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Module 1

Network is an interconnection of communication devices or collection of autonomous devices interconnected by a single tech or group of connected devices

Internet is a network of networks.

1960s - ARPA (Advanced Research Project Agency)

1967 - ACM (Adv. Computer Machinery)

1969 - ARPANET - 1st network

IMP (Interface Message Processor) acted as a server.

The clients were the computers of 4 universities.

Network Control Protocol was used.

Uses of Computer Networks

(i) Business Application

- E-commerce
- Resource sharing } client-server
- Communicatn medium among employees

(ii) Home Application

- E-commerce
- Communicatn media (person-to-person)
- Entertainment (Interactive) → videos, games
- Access to remote info.

Client-server or peer-to-peer → eg: torrent, napster, skype

(iii) Mobile Users

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- M-commerce
- Wireless smoke detectn
- " parking area
- Utility meter reading → gas, water, electricity

(iv) Social Issues

- People can exchange messages with like-minded people
- Social media
- Politician collect relevant ideas & opinions of people from social media.

There are ethical problems, political problems & security issues.

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Taxonomy of Network

2 dimensions to classify network

(i) Based on txm technology → Broadcast
→ Point-to-point

(ii) " " scale Based on txm tech

Broadcast → msg is transmitted to all hosts in the network. (.255 at the end of network addr)

eg. 192.168.0.255
↳ Addr field

Multicasting → Send packets to subset of machines in the network

Total N-bit addr → 1- bit for multicast
(n-1) bits for group id

Point-to-Point → Dedicated link btw sender & receiver. There is a permanent link btw 2 points.

Unicasting → Point-to-point txm with 1 sender & 1 receiver.

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Based on Scale

Distance	Located in	
1m	sqa. meter	PAN (Personal Area Network)
10m	Room	LAN (Local Area Network)
100m	Building	LAN (Local Area Network)
1km	Campus	LAN (Local Area Network)
10km	City	MAN (Metropolitan Area Network)
100km	Country	WAN (Wide Area Network)
1000km	Continent	WAN (Wide Area Network)
10,000km	Planet	Internet

- PAN

→ Meant for a person

→ eg: wireless network connecting a computer with keyboard, mouse, ~~etc~~ printer etc

- LAN

→ Privately owned network

→ Network within a single building / campus

→ They can be distinguished from other networks by:

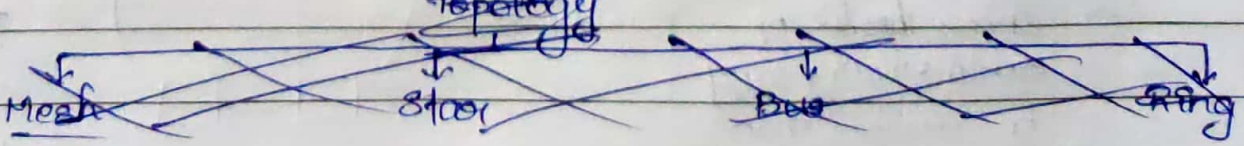
(i) tx'm technology → by speed → 10 Mbps, 100 Mbps, 1 Gbps, 10 Gbps

(ii) size → within few metres

(iii) topology

→ Network laid out physically

topology



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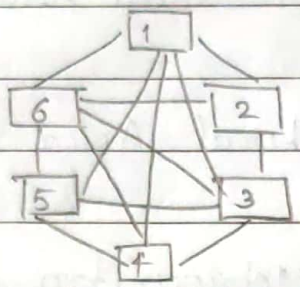
Topology

Mesh



dedicated link to all other hosts.

n host ⇒ $\frac{n(n-1)}{2}$ links

Adv

→ Eliminating traffic problem

→ Robust (If 1 line is unusable, it doesn't stop entire system)

→ Privacy / security

→ Fault identificat° & isolat° is easy

Disadv

→ Amount of cabling & I/O ports

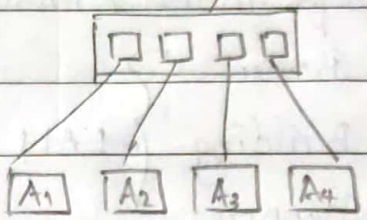
→ Installat° & reconnect° are difficult

→ Expensive

→ Sheer ~~bulk~~ of ~~cable~~ wiring may be greater than available space

Star

Hub



P-to-p connect° btw controller & device.

No direct comm btw 2 hosts.

Adv

→ Less expensive compared to mesh

→ Robustness

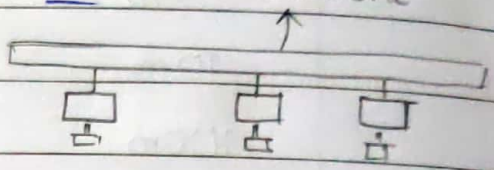
Disadv

→ Dependency to controller. If hub fail, entire network failed

→ More cabling

Bus

Backbone



Multi-point connect°

Adv

→ Ease of installat°

→ Requires less cabling than mesh & star

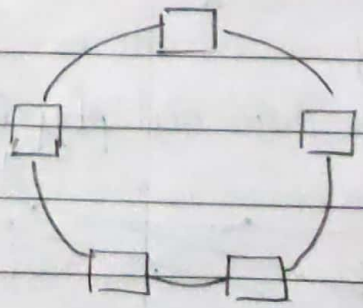
Disadv

→ Difficulty of fault detect° & isolat°

→ If backbone fails, entire network fails.

→ Adding new devices may require replacement / modificat° of backbone

Ring



Each device has a dedicated point-to-point connect° to 2 devices in the n/w

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Signal passes through the ring in a single directn.

Adv

→ Relatively easy to reconfigure
→ Fault isolatn is easy
→ Signal is circulating at all times.

Disadv

→ Break in ring fails entire network.
→ Unidirectnal traffic

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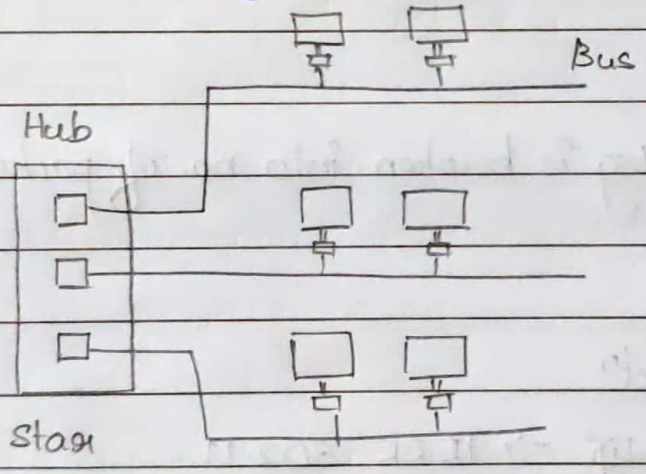
Hybrid Topology



Bus + Star (Hybrid)
Hybrid → Combo of different topologies

- MAN

→ LAN < MAN < WAN
→ eg. Cable TV
→ Within a city

- WAN

→ Large geographical area
→ Continent / country
→ Combo of Host & subnets

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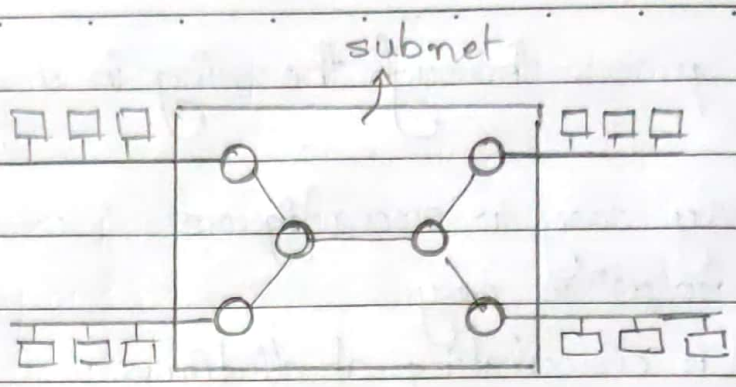

Hosts → individual systems

Subnet { txm lines → to transmit data
+
routers

→ Routers routes ~~signal~~ packets based on routing algorithm
→ Subnets are based on 2 principles
(i) Store & forward
(ii) Packet switching
→ Packet switching → Msg is broken into no. of packets & reassembled at destinat^n

Wireless Network

(i) Systems interconnect^n
(ii) Wireless LAN → Wifi → IEEE 802.11
(iii) " WAN → Wimax, 4G LTE (Long Term Evolut^n)

• System Interconnect^n
→ Interconnecting computers & devices using short range radio waves
→ eg: Bluetooth → IEEE 802.15
• Wimax → IEEE 802.16
• Ethernet - LAN → IEEE 802.3
• Home Network
→ Devices capable of communicating with each other & access

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through internet

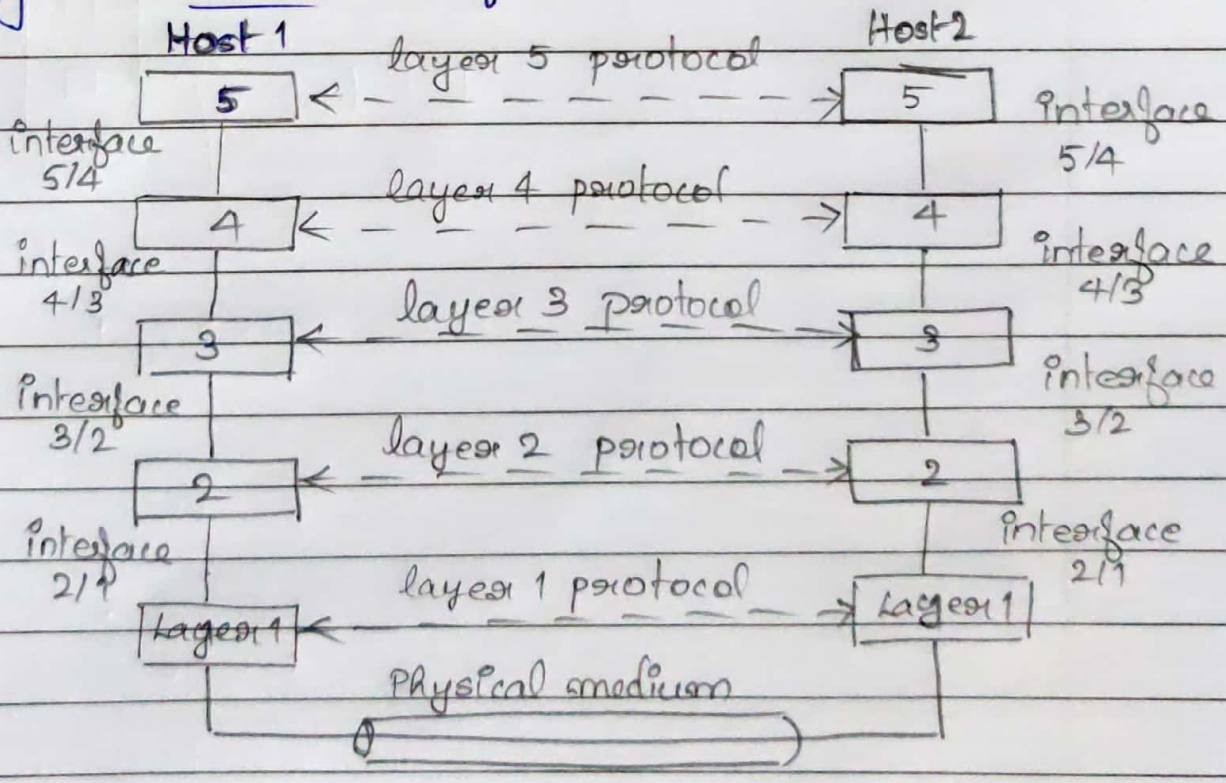
Internetwork

- Collectn of interconnected networks.
- Collectn of LANs connected by WAN

Network Software

- Highly structured
- To reduce design complexity, networks are arranged as stack of layers.
- The purpose of each layer is to provide services to the upper layers.
- Each layer has its own protocols & equipment for communicatn btw parties.

Layer Protocols & Interfaces



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- Sender → Data flows from top to bottom
- Receiver → " " " bottom to top
- Set of layers & protocols is called architecture
- The corresponding layers in the sender & receiver communicate with each other.

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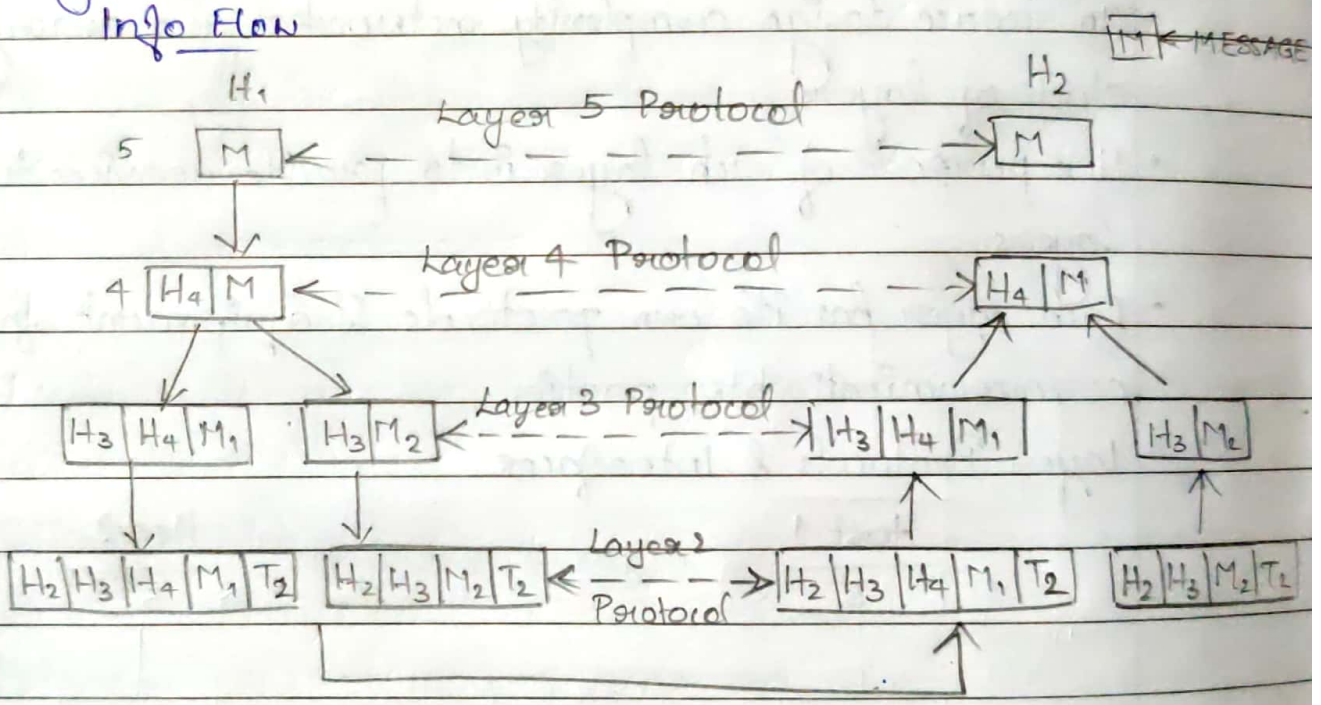
Layered Architecture / Protocol Hierarchy / Protocol Stack

Info Flow



- Complexity is reduced since each layer provides services to upper layer.
- Each layer has its own protocol
- Topmost layer → app layer
- Message is sent from higher to lower layer in H1.
- In the lower layer, a header is attached to the message which contains control info & identity of each layer.
- In the next layer message is fragmented & the header of that layer is attached to both the units.

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- In layer 2, a trailer is attached to each unit (T_2 → Trailer of layer 2)
- On the receiver side, the message travels from the bottom to the top.
- Each layer removes the corresponding headers & finally the message is obtained in the top layer.

Design Issues for Layers

- Every layer need identity of sender / receiver
- Rules for data transfer (unidirectional / bidirectional)
- Error control (chance of loss of data)
- Order of message sent (Protocol must make sure about order)
- Flow control (Buffering)
- Routing (Choose best path)

Connectn Oriented & Connectn Less

Connectn Oriented

- 1st establish connectn
- Use connectn / send data
- Release connectn
- eg: Telephone communicatn

Connectn Less

- Full id of source & destinatn
- Each packet is routed independently to the destinatn.
- eg: postal system
- Small messages

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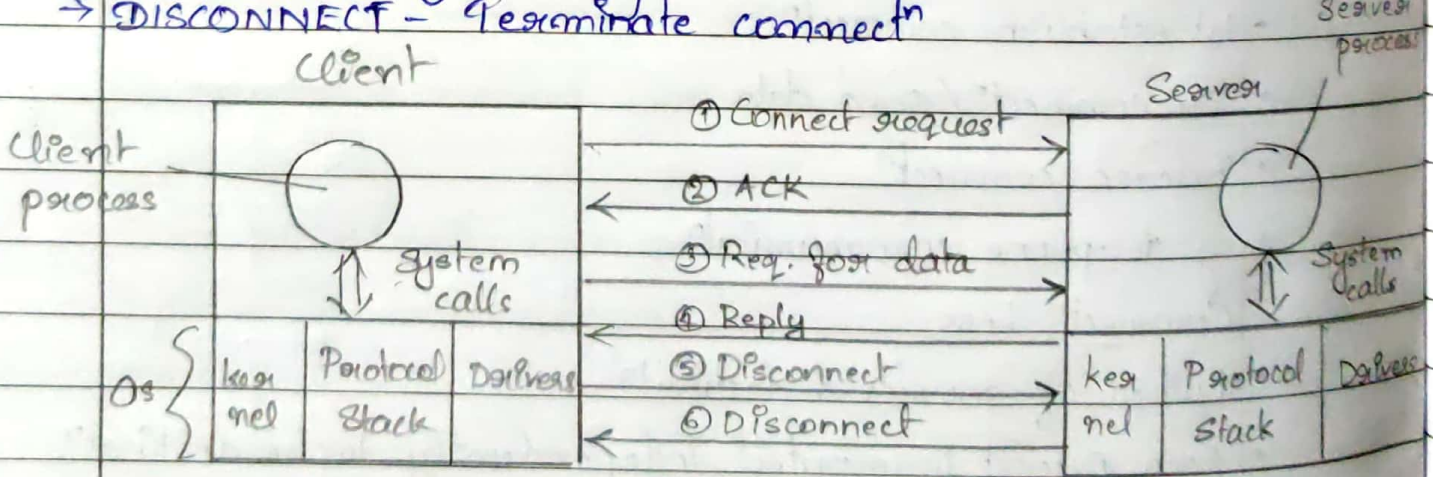
	Service	Example
Connect oriented	(i) Reliable message stream	→ Sequence of pages
	(ii) Reliable byte stream	→ Remote login
	(iii) Unreliable connect	→ Digitized voice
Connect less	(iv) " datagram	→ Electronic junk mail
	(v) Acknowledge "	→ Registered mail
	(vi) Request-reply	→ Database query

Service Primitives

- Service → Set of primitives/operations available to a user process. ~~access service~~
- Primitives for implementing connect oriented service.

→ LISTEN - Waiting for incoming connect
→ CONNECT - Establish a connect
→ RECEIVE - Waiting for incoming message
→ SEND - Sending message
→ DISCONNECT - Terminate connect



- Services → Set of primitives that each layer gives to upper layer
- Protocol → Set of rules governing the format & meaning of

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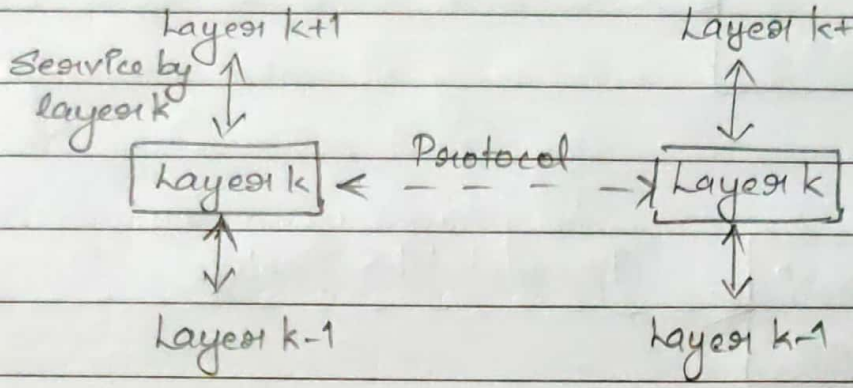
packet that exchange by peer entity



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Reference Model

- Network Archive Ref. Model
  - → OSI ref. model
  - → TCP/IP "

OSI Ref. Model

- Proposed by ISO
- Known as ISO/OSI ref. model
- OSI → Open system Interconnectn (Open system → System open for communicatn)
- It has 7 layers
- Principles behind 7 layers:
  - → Each layer has different abstract
  - → " " " well-defined funct's
  - → Layer boundaries are set to minimize the flow of info.

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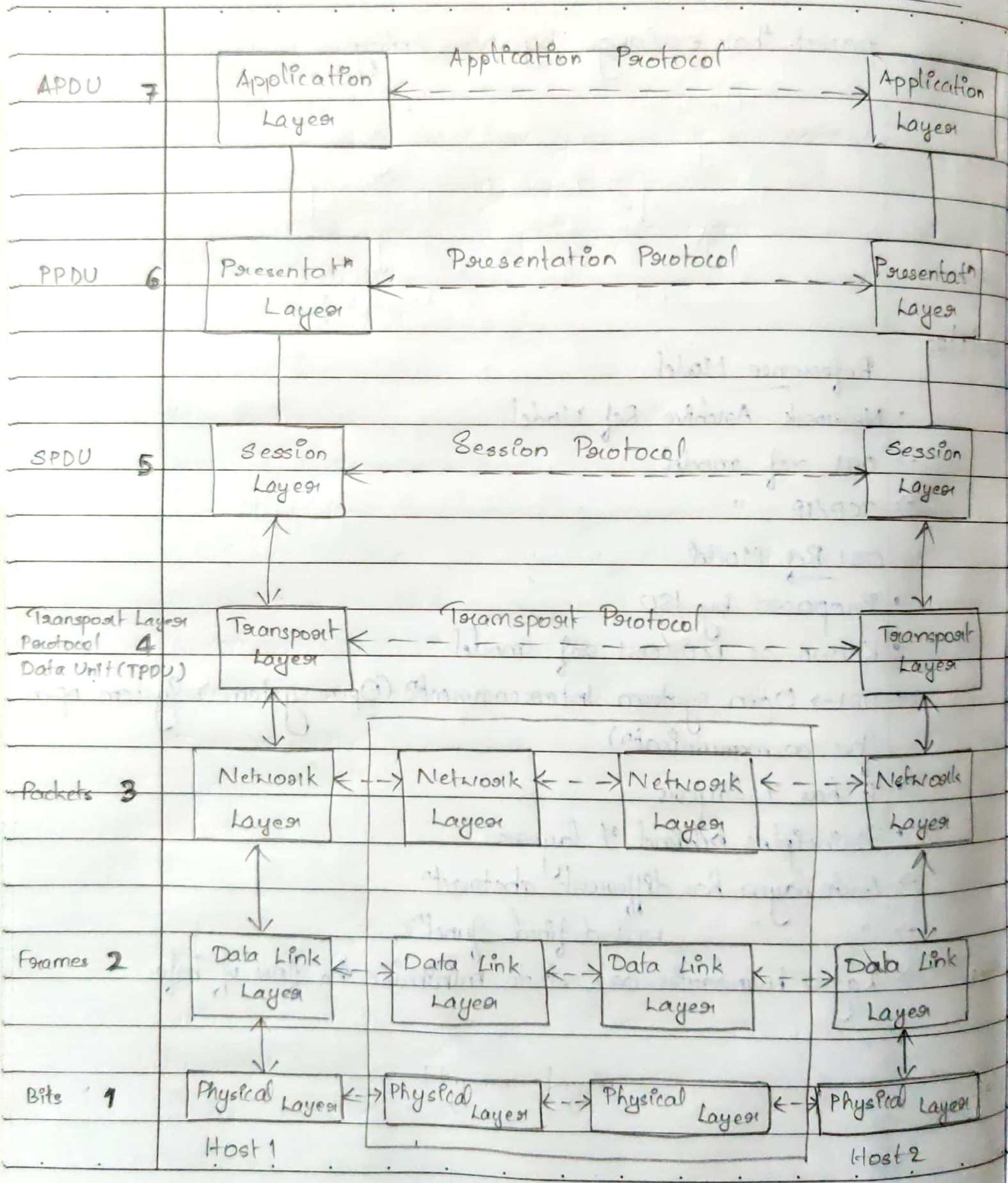

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(i) Physical Layer

- Coordinates the funct^n required to carry bit stream over a physical medium.
- Funct^n

(a) Data rate = No. of bits/sec.
(b) Physical characteristics of interface & medium
(c) Represent^n of bits (Encoding) into electrical/optical)
(d) Synchronizat^n of bits
(e) Line configurat^n → Point-to-Point
→ Multipoint
(f) Physical topology
(g) Transmission mode → Simplex
→ Half-duplex
→ Full-duplex

(ii) Data Link Layer

- ~~Framing~~ Funct^n

→ Framing → Divides the bit stream into managable data units known as frames.
→ Physical addressing.
→ Flow control
→ Error control
→ Access control → To access the link at given time
- Hop-to-hop delivery

(iii) Network Layer

- Logical addressing → For src-to-dest delivery
- Routing → Forwarding packets to correct destinat^n.

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- Source-to-Destinatn delivery

(iv) Transport Layer

- Process-to-process delivery of entire message
- Service point addressing (port address)
- Segmentatn & reassembly → sequence no.
- Connectn control
  - → Connectn-oriented
  - → " -less
- Flow control
- Error control

(v) Session Layer

- Create, maintain & terminate sessions btw client & server or btw 2 processes
- Token management
  - → Preventing 2 parties from attempting the same operatn at same time.
- Synchronizatn
  - → Session layer allows a process to add checkpoints

(vi) Presentatn Layer

- Syntax & semantics
- Translatn
  - → Interoperability btw different encoding schemes
- Encryptn
- Compression

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(vii) Applicatn Layer
- Network mgmt
- FTP transfer
- Database mgmt
- Mail services
- Service → Network Virtual Terminal

TCP/IP Reference Model
- Also known as TCP/IP Protocol Suite
- It has 4 layers

App Layer	Applicatn Layer
Presentatn Layer	
Session Layer	
Transport Layer	Transport Layer
Network Layer	Network Layer
Data Link Layer	Host to network layer
Physical Layer	
ISO/OSI	TCP/IP

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(i) Host to Network layer → Host to network

(ii) Network Layer (Internet Layer) → To permit host to inject packets into any network.

→ Packets may arrive in different order & it is the job of the higher layers to arrange the packets in order.
- Each layer has its own protocol
- Network layer → IP.

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→ ARP → Addr Resolut" Protocol

→ RARP → Reverse ARP

→ ICMP

→ IGMP

(iii) Transport Layer → It allows peer entities to communicate with each other

→ Peer-to-peer communicat"

→ Protocols

* TCP (Trm Control Protocol)
  ↳ Connect" Oriented Protocol (Reliable)

* UDP (User Datagram Protocol)
  ↳ Connect"less Service (Unreliable)

(iv) Applicat" Layer → AP + PL + SL } in ISO/OSI

→ All High-level protocols

* FTP, TELNET, SMTP