

Communication

Networking (basic): Is the exchange of info and ideas among people with a common profession or special interest.

Internet: A global network providing communication facilities

Network: When two or more systems are connected through wire or wireless medium

Advantages of Using Network

- **File Sharing:** Users can share files with other users
- **Hardware Sharing:** Users can share hardware such as printers
- **Software Sharing:** Users can share software applications
- **Communication:** Users can send mail or chat

Disadvantages of Using Network

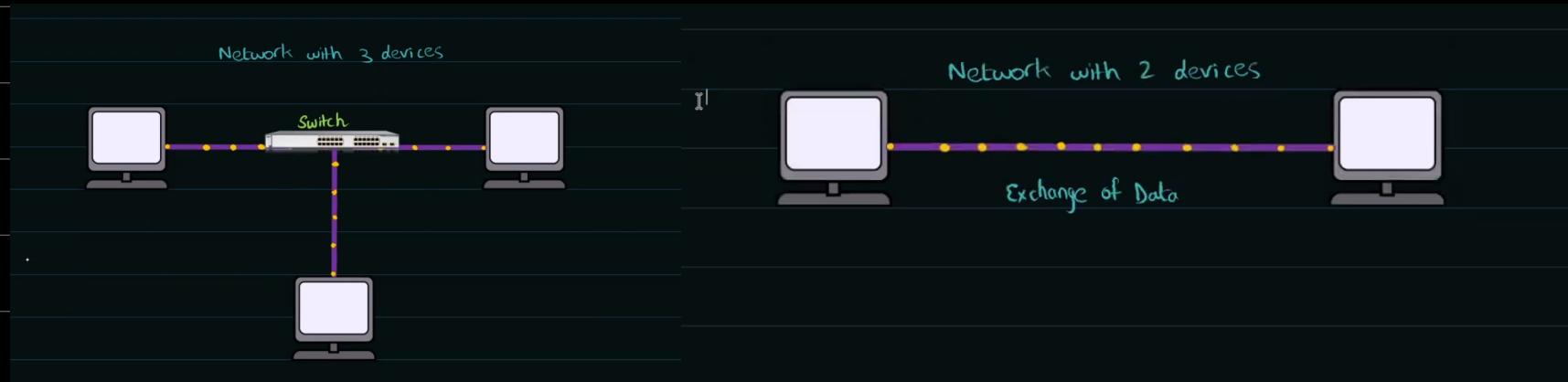
- **Cost:** Additional equipment would be required
- **Management:** Networks requires management for technical stuff
- **Malware:** Virus can spread easily through improperly secured network
- **Hacking:** Once a device is connected to another device, it is easier to hack

Network



LAN (Local Area Network)

WAN (Wide Area Network)

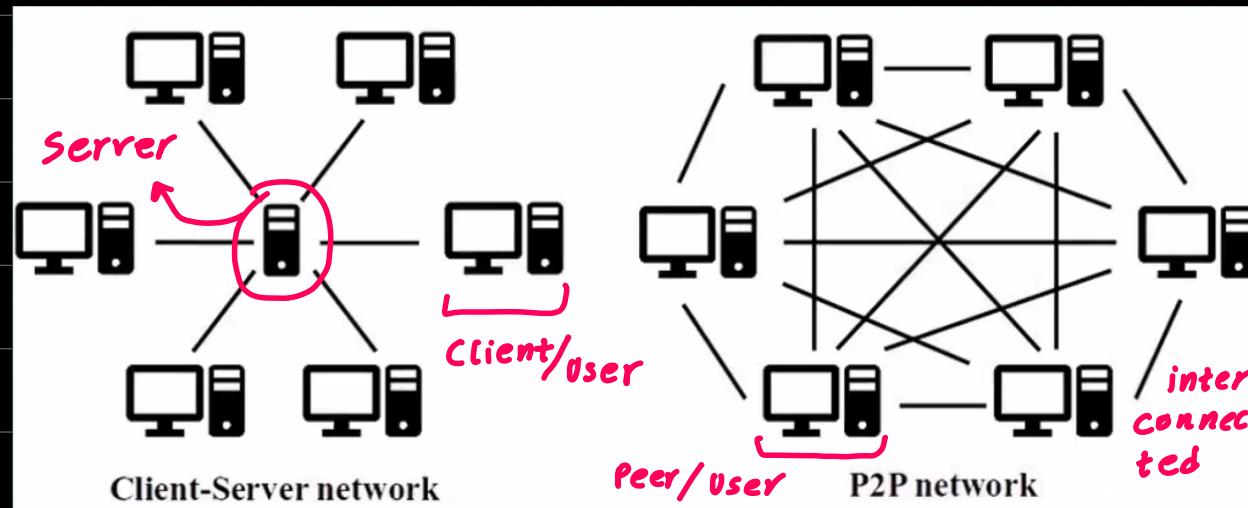


Network: When two or more systems are connected wirelessly or through wire.

- Local Area Network (LAN) : A network connecting computers in a single room, single building.
- Wide Area Network (WAN) : A network ^{connecting} computers on different sites, possibly thousands of kilometers apart.

Client-Server + Peer-to-Peer Model

- Network can be designed in two different ways. ① Client - Server
② Peer - to - Peer



Server

- A server is a comp./system that provides resources, data to other comps known as clients



e.g: File server → stores files.

Print server → handles operations relating to printers

Proxy server → Filters network traffic

Application Server → stores apps'

Web Server

data

Q- What is meant by client -server model of networked comps?

- At least one computer is used to "serve"
- Other comps. are referred to as clients
- Server provides services/ application

Scenario - Based Questions

Downloading a file from a website is an example of client-server application

Q- What is meant by the term client-server?

- The file is made available from web-server
- The user's browser is the client software.
- The client (software browser) requests the file from the server
- The desired file is returned to the client comp.

Bank has a client-server model of networked comps.

Q- Describe, using the bank as an example, the key features of a client-server model?

- The bank's server holds the customer account data
- and performs the requested task.
- The computers, used by the customers, are known as clients
- that send requests to the server
- which returns results of the requests
- E.g: A customer asks a list of recent transactions on their account.

Q- How client - server model enables the employees to access same files from different comps?

- The employees comps are known as clients
- The server hosts the shared file.
- An employee can request a file (from the server) from any of the client comps.
- Several employees can access the same file (on the server) at the same time.

Benefits of Client- Server Model

- Files and resources are centralised (controlled by organisation)
- Creation of security / management of security
- Centralised Backup
- Internet Monitoring
- Clients can be less powerful machines, therefore less expensive to buy
- Saving resources on the server reduces burden on the client

Q- Describe the key features of a Peer to Peer network

- All comps are of equal status (peers)
- Each comp. provides access to resources and data
- Comps can communicate and share resources
- Each comp. is responsible for its own security

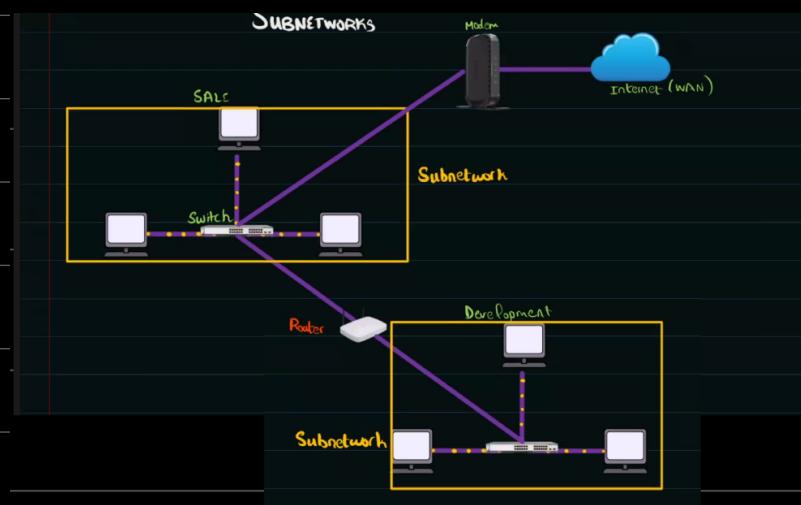
Benefits of Peer to Peer Model

- It avoids possibility of congestion when more clients are simultaneously requesting to download a file
- It allows users to download different parts of files separately
- The parts are available from more than one host.

Drawbacks of Peer to Peer Model

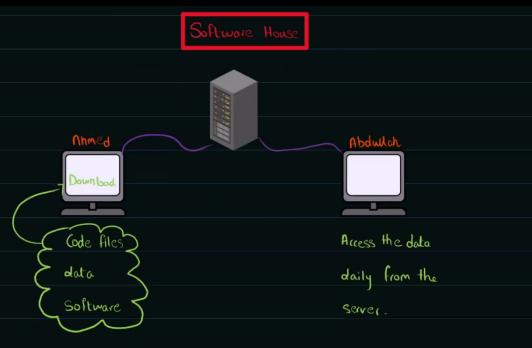
- Reduced Security, each computer is at risk from viruses from other comps.
- No central management of backup, if the data from one comp. is not backed up, it is lost to all of them
- No central management of file, consistency may be difficult to maintain
- Individual comps may respond slower because they are being accessed by other computers.

Subnetworks



Thin and Thick Client

Ahmed bro can go home and work remotely, he will have no issue if server goes down, so more functionality



Abdullah bro needs connection with server. If server goes down, he can not work.

Thin Client

Thick Client

Thin Client: A device or software which is heavily dependant on having access to a server. Thin client will not work unless it is connected to server at all times. E.g: web browser

Thick Client: A thick client can either be a device or software that can also work offline. It is still able to do some processing whether it is connected to a server or not

e.g: Laptop

Advantages and Disadvantages of Thick Client

Advantages:

- More robust as device can carry out processing even when not connected to server
- Better uptime of client
- Reduced server demand (less chances for server crash)
- Clients have more control

Disadvantages:

- Less secure (relies on client to keep their own data secure)
- Each client needs to update data and software individually
- * • Data integrity issues, since many clients access the same data which can lead to inconsistent data.

Advantages and Disadvantages of Thin Client

Advantages:

- Less expensive to expand as low powered and cheap devices can be used
- Data updates and new software installation done centrally on server
- More secure as server can offer protection against hacking and malware

Disadvantages:

- Dependant on server, if the server goes down the device can not work
- More downtime

Q- Difference b/w thin and thick client.

- Thin Client relies on server, thick client can work without server
- Thin client relies on faster internet, Thick client can work on slow network connection

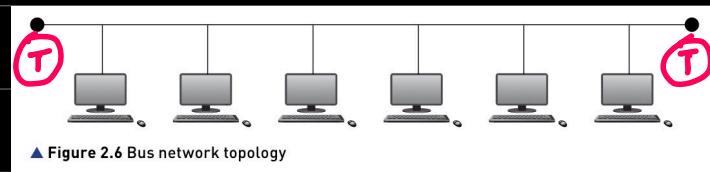
- Thin client requires few local resources such as SSD, HDD, RAM whereas thick client relies heavily on local resources (processing is done on server)
- Data for thin client is stored on server, Data for thick client is stored on device itself.

Topology

- A network Topology is the arrangement with which computer systems are connected to each other.

Bus Topology

- Uses a single central cable to which all computers and devices are connected



▲ Figure 2.6 Bus network topology

T: Devices known as terminators to terminate signals

Advantages:

- Easier to setup/expand
- Less cable required

- Less expensive

Disadvantages:

- If the main cable breaks, network problem degrades badly
- Difficult to detect and troubleshoot fault at an individual station.
- Efficiency reduces as number of devices connected to it increases
- Collisions, not suitable for networks with heavy traffic.
- Security is lower because several computers receive the sent signal from the source

Q- How packets are transmitted b/w 2 computers in Bus Topology?

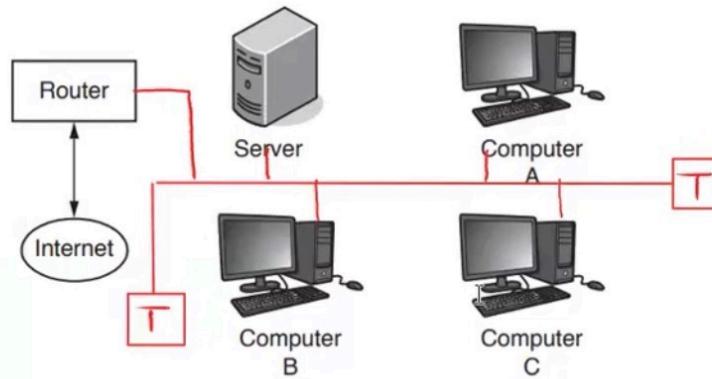
- Packets have address of recipient
- Sender transmits data through the bus.
- The bus carries data along the central cable.
- As data arrives at each computer, the system compares the address to see if it matches

Q- Where will we use Bus Topology?

- When small and temporary network is needed
- Networks which do not rely on high data transfer speed.
- Used in office, schools ↳ only one client can transfer data at a time + pressure on central cable

1 A Local Area Network (LAN) consists of three computers, one server and a router connected to the Internet. The LAN uses a bus topology.

(a) Complete the following diagram to show how the computers, the server and the router could be connected.

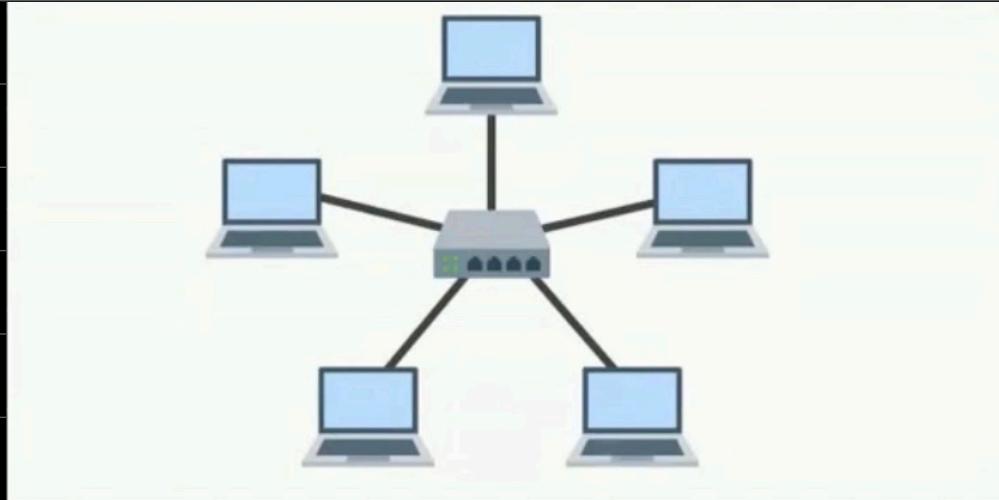


[2]

Star Topology

- Every computer is linked with central device (Can be anything)

e.g. Server, central comp, switch / hub



- Devices are not interconnected

Advantages:

- Signals only go to destination so secure
- Easy to connect / remove node
- Centralized management helps in monitoring the network
- Failure of one node / link doesn't affect the rest of the network
- Fewer collisions (separate channels along which data travels)

Disadvantages:

- If central device fails , whole network goes down
- Performance is dependant on capacity of central device

Q- How packets are transmitted b/w two computers in Star Topology?

- Packets has address of recipients
- Sender sends data to central device
- Server/central device reads address and finds where recipient is.
- Server/central device directly sends data to recipient.
- Server/central device transmits packets only to recipient.

Q- Where will we use star topology?

- Large organisation
- Educational establishment
- Where high performance is must
- Found in home as well , where router acts as a server.

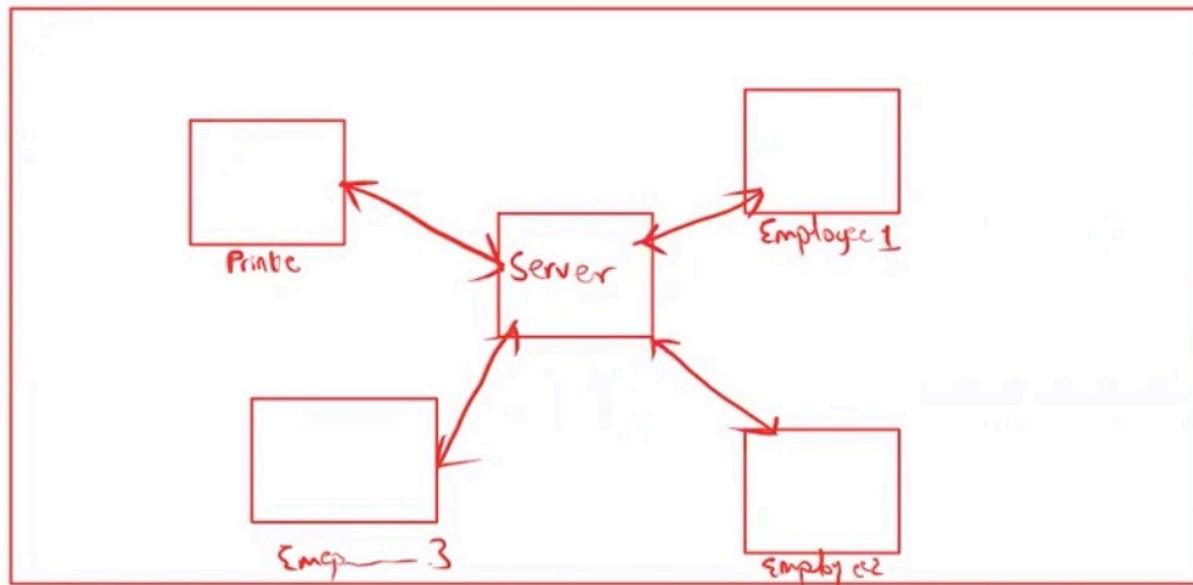
- Features of Star Topology

* Features mean description

- Must have a central device
- Each node is connected to the central device
- Each node has a dedicated connection
- Each connection must be bi-directional

2 Cables connect the computers in a university admissions department in a star topology. The server room contains the server and printer for the employees to use. The department has three employees. Each employee has a computer connected to the star network.

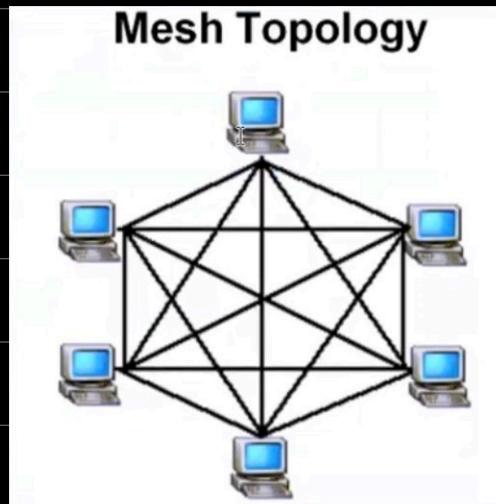
(a) (i) Draw a diagram to show this topology.



[3]

Mesh Topology

- All the devices are interconnected to each other



* If server introduced, then it will act as a node, connected to all computers in the topology.

Advantages:

- Any broken links in the node do not affect the other nodes in the network
- Good Privacy, security since packets travel along dedicated routes

Disadvantages:

- A large amount of cabling is needed which is expensive and time consuming
- Setup and maintenance is difficult and complex.

Q- How packets are transmitted b/w computers in Mesh topology?

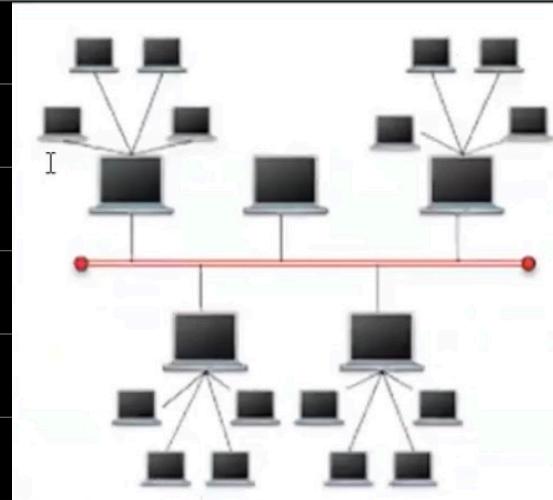
- Packets have address of recipients
- Sender transmits packets directly to node.
- As each node is connected to at least one another node

Q- Where will we use Mesh topology?

- When establishment of communication is important
- Military organisation
- Emergency service

Hybrid Topology

- Combination of two or more topologies



Advantages:

- Highly reliable in case of failure , there are many sub-networks
- Easy to troubleshoot and fix errors

Disadvantages:

- Cost , expensive to set up
- Difficult to manage
- Complex Network

Q- Where will we use hybrid Topology?

- Large organizations with different topologies in each building.

Cloud Computing

· Cloud Computing refers to data and applications being stored and run on the cloud, so less storage is occupied and less processing is done on local device



Q- What is a cloud?

- Cloud is a big building which contains servers.



Advantages of Cloud Computing:

- Files stored on the cloud can be accessed at any time from any device anywhere in the world with internet
- No need to carry external storage device
- Cloud storage can be free

* better for small business

- Most cloud service providers have in-built back up
- Security could be better
- Can easily increase capacity
- Data can be easily shared

Disadvantages of Cloud Computing:

- Can only access the cloud with internet access (Not valid enough)
- No control over security
- It can take a long time to upload / download data
- It can be more expensive in long-term
- There can be a limit to amount of storage unless paid for.

Private Cloud

- Owned by and only accessed by the organisation

Application:

- Highly regulated industries and govt. agencies would use private cloud

Public Cloud

- Owned by a cloud service provider

Application:

- For general use

Transmission Media

Benefits of wireless networks compared to a wired Network :

- Devices can be more mobile as they do not have to be connected to a cable
- Easier to set up as no cables are needed to be installed.
- Additional devices can be easily added.
- Many different types of devices can be connected at the same time.

Drawbacks of wireless network compared to a wired network :

- Easier to hack
- Interference from other waves which causes signal degradation

- Signal degrades quickly

Wired

Cables

- Copper cable (Coaxial, Twisted pair)
- Fibre-optic

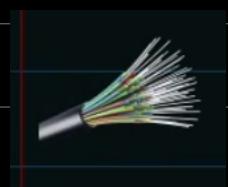


Twisted cable: It is a copper cable used for connecting telephones to telephone lines, one cable with four twisted pairs.

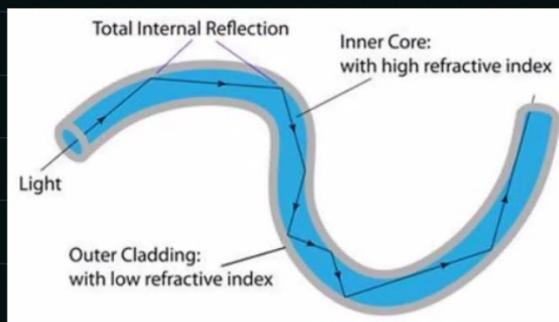
Coaxial Cable: It is a copper cable, used in long-distance telephone cabling by cable television companies



Fibre-optic: Light is transferred by the concept of total internal reflection



How does light travel?



The diagram illustrates a fiber optic cable with a blue inner core and a grey outer cladding. A wavy line labeled "Light" shows how light is bent around a corner by "Total Internal Reflection" at the interface between the core and the cladding. Labels indicate the "Inner Core: with high refractive index" and the "Outer Cladding: with low refractive index".

Pulses of lights are sent, those pulses have values 0 & 1

- Strength of light decreases as light travels.
- We use repeaters to enhance the strength of light



The diagram shows a signal waveform starting with a red rectangle, followed by a blue component labeled "Repeater", and then another red rectangle. The signal shows significant degradation after passing through the repeater, with the second red rectangle being much smaller than the first.

Benefits of fibre optic cables:

- Less interference in the signal (influence of magnetic field)
- Greater bandwidth // faster transmission
- Difficult to hack so more secure
- Requires less signal boosting, hence less repeaters used

- Consumes less power
- lighter in weight (easier - to - install)

Drawbacks of fibre optic cables:

- Installation cost is high
- Trained people are required to maintain the cables and install them
- Only transfers data in one direction.
- Does not carry power , only data
- Difficult to terminate
- Breaks when bent

Benefits of Copper Cable:

- Installation cost is low (less trained people required + old technology)
- More flexible
- Easier to terminate
- Vast knowledge as it has been around for many years.

Drawbacks of Copper Cable:

- less bandwidth rate
- Need repeaters
- higher interference

Wireless

Radio Waves: Electromagnetic waves , used in wifi , frequency $3\text{ kHz} - 3\text{ GHz}$

- Radio waves carry data back and forth from the wireless adapter to the router

Microwaves: Electromagnetic waves , frequency range $3\text{ GHz} — 300\text{ GHz}$

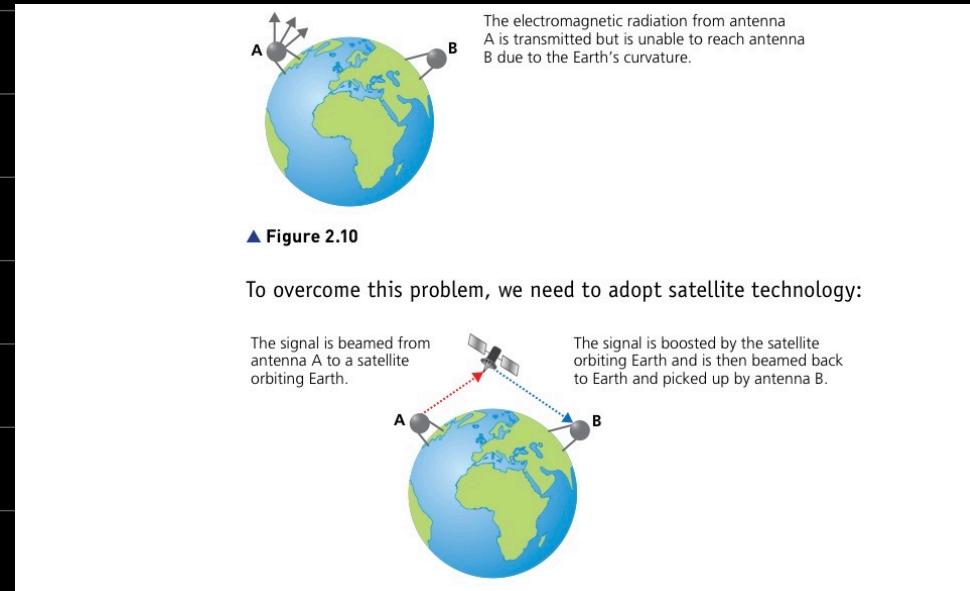
- Used in TV and MRI

Infrared: Electromagnetic waves , frequency range $300\text{ GHz} — 400\text{ THz}$

- Used in TV remote

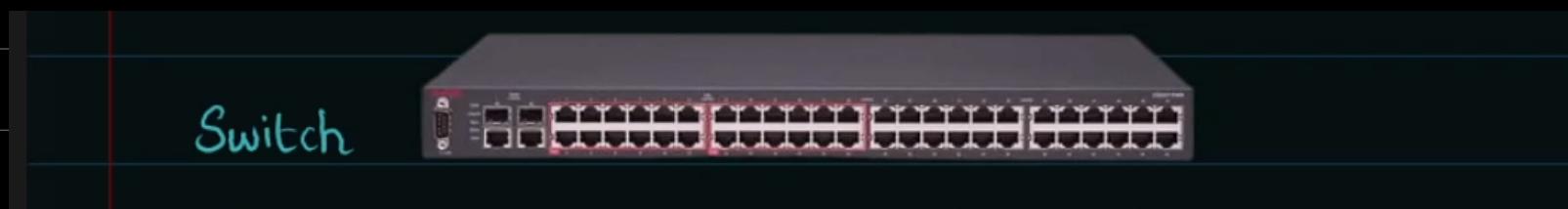
Satellites:

- Signals always travel in a straight line.



Hardwares used in LANs

Switch: A connecting device that can send unicast message (A unicast message is sent directly to host)



- However, it also allows to send data to multiple hosts

NIC (Network Interface Card): Provides device with a MAC address

- to uniquely identify it on the network.
- Allows each individual device to connect to the network



WNIC (Wireless Network Interface Card):

- Provides device with a MAC address
- to uniquely identify it on the network.
- Allows each individual device to connect to the network wirelessly instead of a cable
- They use antennas to communicate with networks via microwaves

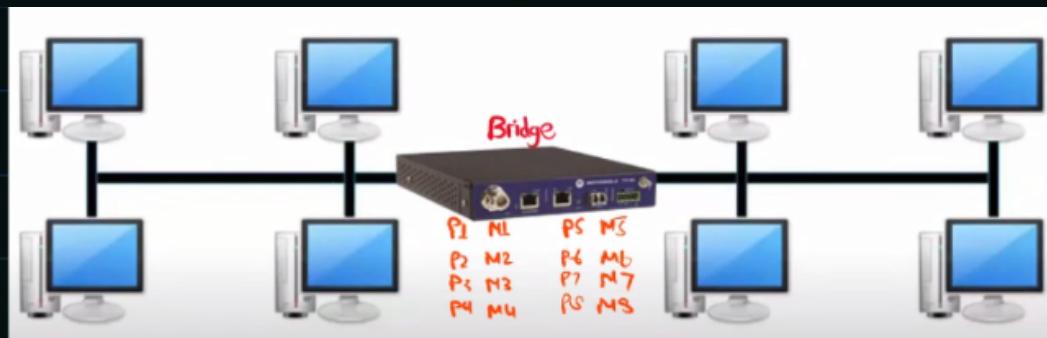
Cables: Fibre optic or copper cable

* IP address is used when communicating on internet while MAC address is used when communicating on a local network.

Bridge:



Data will go to each and every computer which will increase traffic



Bridge has the mac address of each devices

Communication b/w P1 & P8
and P2

-Data will be shared
to all PCs on the
right side , but not
on Left side.



If P1 wants to send data to P2 then data will first go to bridge then bridge identifies if the data should stay on left or right side .

→ Communication b/w P1 & P2

Data will not travel to
right side and since it is
a bus topology data will
be transmitted to every
comp on the left side

Bridge: • Connects two different LAN

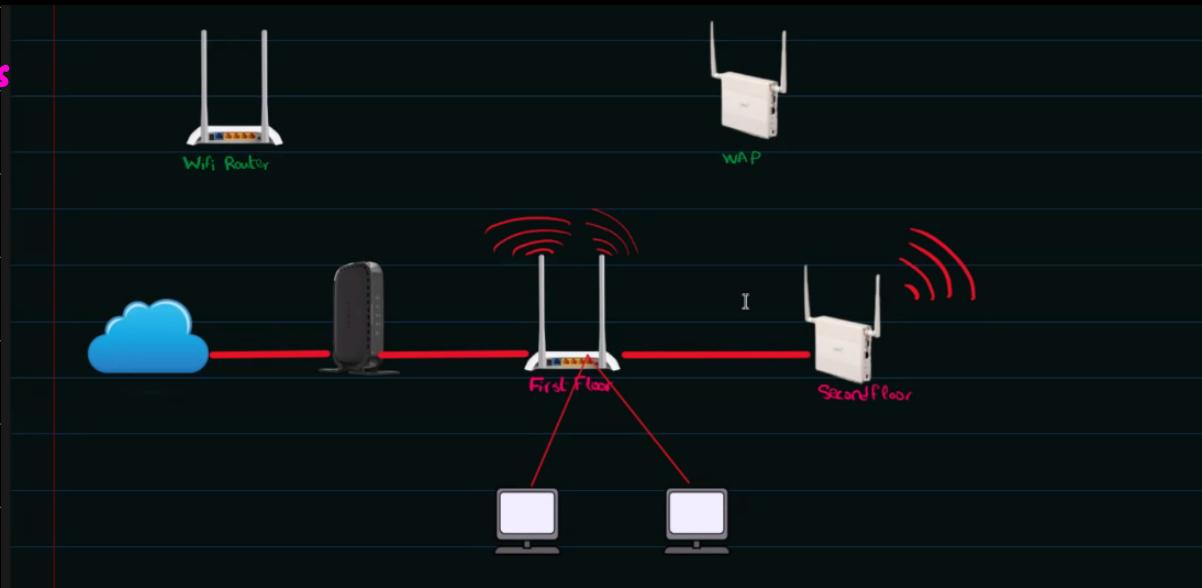
- divides one single LAN into two to reduce traffic

WAP (Wireless Access Point): • Allows devices to connect to the LAN

- instead of using a cable
- Easy to move a device to different location

Note: Wifi router can work as a WAP but they are not the same

* WAP generates signals again



* WAPs are not repeaters

* WAP is connected to router via wire

* WAP only provides wireless connections

Repeater: • Device used to boost signals. (Refer to satellite photo above)

Router and Gateway

Router: • Connects two or more networks

- Can connect network to WAN
- Receives packets and forwards towards destination
- Using IP addresses of destinations
- Assigns private ip address
- Connects similar networks (networks using same protocols e.g:
bus to bus topology or star to star)

Gateway: • Connects two or more networks

- Can connect network to WAN
- Receives packets and forwards towards destination
- Using IP addresses of destinations
- Assigns private ip address
- Connects dissimilar network

Bit Streaming

Q- How a video sent using bit streaming?

- The data is compressed before transmitting
- The video is transmitted continuously as a series of bits
- The video is hosted on media server.
- On download, the server sends data to buffer on client's computer.
- The buffer stores data from server
- The user's stream software receives bit stream from the buffer.

Q- Define on-demand bit streaming

- Digital video tapes are converted to bit streaming format for broadcasting on the net, this is known as encoding.
- These encoded streaming video are then uploaded to a dedicated server
- A link for the encoded video is placed on a website
- A user clicks on the link to download the encoded streaming video
the streamed video is broadcasted to user when they require it.

- Can be paused, can go back and rewatched, fast-forward.

Q- Define real-time bit streaming

- An event is captured live with a video camera
- The video camera is connected to a computer.
- The video signal is converted to streaming media file, encoded on the computer
- The encoded feed is uploaded from the computer to a dedicated streaming server via cable or high speed internet connection.
- Server sends the live images to all the users requesting it as real-time video streaming
- Can not be paused.

Importance of bit rate/broadband Speed on Bit streaming

- Bit rate determines how quickly the data is sent over the internet to the viewers
- Higher the bit-rate / broadband speed , the better the quality of bit streaming and there will be no buffering

Difference b/w World Wide Web and Internet

Internet: (WAN)

- Massive network of networks
- Internet stands for inter connected networks
- Uses TCP / IP protocol

World Wide Web (WWW):

- Collection of (multimedia) web pages / documents

- Stored on web site
- HTTP / protocols used to transmit data
- Web pages are written in HTML
- URLs specify the location of web- pages
- Web documents are accessed using browsers

Benefits of Bit streaming

- No need for whole file to be downloaded
- No need to store large files on user's computer
- Allows on demand playback
- No specialist software is required for playback in browser.

Drawbacks of Bit streaming

- Video hangs if very slow internet
- Video hangs if inadequate buffering capacity
- Loss of internet means can't access films

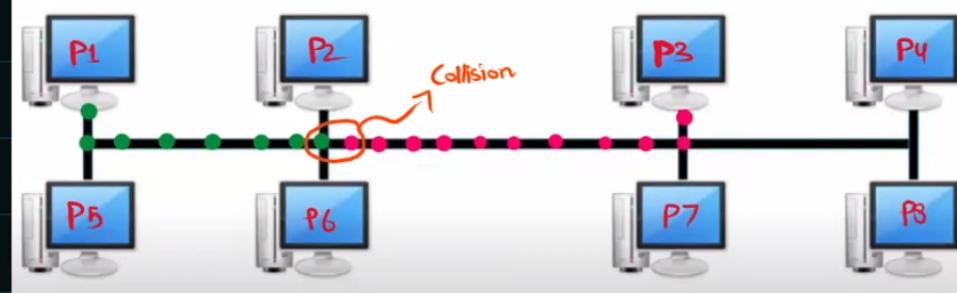
- May require specialist software to run the file
- Viruses can be downloaded from the websites.

CSMA-CD

- Carrier Sense Multiple Access - Collision Detection

* CSMA-CD is
a protocol

P3-P5
P1-P8



* CSMA-CD
measures changes
in voltages to
detect collisions.

collision of data prevents it from reaching its destination.

Q- Explain what is meant by CSMA-CD?

- Carrier Sense Multiple Access with collision detection
- Before transmitting, a device checks if the channel is busy.
- If the channel is free, then data is sent.
- When transmission begins, it listens to the other devices.
- If there is a collision, transmission is stopped
- Both devices wait a different random time, then try again.

Functions of CSMA-CD

- Monitor traffic
- Only allow data to be sent when line is idle
- Detects collision on the network
- Halts transmission when a collision occurs.
- Calculates random wait time
- Allow re-transmission after a random amount of time

Q- How the collision is detected?

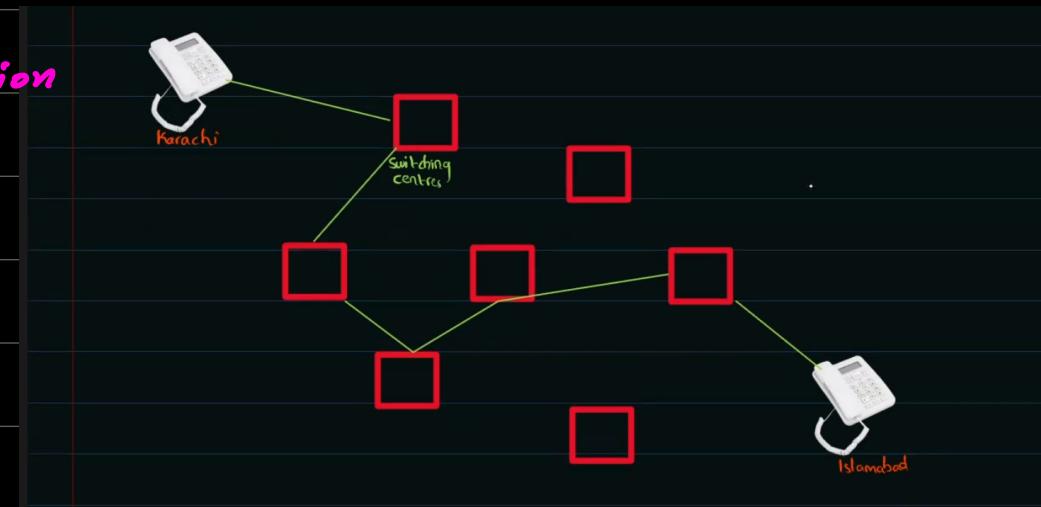
- Due to voltage change collision is detected.

Hardware Devices to Support the internet

Modem: Device that connects router to internet.

PSTN (Public Switched Telephone Network)

- Direct connection to switching centre.



- * Switching centres forward packets to other centres.

Q- Describe the transmission of data using PSTN.

- The PSTN consists of many different types of communication lines.
- Data is transmitted in both directions at the same time
- The communication passes through different switching centres.

There is no 'one'
connection in internet
based system. IP
address is used in
internet based system.

Description	Conventional telephone using PSTN	Internet-based system
connection only in use whilst sound is being transmitted		✓
dedicated channel used between two points for the duration of the call	✓	
connection maintained throughout the telephone call	✓	
encoding schemes and compression technology used		✓
lines remain active even during a power outage	✓	

Benefits of dedicated lines → Direct connections

- Faster transmission of data
- more consistent transmission speed
- improved security

Drawbacks of dedicated lines

- Expensive to set up / maintain
- Disruption to the dedicated lines would leave no alternative.

Modem: Connects a device to internet over a telephone line.

IP Addressing

Q- What IP stands for?

- Internet Protocol

Q- What is the purpose of an IP address?

- IP address is used to locate a device on a network; it gives identifier to each device
- Each address is unique within the network
- It allows a device to send data to the correct destination

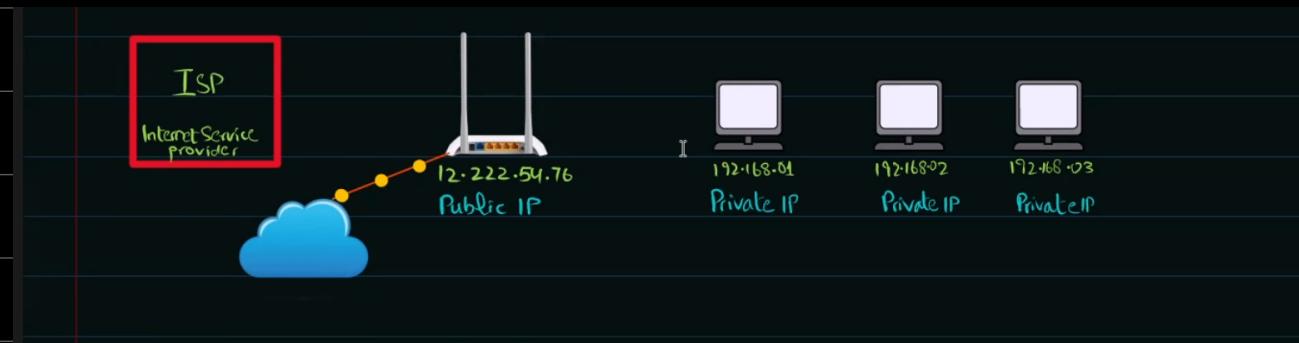
Public and Private IP Address

Public IP Address → *More stable and faster transmission than private IP.



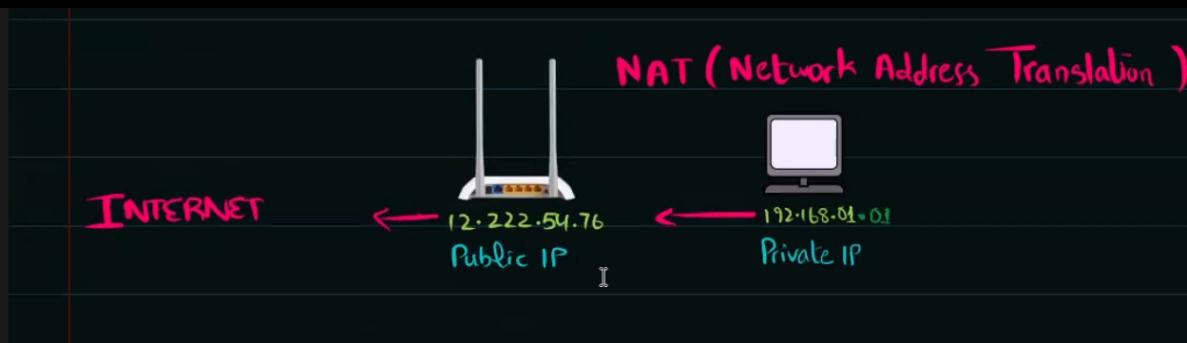
- Public IP addresses are registered on the internet
- It gives access to the internet
- Public IP addresses are unique
- Assigned by ISP

Private IP Address



- Private IP addresses are not registered on the internet
- You can not access internet by just private IP address
- Assigned by router

NAT (Network Address Translation)



Q- Explain the difference between Public and Private IP?

- Public address can be reached across the internet
- Private address can only be reached internally.
- NAT (Network Address Translation) is necessary for a private IP to access the internet but public IP does not need NAT
- A private address is more secure than public address. → Not known publically
- Public IP addresses are provided by ISP whereas private IP addresses are assigned by router.
- Public addresses are unique whereas private addresses are unique within their network but can be duplicated within other network.

Static And Dynamic IP Address

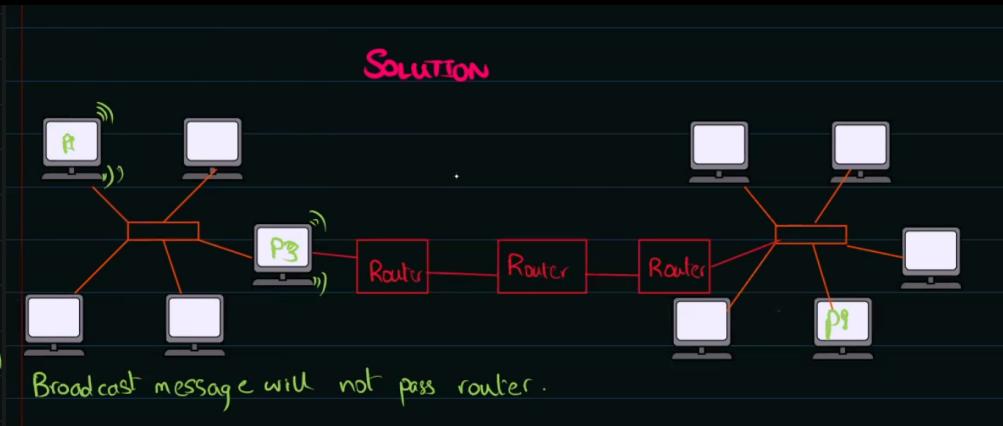
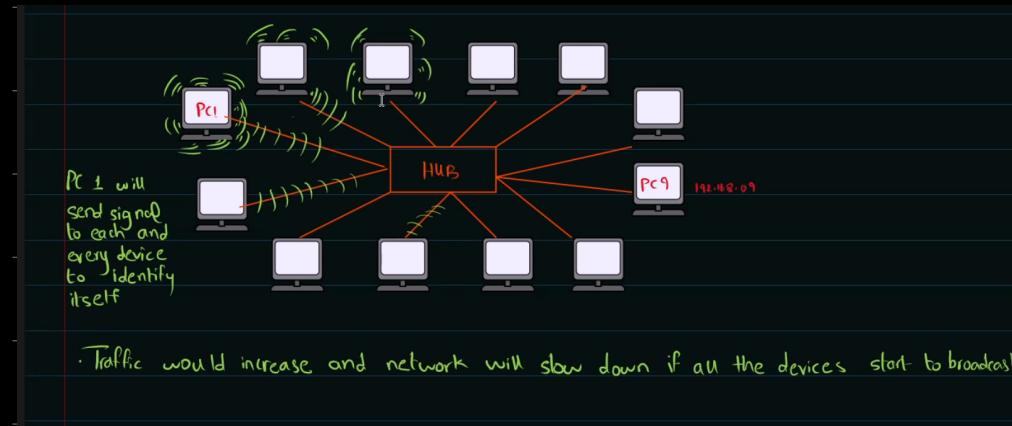
Static:

- When a computer disconnects and rejoins a network
- The address does not change.
- Address is assigned by ISP.

Dynamic:

- Each time the computer rejoins a network
- The address changes
- Address is assigned by network OS.

Subnetting



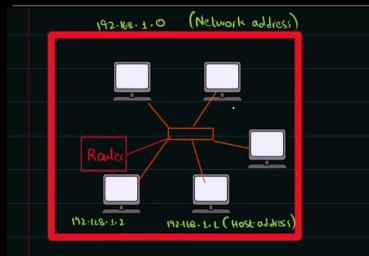
Use of Subnetting

- Split a large network into a grouping of smaller networks.
- To help minimize traffic.
- Improving speed and network performance.
- A subnet mask ensures that traffic remains within its designated subnet.

Subnet Mask

192.168.1.0
octet

- Octet = 0-255
- An IP address contains two things : ① Network Address , ② Host Address



Class A: First octet contains 0-127 (1.0.0.1)

Class B: First octet contains 128-191 (128.1.0.1)

Class C: First octet contains 192-223 (192.168.1.0)

Class D: First octet contains 224-255 (224.0.0.0)

• Subnet Mask is used to identify how many octet are used as Network or Host.



Format of an IPv4 and IPv6

IPv4:

- Each IP address should contain 4 numbers

- Should be in range 0-255
- Separated by Full stops
- The address should not be more than 32 bits
- Full-stops are used as separators not colons
- 4 groups should be there.

E.g: 192.168.0.1

IPv6: • Valid Hexadecimal Number

- Only one double colon is used → In case two adjacent groups are repeated.
- 8 groups
- Separated by colon
- Each Number is 4 hexadecimal digit.

E.g: 2001: 0B00: 0000: 0000: 0000: 0000: 0000: 0000

Q- Explain why there is a need for IPv6?

The number of IP addresses needed will exceed the number available using IPv4

Domain Name Service (DNS)

- Resolves Domain Names to numbers.
- Domain Name is an identifier of the website e.g(youtube.com)

Domain	IP address
Paperdak.com	243.66.243.1
Yahoo.com	222.15.240.1
Youtube.com	221.16.247.2

URL (Uniform Resource Locator)

(b) Consider the URL:

http://cie.org.uk/computerscience.html

I

(i) Give the meaning of the following parts of the URL.

http enables browser to know what protocol is being used

to access information in the domain

cie.org.uk is the domain name

computerscience.html file name which is being viewed

[3]

% 20 : is the coding for space character as <space> are not allowed in URL

? : Acts as separator, separates URL from all parameters.

Q- How a URL is converted to matching IP?

- URL is parsed to obtain the domain name
- Domain name is sent to the nearest DNS Server
- DNS holds a list of Domain names and their matching IP's.
- Domain name resolver searches its database for the domain name
- If DNS does not find the domain name, the request is forwarded to higher Level DNS
- If the Domain name is found, the IP address is returned
- If not found, then error message.