Part 1

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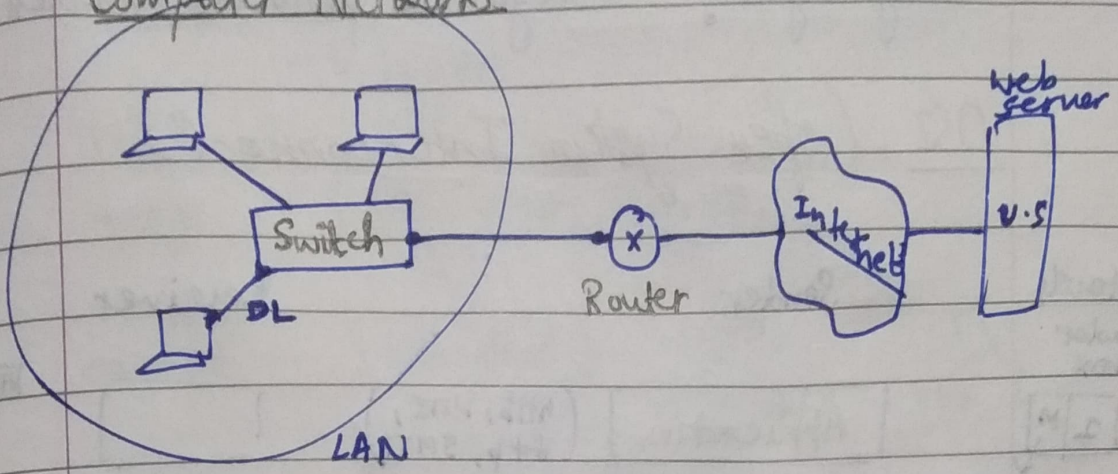
Computer Networks



① **Switch**
- connects computer in small network (LAN)

② **Router**
- connects 2 or more networks

- not good bandwidth utilization algo.
- form single network
- i.e one broadcast to all

Switch	③ Network hub
- connects computer	- bandwidth gets split b/w computers
- x	- slow
- hence fast	- broadcast data packet to all connected devices.

OSI model (theory)

TCP/IP model (used)

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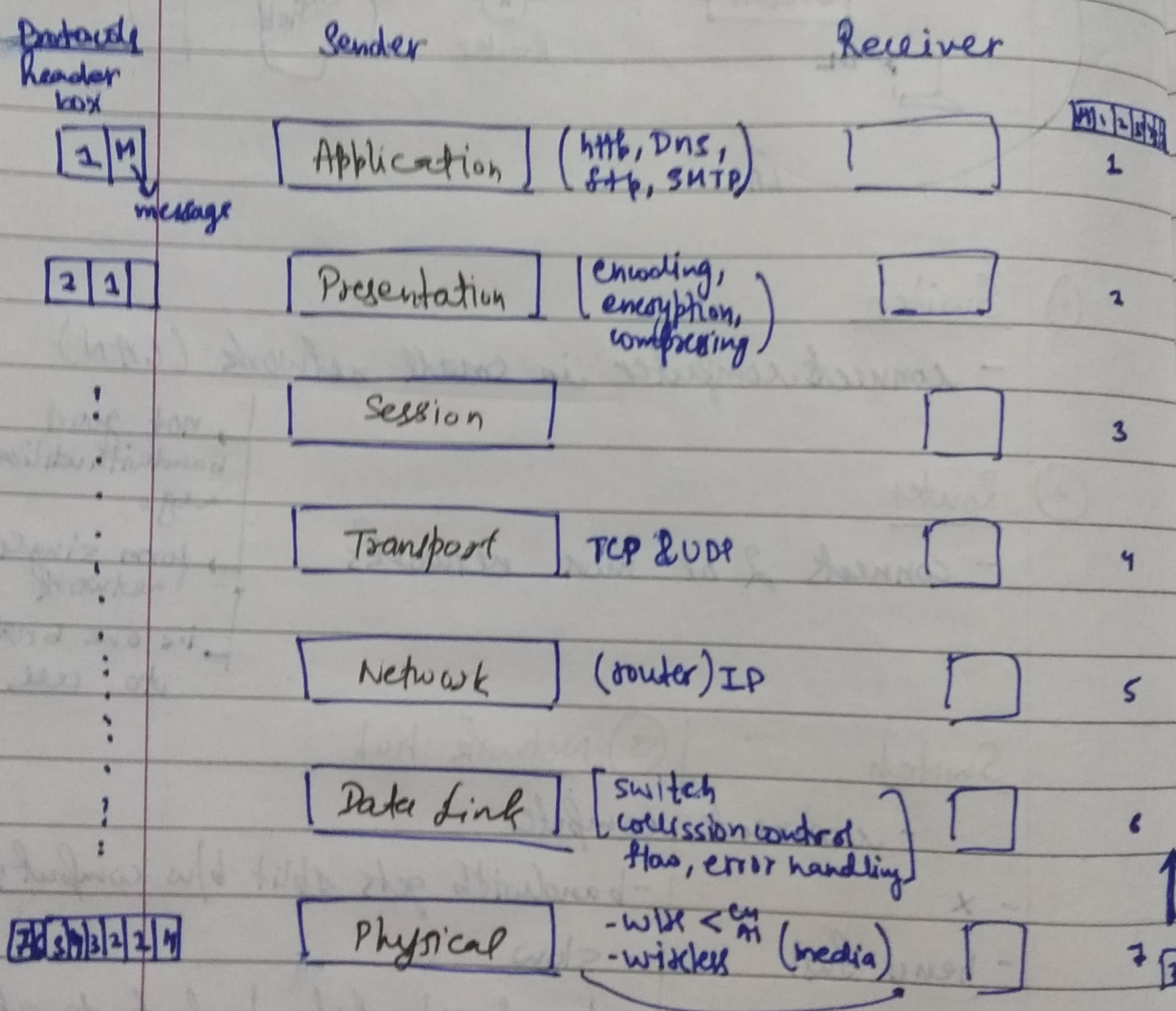
- Why layers? → organize protocols/header

OSI (open System Interconnect)



- 7 layer

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TCP/IP

- 4 layers

Unit		
message	Application	http
segment	Transport	UDP → DNS, DSCP ; TCP → http, FTP
Packet	Network	IP
frame	Link layer	

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(I) Data Link Layer

- implemented in NIC (network interface card)
- every NIC has 48 bit MAC Address / Ethernet address
  (Media Access Control) (unique)
- OS provides drivers for NIC

Functionalities of DL

(1) Framing → Bit Stuffing
↳ Byte Stuffing
↳ ARP (Address Resolution Protocol)

(2) Error Detection - ignores frame with error & retransmits [Cyclic Redundancy Check]
- Parity - CRC - checksum

(3) Error & flow Control
↳ Stop & wait
↳ Go Back N
↳ Selective Refeat
(Sliding Window) — ARQ (Automatic Repeat Request)

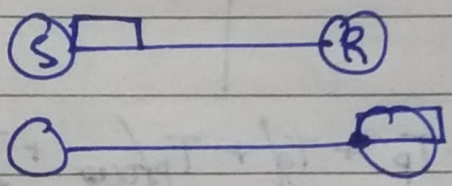
(4) Multiple Access - for no collission
↳ ALOHA
↳ CSMA/CD [Carrier Sense Multiple Access Collission Detection]

Delays

① Transmission Delay
- ↳ link bandwith (B)
- ↳ packet length (L)

$$\text{delay} = L/B$$

② Propogation delay



- ↳ velocity
- ↳ distance

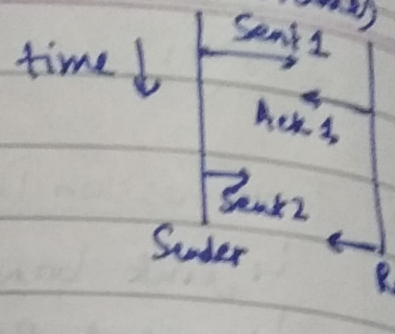
$$\text{delay} = d/v$$

③ Queuing delay
- ↳ depends on traffic

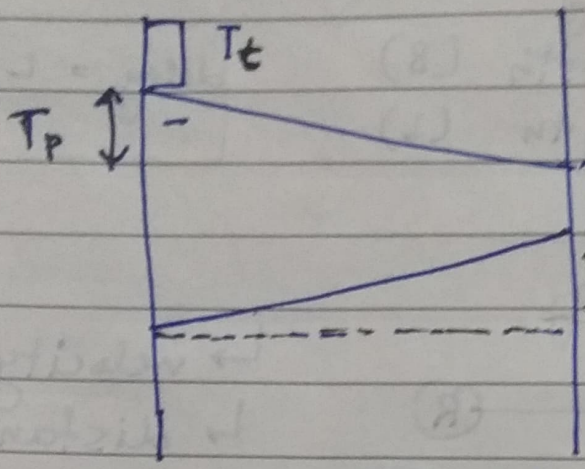
④ Processing Delay
- ↳ depends on loading of router & processing power.

ARQ

Error & flow Control



① Stop & wait



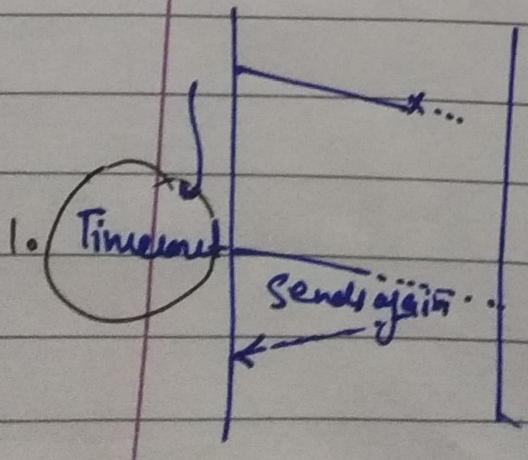
$$Total = T_t + T_p + T_q + T_{process} + T_{Ack} + T_p$$

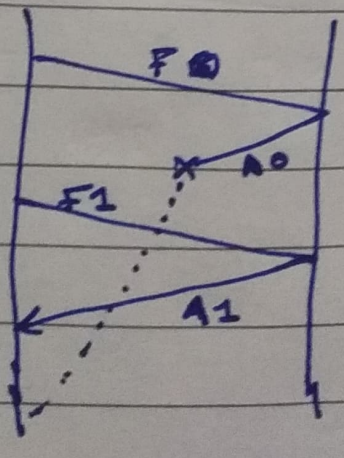
$$Total = T_t + 2T_p$$

$$\text{efficiency} = \frac{T_t}{T_t + 2T_p} = \frac{1}{1+2a} \qquad a = \frac{T_p}{T_t}$$

$$\text{Throughput} = \frac{L}{T_t + 2T_p}$$

Alternating Bit protocol – Frame Seq No. & Ack Seq No. 0 & 1





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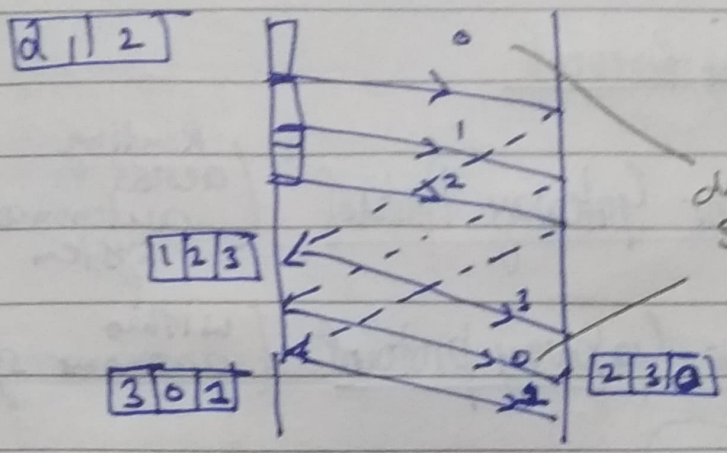
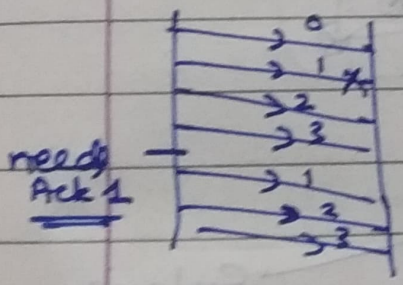
(2) Go Back N – maintains a copy in window Buffer



$$eff = \frac{N}{1+2a}$$

* N → no. of frames

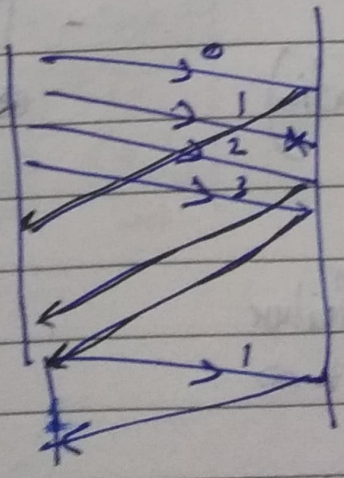
* **Problem** : If a frame is lost. then all frames after that are sent again.



(3) Selective Repeat – complex (more work)
– when channel is too noisy

$$eff = \frac{N}{1+2a}$$

* N → window size



Static (manual)
Dynamic

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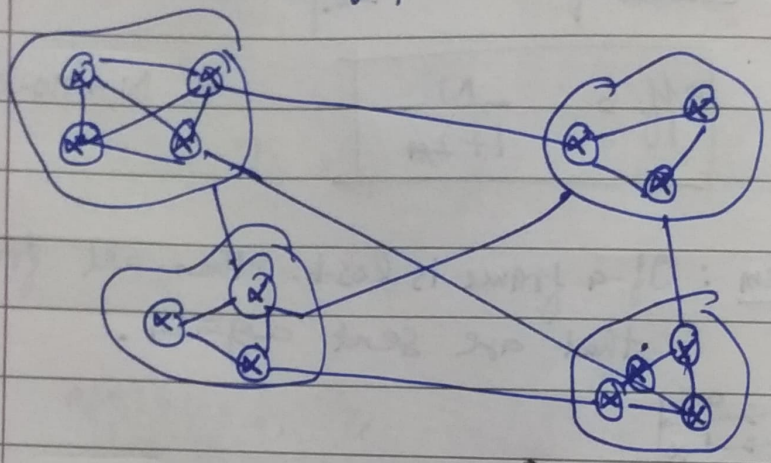
(II) Network layer (Internet Protocol) IP

Routing Protocols

(1) Exterior Gateway Protocol (Routing across autonomous system)

(2) Interior Gateway protocol (within autonomous system)



Which path to travel?

- Interior
  - Distance Vector
    - oldest (ARPAnet)
    - Bellman for algo
    - RIP (Routing Information Protocol)
    - (used more)
    - Problem: In case of failure (slow) count to ∞
  - Link State
    - Dijkstra
    - flooding (neighbour info)
- Exterior
  - Path Vector (BGP)

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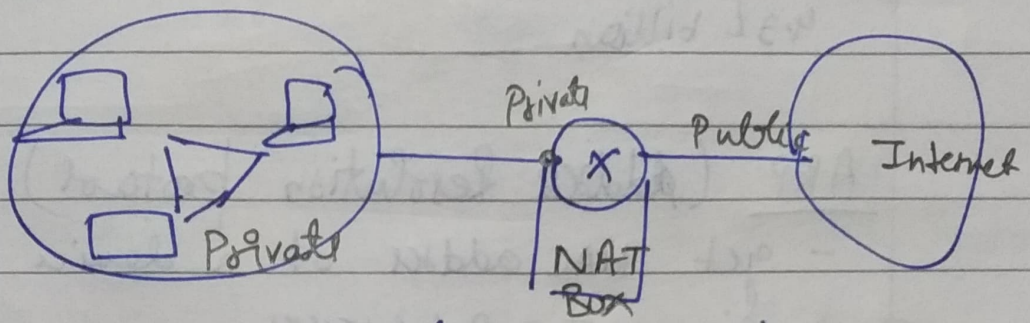
NAT (network Address Translation)

IP Address ⟨ Public
Private

- multiple IP Address is connected to single Public address



(do mapping)
- use TCP/UDP port no.(s)

10. 0. 0. 0 ←
10. 255. 255. 255 → broadcasting

Classfull Addressing

Class A	B	C	D	E
(1/2)	(1/4)	(1/8)	(1/16)	(1/16)
0 ——	10 ——	110 —	1110 ——	1111 ——
N/W | host	N/W | host			
8 | 24	16 | 16			
2^7 network	2^{24} host −2	2^{14} network	$2^{16}-2$ host		

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IP Addressing

IPV4
(32 bit)
2^{32} possible addresses
4.3 billion

IPV6
(128 bit)

ARP (Address Resolution protocol)

- get MAC address of a device in LAN, given IP Addresses
- mapping IP Address → MAC Address

RRP (Reverse Addres Resolution protocol)

- MAC → IP

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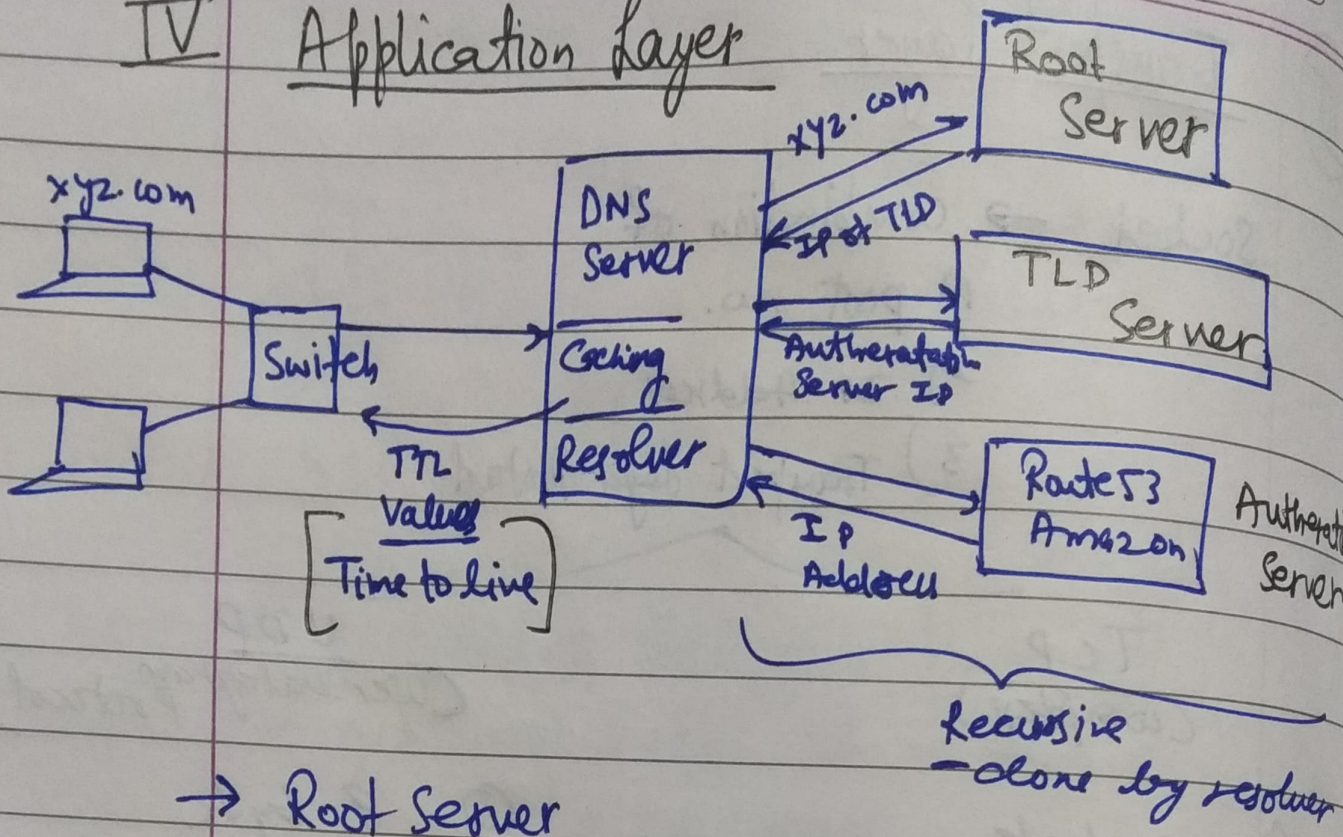
(III) Transport Layer

Socket → combination of
1) port no.
2) IP Address
3) Transport layer Protocol

TCP (complex)	UDP (User Datagram Protocol)
① 20 byte	① 8 byte
② Reliable	② not-guaranteed
③ error handling	③ Basic error correct
④ order of packet maintained	④ ∝
⑤ http, https, FTP, SMTP, SSH.	⑤ DNS, DHCP, online games.
	⑥ Broadcasting / Multicast

IV Application Layer



→ Root Server

use Any-Casting (Iterative Lookup)