Date.
Page No.

Computer Network

It is a set of nodes connected by comunication links. This link can be wired or wireless and carries info.

→ a node can be a computer, printer or any other device capable of sending/receiving data generated by other nodes in the network.

Computer Network V/s Internet

CN	Internet
1. Network is defined as a group of two or more connected computers that can share resources like printer, an internet connection & app.	1. Internet is a collection of interconnected devices which are spread across the globe.
2. ~~Contains~~ nects thousands of PC at one time.	2. Connects milions of computer at one time.
3. One entity has rights to manage the network.	3. No entity controls the system on Internet

→ Internet is a type of network and called network of networks.

Date.
Page No.

Components of a Computer Network:

1. NIC (Network Interface Card)

→ Hardware component used to connect a computer with another computer onto a network.

→ There are 2 types of NIC:

(a) Wired NIC - present inside motherboard, cabels & connectors are used to transfer data.

(b) Wireless NIC - contains antenna to obtain connection.

2. HUB

→ Hardware device that divides the network connection among multiple devices.

→ When a computer request some info, it first sends it to the HUB which broadcast that request to the entire network and all the devices respond accordingly.

* Nowadays, the use of hub is obsolete, and it is replaced by Switches & Routers.

3. Switch

→ a switch is a hardware device that connects multiple devices on a computer network.

→ It is more advance than the hub, it determines the device to whom the message is to be transmitted.

→ It provides a direct connection b/w the source & destination. & inc speed of network.

Date.
Page No.

Router

→ Hardware device used to connect a LAN with an internet connection

→ It determines the best path from the available paths for the transmission of packets

Modem

→ Hardware device that allows the computer to connect to internet over the existing telephone line.

→ It stands for Modulator/Demodulator. It converts the digital data into an analog signal.

Cables and Connectors

→ Cable is a transmission media used for transmitting a signal.

Date.
Page No.

Data Communication

It is the exchange of data b/w two devices via some transmission medium over computer networks.

Components of Data Communication:

1. Message - information (data) to be communicated e.g text, audio, video.
2. Sender - device that sends the message.
3. Receiver - device that receives the message.
4. Transmission medium - It is the physical path by which a message travels from sender to receiver.
5. Protocol - The set of rules that governs the data communication.

Transmission Mode of Data Comm.:

1. Simplex - communication is uni-directional. One device always sends and another always receives.

2. Half duplex - each station can both transmit and receive, but not at the same time.
   E.g. walkie-talkie.

3. Full duplex - both stations can transmit & receive at the same time. It is actually a two half duplex connections.

Date.
Page No.

Computer Network Types

security
mixed
wireless
area
1. LAN (Local) → within a building, office → faster
2. PAN (Personal) → 10 meters range → laptops, mobiles, video player
3. MAN (Metropolitan) → within a city or state
4. WAN (wide) → countries

→ various LAN's are connected to each other through a telephone exchange line to form MAN.

→ Internet is one of the biggest WAN in the world

Network Topology

defines the structure of the network of how all the components are interconnected to each other

* Physical topology is the geometric representation of all the nodes in a network.

→ Bus → Tree → Mesh
→ Ring → Star → Hybrid

Date.
Page No.

Protocols

governs all methods of communication.

* A protocol defines the format & the order of messages exchanged b/w 2 or more communicating entities.

Elements of a Protocol

1. Message Encoding
2. Message formatting and encapsulation
3. Message timing
4. Message size
5. Message delivery options

Date.
Page No.

Computer Network Architecture

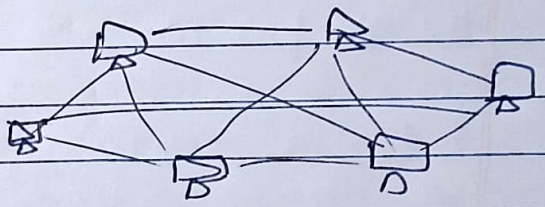
It is the physical & logical design of the software, hardware, protocols & media of the transmission of data.

1. Peer-to-Peer Network Architecture.

→ all computers are linked together with equal privilege & responsibilities for data processing.
→ no dedicated server
→ useful for small environments.

Advantages:
→ less costly
→ One defected computer will not affect others.
→ easy to setup & manage

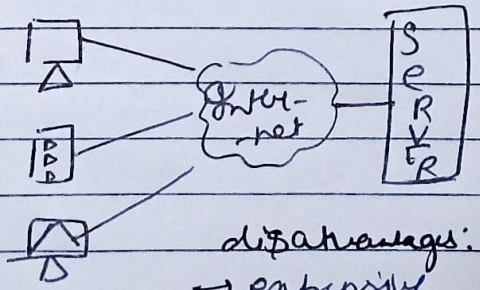
Disadvantages:
→ has security issues
→ can't backup the data.



2. Client-Server Network

→ designed for end users called clients, to access resources from a central computer called Server

→ Server performs all major operations such as security & network management.
→ all clients communicate with each other through a server.



advantage.
→ data can be backup.
→ Improves overall performance
→ security is better.
→ Increased Speed

disadvantages:
→ expensive
→ requires dedicated network administrator

Date.
Page No.

Access Network

→ It physically connects an end system to the immediate router on a path from end system to any other distant end system.

Types of access network:

Ethernet: It is most commonly installed wired LAN tech and it provides services on the physical & Data link layer of OSI reference model. It typically uses coaxial cable or twisted pair wires.

DSL: Digital Subscriber Line.
→ connected to telephone lines
→ carry both data & voice signals.

FTTH: Fiber to the Home
→ uses optical fiber from a central office directly to building
→ high-speed Internet access among all.
→ most expensive

Wireless LAN: → links 2 or more devices using wireless communication. → uses high-frequency radio wave

Satellite Internet - wireless connection that uses satellite communication to deliver internet
→ higher latency & lower bandwidth

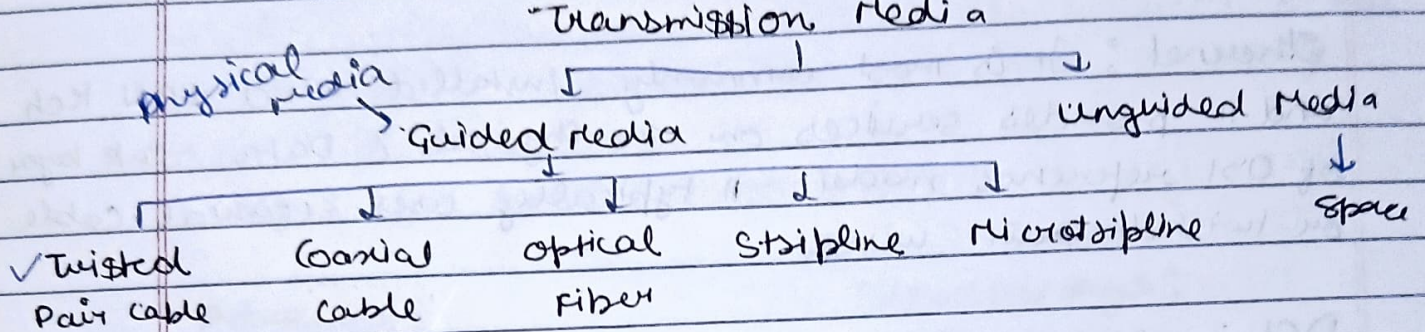
WiMax - Worldwide Interoperability for Microwave Access
→ high-speed Internet over wide area.

5G - latest wireless communication technology
→ high speed internet & increased network capacity.

Date.
Page No.

Types of Transmission Media

a Transmission medium is a physical path b/w transmitter & receiver i.e,
→ channel through which data is sent from one place to another.



Physical / Guided Media:

→ Wired or Bounded transmission media
→ Signals are directed & confined in a narrow pathway by using physical links.

→ High Speed
→ Secure
→ Used for shorter distances

Date.
Page No.

Switching Techniques

In large networks, there can be multiple paths from sender to receiver. The switching technique will decide the best route for data transmission.

1. Circuit Switching

→ In this a dedicated path is established b/w sender and receiver.

→ Once the connection is established then the dedicated path will remain to exist until connection is terminated.

→ when any user wants to send the data, voice, video a request signal is sent to the reciever then the receiver sends back the acknowledgement to ensure availability of dedicated path the dedicated path transfers data.

→ used in public telephone network.

→ It has 3 phases:

1. Circuit establishment
2. Data transfer
3. Circuit Disconnect

Advantages:

→ Guranteed bandwidth (dedicated path)
→ Low latency (time taken by message to travel)
→ Predictable performance

Disadvantages

→ Inefficient use of bandwidth
→ Less efficient
→ High cost (requires dedicated resources)

Date.
Page No.

2. Packet Switching

→ message is sent in one go, but it is divided into smaller pieces, & they are sent individually.

→ message splits into smaller pieces known as 'packets' & packets are given a unique number to identify their order at the receiving end.

→ every packet contains some information in its header such as source address, destination address and sequence number.

→ Packets will travel across the network, taking the shortest path as possible. & then get reassmbled at the receiving end in correct order.

→ if packet is missing or corrupted, message will be resent & if packet reached in correct order, acknowledgement will be sent.

Advantages

→ Efficient use of bandwidth
→ Flexible
→ Scalable
→ Lower cost

disadvantages

→ Higher latency (delays)
→ Packet loss
→ Unsuitable for real-time communication

Date.
Page No.

Delays

The delay of network specifies how long it takes a bit of data to travel across the network from one node to another.

Types of Delays:

MOST

1. **Transmission delay** → Time taken to push the packet bit onto the communication link. It depends on length of packet and bandwidth of N/W.

$$TDE = \frac{\text{length of packet } (l)}{\text{Bandwidth } (b)}$$

2. **Propogation delay** → time for a bit reaching destination.

$$PDE = \frac{\text{distance}}{\text{transmission speed}}$$

3. **Queuing delay** → time the packet spend in queue. It depends on no. of packets arrived earlier in the queue

4. **Processing delay** → a packet consist of header and data field. The header consist address of source and destination.

It is the time required to examine or process the header is called processing delay.

Total delay = Transmission delay + Propagation delay + Queuing delay + Processing delay

or

end to end delay

Date. _____
Page No. _____

Que Transmission speed = 2.1×10^8 m/s s, ms, us
distance = 2.1Km

PDE = $\frac{2.1 \times 10^3 \text{ m}}{3 \times 10^8 \text{ m/s}}$

PDE = 10^{-5} s = 10^{-2} ms = 10 us

Que1 What is the propogation and transmission time for a 2.5KB message if the bandwidth of network is 1 GBps. distance = 12000 km
transmission speed = 2.4×10^8 m/s

TDE = $\frac{2.5 \text{ KB}}{1 \times 10^{-6} \text{ KBps}}$

TDE = 2.5×10^{-6} s

PDE = $\frac{120000 \times 10^3 \text{ m}}{2.4 \times 10^8 \text{ m/s}}$

= $\frac{0.5}{10}$

PDE = 5×10^{-2} s

Que2 message length = 5MB (Bytes) Bandwidth = 1MBps (Bits)
distance = 12000 km trans. speed

TDE = 5 MBytes = 5 Mbits = 5X8 Mbits

= $\frac{40 \text{ Mbps}}{1 \text{ Mbps}}$

= 40s

Date.
Page No.

Que Consider 2 host A and B, connect by a single link of rate 'R' bps. Suppose that 2 hosts are seperated by 'm' meters & suppose the propogation speed along the link is 's' mps. host 'A' send a packet of size 'L' bits to host 'B'.

1. Obtain the expression for end to end delay

distance = m
propogation speed = s
Bandwidth = R bps
length of packet = L bits

$TDE = \frac{L \text{ bits}}{R \text{ bps}}$ $PDE = \frac{m \text{ m}}{s \text{ m/s}}$

$TDE = L/R$ s $PDE = m/s$ s

end to end delay = TDE + PDE

$= (L/R + m/S)$ s

2. $S = 2.5 \times 10^8$ ms^{-1}
$m = ?$
L = 120 bits
R = 56 Kbps

TDE = PDE

$\frac{M}{2.5 \times 10^8 \text{ m/s}} = \frac{120}{56 \times 10^3 \text{ bps}}$

$\frac{56 \times 2.5 \times 10^{10}}{12} m = M$

$14 \times 56 \times 2.5 \times 10^6 \text{ km} =$

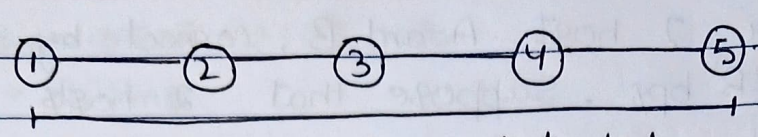
$M = \frac{120 \times 2.5 \times 10^2}{56}$ km

$= 5.357 \times 10^2$ km $= 535.7$ km

Latency = PD + TD

Date. _____
Page No. _____

Que



1. What is the end-to-end packet latency in this store and forward subnet from Router 1 to Routers.

→ All links 2.5 km, C = 100 mbps, QD = PD = 0
propogation speed = 200 m / μs,
packet size = 1000 bytes

Date.
Page No.

Que We consider sending real-time voice from Host A to Host B over a packet-switched network (VoIP). Host A converts analog voice to a digital 64 Kbps bit stream on the fly. Host A then groups the bits into 56-byte packets. There is one link between Hosts A and B, its transmission rate is 2 Mbps and its propagation delay is 10 ms. As soon as Host B receives an entire packet, it converts the packet's bit to an analog signal. How much time elapses from the time a bit is created (from the original analog signal at Host A) until the bit is decoded (as part of analog at Host B)?

conversion speed = 64 Kbps

packet size = 56 byte

Transmission/Bandwith rate = 2 Mbps

PDE = 10 ms

latency = ?

$TDE = \frac{56 \text{ bytes}}{2 \text{ bips}} \Rightarrow \frac{56 \times 8 \text{ bits}}{2 \times 10^6 \text{ bits ps}}$

$TDE = 244 \times 10^{-6}$ s

$TDE = 244 \times 10^{-3}$ ms = 0.224 ms

Conversion delay $= \frac{56 \times 4 \text{ bits}}{64 \times 10^3 \text{ bits s}} \Rightarrow 7 \times 10^{-3}$ s

= 7 ms

latency = Conv. delay + TDE + PDE

= 17.224 ms

Date.
Page No.

Ques In modern packet-switched networks, Consider a message that is $8*10^6$ bits long that is to be sent from host A to Host B with 2 packet switches in b/w. Suppose each link is 2Mbps. Ignore propagation, queueing & processing delays

(a) Consider sending the message from A to B w/o message segmentation. How long does it takes to move the message from Host A to the first packet switch? Keeping in mind that each switch uses store-and forward packet switching. What is total time to move message from A to B

packet size = 8×10^6 bits packet-switches = 2
Bandwidth = 2Mbps

$$TDE = \frac{8 \times 10^6 \text{ bits}}{2 \times 10^6 \text{ bits/s}}$$

TDE = 4s

∵ there are 2 packet switches
∴ total Links = 3

TDE for 1 Link = 4s
TDE for total transmission from A to B
= 4 x 3
= 12s Ans

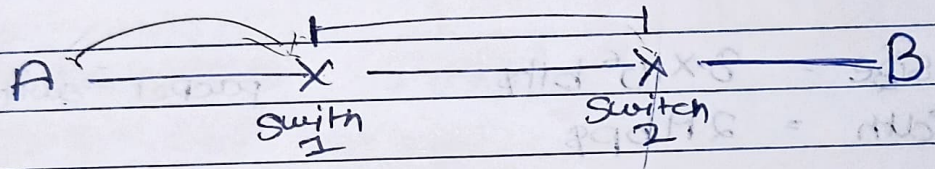
Date.
Page No.

(b) Now suppose that the message is segmented into 800 packets, with each packet being 10,000 bits long. How long does it takes to move the first packet from A to the first switch? ~~to the second switch, the second~~ When the first packet is being ~~is being~~ sent from A the first switch. AT what time will the 2nd packet be fully received at first switch

no of packets = 800

packet length = 10000 bits

Bandwidth = 2 Mbps



$$TDE = \frac{5 \times 10000}{2 \times 10^6}$$

$$= 5 \times 10^{-3} \text{ s}$$

$$= 5 \text{ ms}$$ (from A to first switch [1st packet])

A to switch 2

$\Rightarrow$ [10 ms] (from A to first switch [2nd packet])

(c) How long does it take the to move the file from A to B when msg segmentation is used

TDE = [illegible]

= [illegible]

15 + 5 × 799

= 4010 ms

= 4.01 s

Segmentation is faster

Date.
Page No.

Computer Network Models

ISO has developed a layered approach; In this networking concept is divided into several layers, and each layer is assigned a particular task.

Layering

→ decomposing problem into more manageable components.
→ provides more modular design.
→ Easy to troubleshoot

Protocol Layering

→ The protocols in each layer governs the activities of data communication.
→ Each layer has different set of protocols.

Layered Architechtures

1. OSI Reference Model
2. TCP/IP Model

The OSI reference Model

→ OSI → Open System Interconnection.
→ model for understanding & designing a network architecture that is flexible, robust & interoperable.
→ it is not a protocol just a guideline
→ It was never fully implemented.
→ Its purpose was to show how to facilitate communication b/w diff systems w/o requiring changes of underlying hardware.

Date.
Page No.

→ OSI consists of 7 layers, and each layer performs a particular network function.
→ Each layer is self-contained, so that task assigned to each layer can be performed independently.

The 7 layers of OSI Model

- Application layer
- ~~Physical~~ layer
- Presentation layer
- Session layer
- Transport layer

} Responsibility of the host

- Network layer
- Data Link Layer
- Physical Layer

} Responsibility of the Network

1. Physical Layer

→ responsible for actual physical connection b/w devices.
→ contains information in form of bits.
→ converts signals received from data link layer into 0s & 1s & send them back to data link layer.

functions:

→ Bit synchronisation
→ Bit rate control
→ Physical topologies
→ Transmission mode
→ has physical address

Bit torrent → peer to p...

Date.
Page No.

Data Link Layer

→ responsible for node-to-node delivery of message.
→ this layer makes sure data transfer is error-free from one node to another, over physical layer.
→ divided into 2 sublayers:
1. Logical Link control (LLC).
2. Media access control (MAC)

→ Packets in the DLL is refered to as frames.
→ DLL is handled by NIC (Network Interface card).

functions:
1. Framing → It provides a way to transmit bits that are meaningful to receiver.
2. Physical addressing
3. Error control
4. Flow control
5. Medium access control

Network Layer

→ works for the transmission of data from one host to the other located in different networks.
→ The sender & receiver's IP address are placed in the header by network layer.

Functions
1. Routing
2. IP/logical Addressing
3. Internetworking.

→ Segment in the Network layer is refered as Packet.

Date.
Page No.

4. Transport Layer → called heart of OSI model
→ provides services to the application layer & takes services from the network layer.
→ data is present in the form of of segments.

functions
1. Segmentation & Reassembly
2. Service point addressing → includes port address.

Services provided by transport layer:
1. Connection - Oriented service (TCP)
2. Connectionless Service (UDP)

① Connection - Oriented : Includes 3 phases
- Connection Establishment
- Data transfer
- disconnection / Termination

② Connectionless service
→ one phase process, faster communication

5. Session Layer
→ responsible for the establishment of connection, maintenance of sessions, and authentication, and also ensures security.

functions:
→ Session establishment, maintenance & termination
→ Synchronization.
→ Dialog Control