

Unit I: Fundamentals of Data Communication and Computer Network.  
(Weightage - 12 marks)

TRANSLATE SYLLABUS (SY-COMPS)

Introduction

This chapter provides an introduction to computer networks and covers fundamental topics like data, information to the definition of communication and computer networks.

- \* The main objective of data communication and networking is enable seamless exchange of data between any two points in world.
- \* This exchange takes place over a computer network.

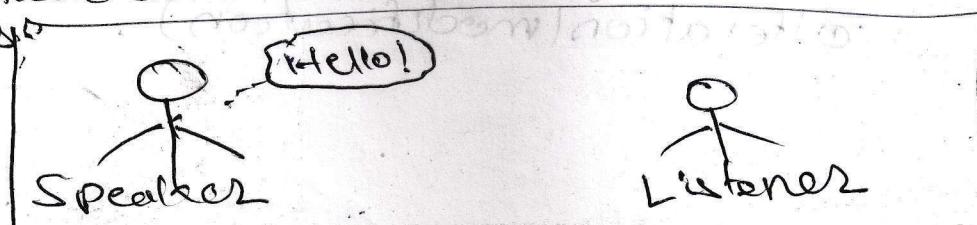
\* Data refers to the raw facts that are collected while information refers to processed data that enables us to take decision.

\* For an example, When result of particular test is declared it contains data of all students. When you find the marks you have scored you have the information that lets you know whether you have passed or failed.

\* The word data refers to any information which is presented in a form that is agreed and accepted upon by its creator and users.

\* Communication

Communication refers to exchanging of information from one entity to another entity in meaningful way. The entities may be referred as human being, machines etc. The meaningful way refers that the meaning of communication must be understandable between two entities.



## 1.1 Process of Data Communication and its components

Transmitter, Receiver, message, medium, Protocol.

### Questions

Q1 Explain the components of Data communication. (4m)  
(Summer-23 Summer-22)

Q2 Name the components of data communication. (2m)  
(winter-22)

Q3 Define Protocol (5-22). Define Data communication (2m)

Q4 Define or list characteristics of Data communication. (6m)  
(19-W)

### Data communication

- \* Data communication means the exchange of data between two devices via some form of transmission medium.
- \* In simple words, Data communication is process of exchanging data or information.
- \* Data communication is process of exchanging data between two devices through a communication medium in meaningful way.
- \* The devices must be the part of communication system.
- \* The communication system is made up of both hardware and software.
- \* The effectiveness of Data communication depends on characteristics.

### Characteristics of Data communication

- ~~Skipped~~
- ① Delivery
    - \* Data must deliver to the correct destination.
    - \* Data should be delivered to the correct user or communicated to correct destination and correct user.
  - ② Accuracy
    - \* Data must be delivered accurately by the system.
    - \* The communication system should deliver the data accurately, without introducing errors.
    - \* The data may get corrupted during transmission affecting the accuracy of delivered data.
    - \* In short terms, Data should be delivered accurately / perfectly without any alteration / modification).

② Timeliness: The communication system must deliver the data without any delay.

\* The communication system must deliver data in timely manner. (less time = more time = useless)

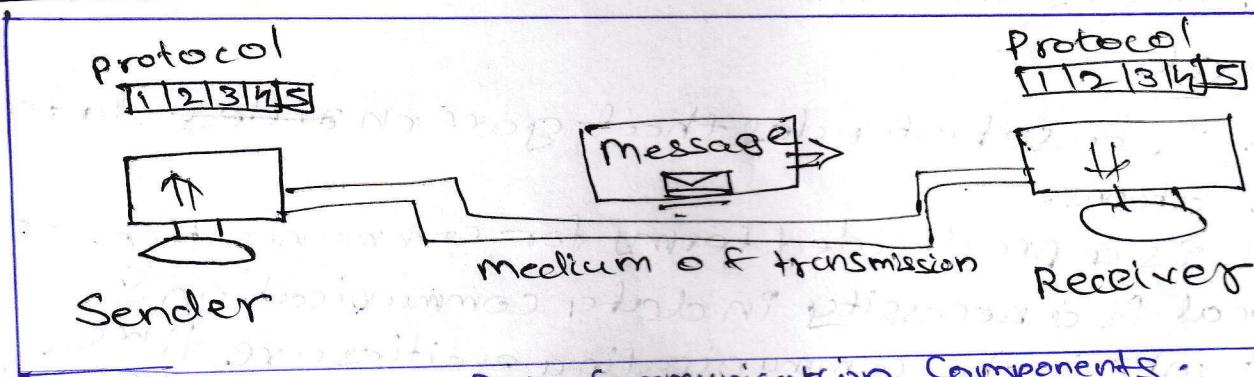
\* Audio and video data has to be delivered in a timely manner without any delay; such a data delivery is called real time transmission of data.

③ Jitter: In network the data are split into smaller groups (packets) and send them separately.

Send Big parts (packet) + smaller parts (packet)  
The variation of arrival between two packets is jitter.

→ If squared order.  
It is a variance in latency or time delay between when a signal is transmitted and when it is received.

Components: Message, medium, Receiver, Sender, Protocol.



A data communication consists of five components.

① message / Data

\* The message is data or information to be communicated. It can be text, number, picture etc...

\* It is the primary part of communication system.

\* The information is communicated between Source (sender) and destination (receiver), is called data / message.

② Sender

\* The sender is device that sends data. Various devices can be used to send the data.

\* The source / sender is a device which generates and sends the data to the receiver (destination).

## ③ Receiver

- \* The receiver is a device that the sender wants to communicate the data.
- \* The receiver receives the information / message transmitted by sender.
- \* In short, it is a device that receives the data.

## ④ Medium

- \* It is the path by which the message travels from sender to receiver. It can be wired or wireless and many subtypes in both.
- \* It is a physical path through which message passes from sender to receiver.
- \* The transmission medium can be radio waves, fiber-optical cable or radowaves.
- \* It acts as a carrier to carry the data from source to destination.

## ⑤ Protocol

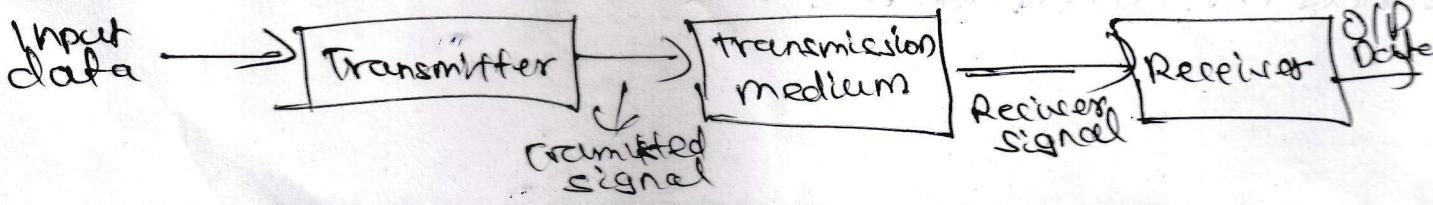
- \* Protocol is a set of rules that govern ~~sets~~ data communications.
  - \* Protocol is a predecided terms for communication.
  - \* A protocol is a necessity in data communications without which the communicating entities are like two persons trying to talk to each other in different language without know the other language.
  - \* It is an agreed upon set of rules used by the sender and receiver to communicate data.
- Synchronously Send Response  
So no communication paper

The source and destination may be computer, mobile phones, workstations, servers, video cameras and so on.

The protocol provides the effective communication thus provides the methodology how to interact with each other without any loss or interface.

## Note

Simple Data Communication System



1.2 Protocols, Standards, Standard organizations, Bandwidth, Data Transmission Rate, Baud Rate and Bits per second.

### Questions

- \* Describe data communication standards. ② (S-23)
- \* Define standards and list its type.
- \* Define Bandwidth ② (S-22)
- \* Define bit rate and Baud Rate ② (19-W)

### Protocols

- \* A protocol is defined as set of rules that governs data communications.
- \* A Protocol is one of components of data communication system. Without protocol system cannot communicate.
- \* Protocols defines the method of communication, how to communicate / when to communicate etc.
- \* For successful communication to occur, the sender and receiver must agree upon certain rules called protocol.
- \* When protocol sender sends a message it may consists of text/number, image etc. which are converted into bits and grouped into blocks to transmitted and often certain additional information called control information is also added to help to receiver to interpret data.

### Important Elements of Protocol

#### ① Syntax

Syntax means format of data or structure how it is presented e.g. first eight bits are for sender address, next eight bits for receiver address and rest of bits for message data. In short, it is arrangement of data in particular order.

#### ② Semantics

It tells the meaning of each section of data bits. It also tells what action/decision is taken based on interpretation. Example, the address of bit means the route of transmission or final destination of message.

#### ③ Timing

Timing means, at what time data can be sent and how fast data can be sent. Readiness of receiver to receive data.

## Communication Standards

- Standards provide guidelines to manufacturers, tenders, government agencies and service providers.
- It ensures the interconnectivity and compatibility of devices.
- Standards help in maintaining market competitiveness and guarantees interoperability.

Data communication standards are of two categories.

- De facto : De facto means by facts or by convention. The standards that are not approved by any organization but are widely used are De facto standards. These are established by manufacturers.
- De jure : De jure means by law or by regulation. These are standards that are recognized officially by an organization.

## Standard Organization

Standards are developed jointly by standard creation committees, forums and government regulatory agencies.

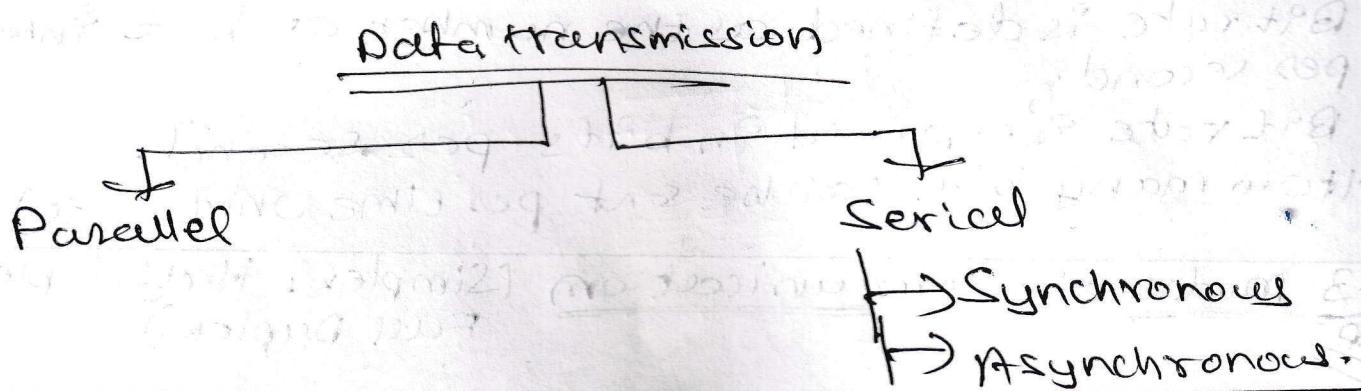
Networking standards define rules for data communications that are need for interoperability of networking technologies and processes.

## Some standard Organizations are :

- 1) ISO (International Standards Organization)
- 2) IEEE (Institute of Electrical and Electronic Engineers)
- 3) ITU (International Organization for Telecommunications Union)
- 4) ANSI (American National Standards Institute)
- 5) World Wide Web Consortium.
- 6) Telecommunication Industry Association (TIA)
- 7) EIA (Electronics Industries Association)
- 8) ETSI (European Telecommunications Standards Institute)

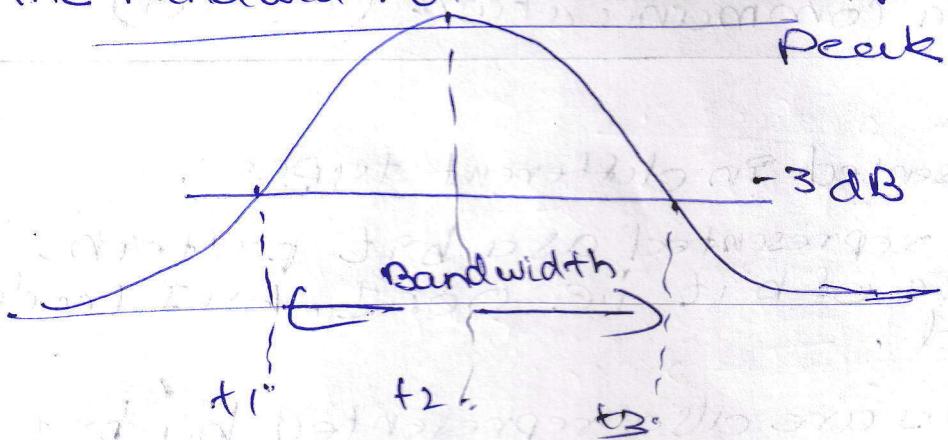
## Data transmission

Data transmission is the transfer of data from one digital device to another.



## Bandwidth

- \* Bandwidth is data transfer capacity of computer network in bits per second (Bps).
- \* Bandwidth is the maximum bit rate that a medium can propagate through it.
- \* The bandwidth of medium is expressed in Bps.



## Data Transmission Rate / Data Transfer Rate

The data transfer rate is commonly used to measure how fast data is transferred from one location to another location.

For example, a hard drive may have a maximum data transfer rate of 480 M bps.

## Baud rate

- \* The baud rate is the rate at which information is transferred in a communication channel.
- \* Baud indicates the rate at which signal level changes over a period of time.
- \* Baud rate is number of signals units transmitted per unit time that is needed to represent those bits.
- \* How many times a signal changes per sec.

## Bit Rate

- \* Bit Rate is simply the number of bit (i.e. 0's & 1's) transmitted in per unit time.
- \* Bit rate is defined as the number of bit intervals per second.
- \* Bit rate is expressed in bits per second.
- \* How many bit can be sent per time unit (see).

## 1.3 Modes of Communication (Simplex, Half duplex, Full Duplex)

### Questions

- Q11 Describe various modes of communication in Computer network. (U.M) OR Explain simplex, half duplex and full duplex modes in data communication. (I.G.W)

## Data Representation

Data can be represented in different types:

- ① Text: Text is represented as a bit pattern, a sequence of bit i.e. 0 or 1. ASCII code is used.
- ② Numbers: Numbers are also represented by bit patterns. ASCII is not used for numbers.
- ③ Images: Images are also represented by bit patterns. Image is composed of matrix of pixels.
- ④ Audio: Audio is different from text, number and images. It is continuous not discrete.
- ⑤ Video: It refers to the recording or broadcasting of picture or movie.

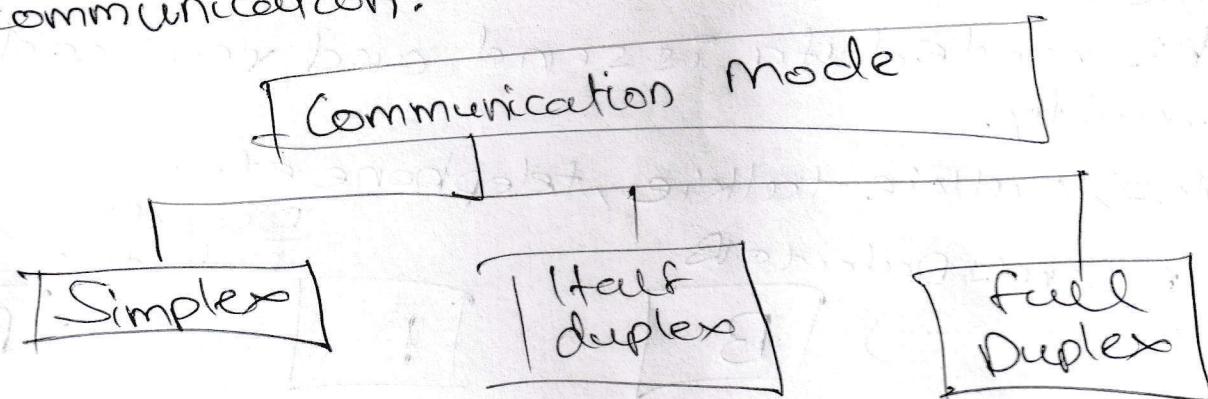
Communication between two devices i.e. sender and receiver can be of three types.

- Simplex
- Half-Duplex
- Full-Duplex

## Modes of communication

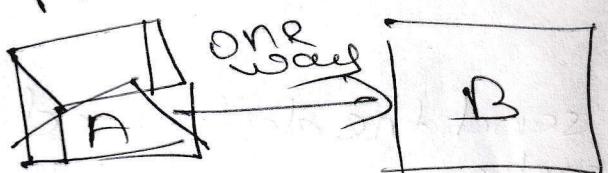
Communication between sender and receiver.

- \* Communication mode refers to mechanism of transferring of data between two devices connected over a network. It is called transmission mode.
- \* In simpler words, the direction of data flow between two linked devices is called mode of communication.

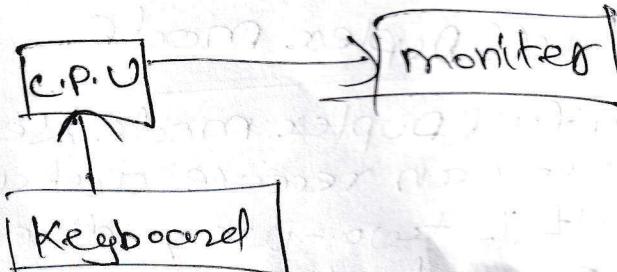


## Simplex Communication Mode

- \* In simplex communication mode, sender can send the data but the sender can't receive the data.
- \* It's unidirectional communication.
- \* In simplex communication mode, the communication can take place in only one direction i.e. data can be sent only in one direction.
- \* Examples of simplex mode are radio and TV.
- \* In computer system, the keyboard, monitor and printer are examples of simplex devices.



Explain --- Asender to B.



## Advantage

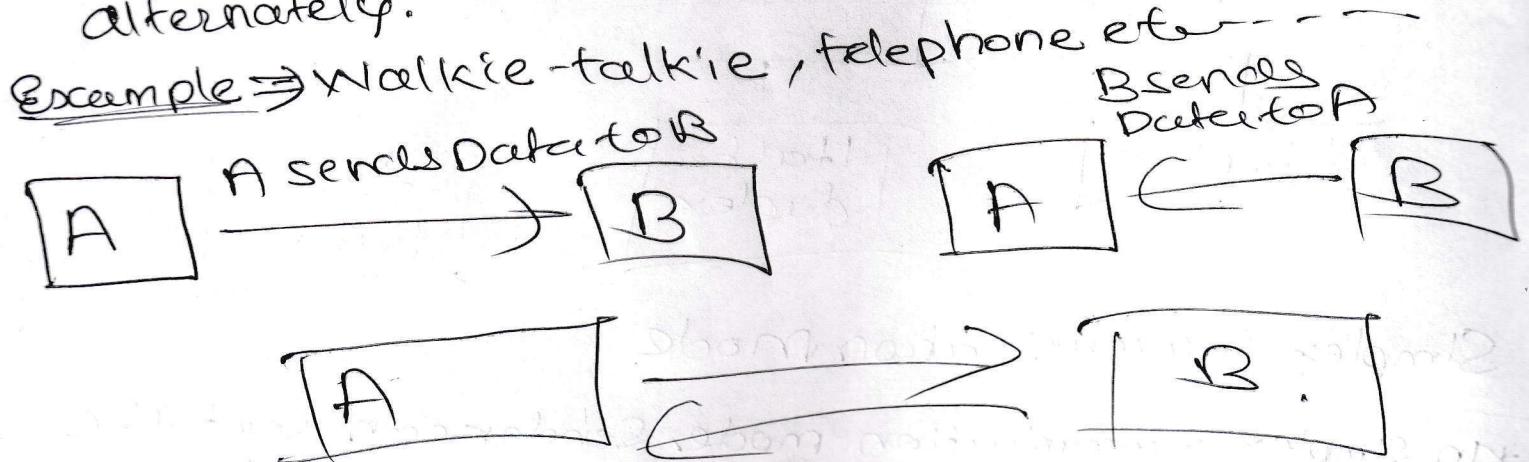
- ① Cheaper in cost.
- ② Very simple & easy communication method.
- ③ One way communication.

## Disadvantages

- \* Only allow for communication in one direction.
- \* Errors cannot be transmitted back to user.

## Half Duplex Communication Mode

- \* In Half Duplex mode, sender can send the data and also can receive the data one at a time.
- \* It is a two-way communication but one at a time.
- \* The communication can take place in both the directions, but only in one direction at a time.
- \* In this mode data is send and received alternately.



## Half Duplex Advantages

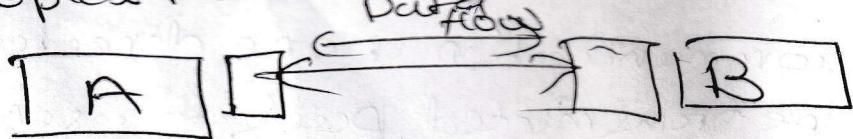
- ① Enable 2 way communication.
- ② Low cost than Full duplex.
- ③ Faster than Simplex.

## Disadvantages

- ① One device at a time.
- ② High cost than Simplex.

## Full Duplex mode

- \* In full duplex mode; sender can send the data and also can receive data simultaneously.
- \* It is two-way directional communication.
- \* Full duplex is the fastest directional mode of communication. i.e. Both device can send & receive data.
- \* Telephone communication system is example of Full-Duplex mode



## 1.4 Analog Signal and Digital Signal

### Question

Compare Analog and Digital signal.

#### Analog signals

It is continuous and time varying signal.

It has infinite value

It is easily affected by noise

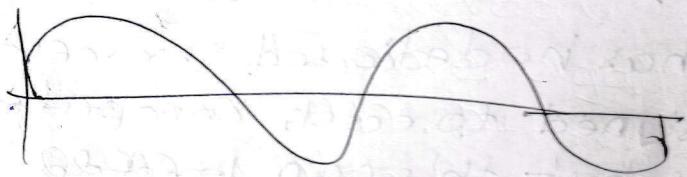
Accuracy is affected by noise

Uses more power

Example,

temperature, voltage, current, sine waveform

waveform



Sine waves

#### Digital signals

It is discrete in nature.

It has only two values (1 & 0)

Digital signals are less affected by noise

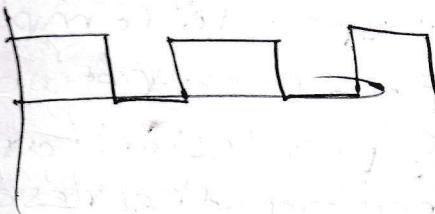
Accuracy is more prompt to noise

Digital uses less power

Example

pulse waveform, data stored in computer

waveform



Square waves

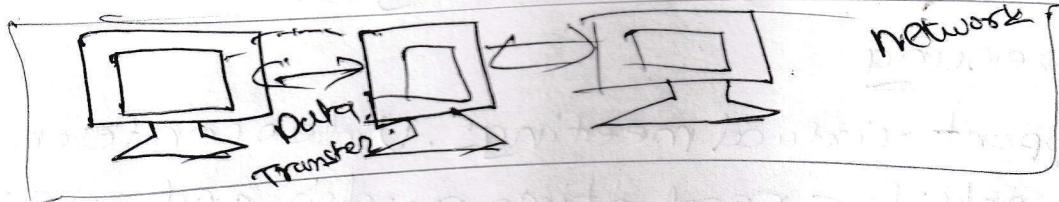
1.5 Fundamentals of Computer Network: Definition And Need of Computer Networks, Applications, Network Benefits.

### Questions

- (Q) Define Computer Network (S-23, S-22, LG-S)
- (Q) State any two needs of Computer Network (C-22)
- (Q) State various Computer network Application (LG-S)

### Fundamentals of Computer Networks

- \* A computer network is defined as two or more interconnected computers to share resources exchange data files or two allow electronic communication.
- \* A computer network is defined as a set of electronically connected computers which can share information and resources among themselves.
- \* It is like digital highway that enables data to travel between different devices, such as computers, printers etc. facilitating communication and resource sharing.
- \* Computer network may be linked through cables, telephone lines, radio waves, satellite etc.
- \* Examples: Internet, Cable TV network & etc.



### Need of Computer Network / Benefits of Computer Networks

- ① Sharing of Information and data over the geographical wide areas
- ② Communication from one computer to other computer.
- ③ Sharing of Expensive software's and database.
- ④ Networking of computer helps the network users to share files.
- ⑤ A lot of network games are available, which allows multi users to play from different locations.
- ⑥ It helps to provide Application sharing.
- ⑦ Exchange of data and info. amongst data and users via network.
- ⑧ Sharing of resources such as printers among network users.

## Applications of Computer Networking

The various applications of Computer Networking is :-

### ① E-commerce

Online shopping and e-commerce platforms depend on computer networks for transactions, secure data transfer, and communication between servers and users.

This enable buying and selling of goods and service over internet.

### ② Resource Sharing

Connected computer can share tools like printers and storage. This teamwork optimizes (reduce) resource use and makes collaborative work smoother.

### ③ Communication

Networks let devices talk to each other. Email, messaging and video calls use networking to send information between computer, phones and more.

### ④ File sharing

Network allows sharing of file between devices. Whether in a local network or over the internet, filesharing enable to exchange data quickly.

### ⑤ Online gaming

gamers connect players worldwide using networks. This connection help in real-time communication and data exchange between players during online gaming.

### ⑥ Video conferencing

Networks support virtual meetings. Videoconferencing app use networks for real-time audio and video exchange between participants.

### ⑦ Social Networking

Social media need networks. Platforms use networks for user to connect, share content, and communicate, creating online communities. This enhanced social interaction.

### ⑧ Electronic mail (E-mail)

Probably it's most widely used computer network application.

# Network Benefits / Advantages of Computer Networks

## ① Easy Communication

It is very easy to communicate through a network. People can communicate efficiently using a network with a group of people. They can enjoy the benefits of emails, instant messaging, meet etc. . . .

## ② Flexible Access

Access of files from computers through out the world, and 24 x 7 environment.

## ③ Speed

Sharing and transferring files within network is very rapid (fast) depending on the type of network. This will save time while maintaining the integrity of files.

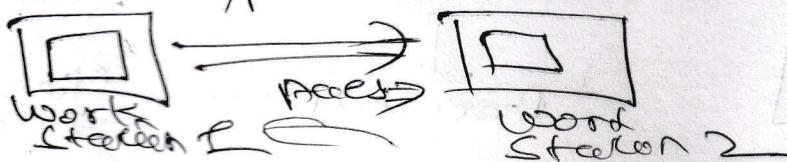
## ④ Inexpensive Set-up

Shared resources means reduction in hardware cost.

## ⑤ File sharing

The major advantages of computer network is that allows file sharing and remote file access.

A person sitting at one workstation that is connected to a network can easily see files present on another workstation, provided he/she is authorized to do so.



## ⑥ Increased storage capacity

Since, there is more than one computer on a network which can easily share files, the issue of storage capacity gets resolved to a great extent.

- \* Computer networks reduces cost of sharing the data and resources.
- \* Network provides standardisation of application.
- \* Computer network provide/allows remote access to computer.
- \* It provides efficient control and administration.
- \* provides reliable connection & communication.
- \* Allows a very flexible working environment.

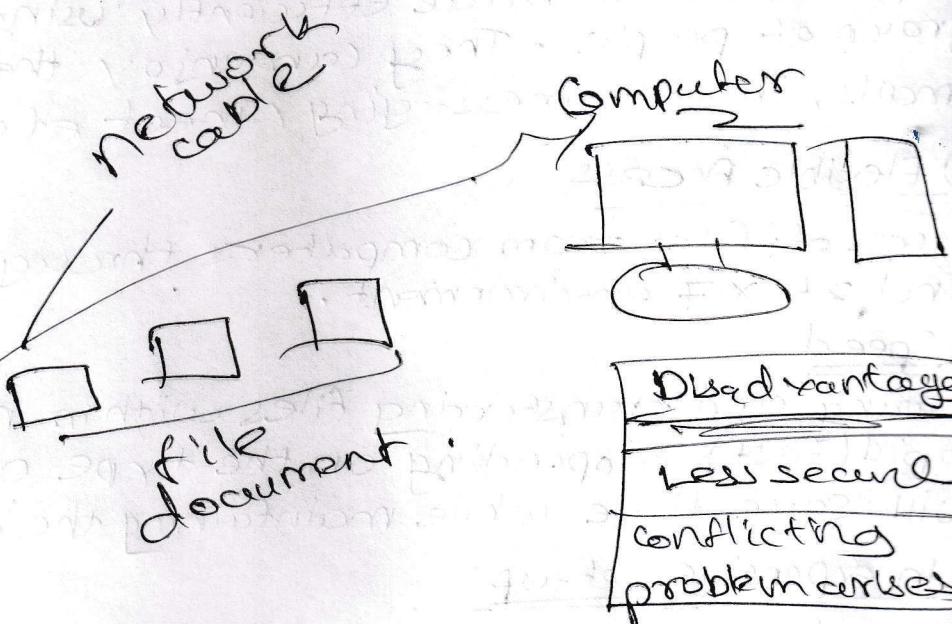
# File sharing through computer Networks

## Advantages

Easy to access info

Simple share data & info. on network.

Computer 1

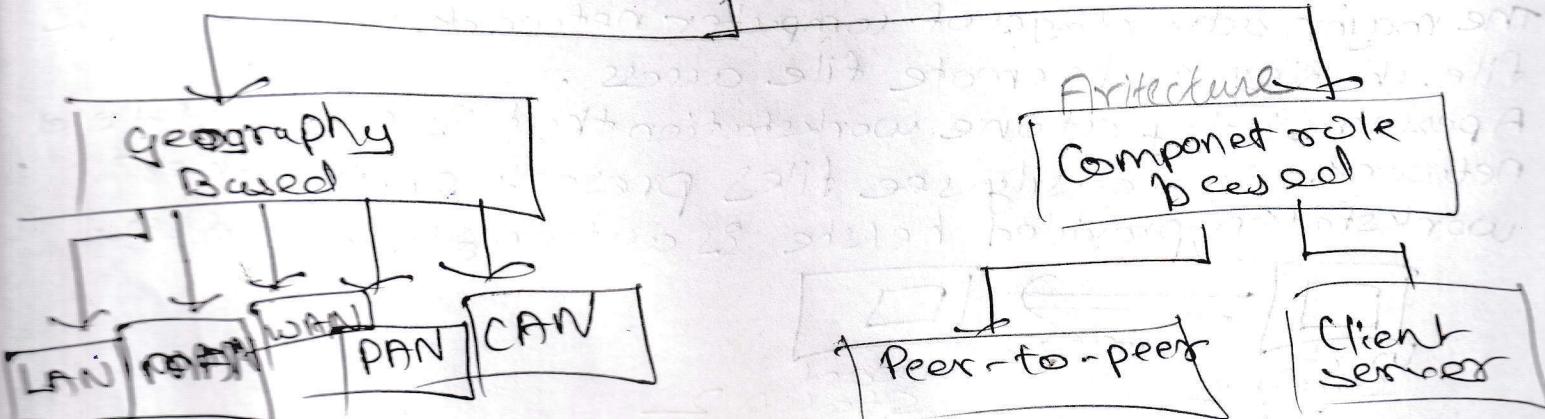


## Disadvantages

Less secure

Conflicting problem arises.

## Classification of Computer Network



## 1.0 Classification of Networks

LAN, WAN, MAN

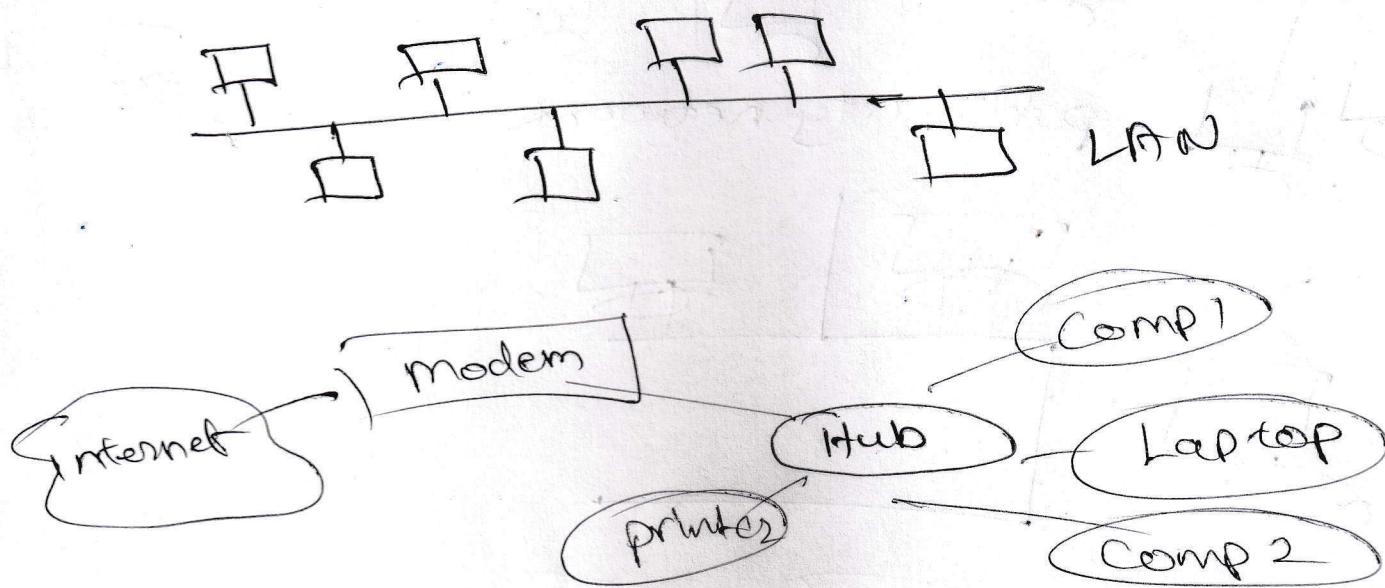
## Questions

Q1) LAN vs WAN (6marks - S2 3, 4marks - W-22)

Q2) Classify the network based on geographical based and components.

## LAN (Local Area Network)

- \* Local Area Network is privately owned networks covering a small geographic area (less than 1-2 km) like a home office, building group or building.  
Example, ST John campus has its own LAN.
- \* LAN is a group of computers and associated peripheral devices connected by a communication channel, capable of sharing files and other resources among users.
- \* LAN transmits data with speed of several megabit per second (106 bit per second).  
mostly transmission medium is coaxial cables.
- \* LAN links computers i.e. software and hardware, in same area for purpose of sharing information.
- \* Usually LAN links computer within a limited geographical area because they must be connected by a cable, which is expensive.
- \* A network which consists of less than 500 interconnected devices across several buildings is still recognized as LAN.

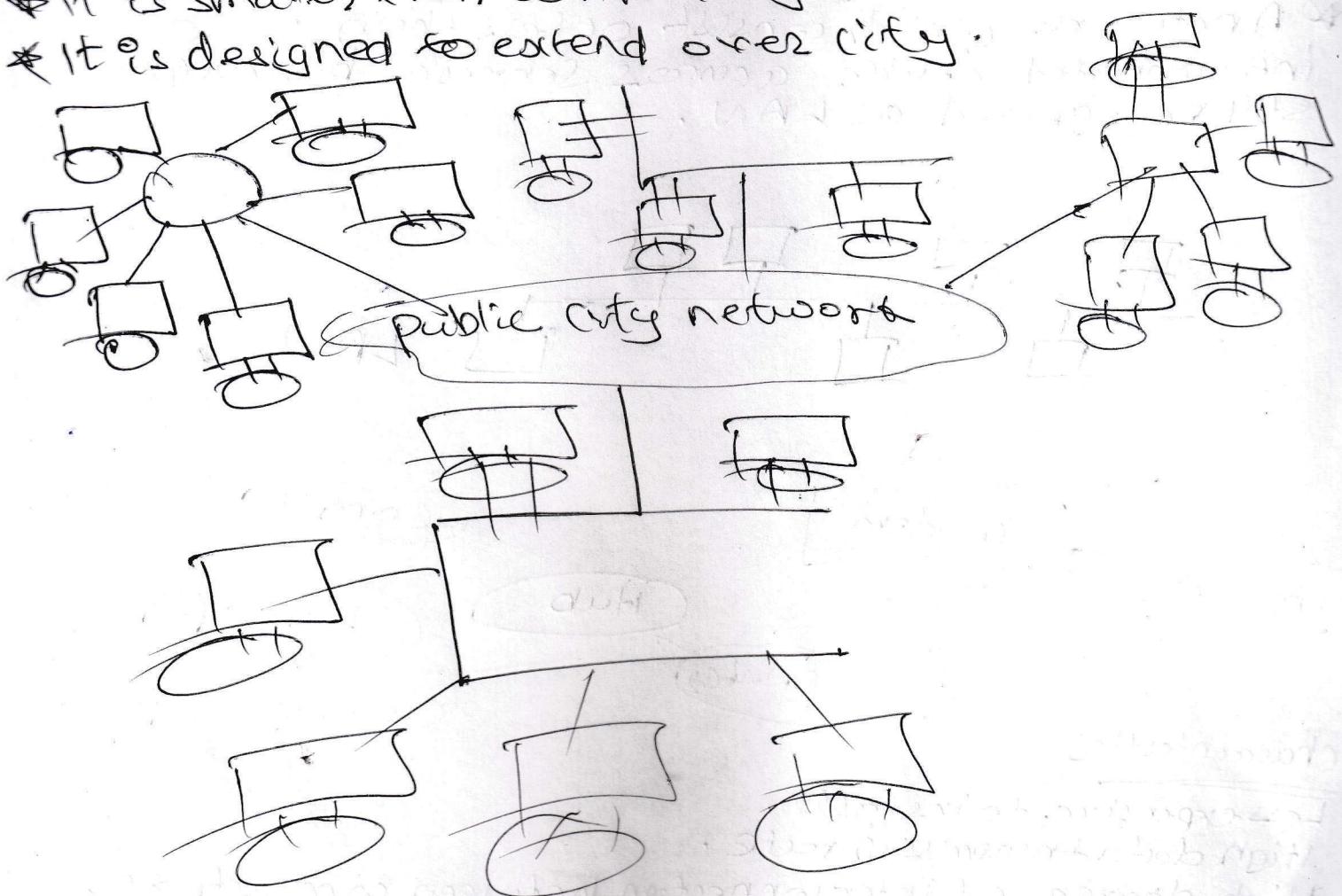


### Characteristics

- Less expensive to install.
- High data transmission rate.
- High degree of interconnection between computers.
- Easy physical connection of computers in network.
- Centralized management.
- Hardware and software sharing.
- Flexibility, speed, reliability, security.

## MAN (Metropolitan Area Network)

- \* MAN (Metropolitan Area Network) which is covering a larger area than LAN, say a network of all computers within a city.
- \* A MAN, which is larger than ~~MAN~~ LAN is limited to city or group nearby corporate offices.
- \* It uses similar technology to MAN.
- \* A MAN may be owned and operated by a single organization but is used by larger number of organizations.
- \* MAN can cover town or city corporate offices either publicly or privately.
- \* Best example  $\rightarrow$  cable television (In early system, larger antenna was placed on top of hill and signal was piped to subscriber).
- \* It is smaller than WAN, larger than LAN.
- \* It is designed to extend over city.

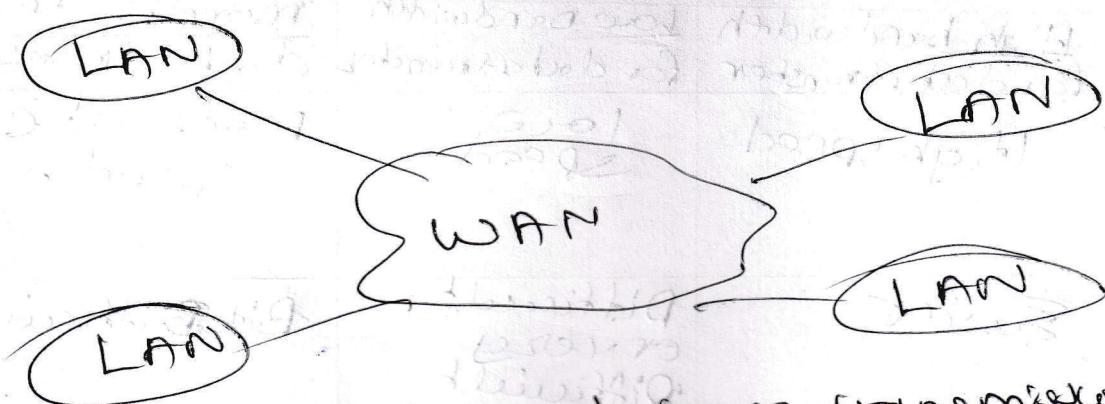


### Advantage

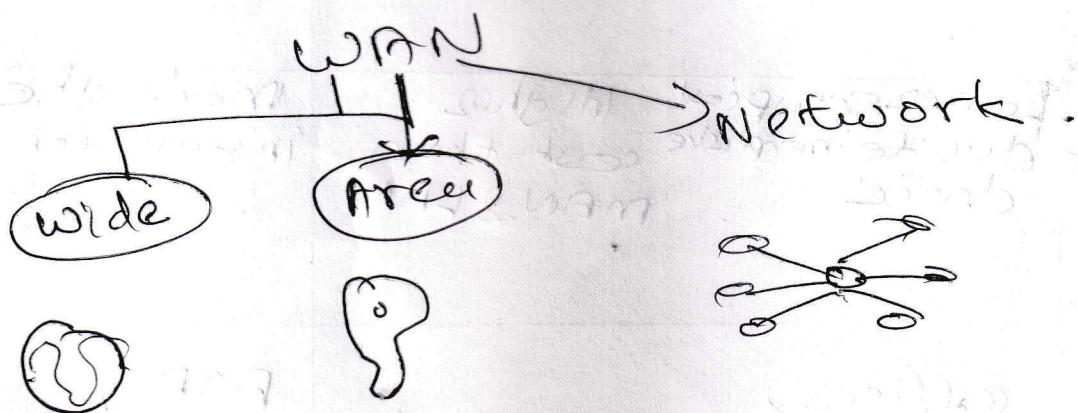
Connect faster than greater than LAN increases the efficiency of handling data. saves cost as compared to WAN Centralized management.

## WAN (Wide Area Network)

- \* Wide Area Network (WAN) is long distance communication network that covers wide geographic area such as a state or country or even the whole world.
- \* A WAN provides long distance transmission of data and voice.
- \* A Network that covers larger area such as a city, State, country or world is called Wide area networks.
- \* A wide area network that spans a large geographical area, the most common example being the internet.
- \* The internet is public WAN, but there are many ways to create a business model or private WAN.
- \* A private WAN is essential to two or more LANs connected to each other.



- \* A WAN provides long-distance transmission of data, voice, image, and video information over large geographical areas that may comprise a country or even whole world.



<u>parameters</u>	<u>LAN</u>	<u>WAN</u>	<u>MAN</u>
<u>Standfor/ full form</u>	Local Area Network	Wide Area Network	Metropolitan Area Network
<u>Definition</u>	A computer network that interconnects computers within a limited area.	A computer network that <del>work</del> connects computer resources in geographical area.	A computer network that extends over a large geographical area.
<u>Area covered</u>	Covers small area i.e. within the building	Covers large geographical area	Covers larger than LAN smaller than WAN.
<u>Error rates</u>	Lowest	Highest	Moderate
<u>Bandwidth</u>	High bandwidth for data transfer	Low bandwidth for data transfer	Moderate for data transfer.
<u>Transmission speed</u>	High speed	Low speed	Moderate speed.
<u>Design</u>	Easier	Difficult or very difficult	Bit Difficult
<u>Equipment cost</u>	Uses inexpensive equipment.	Most expensive	Very moderately expensive.
<u>Set-up cost</u>	Lower setup cost due to inexpensive devices	Higher cost than MAN & LAN	Moderate installation costs.
<u>Example</u>	Offices, Cyber Cafe	Internet, cloud.	ATM, City, EPDI etc.

## 1.6 Network Architecture: Peer-to-peer, Client server etc.

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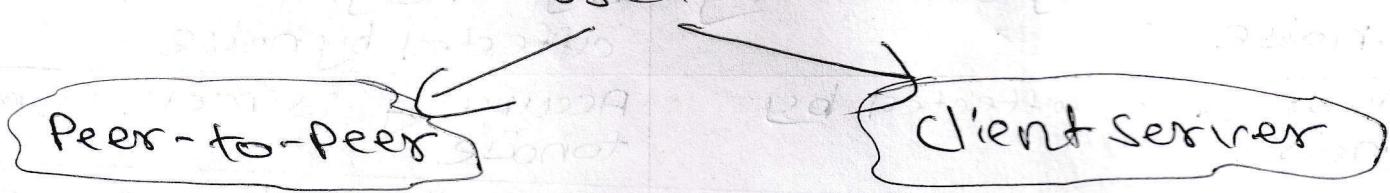
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### Peer-to-Peer Network Architecture

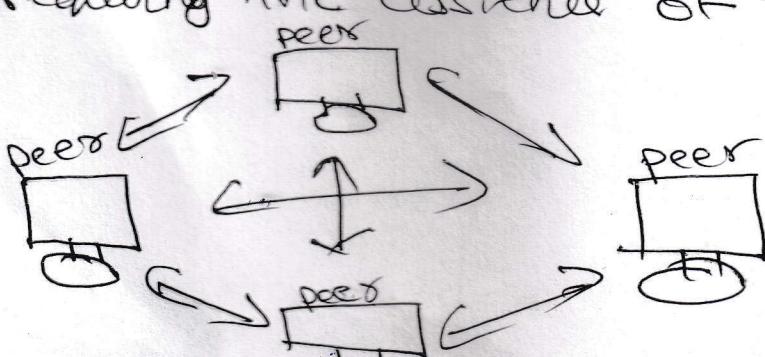
The computer network architecture specifies how the physical and logical components of a computer network are assembled and connected with each other to facilitate information exchange and resource sharing.

There are two types of network architecture used.



### Peer-to-Peer (P2P Server)

- \* Peer-to-Peer is a network in which all the computers are linked together with equal privilege and responsibilities for processing the data.
- \* Peer-to-Peer network is useful for small environments usually up to 10 computers.
- \* Peer-to-Peer network has no dedicated server.
- \* Special permissions are assigned to each computer for sharing the resources, but this can lead to problem if computer will resource as down.
- \* It carry no centralized management system.
- \* In P2P network, computing devices use software to connect with each other over a private network, Such as home local area network (LAN) or a public network, such as Internet.
- \* The direct connection allows each device to share files without requiring the assistance of remote server.



## Advantages of Peer to Peer

- (1) Less expensive.
- (2) No dedicated server required.
- (3) Easy to install and maintain.
- (4) Easy setup and lower cost for small network.
- (5) As all computer are connected one computer stops, others will not stop working.
- (6) No investment in server software or hardware is required.
- (7) No Networking Operating System (NOS) required.

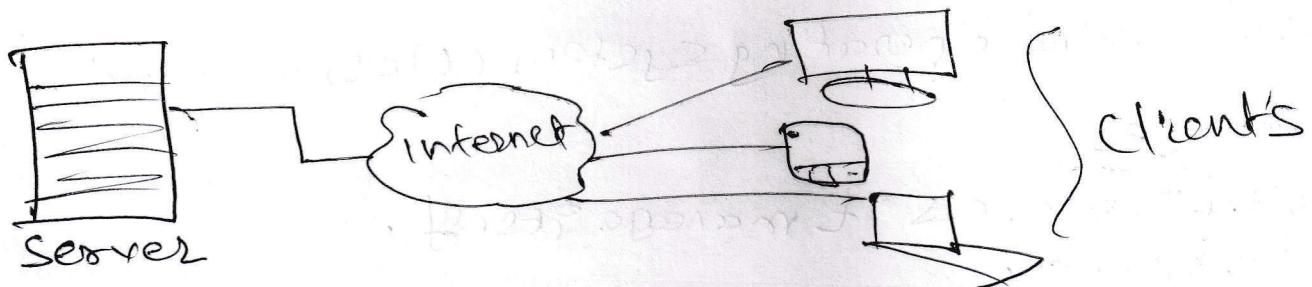
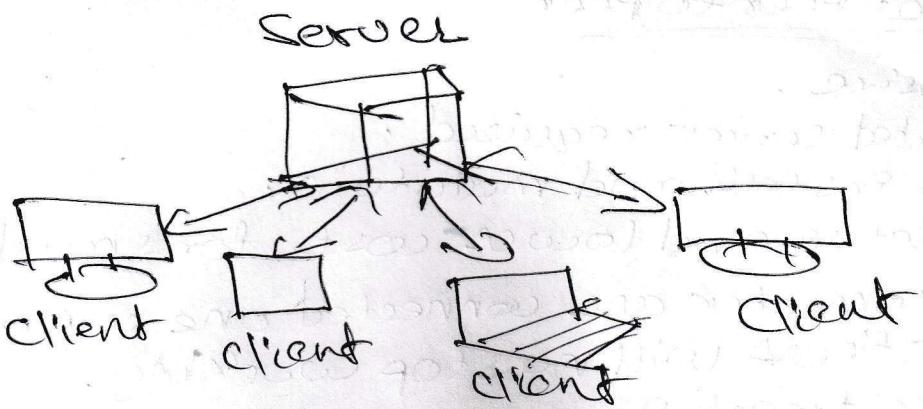
## Disadvantages

- \* Security issue as it manage itself.
- \* Slow in speed.
- \* Less reliable.
- \* Limited expandability.
- \* Lack of central management.
- \* hard to back up
- \* Not secure.

## Client Server Network

- \* Client server network is network model designed for the end users called clients, to access the resources such as songs, video etc from a central computer known as server.
  - \* The central controller is known as server.
  - \* While all other computer/device are known as in network are clients.
  - \* A server performs all the major operations such as security and network management.
  - \* Server is responsible for managing all the resources such as files, directories, printer, etc.
  - \* All clients communicate with each other through a server.
  - \* For example client 1 wants to send some data to client 2, then it first send request to server for permission.
- The server sends response to client 1 to initiate communication with client 2.

## Single Server multiple Client



## Advantages

- \* It has centralized control and administration.
- \* It has backup facility for lost data.
- \* The shared data and resources can be accessed concurrently by multiple clients.
- \* It is more secured as compared to P2P.
- \* Faster than P2P.

## Disadvantages

- \* Setup cost is very high.
- \* There may be network failure, in case of central server failure.
- \* Huge amount of request of client may overload the server.
- \* There is requirement of specialized software for client and server machine to function properly.

## Question (Q-22)

Consider a network with 8 computers which computer network architecture should be used for peer to peer or client server? Justify the answer.

When deciding the type of network for 8 computer you can choose between two

## ① Peer-to-Peer

- \* In P2P, each computer can act both user & server.
  - \* P2P is simple to setup and manage small networks.
  - \* It's usually cheaper as you don't need dedicated servers.

Drawbacks

- \* P2P may struggle as the network grows.
- \* slow in speed.
- \* It might be less secured compared to client server.

## ② Client Server Network

- \* A dedicated Server manages resources, offering better control.
  - \* Ideal for larger networks or future expansions.
  - \* Centralized control improves security.

## Drew Steele

- Higher cost as P2P than D2P.
  - Setting up and maintaining servers can be more expensive.
  - It's more intricate (complex) to set up and manage compared to D2P.
  - If it's only specially made for larger set or more no. of clients.

## Justification

- \* For 8 computers, both options can work, if simplicity and cost-effectiveness are key, go for P2P
- \* If we plan to expand, need strong control and prioritise security, Client server step.
- \* Consider your specific needs, growth expectations, and how much control and security you require for your network.

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