies and procedures for recovery from breaches and data loss.

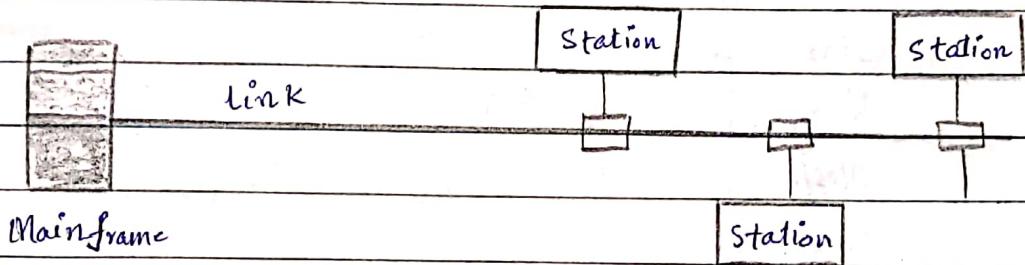
## Types of Connections :

- point to point
- multipoint

### a) Point to point



### b) Multipoint



## \* Network topology

- Physical topology
- Logical topology

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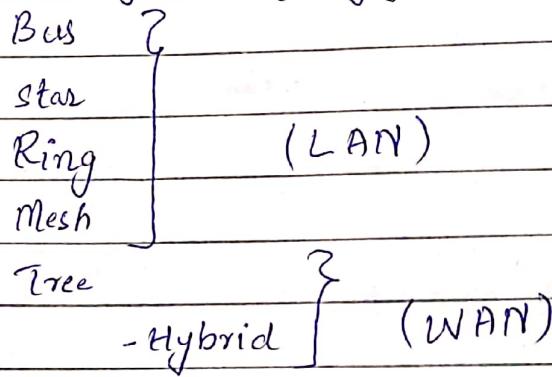
### • Physical topology :

The physical layout or structure of wires or cables that connect the nodes is referred as network topology.

The way devices are interconnected with each other. (Physical design of a network which consists of location, devices and the cable installation).

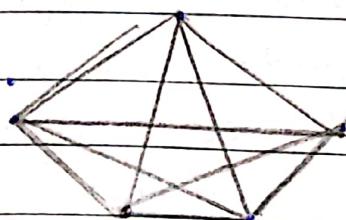
- Logical topology
  - The way devices are interconnected with each other.
  - How data flow b/w devices.
  - The actual transfer of the data in the network as per as its design plan.

### \* Types of topology



### \* Mesh topology:

- In mesh topology all nodes are connected with eachother through a dedicated link.
- Dedicated link means it only carries the traffic of devices it connects.



- If we have duplex link/cables to connect each node then

$$\left\{ \frac{N(N-1)}{2} \right\} = \text{Number of links in mesh}$$

- And if we have half-duplex links then

$$\left\{ \frac{N(N-1)}{2} \right\} = \text{Number of links in mesh}$$

$N$  = No of nodes in mesh

#### \* Advantages of Mesh topology

- High speed / Bandwidth (Bandwidth not shared)
- More secure / No privacy concern
- Quick fault detection
- Network variability
- No any problem of traffic congestion

#### \* Disadvantages

- Costly
- Difficult to manage
- Difficult to identify physical connectivity issues.

- \* Star topology
  - . Most common topology, used.
  - . All the nodes/devices are connected with a central device called a hub or switch.
  - . Broken connection between a node and hub does not effect the rest of the ~~faile~~ network.
  - . However if central devices 'hub' fails then whole network became dysfunctional.
  - . Bandwidth is divided in this topology.
  - . 4, 8, 16, 32 ... 128 ports.

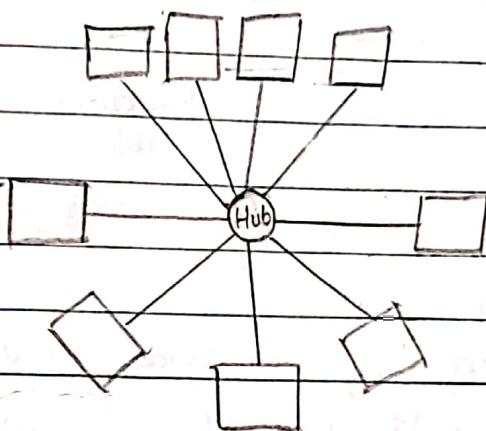
### \* Advantages

- . Star topology is better than bus and ring topologies in speed.
- . Less number of wires required.
- . Easy to manage.
- . Easy to configure.
- . Easy to extend.

(If nodes are more than ports than connect switch in one port and connect more nodes with that switch.).

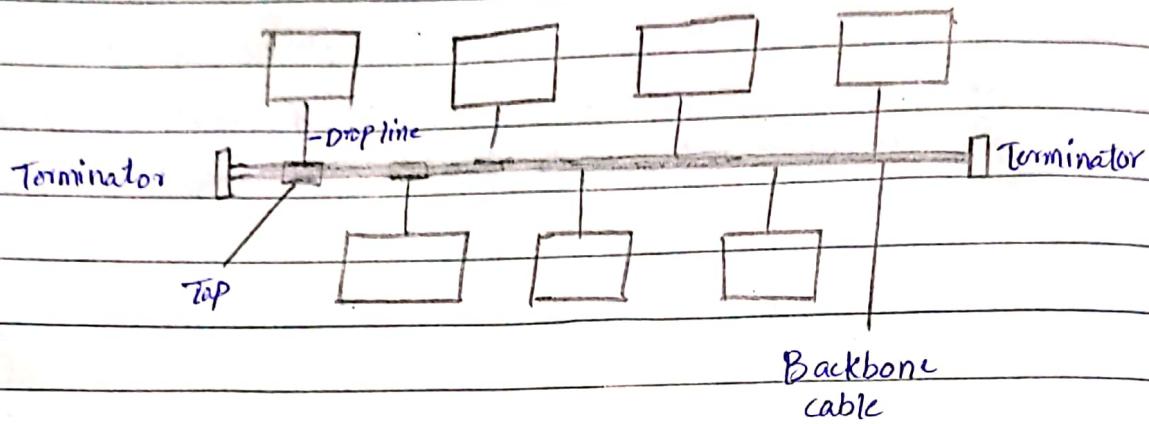
## \* Disadvantages

- Central point of failure.  
(If central device 'hub' fails whole network becomes dysfunctional.)
- That's why it is less reliable.



## \* Bus topology

- All nodes connected with the central cable called as backbone cable.
- There should be a high bandwidth cable in bus topology.
- Mostly used coaxial cable or Fiber optic cable in this topology.
- Dropline connect the mode to cable.
- Shared data (Data shared can be accessed by all nodes.).
- An special device 'terminator' is attached at the cable's start and end point that removes the data so it do not bounce back in cable.



### \* Advantages

- Less expensive
- No need of central device.
- Uses least amount of cabling.  
(However to keep data safe from colliding extra circuitry and softwares are used.)

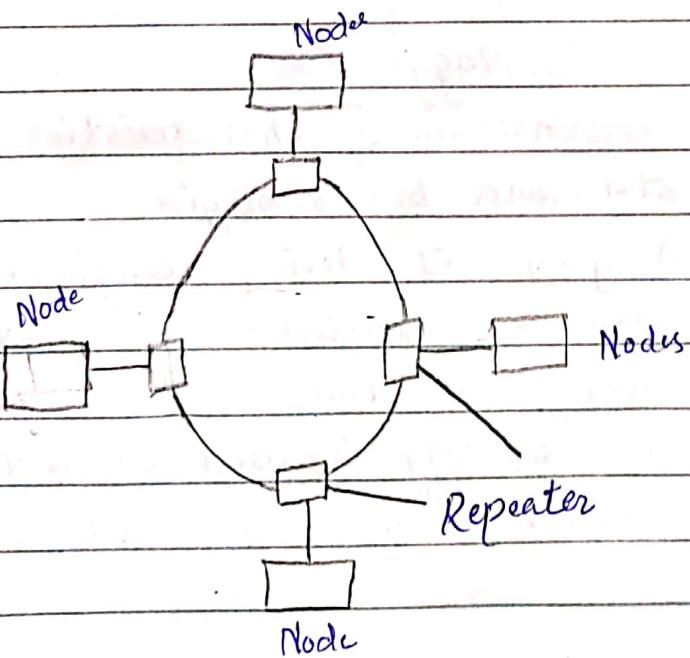
### \* Disadvantages

- Central-point failure.  
(Breaking down of backbone cable can bring down all or part of the network)
- Limited bandwidth,
- Slow in speed.
- Limitation on station of machines connected. (as limited backbone cable).

\*

## Ring topology

- Machines are connected in the form of cycle, each machine is connected with two mediums (one preceding and the one it precedes.)
- Data transfers in the form of token.
- Every message/token has two parts a header and data.
- Ad Header has address of the message.
- Each node examines the data as it travel through the ring.
- If the data is not addressed to the node that is examining it then data is passed to the next.
- Token message releases when data is reached at destination.



## \* Advantages

- Faster than bus.
- No danger of collision. (as only one packet of data travels through the ring at a time)

IP address:

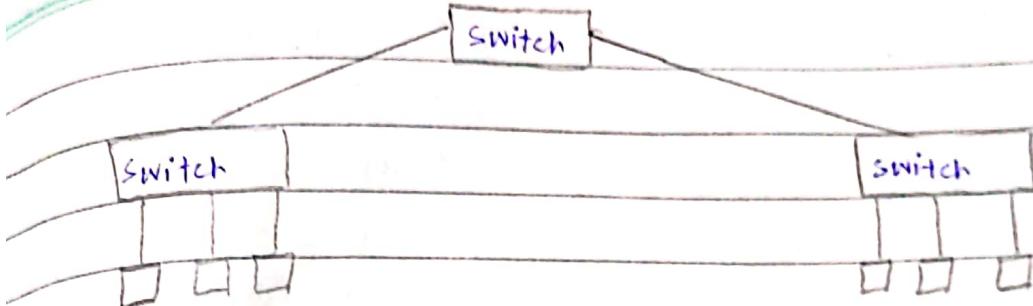
A unique identifier for machine on a network.

## \* Disadvantages

- Time consuming. (Machines have to wait for their turn to send the data).
- If one node, repeater or cable fails the whole network fails. but
- (There is also reverse system).

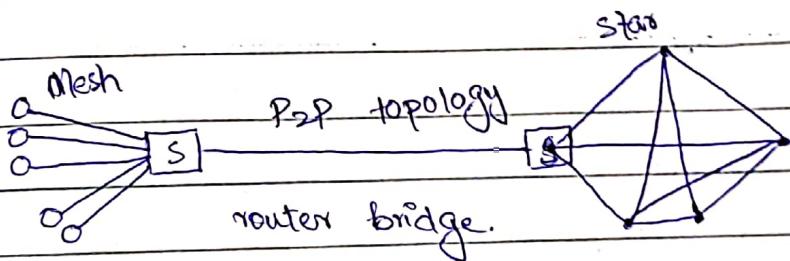
## \* Tree topology

- Combination of characteristics of star and bus topologies.
- A group of devices configured as star is connected to a cable which works as bus backbone cable.
- Tree topology is used in wide area network.



## \* Hybrid topology

- Combination of two or more network topologies.



## \* Network categories

- LAN (Local Area Network)
- WAN (Wide Area Network)
- MAN (Metropolitan Area Network)

## \* LAN

- It is a network formed within small geographic area such as Home, office, buildings.
- It ranges within few kilometers.
- It can connect limited number of stations.
- A single broadcast unit is called LAN.

- Broadcast unit means server.
- Same type of wire is used in whole LAN, and usually same topology is used in single LAN.

⇒ In some cases machines are both ~~machines~~ client and server, In that case we have to install any server application and/or change operating system.

- DHCP.

## \* WAN

A network formed within large geographic area. (Within a country, b/w countries or whole world).

A common example of WAN is internet.

{  
VPN  
Virtual private  
network.

## \* Long Distance transmission

- Switched WAN
- Point to point

### - Switched WAN

Backbone network that connects internet.

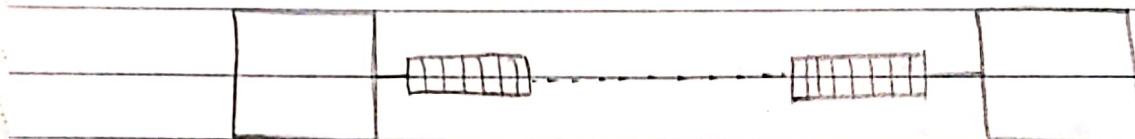
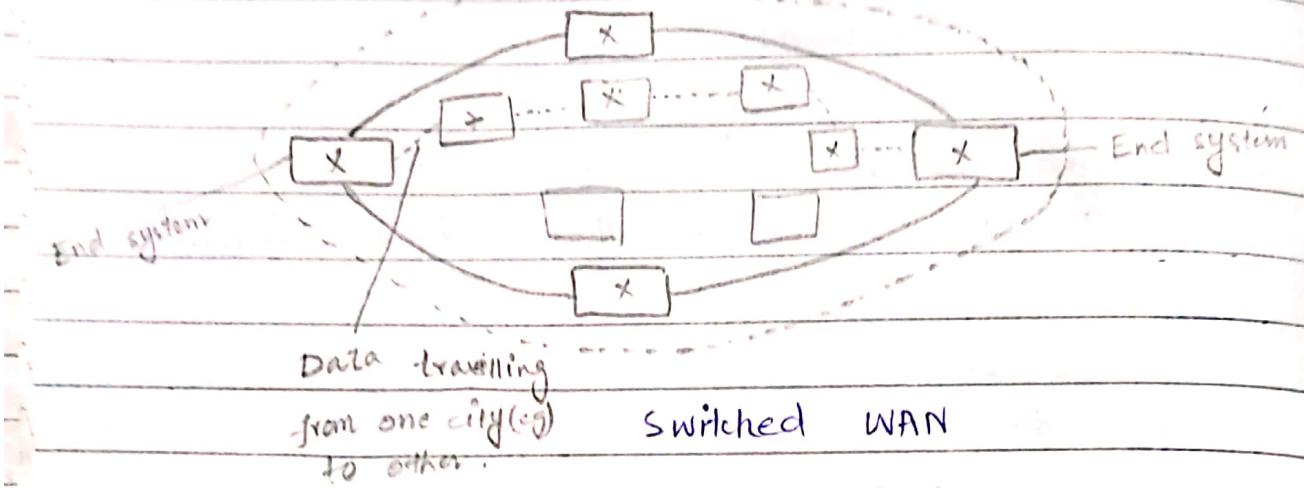
### - Point to point

A leased line provided to user  
to connect with internet.

## \* MAN

- A network larger than LAN and smaller than WAN.
- The typical examples of MAN are tv cable, telephone, company providing internet service.
- This is network within a city.

⇒ Both software and hardware are used in all 3 types of networks.



Point to point WAN.

{ Backbone network  
 Inside Network

- P2P connects end system with ISP - A leased line.

\* The Internet

- Combination of networks.

{ LAN address can be  
started with 192 or  
172 - Eg 192.168.0.1.

## History of Internet

- ARPA (Advance research project agency).  
1967 - ACM → Association for computing machinery.

### • ARPANET (1969)

IMP (Interface message processor)  
NCP (Network control protocol).

## LAB

### \* Network media

- i) Wireless media
- ii) Wirebased media

Network Media refers to the means used to link a network's nodes together.

- Many different types of transmission media, in wirebased media
- While in wireless network, atmosphere itself act as medium, because it carries the wireless signals that nodes and servers use to communicate.

### \* In wireless media there are :

- Radio signals
- IR signals /Infrared signals
- Microwave signals

- Radio signals

- Type of electromagnetic signal designed to carry information through air.

- Infrared (IR) signals

Infrared wireless networking uses infrared beams to send data transmissions b/w devices.

{ This type of signals use LOS (line of sight) which means an unobstructed path from a transmitting device to the receiver. } (not sure)

- Microwave signals

Microwave is a line of sight wireless communication technology that uses high frequency beams of radio waves to provide to provide high speed wireless connection that can send and receive ~~voice~~ data, information.

## \* Wire based media

This type of media uses different types of cables to communicate / transmit data b/w nodes of a network.

### \* Types of cables

- Coaxial cable
- Twisted pair cable
- Fiber optics cable

#### \* Coaxial cable

- Mostly used in tv cables.
- Two conductors, one a single wire in the center of the cable, other is a wire mesh surrounding first wire with an insulator between.
- Expensive
- Better than older types of twisted pair wiring in speed. (speed is 10 MBps)

#### \* Fiber optic

- Thin strand of glass that transmits pulsating beams of light rather than electric current.
- Carry data at a rate of more than a billion bits per second.
- Very secure transmission medium.

- Expensive
- Fastest
- Difficult to manipulate.

### \* Twisted pair

- Consists four pairs of wire.
- Each pair has two wires separately insulated in plastic, then twisted around each other and bound together in a layer of plastic.
- Twisted pairs can't be connected to devices directly, they should be configured.
- Twisted pair cables are easy to configure.
- Fast

$\Rightarrow$  Twisted pair cables come in many varieties called cat 1, cat 2 etc.

• Cat means category.

$\Rightarrow$  There is data rate difference in all categories.

$\Rightarrow$  There are cat 1, cat 2, cat 3 ... cat 9 cables.

$\Rightarrow$  All are both:

shielded twisted pair (STP) cables

Unshielded twisted pair (UTP) cables.

- ⇒ STPs are used within buildings while UTPs are used externally (outside buildings, on roads etc.).
- ⇒ Shielded wires are more expensive than unshielded.
- ⇒ There are 8 specific colors of each pair of wire in (UTP).
- ⇒ Basic colors are 4. (Blue, Green, Orange, white).

## \* Ethernet Cables

- Straight through cable
- Cross over cables
- Roll over cables

### Applications:

- Straight through:

Used for different device configuration same on both sides i  
on other side.

- Cross over

Used for similar devices.

Configuration a on one and b  
on other side.

- Roll over cable

→ Special purpose cable (used in router to PC).

→ One time use.

{ RJ 45  
stripping tool.

\* 100  
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For direct connection right length

## → \* Computer network model :

- The whole communication process is carried out in different layers, where each layer performs one or more specific tasks.
- So the internet uses layered communication models like TCP/IP model or OSI model.
- The concept of layering can be explained with post office example.

## Computer network models:

TCP/IP = (Transmission control protocol / Internet protocol)

⇒ Interconnected computer network use internet protocol suit also called TCP/IP model.

⇒ It helps devices in how they would connect and how data would transfer.

⇒ The TCP/IP is suit of protocols that provides end-to-end connectivity b/w devices.

It consists of five layers.

★ HTTP: Hyper text transfer protocol.

Used for web pages.

★ FTP: File transfer protocol.

Used to transfer files/documents.

★ SMTP:

Used to send mail.

★ Five layers:

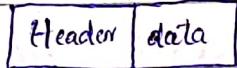
- Application layer
- Transport Layer
- Network layer
- Data link Layer
- Physical layer

### • Application Layer

Layer where you type message and send.

OR You request for any web page on internet.  
(Where you aren't concerned about kind of network (wireless or wired))

The address of receiving device is provided in the form of header before message content.



### • Transport Layer

This establishes connection b/w a client and server. If any error occurs, sends error message.

If the network is fine, the port number is added with message header, which consist of source port and destination port.



### • Network Layer

Network Layer moves the data from one network to other.

⇒ At this stage IP address is added to header.

## • Data link layer

Sends a message to the server connected with sender.

⇒ Here Network interface card (NIC) address is added, which is called frame.



## • Physical layer

Transfer data in the form of bits.

⇒ And it is also about the physical medium used in communication, like cabling etc.

## \* Addressing :

Four levels:

- physical
- logical
- Port
- Specific

## • Physical

→ Permanent, hardware level address

→ Embedded in network Interface card

→ NIC is made by many manufacturers.

Ex: Belkin, Nortel, Cisco

- IEEE gives a block of addresses to manufacturer.
- (48)bit (6 byte) address written 12 hex numbers, every 2 hex separated by a colon.

### • Logical Address

Multiple Devices in internet, the devices are identified with logical address.

- 32-bit address, in the form of decimal numbers separated with dots. (called dotted decimal notation). (0-255)
- Logical address is unique.

### • Port Address

For ex one PC sends data to other PC, that is running many programs at a time, so every program /Process an address have been assigned, that is called port address.

- Port address in TCP/IP is 16 bit in length

### • Specific addresses

User friendly /specifically addresses.

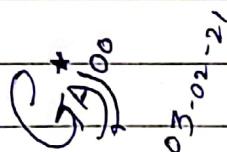
Ex:

Email address

URL

- Logical address delivers data to right network.
- Physical address - - - - Host
- Port address - - - - Process.

## Encapsulation :



## \* Analog and digital

When data is sent over physical medium,  
it needs to first convert into  
electromagnetic signals.

Data itself may be analog and/or digital.

Example of analog is human voice.

Example of digital is any file on disc.

(Explanation of both is in ppt).

## Digital signal:

- Discrete in nature. and represent sequence of voltage pulses.
- Used within circuit of co

\* Periodic and nonperiodic signals :

Period:

Time required by a signal to complete its cycle.

Periodic signal:

Signals which follows pattern and repeats, itself at regular interval of time.

Non - periodic signal

Does not follow pattern.

\* Sine Waves

Simple periodic analog signal

Follows simple pattern.

→ Have 3 attributes

Amplitude

Frequency

Phase | Phase shift

• Amplitude :

Value of a signal at a point.

## Propagation mode:

### 2- Frequency

• Period ( $T$ ) : Time required (second) by a signal to complete its cycle.

• Frequency ( $f$ ) : Periods/second

Rate of change of sine wave.

### 3- Phase shift

Position (shift) of wave while starting.

## \* Wavelength

Distance a simple signal can travel in one period.

## \* Bit rate

Rate at which bits are transferred from one location to other.

In other words, it measures how much data is transmitted in a given amount.

## Bit length:

The bit length of each word defines, for one thing, how many memory location can be independently addressed by the processor.

## Bandwidth:

The maximum amount of data transmitted over an internet connection in a given amount of time.