New syllabus 2021-22

Chapter 8
Computer Network
and
Network types

Computer Science

Class XII (As per CBSE Board)

Computer Network

A computer network is a set of nodes like computers and networking devices that are connected through communication for the purpose of communication and sharing resources(hardware/software) among the users.

Networks are used to:

(Benefits of computer network)

- Facilitate communication through email / video conferencing / instant messaging or any other mode.
- Share hardware devices like a printer or scanner
- Enable file sharing
- Share software or operating programs
- Share information

Disadvantages of computer network

Lack of robustness, security issue, cost of network

Evolution of networking

ARPANET (Advanced Research Projects Agency NETwork): In 1969, The US govt. formed an agency named ARPANET to connect computers at various universities and defense agencies. The main objective of ARPANET was to develop a network that could continue to function efficiently even in the event of a nuclear attack.

The National Science Foundation Network (NSFNET) was a program of coordinated, evolving projects sponsored by the National Science Foundation (NSF) from 1985 to 1995 to promote advanced research and education networking in the United States

Internet (INTERconnection NETwork): The Internet is a worldwide network of computer networks. It is not owned by anybody. The internet has evolved from ARPANET. The internet is a globally connected network system that utilizes TCP/IP to transmit information. following services are instantly available through internet : Email, Web-enabled audio/video conferencing services, Online movies and gaming , Data transfer/file-sharing, Instant messaging , Internet forums , Social networking , Online shopping ,Financial services

Interspace: is a client/server software program that allows multiple users to communicate online with real –time audio, video and text chat in dynamic 3D environments.

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Data Communication Terminologies

Communication means means of sending or receiving information, such as phone lines or computers.

Components of communications sender, receiver, message, communication media, protocols
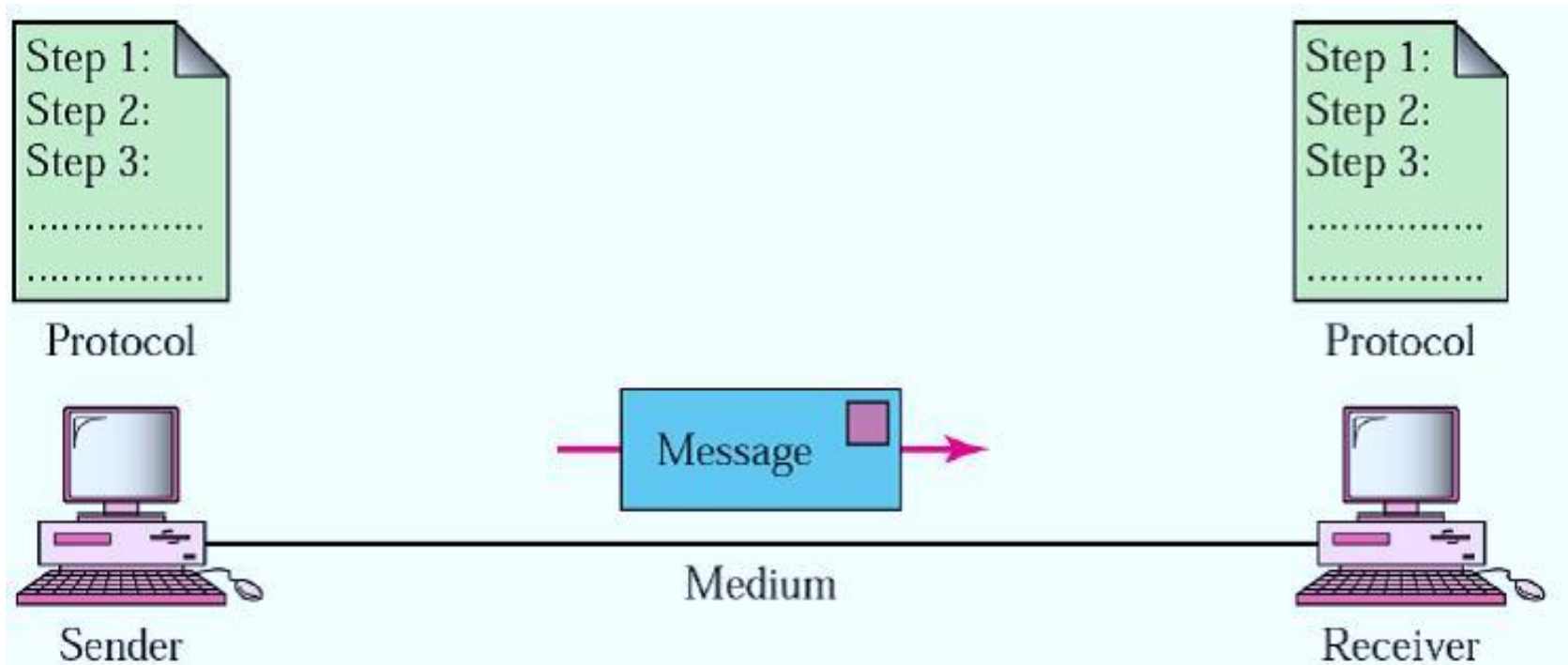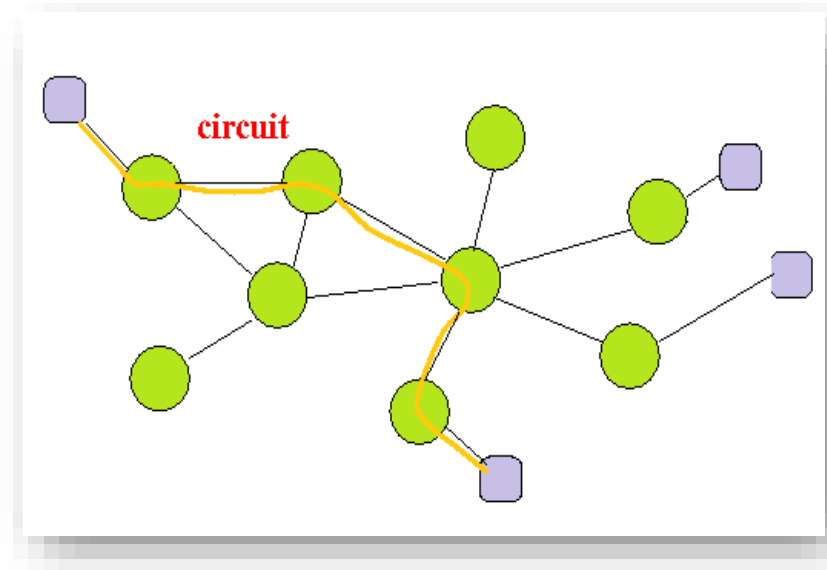
Switching techniques

Switching Techniques: Switching techniques are used for transmitting data across networks. Different ways of sending data across the network are:

Circuit Switching:

- First the complete end-to-end transmission path is established between the source and the destination computers.
- Then the message is transmitted through the path.
- The main advantage of thistechnique is guaranteed delivery of the message.
- Mostly used for voice communication.

circuit

Switching techniques

Packet Switching:

- Using the TCP protocol a single large message is divided into a sequence of packets of size limits from 128 to 4096 bytes.
- Each packet is independent and has the address of sender and destination.
- The IP (Internet protocol) does the routing for the packets. It keeps track of all the different routes available to the destination. If one route is not available it finds the alternate route to the destination.
- At the destination, the TCP protocol re-assembles the packets into the complete message.
- If any packets are lost or damaged, a request is sent to retransmit the same message.


```
----  Packet1
----  Packet2
----  Packet3
```
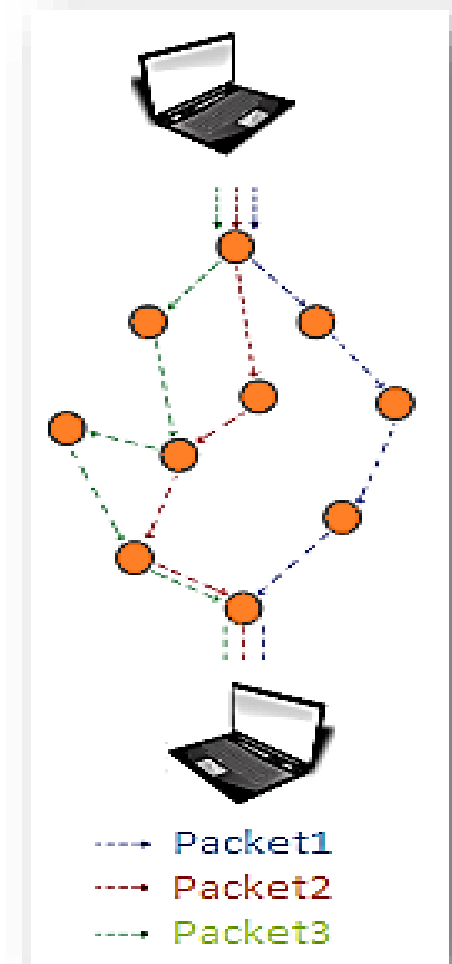
Data Communication terminologies

Communication Channel (Transmission media): A communication channel is either a physical transmission medium such as a wire, or to a logical connection over a multiplexed medium such as a radio channel in telecommunications and computer networking.

Bandwidth: The amount of data that can be transferred from one point to another.it is a measure of the range of frequencies a transmitted signal occupies. In digital systems, bandwidth is the data speed in bits per second. In analog systems, bandwidth is measured in terms of the difference between the highest-frequency signal component and the lowest-frequency signal component.Bandwidth is expressed in Hz, KHz, and MHz. The hertz (symbol: Hz) is the derived unit of frequency in the International System of Units (SI) and is defined as one cycle per second.It is named after Heinrich Rudolf Hertz. Hertz are commonly expressed in multiples: kilohertz (103 Hz, kHz), megahertz (106 Hz, MHz), gigahertz (109 Hz, GHz)

Data transfer rate: DTR is the amount of data in digital form that is moved from one place to another in a given time on a network. Data rates are often measured in megabits (million bits) or megabytes (millionbytes) per second.

bps bits per second   **Bps** bytes per second

Kbps kilobits per second   **KBps** kilo bytes per second

Mbps megabits per second   **MBps** megabytes per second

Gbps giga bits per second   **GBps** giga bytes per second

Tbps tera bits per second   **TBps** tera bytes per second

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Transmission media

Wired Networks - It is also known as Ethernet networks, that is most common type of LAN technology. A wired network is simply a collection of two or more computers, printers, and other devices linked by Ethernet cables/ any form of wired media. Ethernet is the fastest wired network protocol, with connection speeds of 10 megabits per second (Mbps) to 100 Mbps or higher. Computer must have an Ethernet adapter (sometimes called a network interface card, or NIC) to connect with wire. Most of the network topology uses wired networks.

Cable	Twisted pair	Coaxial cable	Fiber optic
Signal form	electricity	electricity	Light
cost	least	moderate	High
speed	low	moderate	High
Ease of use	Easy to install	Professional installation	Professional installation
reliability	low	moderate	High
Real life application	Telephone network	Tv cable	Data transmission & telephone line
Data transmission rate	10Mbps – bps	100Mbps	>100Gbps
Data transfer range	100m	185m - 500m	-
image			

Transmission media

Wireless Networks – It uses high-frequency radio waves rather than wires to communicate. Wireless allows for devices to be shared without networking cable which increases mobility but decreases range.

Infrared Wave Transmission - Short Range Communication: Infrared waves can travel from a few centimetres to several meters.(Approx. 5m). Line of Sight Propagation:Infrared uses point to point communication, both transmitter and receiver should be placed in line of sight of each other and there should not be any obstacle in between. Cannot Penetrate Solid object. It is Inexpensive mode of Communication. Secure : At a time only two devices can communicate therefore information passed to one device is not leaked to another device.

Radio Wave Transmission:- Long Range Communication : Radio waves can cover distances ranging from a few meters (in walkie-talkies) up to covering an entire city. Omnidirectional: Radio waves are propagated in all directions. Therefore sending and receiving antennas do not have to be aligned. Penetrates Solid Objects. Inexpensive mode of communication. Radio wave communication is insecure communication.

Transmission media

Microwave radio, a form of radio transmission that use. Ultra-high frequencies. It is a point-to-point, rather than a broadcast, transmission system. Additionally, each antenna must be within line of sight of the next antenna. Frequency Bands Maximum Antenna Separation Analog/Digital 4-6 GHz 32-48 km Analog 10-12 GHz 16-24 km Digital 18-23 GHz 8-11 km Digital.

Satellite Communication It provide worldwide coverage independent to population density.Satellite   ommunication Systems offer telecommunication (Satellite Phones), positioning and navigation (GPS), broadcasting, internet, Mobile, TV, etc.
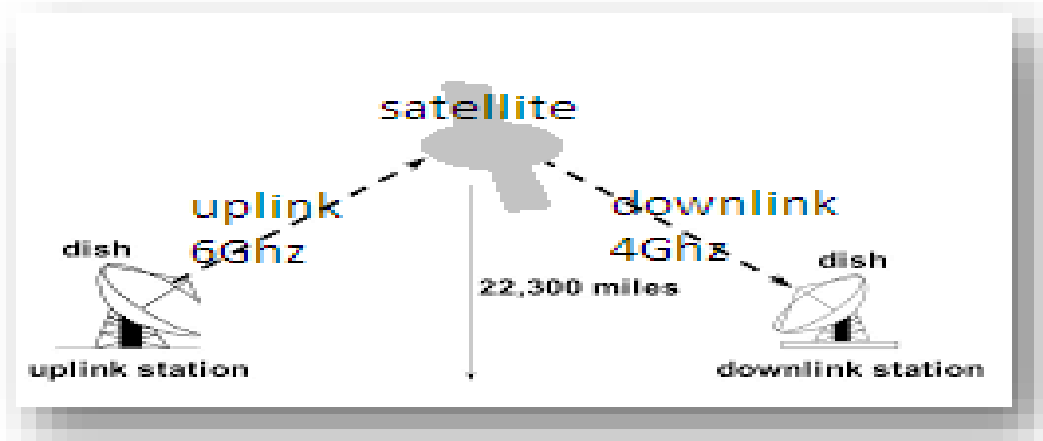
It support Very Long Range Communication with Line of Sight Propagation . It Cannot Penetrate Solid Objects.It is Very Expensive communication mode.

Microwave link vs Optical fiber

Microwave which is also known as Radio links have been used by many companies for decades. Most of the Mobile (Cellular) networks use microwave to connect their cell towers to their backhaul networks.For mobile operators, a reason using microwave is not the speed which microwave provides. It is used to connect their remote sites (Rural areas) , because microwave is a faster and cheaper deployment option compare to fiber.

When more capacity (bandwidth) is required, fiber becomes more economical. Actual cost of fiber deployments is laboring cost. Digging a trench and laying the fiber , getting the required permissions from the land owners and from the municipalities.we have to dig a trench that's hundreds (or thousands) of kilometers long, or lease access to ducts that have already been laid by infrastructure companies.Geography of the land is very important for the fiber deployments. For example, when faced with a mountain or river, do we go straight across at great expense, or do you make a diversion to the nearest bridge or tunnel? Combine all of these factors and you'll understand why most of the world's terrestrial fibre networks are deployed alongside existing roads and railways.
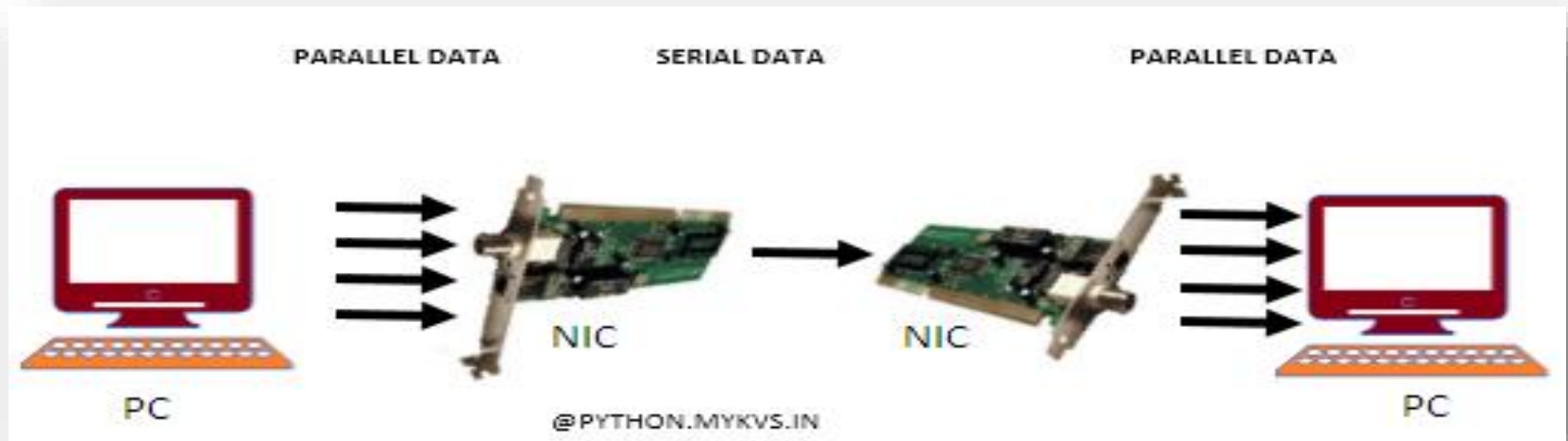
Network devices

Computer hardware devices which are used to connect computers, printers, or any other electronic device to a computer network are called network devices. These devices transfer data in a fast, secure and correct way with some specific functionality over same or different networks.

Some devices are installed on the device, like Internal modem, NIC card or RJ45 connector, whereas some are part of the network, like router, switch, etc.
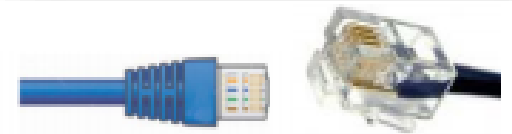
Network devices

NIC – This is at top among other networking devices and mostly used networking device. This is also known as network adapter card, Ethernet Card and LAN card. It allows our PC to communicate with other PCs. A PC uses parallel data transmission to transmit data between its internal parts where as the media that connects this PC with other device/PCs uses serial data transmission. A NIC converts parallel data stream into serial data stream and vice versa.

RJ-45 (Registered Jack – 45) is an eight wired connector that is used to connect computers on a local area network (LAN), especially Ethernet.

Network devices

HUB – HUB is used to connect multiple computers in a single LAN network of one workgroup. Generally HUBs are available with 4,8,12,24,48 ports.

When a hub receives signal on its port, it repeats the signal and forwards that signal from all ports except the port on which the signal arrived. In below diagram leftmost node try to send signal to rightmost node ,but signals are distributed to all ports(nodes).

There are two types of HUB

Passive HUB:- It only forwards the signal on all ports without amplifying the signal.

Active HUB:- it forwards the signal with improvement in the quality of data signal by amplifying it. That why such hubs need additional power supply.

Based on port type, there are two types of HUB:-

Ethernet HUB :- All ports have RJ-45 connectors.

Combo HUB :- Several different types of connectors such RJ-45, BNC, and AUI available as ports in such HUB.


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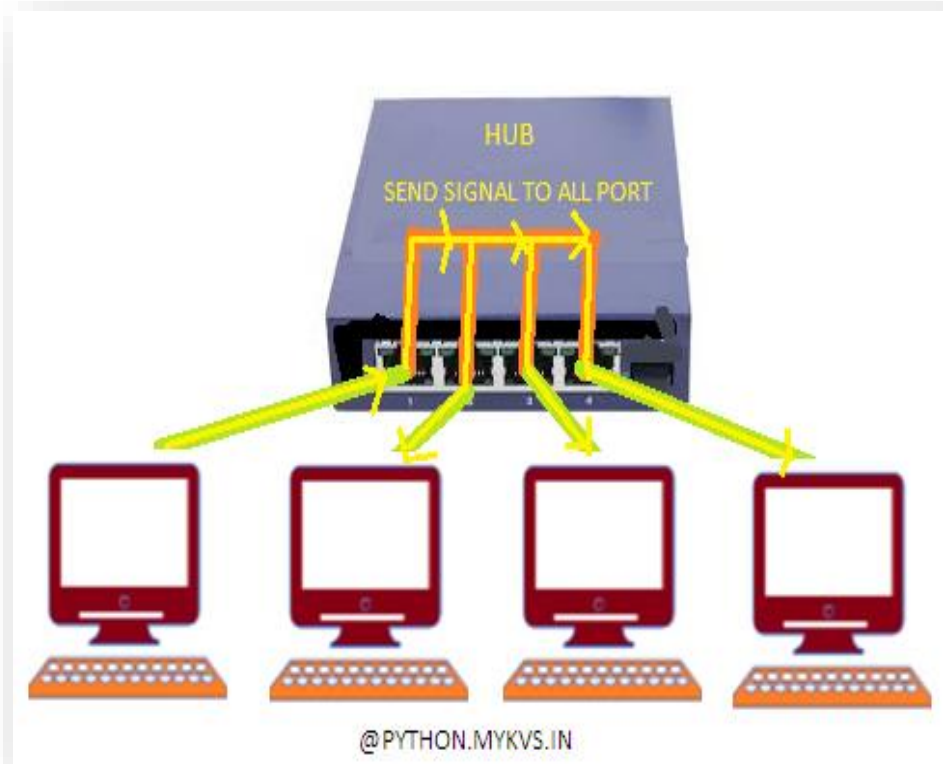
Network devices

SWITCH –Switch is also used to connect multiple computers together in a LAN workgroup,just like hub. Switches are available with 4,8,12,24,48,64 ports. Switch makes their switching decisions by using application specific integrated circuits (ASICs).Due to switching decision capability, switch sends signal to recipient only and that's why switches are called as intelligent hub. In below diagram leftmost node sending signal to rightmost node.
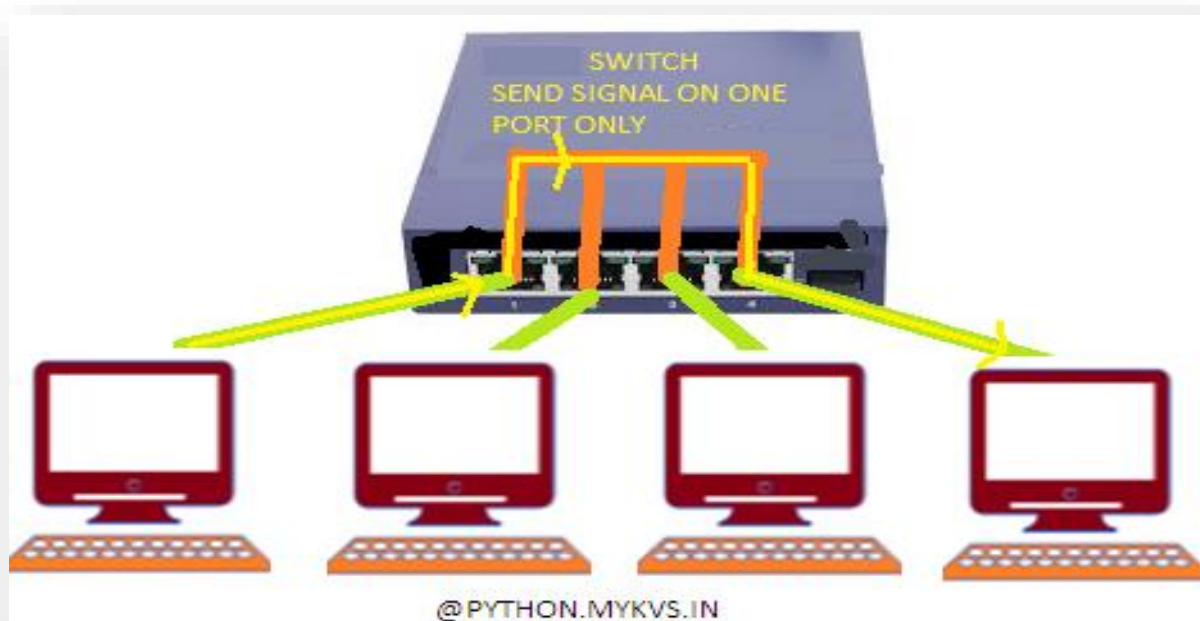
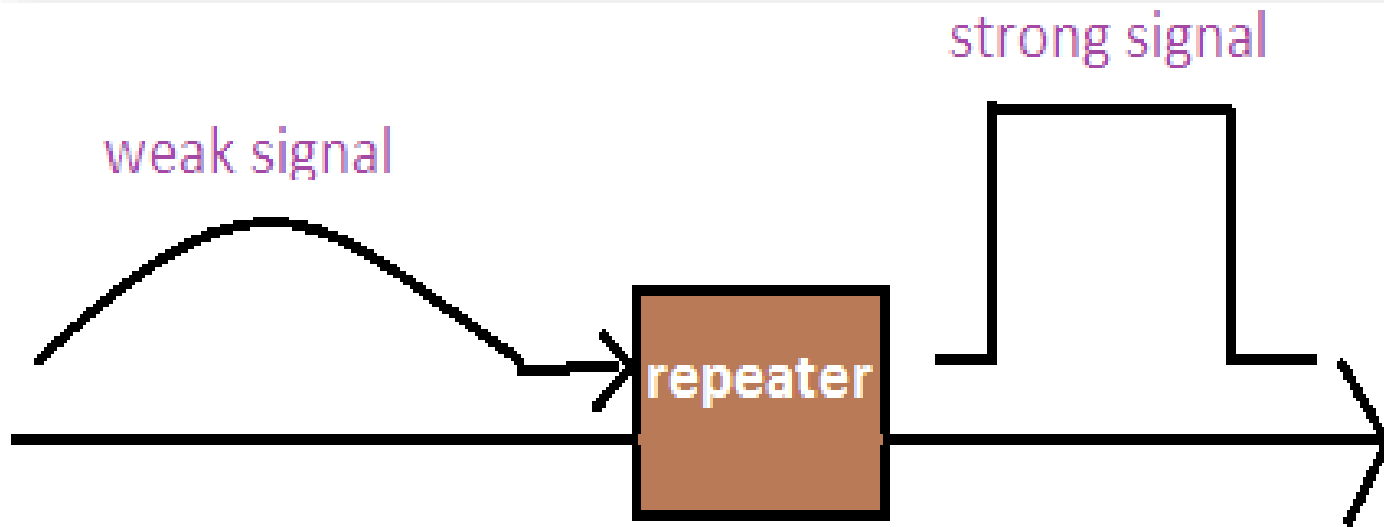# Network devices

Modem – Modem is short for Modulator Demodulator. It's an electronic device used to access the Internet that modulates carrier waves to encode information to be transmitted and also demodulates incoming carrier waves to decode the information they carry.Modulation means digital to analog signal conversion and its vice versa is known as demodulation.

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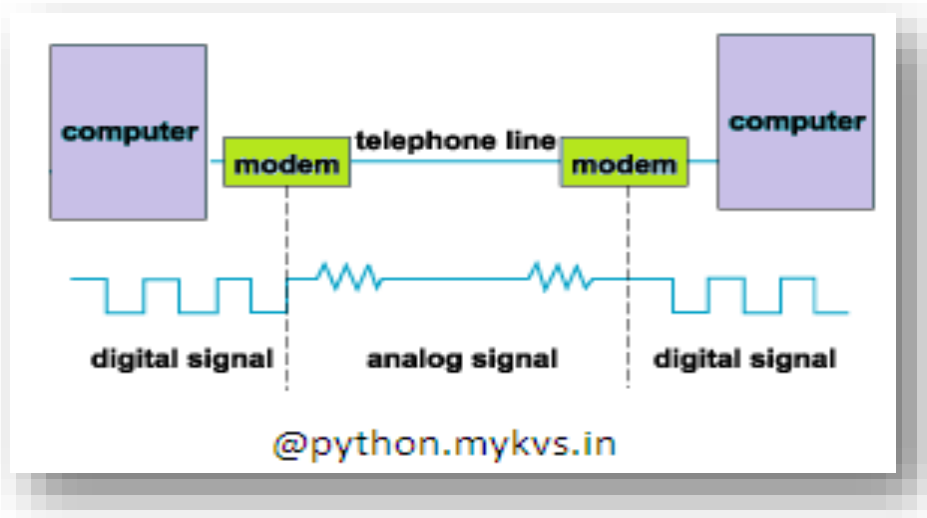
Network devices

Repeater – In a network signal travels a long distance in transmission media. Due to resistance of media signal becomes weak. Repeater is a networking device which regenerates the signal and forwards these signal with more power.

Network devices

Router – Routers operate in the physical, data link and network layers. Router is a networking device which chooses the best optimal path from available pats to send the signals. It interconnects different networks. The simplest function of a router is to received packets from one connected network and pass them to second connected network.

Gateway – A networking device capable to convert protocols so that two different network architecture based system can communicate with each other.It works as protocol convertor.

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Network devices

Hub Vs. Switch

A hub works on the physical layer (Layer 1) of OSI model while Switch works on the data link layer (Layer 2). Switch is more efficient than the hub. A switch can join multiple computers within one LAN, and a hub just connects multiple Ethernet devices together as a single segment. Switch is smarter than hub to determine the target of the forwarding data. Since switch has a higher performance, its cost will also become more expensive.

Switch Vs. Router

In the OSI model, router is working on a higher level of network layer (Layer 3) than switch. Router is very different from the switch because it is for routing packet to other networks. It is also more intelligent and sophisticated to serve as an intermediate destination to connect multiple area networks together. A switch is only used for wired network, yet a router can also link with the wireless network. With much more functions, a router definitely costs higher than a switch.

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Network devices

Router vs Gateway

Gateway regulates traffic between two dissimilar networks, while router regulator traffic between similar networks. A router is a hardware device that forwards data packets between computer networks. Routers perform the traffic directing functions on the Internet.

- ❑ Connection In One Network With Router - For example, there are 30 computers connected inside Network A. All these computers communicate with each other. In this situation, no gateway is needed. Because a router with a routing table that defines the hops within those 30 computers is enough.

- ❑ Connection Between Different Networks With Gateway - In another hand, we suppose that there are two networks, that are Network A and Network B. Computer X from Network A wants to send data to Computer Y from Network B, then there need to have both a Gateway A and a Gateway B so that the two networks will be able to communicate.

Network devices

Wi-Fi cards - are small and portable cards that allow your computer to connect to the internet through a wireless network. Wi-Fi transmission is through the radio waves, these signals are picked up by Wi-Fi receivers such as computers and cell phones equipped with Wi-Fi cards. The devices need to be within the range of a Wi-Fi network to receive the signals and produces a wireless internet connection. Once a connection is established between userand the network, the user is prompted with a login screen and password for establishing is a secure connection.Wi-Fi cards can be external or internal. If a Wi-Fi card is not installed inside your computer, you may purchase an external USB antenna attachment and connect it to your device. Many computers and mobile devices are now adays equipped with wireless networking capability and do not require a Wi-Fi card.

Computer Network

Structure of a network- The geometrical arrangement of computer resources, network devices along with communication channel is known as Network structure or Network topology.

Topology can be physical or logical

- Physical Topology-physical layout of nodes and cables in the network.
- Logical topology - the way information flows between different components.
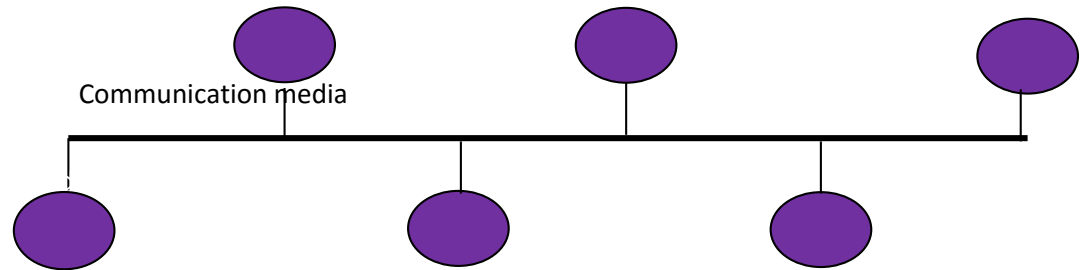
Types of Physical Network Topologies

- Bus Topology
- Star Topology
- Ring Topology
- Mesh Topology
- Tree Topology
- Hybrid Topology

Computer Network

Bus Topology

Nodes are connected through a common communication media like diagram given below.

Communication media

Advantages of a Bus topology
- Easy to install
- Minimal Cable

Disadvantages of a Bus topology
- Difficult reconnection
- Difficult to find the problem
- Difficult to add new devices
- Break stops all transmission of data

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Computer Network

Star Topology

The star topology uses a separate cable for each node/workstation.The cable connects the node to a central device typically a HUB.

Advantages of a Star topology
- Less expensive than mesh
- Easy to install, easy to configure
- If one link fails the network can still function

Disadvantages of a Star topology
- Everything depends on the hub
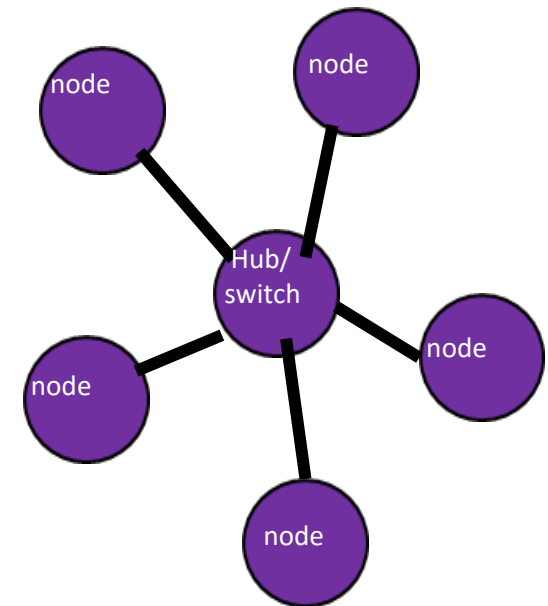
Ring Topology

In ring topology every computer is connected to the next computer in the ring and each transmit the signal ,what it receives from the previous computer. The messages flow around the ring in one direction.

Advantages of a Ring topology

- Easy to install
- Easy to reconfigure
- Easy to detect a problem

Disadvantages of a Ring topology

- Break means the whole system is dead
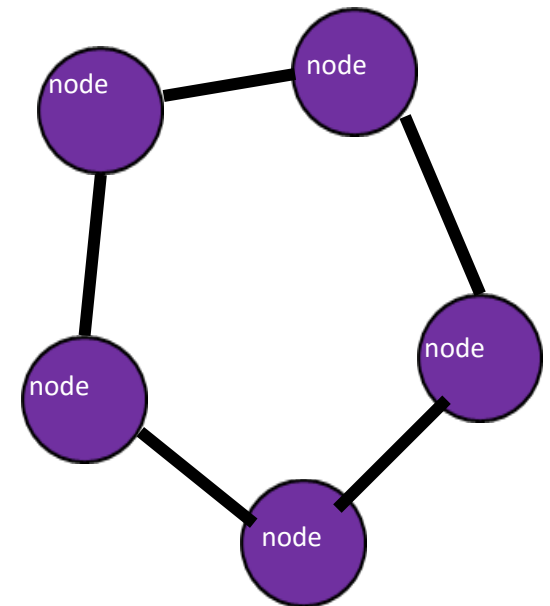
Computer Network

Mesh Topology

In mesh topology , separate cable is used to connect each device to every other device on the network, providing a straight communication path.

Advantages of a Mesh topology
• Avoid traffic since each link can carry its own data and none are being shared
• If one link breaks, the rest of the network is still functional
• Easy to detect a problem in the network by discovering which device is having problems and examining the link that connects to it.

Disadvantages of a Mesh topology
• A lot of cables are needed
• Too many cables means too much cost
• Too many cables means complex network

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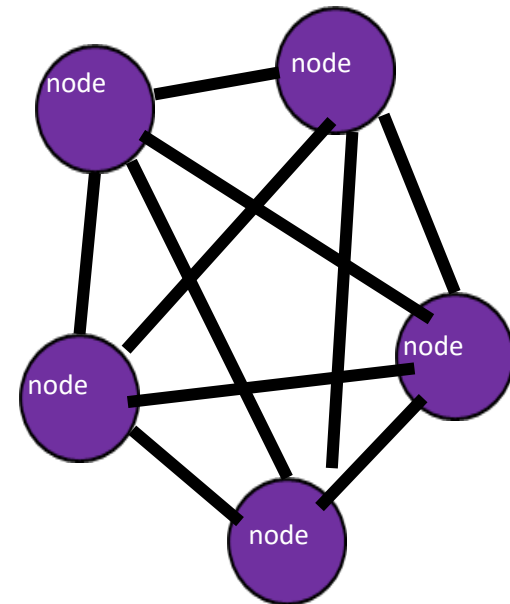
Computer Network

Tree Topology

In which a central root node (the top level of the hierarchy) is connected to one or more other nodes that are one level lower in the hierarchy

Advantages of a Mesh topology

- It is scalable.
- Easier fault identification and isolation.

Disadvantages of a Mesh topology

- Maintenance of the network may be an issue when the network spans a great area.
- if the backbone fails, the entire network is crippled.
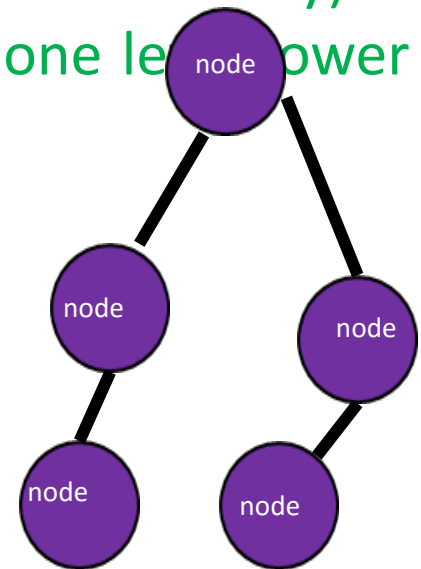
Hybrid Topology

use a combination of any two or more topologies in such a way that the resulting network does not exhibit one of the standard topologies (e.g., bus, star, ring, etc.).
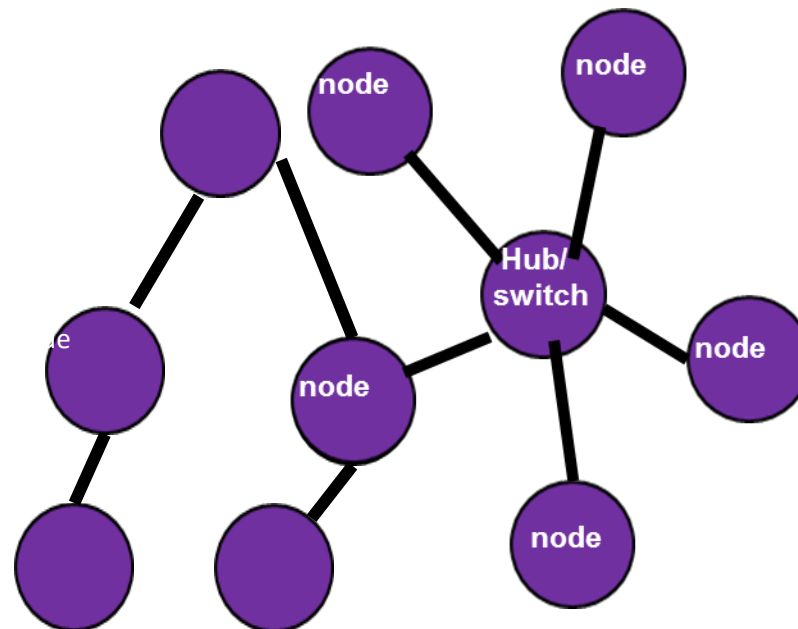
Computer Network

Types of network
1. Personal Area Network (PAN) – communication between two-three mobile devices or PC for personal purpose.
2. Local Area Network (LAN) – limited area (within building)
3. Metropolitan Area Network (MAN) – within city
4. Wide Area Network (WAN) – within multiple city/state/ countries

Computer Network

1. **Personal Area Network(PAN) –**

Spread in the proximity of an individual. Cover an area of a few meters radius. Set up using guided media(USB cable) or unguided media (Bluetooth, Infrared). Owned, controlled, and managed by a single person.

Examples: A network of devices such as computer, Phone, MP3/MP4 Player, Camera etc. Transferring songs from one cell phone to another is a PAN of two phones. Transferring files from a PC to an MP3 playeris a PAN between the two.

Computer Network

2. Local Area Network (LAN) – LANs are the most frequently used/discussed networks.It is one of the most common one of the simplest types of network.It is designed for small physical areas such as an office, group of buildings.Any of different types of topologies can be used to design LAN like Star, Ring, Bus, Tree etc.

Characteristics of LAN

- private networks means no need of regulatory control.
- Operate at relatively high speed.
- Ethernet, Token ring etc type media access controls are used
- Connects computers in a single building, block or campus.

Computer Network

Advantages of LAN

- Resource Sharing
- Software Applications Sharing
- Easy and Cheap Communication
- Centralized Data
- Data Security
- Internet Sharing

Disadvantages of LAN

- High Setup Cost
- Privacy Violations
- Data Security Threat
- LAN Maintenance Job
- Covers Limited Area

Examples: A networked office building, school or home. Sometimes one building can contain a few small LANs (Like some schools have independent LANs in each computer lab.).

Computer Network

3. Metropolitan Area Network(MAN):– Spread within a city . Cover an area of a few kilometres to a few hundred kilometres radius. Set up using all types of all guided and unguided media. Owned and operated by a government body or a large corporation.

Examples: A network of schools, or banks, or Government offices etc. within a city. A MAN is usually formed by interconnecting a number of LANs and individual computers.

4. Wide Area Network (WAN) –Slightly more complex than a LAN, a WAN connects computers across longer physical distances. The Internet is the most basic example of a WAN, connecting all computers together around the world. Because of a WAN's vast reach, it is typically owned and maintained by any single person or owner.

Characteristics of WAN

- Covers large distances(states, countries, continents).
- Communication medium like satellite, public telephone networks etc and routers are used establish connection.

Examples: A network of ATMs, BANKs, National Government Offices, International Organizations' Offices etc., spread over a country, continent, or covering many continents.

Computer Network

Advantages of WAN

- Long distance business can connect on the one network.
- Shares software and resources
- Messages can be sent very quickly to wide range of nodes
- Hardware devices can be shared.

Disadvantages of WAN

- Need a good firewall to restrict unauthorized access
- Setting up a network can be an expensive, slow and complicated.
- Maintaining a network is a full-time job
- Security is a mazor issue when many different people have the ability to use information

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Computer Network

Network Layout –

The plan or design or arrangement of network wings and nodes to be laid out is known as network layout.

A good network layout provides the following features
❖ Communication speed
❖ File sharing
❖ Back up and Roll back is easy
❖ Software and Hardware sharing
❖ Security
❖ Scalability
❖ Reliability

How to decide Network Layout –

The network layout can be best which provide less installation and maintenance cost as well as easy installation and maintenance. It is only possible when it is properly designed, design with shortest cable length and fulfill our network requirements.

How to decide Network Layout – Example

Freya Tech Corporation (FTC) is a professional consultancy company. The company is planning to set up their new offices in India with its hub at Udaipur. As a network adviser, you have to understand their requirement and suggest them the best network layout.

Physical Location of the blocks of FTC
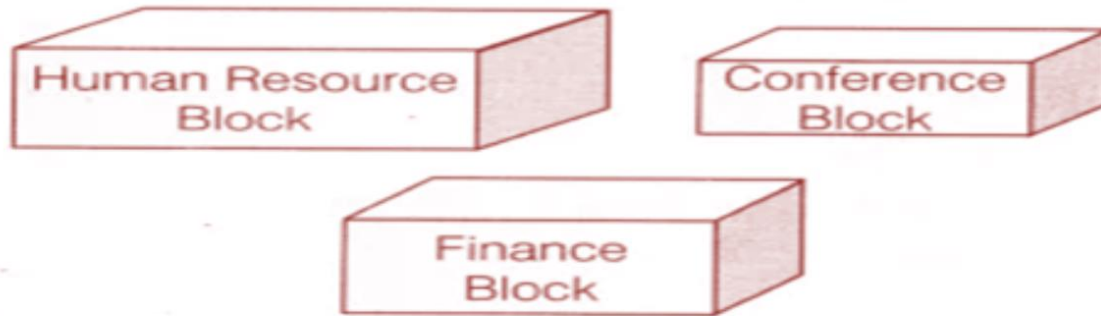
Human Resource Block

Conference Block

Finance Block

Block to block distance (in m)

Block (From)	Block (To)	Distance
Human Resource	Conference	110
Human Resource	Finance	40
Conference	Finance	80

How to decide Network Layout – Example

Block to block distance (in m)

Block (From)	Block (To)	Distance
Human Resource	Conference	110
Human Resource	Finance	40
Conference	Finance	80

-> Possible bus topologies

a) Human Resource -> Conference -> Finance = 110+80 =190m

b) Conference -> Finance -> Human Resource = 80+40 =120m

c) Finance -> Human Resource -> Conference = 40+110=150m

All can be arranged in round robin manner

Ring topology will be discarded as it will increase the cable length

How to decide Network Layout – Example

Block to block distance (in m)

Block (From)	Block (To)	Distance
Human Resource	Conference	110
Human Resource	Finance	40
Conference	Finance	80

-> Possible Star topologies

a)

Human Resource → Conference, Finance   = 110+40 =150m

b)

Finance → Conference, Human Resource   =   80+40 =120m

c)

Conference → Finance, Human Resource   = 80+110=190 m

❖ **Here best layout is b) finance to conferece and finance to Human resourse as it require minimum cable length**

❖ **Tree topology will be also same due to only three blocks are here**

How to decide Server location– Example

Expected number of computers to be in each block

Block	Computers
Human Resource	25
Finance	120
Conference	90

Server location can be decided by seeing the number of computers/nodes required in each block of network.

Server must be installed at the wing/block with Maximum number of Computers due to maximum load/requirement of services in that block in whole network .So in above example Server can be installed at Finance block.

How to decide Repeater location

❖ We need a repeater when the total length of a single span of network cable(Twisted pair) exceeds 100 meters (328 feet).

❖ We need a repeater when the total length of a single span of network cable(Coaxial cable) exceeds 500 meters.

❖ maximum distance of a fiber optic link can be 80-100 km but it depends on varying factors like the bit rate and the quality of the splices and the total attenuation of distance. It also depends on the power of the transmitter and receiver quality.

Satellite link is required when network blocks/wings are too much far from each other or where installation of cable is hard.

For data security firewall can be installed in network.

For economic internet connection – dialup internet connection would be preferred but for faster internet broadband internet connection would be preferred.

How to decide hub/switch location

The answer is always switch when we can afford it. A Hub is always half-duplex, and simply acts as a repeater. The resulting packet collisions, even with only 2 devices, will make it slower than simply using a cable, whereas a switch intelligently directs traffic based on the Ethernet address(MAC address), and is full duplex, resulting in full speed between any devices on the network at the same time.

In general sense Hub or switch any device can be installed when there are more than one computer in a wing/block.