UNIT-1

COMPUTER NETWORK

① Computers are interconnected using communication media or inter-connected autonomous computers are called computer networks.

② Goals of computer networks are -

(1) To provide sharing of resources such as information or processors
(2) To provide inter-process communication among users and processors
(3) It provides the network user with maximum performance at minimum cost.
(4) It provides centralized control for a geographically distributed system.
(5) It provides compatibility of dissimilar equipment and software
(6) It provides centralized management and allocation of network resources
(7) It provides distribution of processing functions.

③ Computer Network components -

Hardware - Computers, modems, interfaces, network cards, peripheral devices etc
Software - Operating systems, protocols etc

④ Network architecture -

→ Peer-to-Peer -

NO centralized area of control, small network ($n < 50$), easily manageable.

Disadvantage - user dependency, machine dependency, data loss, uncensored

→ Client-Server -

Centralized area of control, large network, central storage of data, network management is good.

⑤ Classification and Types of Networks -

→ Based on transmission technology -

(1) Broadcast Networks
(2) Point to Point Networks

→ Based on scale -

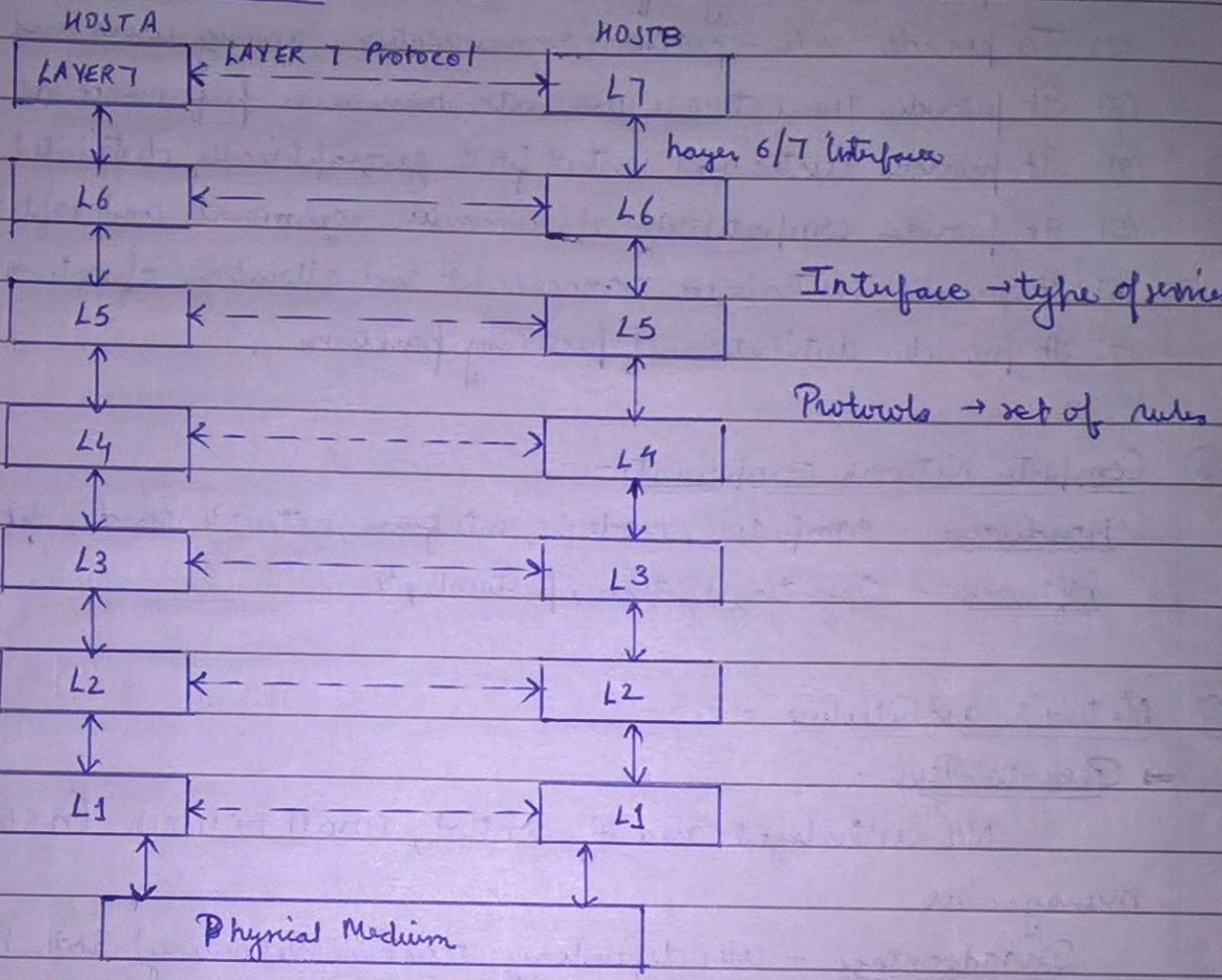
(1) LAN (2) MAN (3) WAN

→ Based on Network Topologies -

(1) BUS (2) STAR (3) RING (4) MESH (5) HYBRID

(5) ~~layered architecture~~ - LAYERED ARCHITECTURE

(6) Protocol Hierarchies -



Set of layers and protocols is called a network architecture

(7) Design Issues for the layers -

(1) Data transfer mode is considered for transmission - Simplex, half duplex and full duplex

(2) Protocol check the logical channel and its priority.

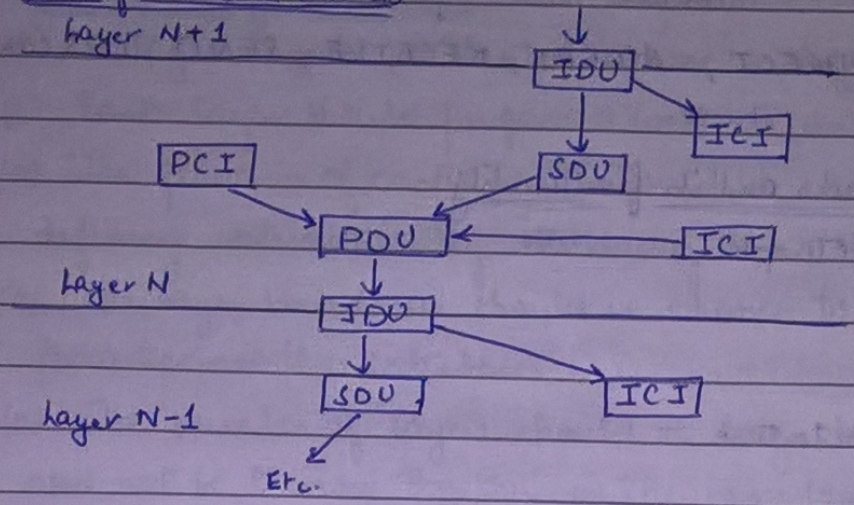
(3) Actual data transfer place through physical channel.

(4) loss of data because of slow receiver and faster sender.

(1) Addressing (2) Error Control (3) Flow Control

(4) Multiplexing (5) Routing.

⑧ Interfaces and Services -



Service Data Unit (SDU) - Transfer user data by layer N+1 to layer N and N-1.

Protocol Control Information (PCI) - To perform service function

Protocol Data Unit (PDU) - Combination of SDU and PCI

Interface Control Information (ICI) - It passes temporary parameter between N and N-1 to invoke service function.

Interface Data Unit (IDU) - Total unit of information transferred across the layer boundaries.

⑦ Connection oriented and connectionless services -

(circuit switching) Connection oriented - Direct path is established between source and destination. Eg:- Telephone system. Connection Establishment → Send data

(packet switching) Connectionless (datagram) - Goes directly from an idle condition into a data transfer mode, followed directly by idle condition.

'Send data → connection establishment'

⑧ Service Primitives -

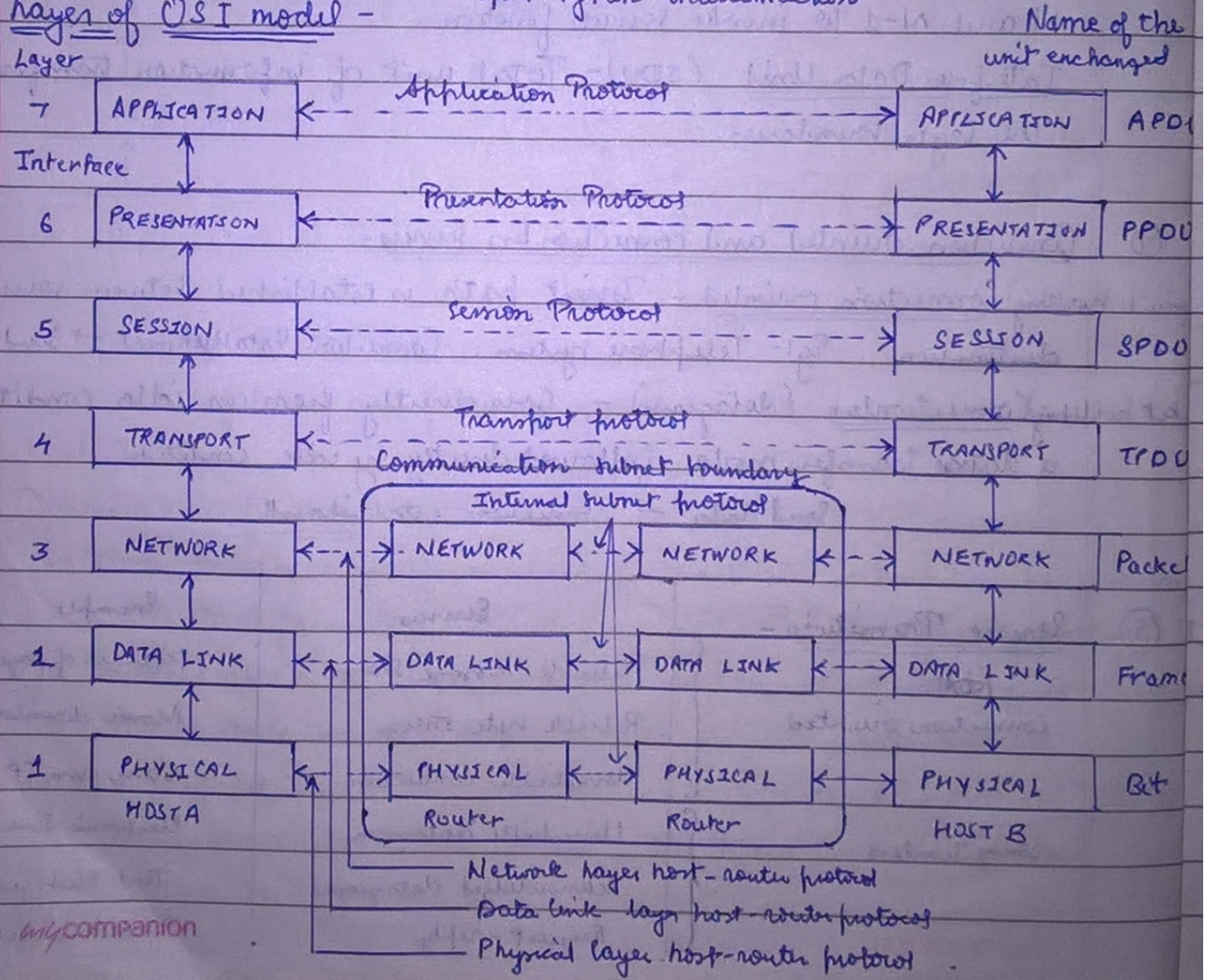
	Services	Example
Connection oriented	Reliable message stream	Sequence of pages
	Reliable byte stream	Movie download
	Unreliable connection	Voice over IP (VoIP)
Connectionless	Unreliable datagram	Electronic Junk Mail
	Acknowledged datagram	Text Messaging
	Request - reply	Database query

⑧ Services Primitives → Primitive means operation,
LISTEN, CONNECT, ACCEPT, RECEIVE, SEND, DISCONNECT

⑨ Network Design Issues and its functionality -
(1) Justifying a Network
(2) Scope
(3) Manageability
(4) Network architecture
(5) Switch mode
(6) Node placement and sizing
(7) link topology and sizing
(8) Routing.

ISO-OSI REFERENCE MODEL - International Organization for Standardization - Open system interconnection

⑩ layers of OSI model -



(11) Principles of OSI model -

(1) A layer should be created where a different abstraction is needed
(2) Each layer should perform a well-defined function.
(3) The function of each layer should be choosen with an eye toward defining internationally standardized protocols.
(4) The layer boundaries should be choosen to minimize the information flow accross the interfaces.
(5) The number of layers should be large enough that distinct functions need not be thrown together in the same layer out of necessity and small enough that the architecture does not become unwieldy.

(12) → Application layer - provide access to OSI environment for users and also provides distributed information services.
Protocols - DNS, FTP, TFTP, Network Components - Gateway

→ Presentation layer - provides independence to application processes from differences in data representation (syntax).
Protocols - SMP, NCP Network Components - Gateway.

→ Session layer - provides the control structure for communication between applications. Establishes, manages and terminates connections (sessions) between cooperating applications.
Protocols - NETBIOS, RPC Network Components - Gateway

→ Transport layer - provides reliable, transparent transfer of data between end points; provides end-to-end error recovery and flow control.
Protocols - TCP, ARP, NETBIOS Network Components - Gateway, Brouter

→ Network layer - provide upper layers with independence from the data transmission and switching technologies used to connect system. Responsible for establishing, maintaining, and terminating connections.
Protocols - IP, ARP, IPX Network Components - Router, Brouter

→ Data link layer - provides for the reliable transfer of information across the physical link; send blocks (frames) with the necessary synchronization, error control and flow control. Protocols - LLC, Network Components - Bridge, switch, Hub, NIC

SMTP → Simple mail Transfer protocol.
ICMP → Internet control message protocol

→ Physical layer - Concerned with transmission of unstructured bit stream over physical medium; deals with the mechanical, electrical, functional and procedural characteristics to access the physical medium.
Protocols - IEEE 802, ISDN Network Components - Repeater, multiplexer, hub, amplifier.

(13) TCP/IP Reference Model - (Transmission Control Protocol / Internet Protocol

	Protocols
Application layer	HTTP, SMTP, FTP, DNS
Transport layer	TCP, UDP
Internet layer	IP, ICMP
Host to Network	DSL, SONET, 802.11, Ethernet ← Network

Application layer - It includes all process and services that use the transport layer to deliver data.
Transport layer - It is designed to allow peer entities on the source and destination hosts to carry on a conversation.
Internet layer - It handles machine to machine communication
Host to Network - It cannot define any protocol. Same as ~~fdp~~ physical layer + data link layer.

(14) Comparison of OSI and TCP/IP -

OSI	TCP/IP
(1) 7 layers	(1) 4 layers.
(2) Model was first defined before implementation takes place	(2) Model defined after, protocol were implemented.
(3) OSI model based on three concept ie services, interface and protocol	(3) TCP/IP model did not originally clear distinguish between service, interface and protocol.
(4) OSI model gives guarantee of reliable delivery of packet	(4) Transport layer does not always guarantee the reliable delivery of packet.

OSI	TCP/IP
(5) OSI does not support internet working	(5) TCP/IP support
(6) Strict layering	(6) loosely layering
(7) Support connectionless and connection-oriented communication in the network layer	(7) Support only connection-oriented communication in the transport layer

(15) Network Standardization –

For coordination between network vendors and suppliers, the standard comunity is form. Several organization are-

(1) ITU (International Telecommunication Union) –

(a) ITU-K (Radiocommunication sector)

ITU-T (Telecommunication Standardization sector)

ITU-D (Development sector)

(2) International Standards –

ISO (International Standards Organization)

ANSI (American National Standards Institute)

IEEE (Institute of Electrical and Electronics Engineering)

(3) Internet Standards –

IAB (Internet Activities Board)

RFCs (Request for Comments)

IRTF (Internet Research Task Force)

IETF (Internet Engineering Task Force)

W3C (World Wide Web Consortium)

QUEUEING MODELS –

(16) It is mathematical study of waiting lines and queues.

M/M/3/20/1500/FCFS – A single queue system with – (M/M/3)

exponentially distributed arrivals.

exponentially distributed service times

three servers.

Capacity 20 (queue size is 20 – 3 = 17)

Population is 1500 Total

Service discipline is FCFS.

(17) Little's Law (Theorem) -

Mean jobs in system = arrival rate × mean response time

Arrival rate = $\frac{\text{total arrivals}}{\text{total Time}} = \frac{N}{T}$

Applies if jobs entering equal jobs serviced

Area in each is same, call it J

Mean time in system = J/N

Mean number in system = J/T

Multiply by N×N

$= \frac{J}{T} \times \frac{N}{N} = \frac{N}{T} \times \frac{J}{N}$

= arrival rate × mean time in system

QUEUEING SYSTEM -

(18) Single queue, single server (M/M/1) queue (Utilization) $\rho = \frac{\lambda}{\mu} = \frac{\text{Arrival rate}}{\text{service rate}}$

No buffer or population limitation.

Mean jobs in system, $E[n] = 1/(1-\rho)$

Variance of jobs in system, $Var[n] = \rho/(1-\rho)^2$

Probability of n or more jobs, $Pr(\geq n \text{ jobs in system}) = \rho^n$

Mean response time, $E[r] = \frac{1}{\mu(1-\rho)}$

Mean jobs in queue, $E[n_q] = \frac{\rho^2}{1-\rho}$

(19) Single queue, multiple servers (M/M/m) queue -

$E[n] = c\rho + \frac{\rho k}{1-\rho}$ $\qquad E[n_q] = \frac{\rho k}{1-\rho}$

$Pr(\geq c \text{ jobs}) = [(c\rho)^c] / [c!(1-\rho)]p_0$

$E[r] = \frac{1}{\mu} + \frac{k}{[c\mu(1-\rho)]}$, $\quad E[w] = \frac{k}{[c\mu(1-\rho)]}$

(20) M/M/m/m, M/M/∞, M/G/1 (G → General distributions)