19/7/2024

Networking

What is networking or computer networking?

-> A group of digital devices are interconnected to share information using wired or wireless connections.

Computer networks works by certain protocols or rules.

~~Communication done by cat~~ wire

Basic Terminologies of Computer Networks

1. Nodes - devices connected to a network. [e.g computers, servers, printers, routers, switches] - "simply the networking devices"

2. Protocol - set of rules for transmitting data over a network.

   e.g TCP/IP, HTTP and FTP

3. Topology - refers to physical and logical arrangements of nodes on a network

   It includes:

   - bus
   - star
   - ring
   - mesh
   - tree

4. ISP [internet Service provider]

* It is a company or organization which provides internet access to individuals and other companies and other related services like

-> Web hosting

-> email services

-> domain registration

eg Vodafone, Reliance jio, Verizon

ISPs provide internet access through technologies like

1. Dial-up (telephone lines to connect internet)
2. Digital subscriber line
3. Cables
4. Fiber optic
5. Satellite
6. Wireless (radio signals)

NOTE:

95% Data transfer in internet occurs in Ocean cables - 95%

remaining 5% - Satellite

5. IP address

-> It is a unique numerical address assigned to devices on a network

-> Simply called "computer address"

-> It will in form nnn.nnn.nnn.nnn (nnn ranges from 0 to 255)

6. DNS (Domain Name System)

-> It is protocol used to translate

domain names (www.google.com) ⟶ IP addresses (142.250.70.46)

domain names (www.google.com) — human readable

IP addresses (142.250.70.46) — computer readable

7. Fire Wall

- A fire wall is used to protect networks from unauthorized access and other security threats.

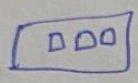
Basics of Networking

let us take an example network LAN (local area network)

LAN

-> In this network, devices are connected together in one physical location (e.g building, office, home)

-> It uses single internet connection

Switch 

-> It joins devices in a network and allows them to communicate by exchanging data packets.

-> It differentiates each devices by its IP/MAC addresses

Now, How this Local network can connect with other networks?

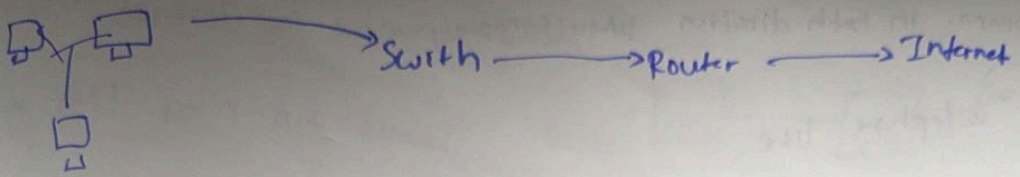
Switch is connected to Router

Router 

-> It is a device used to forward data packets between computer networks

-> Connected to atleast two networks

LAN



Data Communication and protocols

exchange of data between two nodes via some transmition medium.

Data flow -> data flowing from one node to another

- Simplex
- Half Duplex
- Full duplex

Simplex -> 1. Communication always unidirection (one transmit, other receive)
eg keyboard.

Half duplex
-> Communication in both direction, but not at same time

-> one sending another receiving and viceversa

e.g Walkie-Talkie

Full duplex

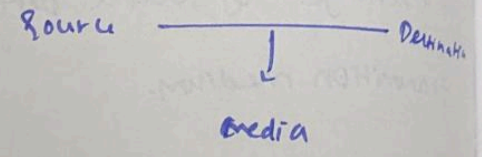
Comm. in both direction simultaneously

e.g. Telephone line

protocols

All communication having common things.

* Source or Sender
* Destination or receiver
* Channel or media.



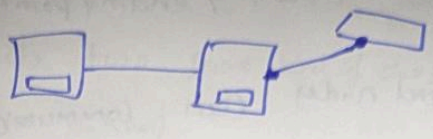
protocals or rules govern these methods. (Data communication)

If no protocols, communication becomes useless

protocol defines
- Msg encoding (encodes the data)
- " formatting and encapsulation → receiver identity who has sent data (provides details what sent)
- Msg timing (flow control and response time)
- Msg size (msg broken into smaller parts to travel)
- delivery options
  - unicast → Sender sends to one receiver
  - multicast → Sender sends to two or more receivers
  - broadcast → Sender sends to all receivers in network.

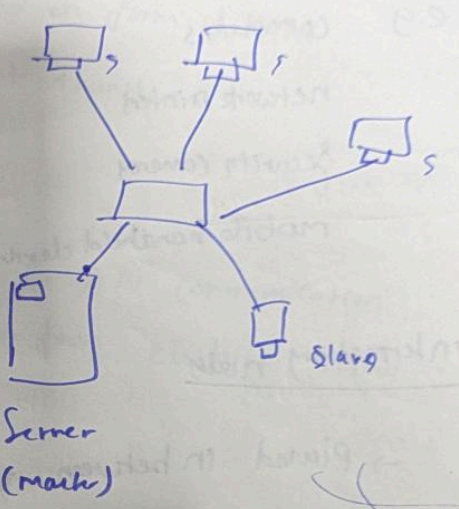
Peer to Peer Network

- No Centralized administration.
- All peers are equal.
- Not Scalable
- All can repond and requst.



Client Server Network

- → Centralized administration.
- → Request - Response model
- → Scalable



→ Other network devide request to the Server.

NOTE: any device can be turned into Web Server by installing Proper Web Server Software.

Components of Computer network

→ A computer network has 3 Components

1. Nodes
2. Media
3. Services

1. **Nodes:** (can relive / send data)

End nodes / computers

Intermediate nodes

End nodes

-> Starting point / ending point of communication.

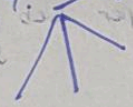
-> End nodes can communicate with each other through intermediary nodes

e.g computers
network printers
Security cameras
mobile handheld devices.

intermediary nodes

-> Placed in between ~~intermediary~~ end nodes

-> transfer data between end nodes.

e.g. 
Switches
wireless accesspoint
Routers
Fire wall
Bridge
Hub
repeaters
Cell Tower

2. Media (like medium)
   - Wired medium (Guided) (cable present btw nodes) (data converted to electrical or light signals) ~~Ethernet~~
   - Wireless medium (unguided) (no cable)

Wired media

- Ethernet cable
  - Straight-through → connects two different devices
    - → data in electrical signal.
  - Crossover → connects two same kind of device
    - eg (two switches)
- Fiber optic cable → ~~high~~ data in form of light
  - → fastest transfer
- Coaxial cable → mainly for A/V communication
  - → data in form electrical signal
- USB-cable → Computer - Smartphone.

Wireless media

data converted into form of infrared, radio, microwave.

~~Not~~ i.e data → waves

i) infrared → short range communication e.g TV-remote

ii) radio → radio > infrared e.g bluetooth, wifi

iii) microwaves (cellular system - long range) smartphone - cell tower

iv) satellite → long range communication e.g GPS

3. Service (exchange of information)

e-mail — online gaming

Storage service — voice over IP

File sharing — video call

instant messaging — WWW

Network Device

1. Host
2. IP address
3. Network
4. Repeater
5. Hub
6. Bridge
7. Switch
8. Router.

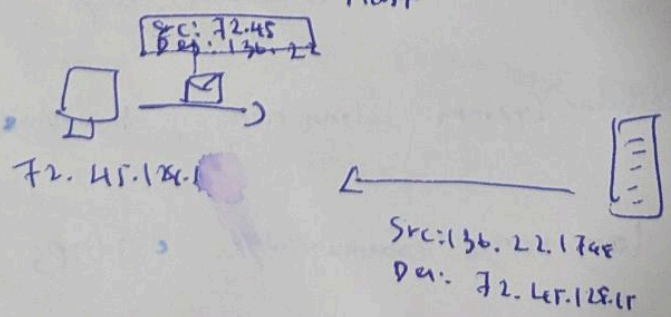
Hosts

→ any device sends/receives traffic over network (data consumer) eg. Computer (laptop, mobile, IOT)

e.g. Cloud Server

IP address

→ identity of each host



- IP addresses are 32-bits [bit → 0 or 1]

→ 32-bits divided into 4 Octets

n.n.n.n

136. 22. 17. 98

n → 1 octet (11111111) → 255

(n → 0 to 255)

- ~~Each~~

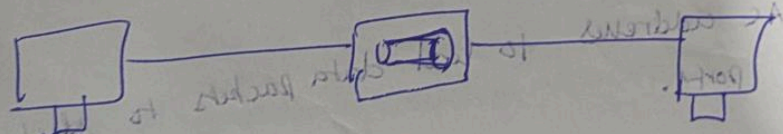
→ Each Octect (n) can be 0 to 255

Repeater

→ Operates at physical layer.

→ It amplifies or regenerates the signal over same network (before signal becomes weak).

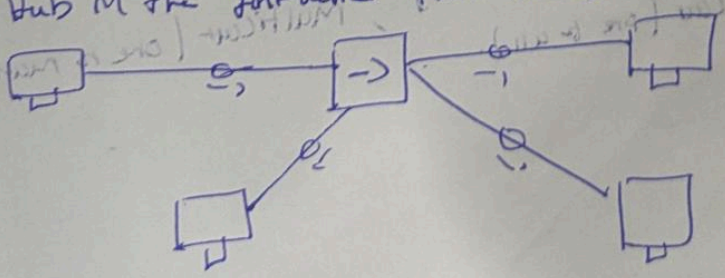
→ 2-port device.



Hubs

- Multi-port Repeater

→ Hub is the first device that allows to connect multiple de... at center

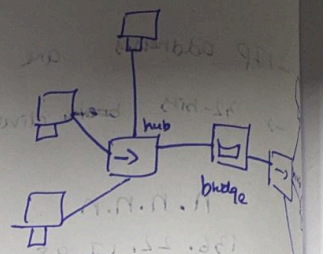


→ Prbm: everyone receives everyone else's data.

accepts packets & amplifies.

Bridge

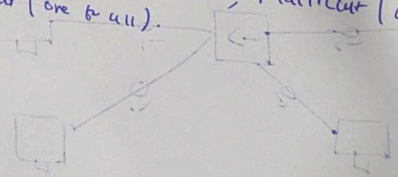
- sits between two LANs
- Hub-connected halfs.
- only have two ports.



- operate at Data link layer
- allows the passing of only selective packets
- only passes packets addressed from node in one network to another node in other network.

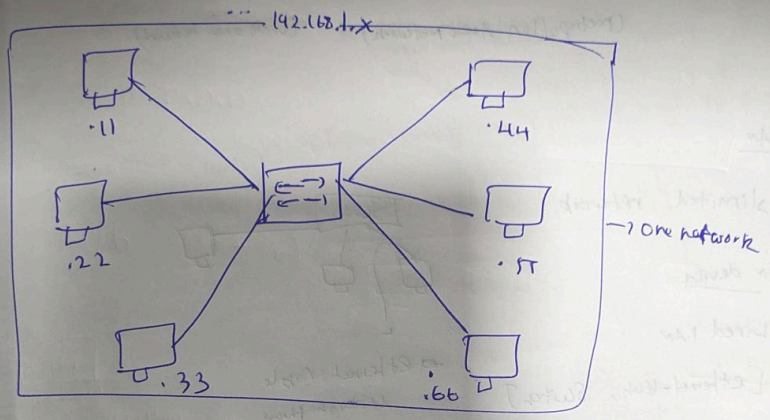
Switch

- facilitate communication within network
- data link layer
- multi port network bridge.
- uses MAC addresses to send data packets to selected destination ports.
- uses packet switching technique to transfer / receive data packets
- supports unicast (one to one), multicast (one to many), and broadcast (one to all).



Note:

Hosts on Network Share Same IP address Space



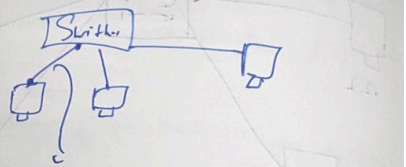
Routers

facilitate communication between networks

Classification of networks

1. LAN 2. MAN 3. WAN

(Metropolitan Area Network) (Wide area network)



1. LAN

- limited network.

LAN devices

→ Wired LAN

[ethernet-Hub, Switch]

→ Wireless LAN

[wifi]

→ Ethernet Cable
Straight through

→ To connect two computer, use ethernet cross over Cable

2. MAN

interconnects Computers in region of size of metropolitan City.

e.g ~~two~~ two or more LAN M connected, then it falls into MAN

Man-devices

→ Switch / Hub

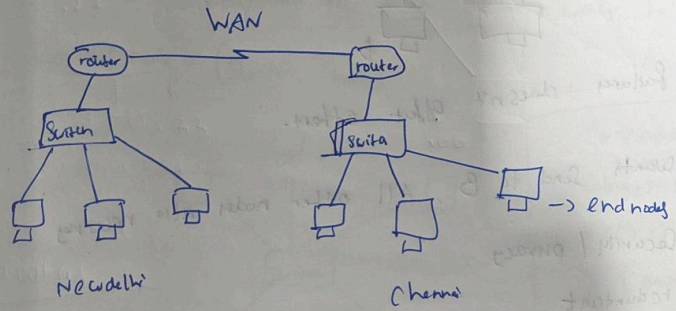
→ Routers / Bridge

3. WAN (wide area network)

-> A telecommunication network that extends over large area (actual computer networking)

WAN devices

-, End devices (nodes)
-) Intermediary devices (switch, routers)



Network topology

-> Arrangement of nodes of a computer network. to make communic

topology = layout

-) two types / kinds < physical [placement of various nodes]
logical [dataflow in the network]

Types of topology

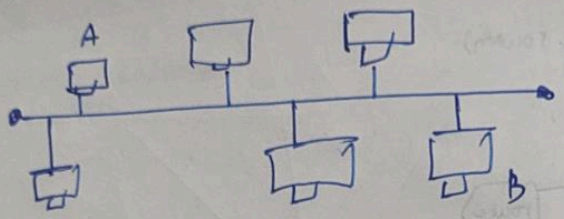
Bus, Ring, Star, Mesh, Hybrid

Bus Topology

-> All data transmitter between nodes in over common transmission medium.

-> Bi directional communication.

-> received by all nodes simultaneously.



-> Node failures doesn't affect others.

problem

-> If A wants send to B, All other nodes also receiving

-> No Security / privacy

-> No redundant

Ring topology

-> A bus topology in a closed loop.

-> Peer to peer LAN [No Supervisor, all are equal]

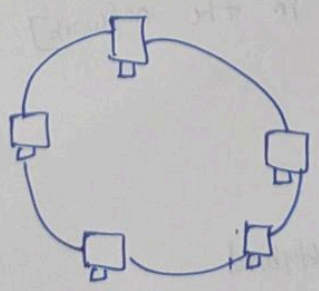
-> Unidirectional

-> Sending and receiving takes with token.

N-> no. of nodes

Cables = N

ports = 2*N



-> The one holding Token can send ~~data~~ the data.

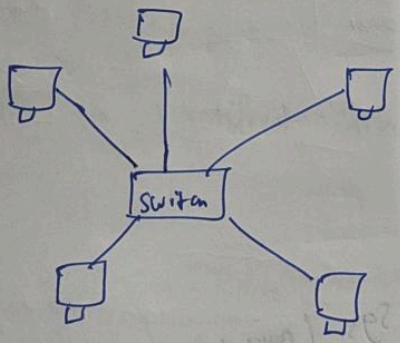
-> It travels (circulates) all nodes until it reaches its destination.

Problem

-> Single point failure
-> No security
-> ↑ load ↓ performance.

Star topology

-> Every node is connected to each other with help of Central node (switch / hub).



n - no. of nodes

Cable -> N

Ports -> 2×N

(1 port in switch also)

-> Centralized network

-> All traffic must pass through Central node (switch / hub).

-> Scalable

Problems

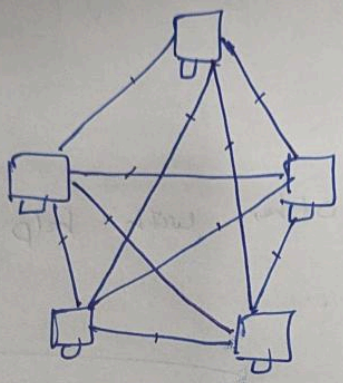
-> Single point failure.

-> heavy traffic ↑/↓ performance.

-> Cost.

Mesh topology

→ each node is directly connected to every other node in network.



N → nodes

Cable = $n(n-1)/2$

Port = $n*(n-1)$

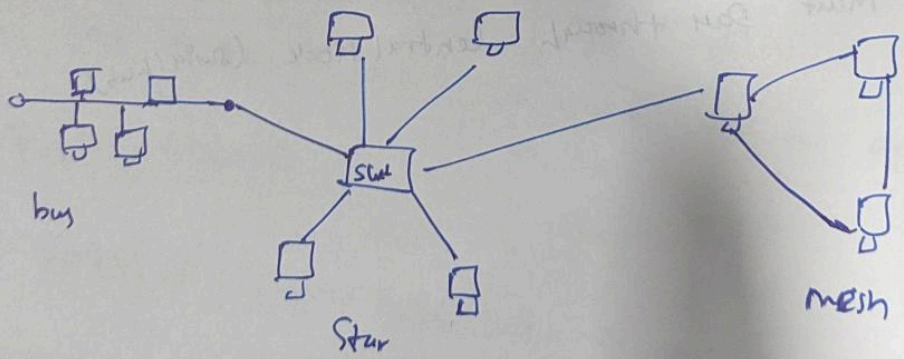
→ No single point failure.

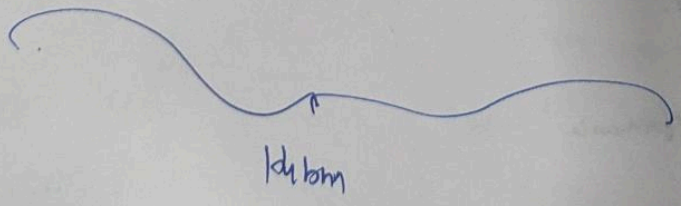
Problems

→ issues with broad casting msgs (router to all)

→ Cost.

Hybrid topology

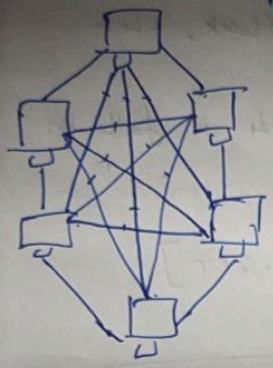




Hybrid

How many cables and ports?

mesh network of 6 nodes



6.3.3

nodes = 6

Cables = 15 (i.e $\frac{6(6-1)}{2} = 3 \times 5 = 15$)

Ports = $n*(n-1) = 6 \times 5 = 30$

Basics of IP address (address of computers)

IP- Internet Protocol.

→ Every node is identified with help of IP address in the network.

→ two versions IPs ┬ IPV4 32-bit
                   └ IPV6 128-bit

→ logical address and changeable.

→ IPV4 address → has 32-bit of 4 octets (X.X.X.X) in decimal

→ range. 0.0.0.0 to 255.255.255.255

as octets → can have 8 1's and 0's (e.g X → 0|111000|)

max X → (11111111)

Notes:

DHCP (Dynamic Host Configuration Protocol) Servers assigns the IP address and other configuration parameters like Subnet mask, default gateways and DNS servers to devices.

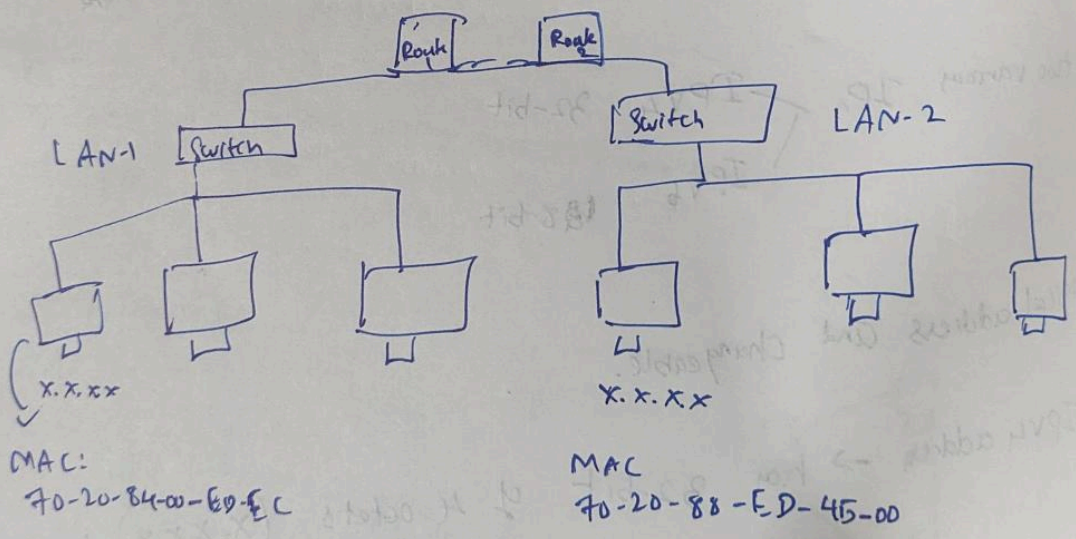
Now, if a node is { not connected to any network, then DHCP as a Link-local address, for IPV4 it falls in range [169.254.0.0 to 169.254.255.255]

Basics of Mac addressing

MAC → media access control

→ Every node in LAN is identified with help of MAC address

→ It is called the Physical or Hardware address



Here, Router needs IP address to forward data

Switch needs MAC address to forward data

→ unique / Cannot be changed

→ Assigned by Manufacturer.

→ Rep. in Hexadecimal. e.g 70-20-84-00-ED-FC

-> It consists of 48 bits.

-> Separator can be - , . , : (based on manufacturer.)

Command to find

IPconfig/all

Public and private IP address

-> Public IP is assigned to device for use on Internet.

-> It is unique

-> They are assigned by ISP.

e.g 203.0.113.1

Private IP

-> Private IP is used with LAN

-> not unique across internet.

They fall within range :-

-> 10.0.0.0 - 10.255.255.255

-> 172.16.0.0 - 172.31.255.255

-> 192.168.0.0 - 192.168.255.255

In home network (LAN), the router itself has private IP apart from Public IP from ISP. The router assigns private IP to

-> Computer (192.168.1.2)

-> Smartphone (192.168.1.3)

and etc..

e.g Scenario

My PC connected Wifi (home/CIA)

PC → with private ip address (wants to communicate on the
(192.168.1.2)

↓

The wifi router translates the PC's private IP to
wifi's public IP

↓

The website sees request from router's public IP

↓

And reponds to it.

↓

router then forwards to corresponding IP(PC).