COMPUTER NETWORKS

A Computer Networks is a collection of interconnected computer and other devices to share data and other resources (hardware and software resources.) For example :- if in your home, you can connect your smartphone, your laptop with your smart TV, gaming console and a printer simultaneously either using cables or through WiFi, it will be termed as a Computer Network

Advantages of Computer Network

(a) Resource Sharing :- From that we can share resources among users programs/applications, data and peripheral devices connected to the network, without going to the physical location.

(b) Improve communication :- Messages can be sent. eg. internal email.

(c) Reduced communication cost :- Sharing resources also reduces communication cost. Using public network, from that we can send large quantity of data or file in low cost.

(d) Reliability of Data :- Reliability means backing up of data, i.e., data can be copied and shared on multiple computers

(c) Central storage of Data - Files can be stored on a central node (the file server) that can be shared and made available to each and every user in an organization

Disadvantages of computer networks

- Cost of network, the cost of implementing the network including cabling and hardware can be pricey.

- Security Concerns, file security is more important especially if connected to WAN's e.g., protection from viruses

- Virus and Malware

- Lack of independence.

Components of a Computer Network/Elementary terminology of Networks

(a) Hosts/Nodes (workstation) The term hosts or nodes refers to the computers that are attached to a network and are seeking to share the resources of the network

(b) Server A computer that facilitates the sharing of data, sofware and hardware resources on the network (It is a receiver)
e.g., pointers, modems, etc) on the network, is termed as a server.

(c) Clients. Client is a related term. A client computer is a host computer that requests for some services from a server.
In Other words, a server computer serves the requests of client computers (it is server)

(d) Network Hardware. Other than hosts and wiring, a network requires specialized hardware to carry out various roles

Network Hardware such as :-

⇒ NIC (Network Interface Unit) (MAC Address) It is network card attached to a host so as to establish network connections. between the server and the client

⇒ Hub, switch, router :- These are connectivity devices
⇒ IP Address :- Every machine on a TCP bar IP Network has a unique identifying number called an IP Address

⇒ Domain name :- It is way to identify and locate the computers connected to the internet. It must be unique.

(e) Communication channel. Hosts in a network interact with other hosts and server(s) through a communication channel or communication medium.
It can be wired or wireless.
⇒ Wire Communication channels :- When host and Server are connected with one another through guided media like network cables, it is called wired communication channel/medium. Eg. twisted-paid cables, co-axial cables, etc.

⇒ Wireless Communication channels. When hosts and server(s) are connected with one another through unguided media like radio waves, satelite, etc, it is called wireless communication channels. eg., Microwaves, radio waves, infrarred waves, etc.

(f) Software - The sofware layers of a network make networking possible. These comprise of network protocolss, network operating system etc.

Here protocols refers to a pre-decided set of rules using which all parties of a network connect and interact with one another

A network operating system is a specialized operating system that can handle networking tasks.

(g) Networking Services — These refers to the application that provide different functionalities over a network, such as DNS (Domain name system), File sharing, VOIP (voice over Internet protocol) and many more

TYPES OF NETWORKS

Types of networks based on Geographical spread

⇒ PAN - Personal Area Network — PANs are small network used to establish communication between a computer and otherheld devices in the proximity of up to 10 metres. Using wired USB connectivity or wireless systems like Bluethooth or infrared. (The network that belongs to a single person or user is known as PAN)

• PANs are used to connect computers devices

• The bluetooth technology implements PAN. It may include wireless keyboard and mouse, etc.

⇒ Local Area Network (LAN) — LAN is a privately owned computer network covering a small geographical area or localised area (small physical area) like a home, office or a building such as a school. It can cover an area spread over a few metres to a radius of a few kilometres. (Traditionally it is said that it spread up to 1km)

• LAN is owned, controlled and managed by a single person or organization.
• A LAN can be set up using wired media (UTP cables), etc or wireless media (infrared, radiowaves).
• If a LAN is set up using unguided media, it is known as WLAN (Wireless LAN)
• LAN users can share data, programs, printer, disk, modem, etc.
• Data transfer rate speed over a LAN can vary from 10Mbps to 1Gbps

⇒ Metropolitan Area Network (MAN) — MAN's network is larger than a LAN and can cover a city and its surrounding areas. A MAN usually interconnects a no. of LANs and individual computers. It also shares the computing resources among users.
• All types of communication media (guided and unguided) are used to set up a MAN
• It is owned and operated by single entity like government body or a large corporation.

• Example of MAN is the interconnected offices of a Multinational Corporation (MNC) or cable television networks available in the whole city.

⇒ (WAN) Wide Area Network. WAN is a telecommunication network. This type of network spreads over a large geographical area across countries and continents.
• WANs generally used to interconnect several other types of networks.
• They facilitate fast and efficient exchange of information at a high speed and low cost.
• It uses common carriers like satelite systems, telephone lines, etc.
• It can cover an area with a radium spanning hundreds of km's.
examples:— A network of ATM's, banks, government offices, etc., spread over a country, continent, or covering many continents are examples of WAN
• WAN used to set up All types of communication media.
The best exa of WAN is the 'Internet'. The internet is the largest WAN spanning the entire planet.

(A WAN interconnects all the computers across the world)

Note:— LAN and WAN are the two primary and best-known categories of area networks; the others have emerged with technological advances.

Structure of a Network

=> Sender :- A device or a computer that sends the data

=> Receiver :- A device or a computer that receives the data

=> Message :- Message is the information to be communicated. It may be text, image, audio or video.

=> Transmission Medium - A transmission medium is a physical path through which the data flow from Sender to receiver. A cable or wire or Radiowaves can be the medium.

=> Protocol.

Types of Network based on Communication channel.

There are two types of communication medium that is.

(i) Wired Computer Network

It is also known as physical or conducted media. Wired Networks also called Ethernet networks, are the most common type of local area Network (LAN) technology.

Ethernet is the fastest wired network protocol with connection speeds of 10 megabits per second (Mbps) to 100 Mbps or higher.

P.T.O

Most commonly used cables in wired networks are one of the following three types

(i) Twisted pair cable : Twisted pair or Ethernet cable is a pair of insulated wires that are twisted together to improve electromagnetic capability and to reduce noise from outside sources. It is usually used for creating small computer networks and extensively used in Local Area Networks (LANs)

- Twisting helps reduce crosstalk and electro-magnetic Interference (EMI) affects.
- CAT-5 and CAT-6 specifications are mostly used to set up a LAN.
- RJ-45(Registered Jack) Connector is used to connect this cable to a computer.

- It is available in shielded Twisted pair (STP) or Unshield Twisted pair (UTP) types.
— in STP, pair are covered by an extra insulation to further reduce the signal interference,.

Advantages
- It is a low-cost, low-weight and flexible cable.
- It is a thin and flexible cable and, therefore, easy to install maintain.

Disadvantages
- It is suitable for short distances (up to 100 metres) for longer distances, a Repeater is required.
- It supports low bandwidth and offers speed up to 100 Mbps.

Coaxial Cable (or Coax)

A coaxial cable consists of two solid insulated conductors that share a common axis.
The inner conductor is a straight wire surrounded by wired mesh, each separated by some kind of foil or insulator (Plastic insulator)
• Coaxial cable or coax is most commonly used in cable TV transmission.
- commonly used types of coaxial cables are thicknet and thinnet.

Advantages:
• It offers high bandwidth and carries data for a longer distance (185-500m) at a stretch.
• It is suitable for broadband transmission (cable TV) and can also be shared cable network.
• It is less susceptible to electromagnetic field.

Disadvantages:
- It is less flexible and expensive compared to twisted pair cable.
• It is not compatible with modern cables like UTP and STP.
• Its thickness is 1cm diameter and poor flexibility, it is difficult to install as compared to Twisted pair cable.

Optical fibre Cable
fibre optic cable consist of long, thin stands/thread of glass or glass like material and carries light.

- Signals are modulated and transmitted in the form of light pulses from source using Light Emitting Diode (LED) or LASER Beam.
- They are arranged in bundles called optical fibre cables and used to transmit data through light signals over long distances.

It consists of following parts.

=> Core (Glass or plastic) it is at the centre through which light travels (thin rod)

=> cladding - It is outer optical material that surrounds the core that reflects the light back to the core.

=> Buffer Coating - It is plastic coating, it protects from damage and moisture.

Advantages
- It is free from EMI since no electrical signals are carried.
- It offers secure and high speed transmission for a very long distance at a stretch.
- It is the most efficient cable available for computer networks.

Disadvantages
- It is most expensive cable and is quite breakable.
- Its installation procedure is quite complicated. Also, it is difficult to join two broken fibres
- It is not suitable for domestic purposes due to its high maintenance cost.

(B) Wireless Computer network

(i) Radio waves :- Radio waves are used to transmit television and radio programmes.
all radio waves nowadays, use continuous sine waves to transmit information (audio, video, data)
• It uses radio frequencies in the range of 3kHz to 3GHz.
eg. Walkie - talkie and one more best eg. is Wifi.

Merits.
• It offers ease of communication over difficult terrains
• It is cheaper than laying cables and fibres

Demerits :
• It is an expensive and unsecured mode of communication
• It is susceptible to weather effects.

(ii) Microwaves :- Microwave signals are used to transmit data without the use of a cable over a long distances.
• It is a line of sight transmission as signal travels in a straight line.
• In microwave communication, two directional parabolic antennas (that is transmitter and receiver) are mounted on towers, buildings, etc to receive a signal through (Atmosphere) air.
Merits
• Microwave system permit data transmission rates of about 16 giga bits per second.

Demerits :-
- It is an unsecured communication.
- The cost of installing towers, antennas is relatively high.

(iii) Infrared waves :- it network allows devices to communicate within a short range of 300 GHz to 400 GHz (approx 5 metres) using wireless signals
eg. Use in T.v Remotes, cordless phones, etc.

merits :-
- It is a line of sight transmission
- No government licence is required

Demerits :-
- It waves do not cross any solid object in between.

(iv) Bluethooth :- Bluetooth is a wireless technology used for creating personal networks operational within a range of lo metres. It uses 2.4 GHz unlicensed band.

WiFi (wireless fidelity) communication is similar to Bluetooth in operation but covers a larger range (50 - 200) metres.

Characteristics of Bluetooth Transmission
- Bluetooth can connect up to eigh devices simultaneously.
- Data transfer rate is slow (up to 1Mbps)
- Line of sight between communicating devices is not required.

Satellite Link (satellite microwave):- satellite communication is a special case of microwave relay system. Satellite communication use the synchronous satellite to relay the radio signal transmitted from ground station.

Services like DTH, VSAT, GPS Satellite phones, etc., are offered by satellites.

- A satellite works like a trans-Receiver Antenna in space, which receives, regenerates and redirect signals.

merits
- It covers a larger geographical area.

Demerits
- It is slower than microwave transmission
- It requires legal permissions.

Types of Networks by Components Roles

(i) Peer to Peer networks
(ii) Client/server networks

(i) Peer to peer networks (P2P) networks.
Peer refers to someone with equal standing
e.g., look at these example sentences;
The staff is trained by peers (equally).
Peer (equally) group of children is really important.

The computer that serve on a peer to peer computer are often termed as non-dedicated servers —on small network, a workstation that can double up as a server is known as non-dedicated servers

Typically a peer to peer network has upto ten computers (an accepted limit)

The Client-Server Networks

In this model, the data is stored on powerful computer called servers. These are maintained by a system administrator. In contrast employees have simpler machines, called clients, on their desks with which they access remote data. These whole arrange is called client server model.

It is also known as Dedicated server (operates solely)

- It is applicable when both the client and the server are in the same building, and also when they are far apart.

Advantages of a client-Server network

- The biggest advantage of using this set up is central management of the server.
- Configuration is simple to set up and takes less time to troubleshoot.

New Technologies:

(i) Cloud Computing :- Cloud computing is a type of Internet based computing that provides shared computer processing resources and data to computers and other devices on demand

- cloud computing and storage solutions provide users and enterprises with various capabilities to store and process their data in their privately owned space (popularly called as cloud)

Types of clouds.
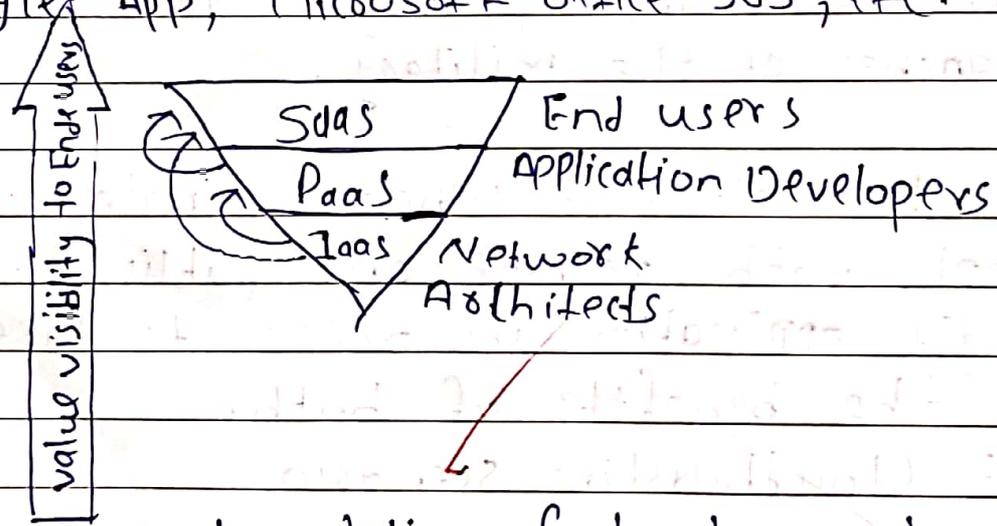There are different types of clouds that are :-

(i) Private clouds := Private cloud is a virtual private interface provided by an individual or owned by one organization.
In this cloud, all the resources such as memory and services are dedicated solely to an organisation
e.g.:- VPN is a private cloud

(ii) Public clouds :- It is defined as a public or common cloud service provided to multiple users on a network. Public cloud services are provided through a common portal or virtual platform owned and operated by a third party cloud provider that is
for exa:- Google drive, icloud, Amazon cloud Drive, etc.

(iii) Community clouds :- These are the clouds for use by a group of related organizations who wish to make use of a common cloud computing environment.
e.g.:- a community might consist of the different branches of the military.

(iv) Hybrid clouds :- when a single organization adopts both private and public clouds for a single application in order to take advantage of the benefits of both.
e.g:- Cloudbursting scenario.

The basic concepts of cloud computing further comprises

⇒ Iaas (Infrastructure as a service): A computer infrastructure, typically presented in the form of virtualization, is a service within the cloud hosting.
e.g., Amazon Ec2, Windows Azure, etc.

⇒ Paas (Platform as a service): An integrated platform for the development, deployment, testing and support of web-applications; presented as a service on the basis of the concept of cloud hosting.
e.g:- Google App Engine, Force.com, etc.

⇒ Saas (Software as a service): A business model of software licence, which involves the development and support of the software vendor. Customers also have the opportunity of paid use, usually through the Internet.
e.g:- Google App, Microsoft office 365, etc.

Saas	End users
Paas	Application Developers
Iaas	Network Architects

value visibility to End users

implementation of cloud computing.

§ Daas (Desktop as a service): Another business model which is a slightly improved model of Saas, mostly involving the use of multiple services at the same time necessary to complete the work, was first introduced in the early 2000s.

Pros and cons of cloud computing

Pros :-
• Instant access to the entirely of human knowledge
• Instant access to friends and family anywhere in the world at any time (this can also be a drawback)

Cons :-
• Privacy and security :- while the cloud might seem safe and secure, assume that nothing you do online is private.

Inshort :- Cloud computing refers to having access to all your applications and data from any network devices

(ii) Internet of things (IOT)

IOT is the network of physical objects or "things" embedded with electronics, software, sensors and network connectivity, which enables these objects to collect and exchange data.

Here things refers in the context of the Internet of things is an entity or physical object that has unique identifier, an embedded system and the ability to transfer data over a network.

Enabling technologies for IOT

(i) RFID (Radio frequencies Identification):
This technology is designed to use radio waves to read and capture information stored on a tag, called an RFID tag, Attached to an object. Every device (thing) on IOT has an RFID tag.

- An RFID tag is a small microchip attached to an antenna.

(ii) Sensors :- A sensor is a device that is able to detect changes in an environment. A sensor is able to measure, a physical phenomenon (like temperature, pressure, and so on) and transform it into an electrical signal.
Most common sensors of Modal age that is used in IOT are temperature sensors, pressure sensor, motion detection sensors, etc.

(iii) Smart technologies :- It includes additional functionality to take action and have other processing capabilities as per the requirement. For exa'- smart controllers can connet with smart devices an act upon them, eg:- stopping a vehicle, locking/unlocking a door, etc.

(iv) Software :- The software part is equally important in the success of any technologies. The software provides the reusable solutions for

connecting , taking actions and solving issues that may arise .

(v) Efficient network connectivity :- IOT is formed through interconnections of devices to internet.

Devices that can form Iot

The devices which has RFID tag can be part of IoT. RFID technology devices such as

⇒ Home appliances
⇒ Wearables — clothes, shoe, etc.
⇒ Vehicles
⇒ factories
⇒ Agriculture — Biochip transponders on farm animals and plants.
⇒ Food — Sensors for monitoring the condition of foo
⇒ Transportation — traffic management.

Challanges and Risks
⇒ Most important challenge is security for IoT

IoT cloud :- It is a platform that is designed to store and process IoT data. The platform is built to take in the massive volumes of data generated by devices, sensors, websites, applications, customers and partners, and initiate actions for real time responses.
e.g :- Airline passengers whose connecting fliets are delayed or cancelled could be rebooked even before the planes they are on have landed.

Network Devices / Hardware

(i) Network Interface Card (NIC)

NIC is a device that enables a computer to connect to a network and communicate. This is also known as network adaptor card, Ethernet card, LAN card, Network Interface Unit (NIU) or Terminal Access point (TAP)

Nowadays WLAN cards are also becoming popular for connecting PCs or laptops with wireless network.

(ii) MAC Address

The NIC manufactures assigns a unique physical address to each NIC card, this physical address is known as media access control address (MAC Address).

- A Mac address is a 6 byte address separated by a colon e.g:-

10 : B5 : 03 : 63 : 2E : FC

↳ manufactured id (assigned for manufacturer by an International organization IEEE)

last three bytes are the card no. (assigned by manufacturer)

EACH MAC ADDRESS IS UNIQUE
FOR EACH NETWORT CARD.

(iii) Wifi Card

A Wifi Card is either an internal or external LAN Adapter with a built in wireless radio and antenna.

The most common Wifi cards used in desktop computers are PCI-Express. The wifi card made to fit PCI Express card slots on Motherboard.

(iv) Hub

A Hub is an connecting device that used to connects multiple computers in a single LAN Network of One workgroup. Generally HUBs are available with 4, 8, 12, 24, 48 ports.

When hub recieves signal on its port, it repeats the signal and forwards that signal from all port except the port on which the signal arrived.

There are two types of Hub

Passive Hub :- It only forwards the signal on all port without any change

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.

. Port type

(i) Ethernet Hub - All ports have RJ-45 Jack.

(ii) Combo Hub - Several different types of connectors such as RJ-45, BNC, and AUI available as ports in such Hub.

(v) Switch :- A switch is an intelligent device that connects several nodes to form a network and redirects the received information only to the intended nodes)
Switch are available with 4, 8, 12, 24, 48, 64 Ports.
. switch sends signal to recipient only and that's why switches are called an intelligent hub

(vi) 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 those signal with more power.

(vii) Bridge :- A bridge is a device that lets you link two networks together.
Bridges are smart enough to know which computers are on which side of the bridge.

(viii) Gateway :- A Gateway is a network device that connects dissimilar networks. It establishes an intelligent connection between a local network and external networks with completely different structures.

Router :- Routers are networking devices that forward data packets from the source machine to the destination machine using the shortest path.

(X) Access Point

A Access point (AP), also called Wireless access point (WAP). An access point is a hardware device that establishes connection (s) of computing devices on wheels wireless LAN with a fixed wline network.

(XI) Network Stack

Network stack is an implementation of a computer networking protocol suite or protocol family. The suite is the definition of the communications protocols and the stack is the software implementation of them.

(Xii) Modulation —

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.

it mean digital to analog signal conversion and its vice versal (opposite) is known as demodulation.

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