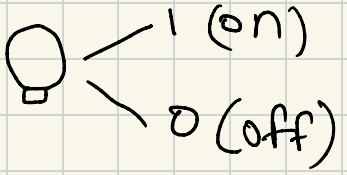
Number System

Lec 1

Decimal

$Base_{10}$: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]

* 1950 : Transistor



* Binary Number System ($Base_2$) {0, 1}

$$\begin{array}{r} 0 \\ +\ 0 \\ \hline 0 \end{array} \quad \begin{array}{r} 0 \\ +\ 1 \\ \hline 1 \end{array} \quad \begin{array}{r} 1 \\ +\ 0 \\ \hline 1 \end{array} \quad \begin{array}{r} 1 \\ +\ 1 \\ \hline 10 \end{array} \quad \begin{array}{r} 10 \\ +\ 1 \\ \hline 11 \end{array} \quad \begin{array}{r} 11 \\ +\ 1 \\ \hline 100 \end{array} \quad \begin{array}{r} 100 \\ +\ 1 \\ \hline 101 \end{array}$$

decimal → 0 → 1 → 1 → 2 → 3 → 4 → 5

Decimal	Binary
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001

Decimal to Binary

2	27	rem.
2	13	1
2	6	1
2	3	0
2	1	1
	0	1

$27 \rightarrow 11011$

2	57	rem.
2	28	1
2	14	0
2	7	0
2	3	1
2	1	1
	0	1

$57 \rightarrow 111001$

Binary to Decimal

$Base_{10}: 386 \rightarrow 3\times10^2 + 8\times10^1 + 6\times10^0 = 386$

$1101 \Rightarrow 1\times2^3 + 1\times2^2 + 0\times2^1 + 1\times2^0$

$8 + 4 + 0 + 1 = 13$

1	1	0	1	1	0
2^5	2^4	2^3	2^2	2^1	2^0

$32+16+0+4+2+0 = 54$

Octal (Base 8) ⇒ [0, 1, 2, 3, 4, 5, 6, 7]

Base 8	37	rem.
8	4	5
	0	4

37 ⇒ 45 → octadecimal

octadecimal to decimal

$4 \times 8^1 + 5 \times 8^0$

$32 + 5 = 37$

Hexadecimal (Base 16)

[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F]

16	38	rem.
16	2	6
	0	2

38 ⇒ 26 → hexadecimal

hexadecimal to decimal

$2 \times 16^1 + 6 \times 16^0$

$32 + 6 = 38$

1 byte → 8 bit

0 0 0 0 0 0 0 0

on on on

0 0 1 0 0 1 1 0 → 38

⇒ (128 64 (32) 16 8 (4) (2) 1)

A → 65 → 1000001

Lec 2

H E L L O

refer : ascii-code.com

72 69 76 76 79 → 01001111

01001000 01000101 01001100 01001100

→ only english char and symbols

2^8 = 256 Characters is not sufficient

Hindi and other languages

UTF-8

UTF-16 } Emoji support

UTF-32

(read punching card)

High level code → Compilation → Assembly lang → Machine code

ARPANET (1960-1969) (Analog ⇄ modem ⇄ digital)

Use cases

① Circuit switching : Traditional telephony

② Message switching : Telegraphy, early data

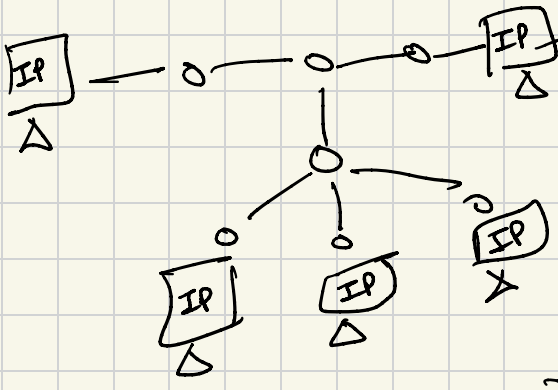
③ Packet switching : Internet, modern data

④ Cell switching (ATM) : Video, voice networks

Ip Address given by ISP (airtel, jio etc) lec-3

↳ Internet Protocol

ARPANET (1960) → TCP/IP ← 1970



Ip address → unique address

↓ IpV4 (eg. 192.36.15.8)

32 bit

↳ 4 bytes = 4 × 8 = 32 bit

8 bit

00000000 → 11111111

255

$(2^8 = 256)$

0-255

{ — . — . — . — } IpV4

0-255 0-255 0-255 0-255

Devices Ip address ⇒ 2^{32} ⇒ 400 crore is not enough

$IpV_4 = 2^{32} = 4.3$ billion

$IpV_6 = 2^{128} = 340$ undecillion

↳ 16 × 8 = 128 (16 → hexadicimal)

So IpV6 came

↓

→ 16 bits

{ 0000 : 0000 : 0000 : .... }

{ FFFF : FFFF : FFFF : .... }

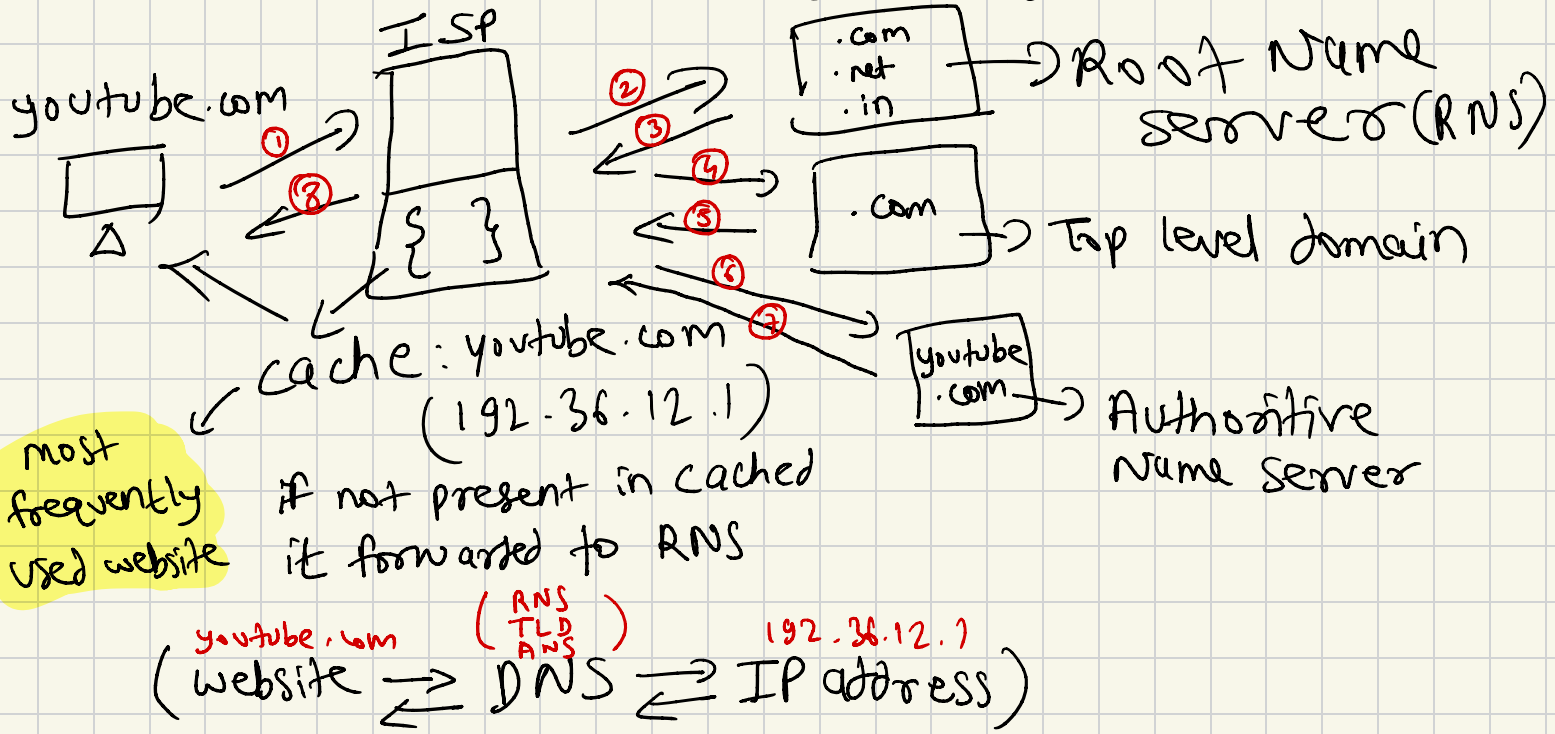
4 4 4 4 → 16 × 8 = 128 bits

9 :2001:0db8:85a3:0000:0000:8a2e:0370:7334

8 segments ; 4 hexadecimal characters

2^{32} ✓ → ~~2^{64}~~ → 2^{128} ✓ ⇒ IpV4 ✓ → ~~IpV5~~ → IpV6 ✓

DNS (Domain Name System)



youtube.com (RNS TLD ANS) 192.36.12.1

(website ⇄ DNS ⇄ IP address)

① Static IP address : remain fixed (eg : web server)

② Dynamic IP address : change each time (eg : Home Router)

IP address class (0-256)

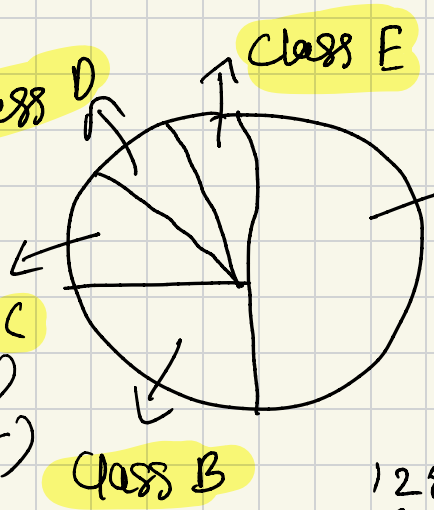
class A : 50 % (0-127)

class B : 25 % (128-191)

class C : 12.5 % (192-223)

class D : 6.25 % (224-239)

class E : 6.25 % (240-255)



class A : 0...
class B : 10...
class C : 110...
class D : 1110...
class E : 1111...

Class	IP Range	Subnet Mask	Hosts per Network	Use Case
A	`1.0.0.0` to `127.255.255.255`	`255.0.0.0` or `/8`	16,777,214	Large networks
B	`128.0.0.0` to `191.255.255.255`	`255.255.0.0` or `/16`	65,534	Medium networks
C	`192.0.0.0` to `223.255.255.255`	`255.255.255.0` or `/24`	254	Small networks
D	`224.0.0.0` to `239.255.255.255`	N/A	N/A	Multicast
E	`240.0.0.0` to `255.255.255.255`	N/A	N/A	Reserved/Experimental

128 → (0-127) → Class A

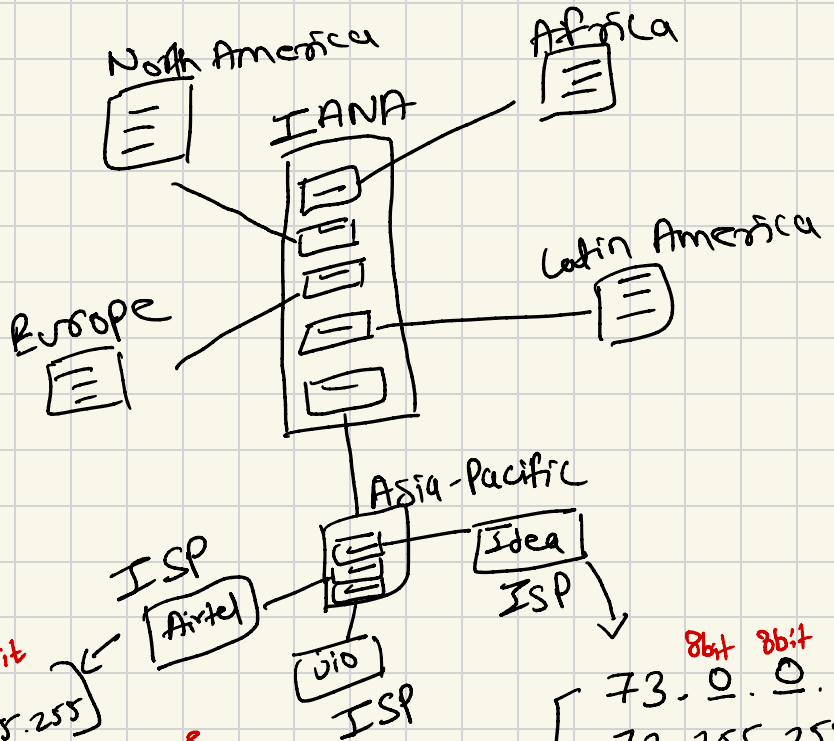
64 → Class B (128-191)

32 → Class C (192-223)

16 → Class D (224-239)

→ Class E (240-255)

Lec-4



IANA (International Assigned Number Authority)

ISP (Internet service Provider)

8bit 8bit 8bit
[86.0.0.0
86.255.255.255]

2^{24} address ≈ 1.67 crore

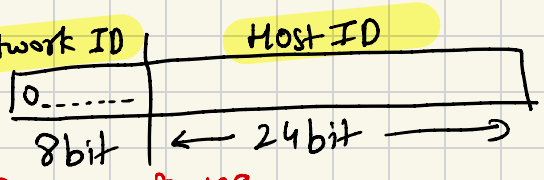
8bit 8bit 8bit
[73.0.0.0
73.255.255.255]

2^{24} address ≈ 1.67 crore

Class A: 0-127.___.___.___

(1-126)

Class A: 32 bit address



(8-1=7) ∴ 2^7 = 128

Host ID = 2^{24} - 2 → reserved

Network address

Broadcast address

73.0.0.0 → reserved

{ ⋮ → given to public

73.255.255.255 → reserved

128 - 2 → reserved = 126 → given to network ID

[0
127]

0.0.0.0

↳ loop back address

0 _ _ _ _ _ _ _

2^7 = 128 Network ID (Idea, airtel, Jio)

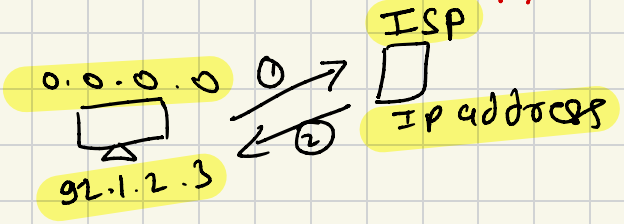
[73.0.0.0
73.255.255.255]

2^{24} = 1.67 crore (devices can connect)

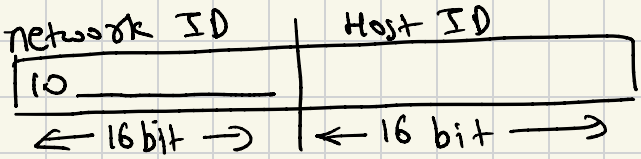
host ID

* Network address is reserved for company server

* Brodcast address is reserved for brodcasting msg. to every person like "Happy diwali"



Class B :



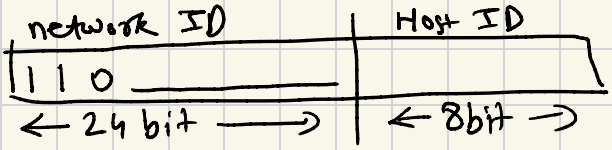
(16 − 2 = 14)

Network ID : $2^{14} \Rightarrow 16k$

Host ID : $2^{16} \Rightarrow 65k$

2^{16} − 2 → network address, Broadcast address (reserved)

Class C :



(24 − 3 = 21)

Network ID : 2^{21}

Host ID : $2^8 \Rightarrow 254$

2^8 − 2 → network address, Broadcast address (reserved)

Requirement

↳ 1.6 crore IP address ⇒ Class A (1.6 crore)

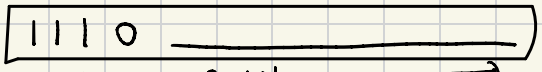
↳ 2 lakh IP address ⇒ Class B (65k + 65k + 65k + 65k)

↳ 1000 IP address ⇒ class C (254 + 254 + 254 + 254) = 1016 (2 lakh)

Buy complete network ID

[8.0.0.0 , 8.255.255.255] → brought by ISP (airtel)

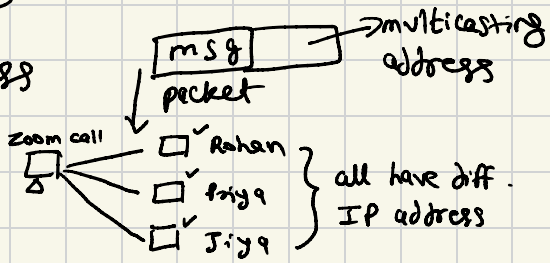
Class D :



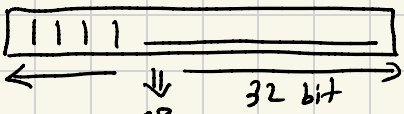
(32 − 4 = 28)

2^{28} → IP address

Multicasting



Class E :



(32 − 4 = 28)

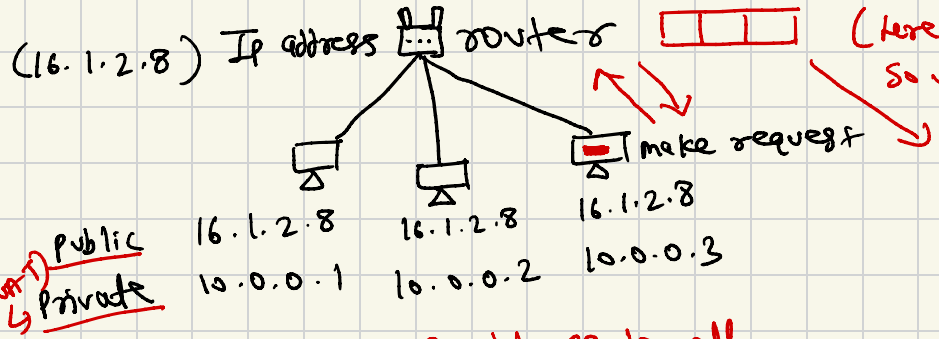
2^{28}

[Reserve for future use]

Types of network

lec 5

① LAN : Local Area Network



(Here IP address are same so we use private address)

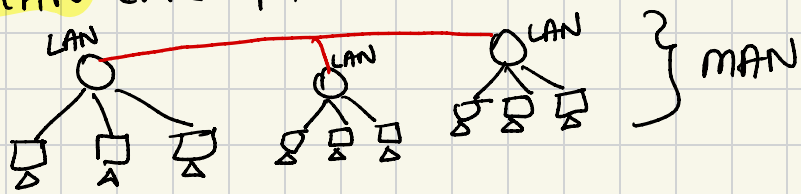
16.1.2.8	Req (fb.com)	10.1.2.3

↑ ↓

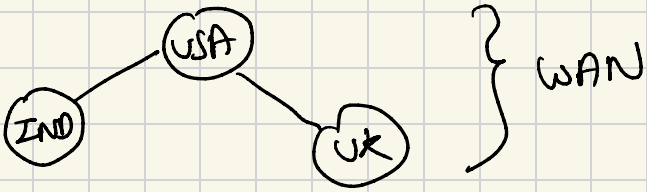
10.1.2.3	Data	~~16.1.2.8~~ 10.0.0.3

(Router give same IP address to all devices which are connected to router because IP address are limited)

② MAN (Metropolian Area Network)

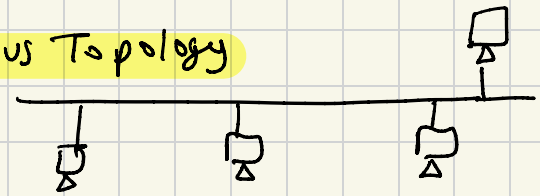


③ WAN (Wide Area Network)

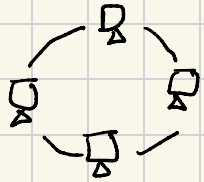


Types of Topology

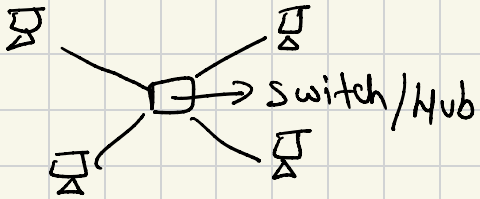
① Bus Topology



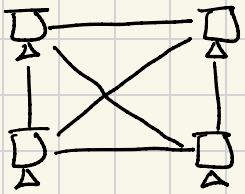
② Ring Topology



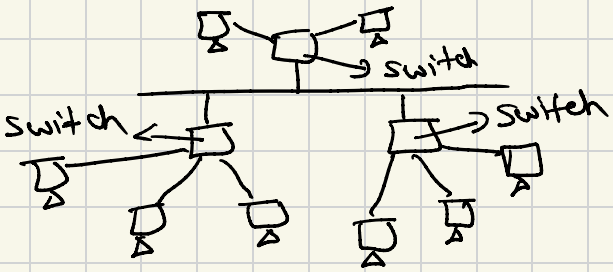
③ Star Topology

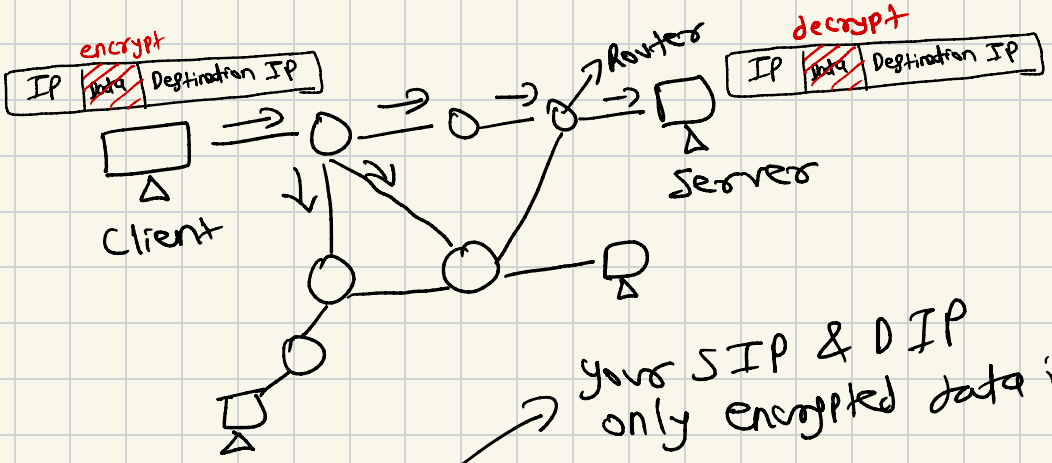


④ mesh Topology



⑤ Hybrid Topology (Bus + Star)



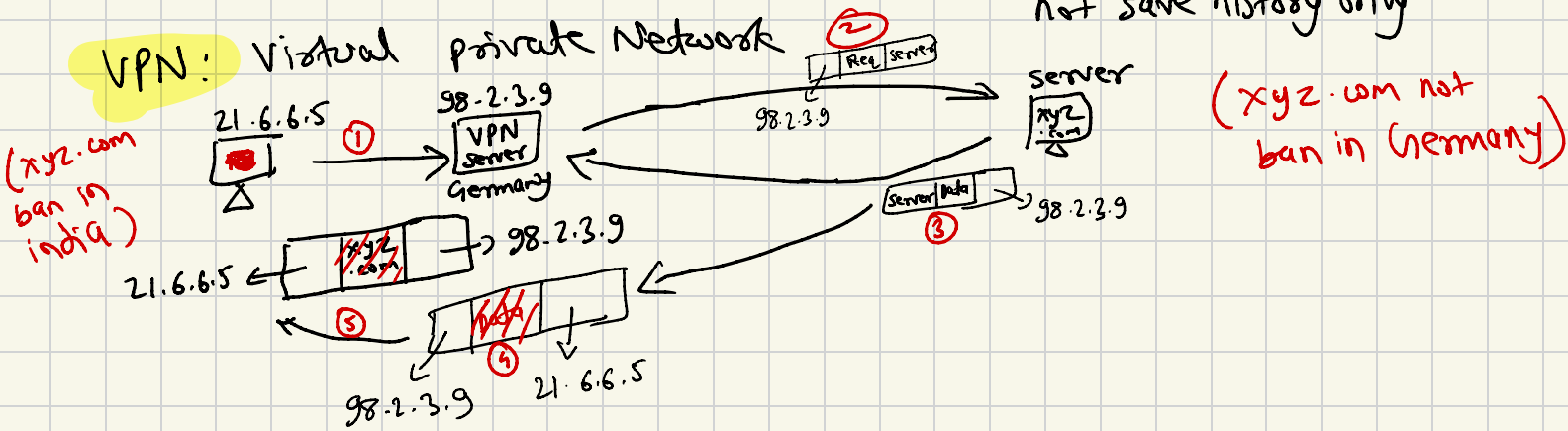


your SIP & DIP only encrypted data is hide

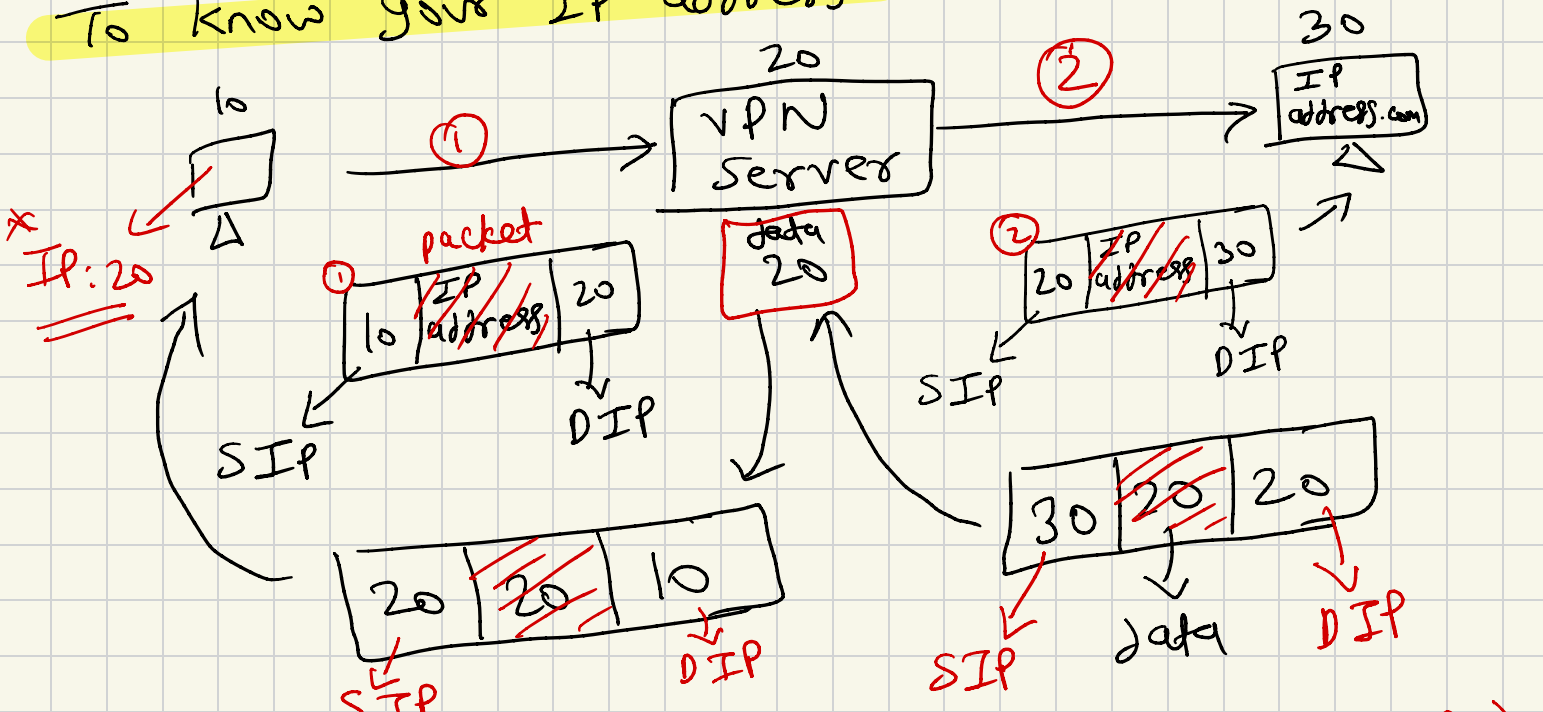
(ISP know everything if we still using Incognito Mode)

Not save history only

VPN: Virtual private Network



To know your IP address



SIP → Source IP

DIP → Destination IP

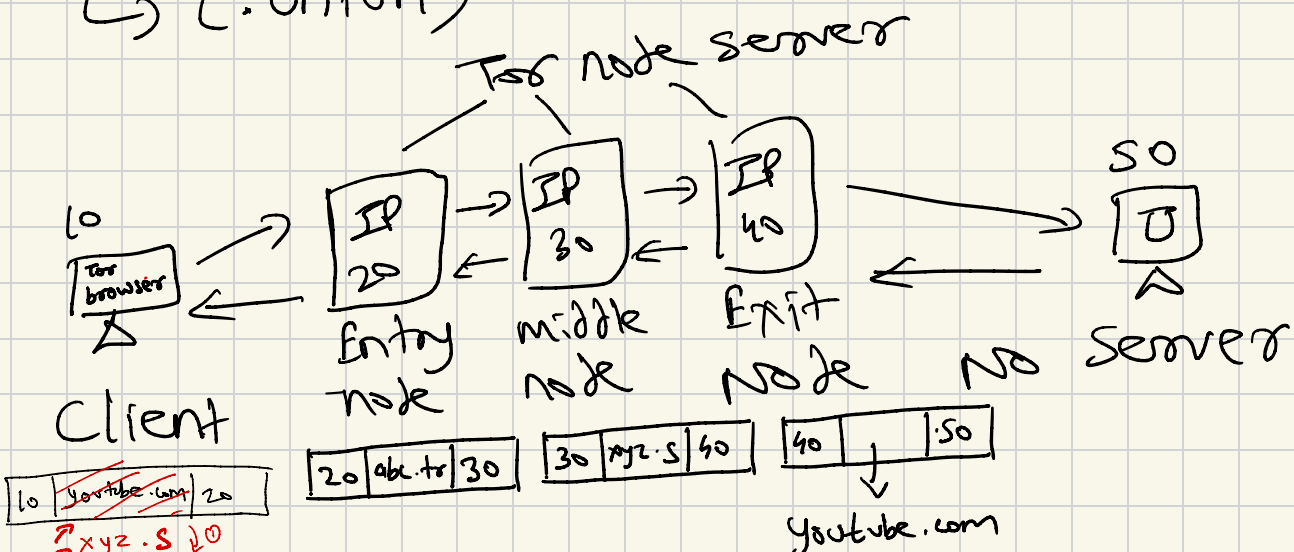
(*Note: 20 is showing IP address because we are connected with VPN)

Dark web : Illegal

Lec 6

↳ Tor browser

↳ (.onion)



xyz.s ① ② ③ 3 level encryption

abc.Tor

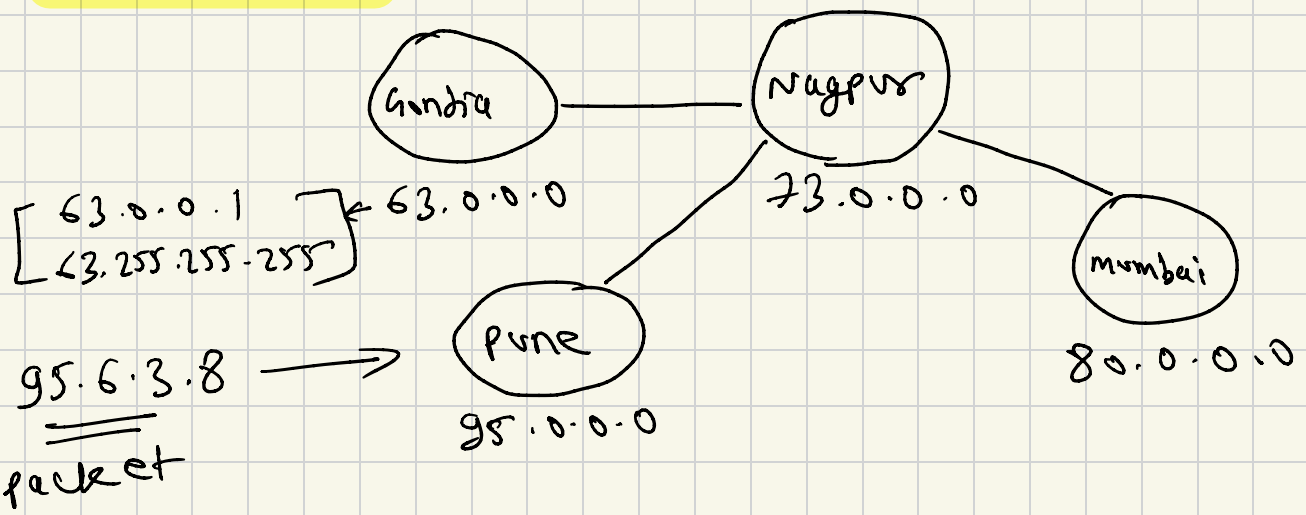
TPK.NP

decrypt

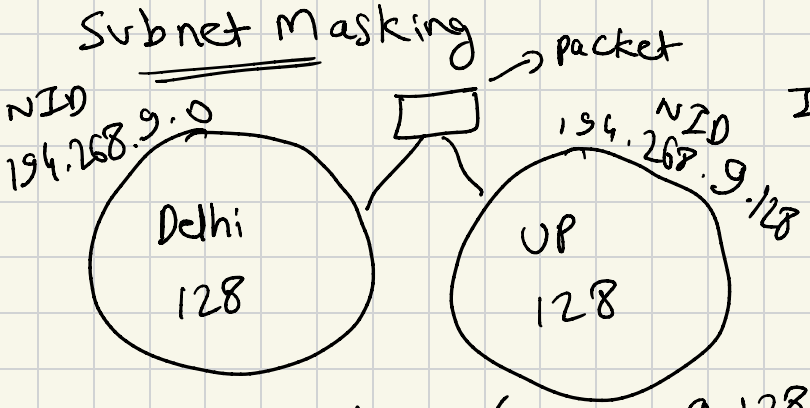
(only one level decryption in each node)

(Tor browser use when we want to hide our identity IP address through Tor nodes)

Idea Network (Region wise distributed IP addresses)



Subnet Masking



class C

Idea: 194.268.9.0

NID → 2^{21}

HID → $2^8 \Rightarrow 256$ / 1

128 128

✓ 194.268.9.0 /25
194.268.9.127/25

✓ 194.268.9.128/25
194.268.9.255/25

194.268.9.8/25 (leave ~~starting~~ 25 bit)

8 8 8 8

24 + 1(0,1) = 25

0 | 0 0 0 0 1 0 0
1 | 0 0 0 0 0 0 0

Network ID = 25 bit
Host ID = 7 bit

194.268.9.0 (Router have Subnet mask)

8.9.6.128/8 → NID

8.0.0.0 ✓

194.268.9.0	1	1	1	1	1	1	1	0 – 127
194.268.9.1	1	1	1	1	1	1	1	128 – 255
	128	64	32	16	8	4	2	1
	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

mobile : Sim ——— Vi

/ Airtel Uninor Jio

lec 7

Airtel : 9 _ _ _ _ _ _ _ _ _ 10^9 (big)

Jio : 8 8 _ _ _ _ _ _ _ _ 10^8 (large)

Vi : 7 7 7 _ _ _ _ _ _ 10^7 (medium)

Uninor : 6 6 6 6 _ _ _ _ _ 10^6 (small)

Idea: Class C = [198.67.28.0/24]

NID HID

8 bit $\Rightarrow 2^8 = 256$

0 0 % % % % % %

0 1 % % % % % %

1 0 % % % % % %

1 1 % % % % % %

$2^6 = 64$

$2^6 = 64$

$2^6 = 64$

$2^6 = 64$

64 64 64 64

Delhi UP MAH MP

0 0 0 0 0 0 0 0 = [198.67.28.0

0 0 1 1 1 1 1 1 = [198.67.28.63

8 bit + 8 bit + 8 bit + 2 bit (00, 01, 10, 11) = (26)

198.67.28.0/26 $\Rightarrow$ Network ID

32 − 26 = 6 bit host ID

Host $2^6 = 64$

Delhi

$2^8 = 256$

Half-Half = 128 128

UP MP

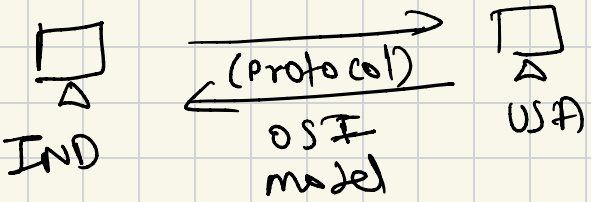
0 ------- 1 ------- = 64 64 64 64

UP MP MAH Delhi

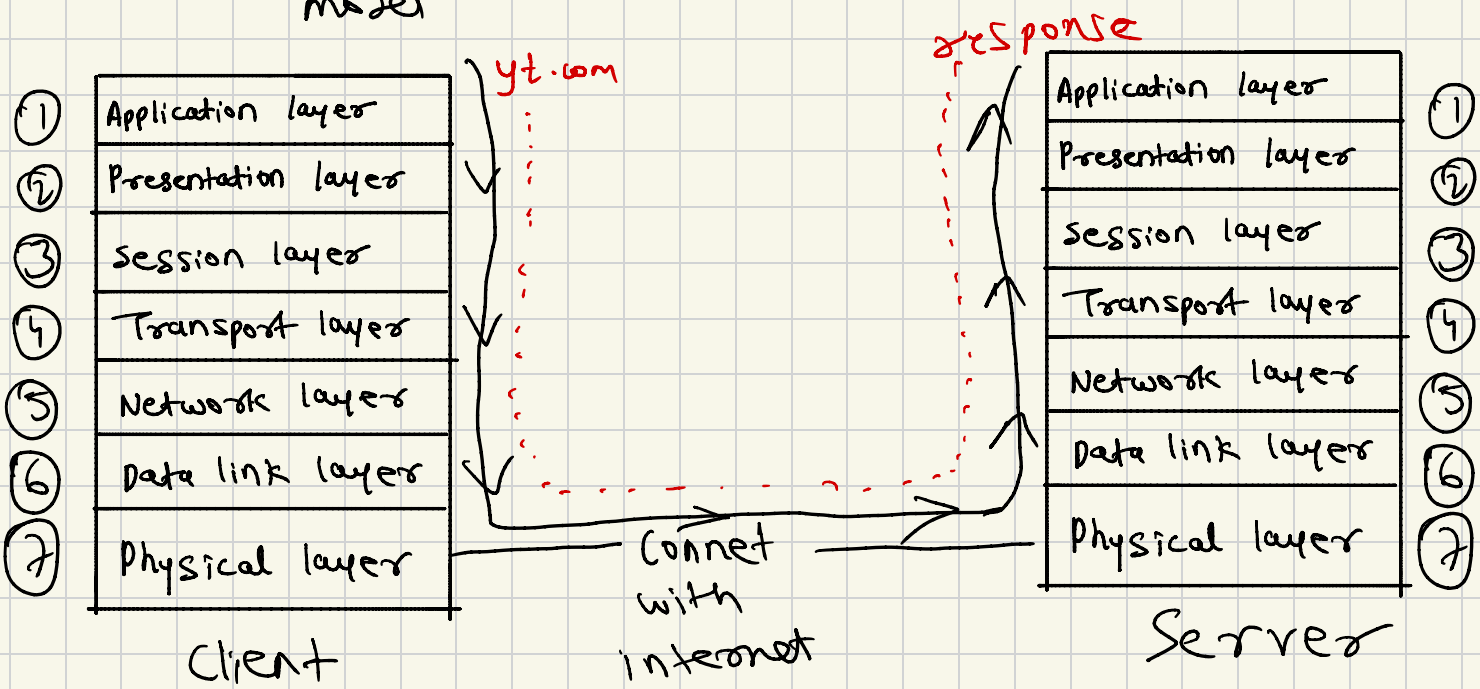
8 = 32 32 32 32 32 32 32 32

UP MP MAH CH UK HP JK Kol

OSI Model (Open System Interconnection)

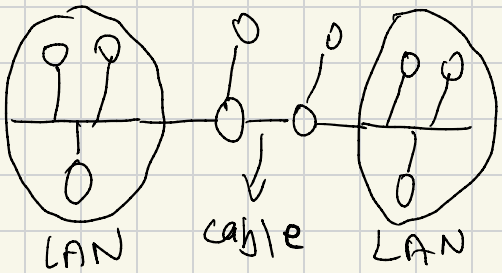


(Protocol followed by IND & USA for connection with OSI model)



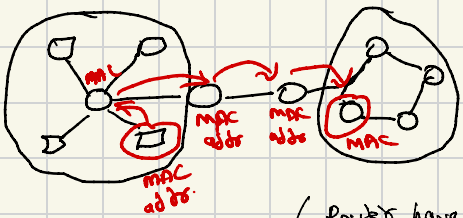
① Physical layer

1. Cable & connector
2. Repeaters (boost speed signal)
3. Data Rate control (3 mbps)
4. Encoding (Digital ⇌ Analog)
5. Physical Topology (Bus topology)



② Data link layer

1. Hop to Hop delivery (MAC add.)
2. Giving Physical address
3. Error Detection & Handling
4. Framing
5. Flow control
6. Access Control



(Router have 3 layer: NLL, DLL, Physical)

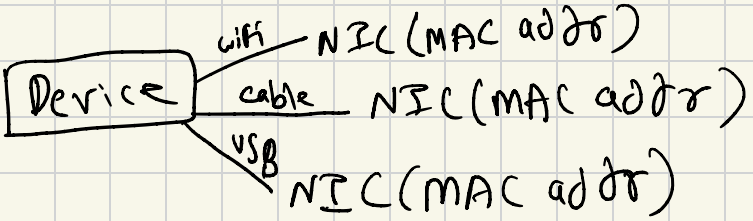
other devices PC, 7 layers

MAC address (Medium access control) 48 bits Lec 8

↳ each devices have many MAC address

↳ NIC (Network Interface card) give MAC addr

↳ diff MAC address: wifi, ethernet, bluetooth etc.



(एक device जो अलग-अलग devices से Internet से connect होता है सभी का अपना अपना MAC addr होता है।)

MAC also called as physical addr.

↳ 48 bits (Hexadecimal format)

00:00:00:00:00:00

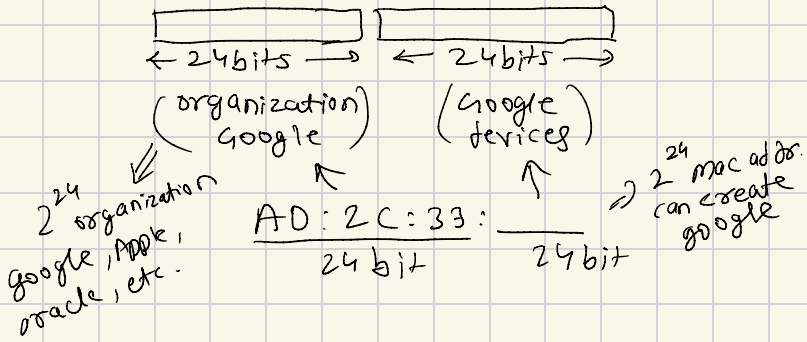
ff:ff:ff:ff:ff:ff

4bit 4bit

6 × 8 = 48 bit

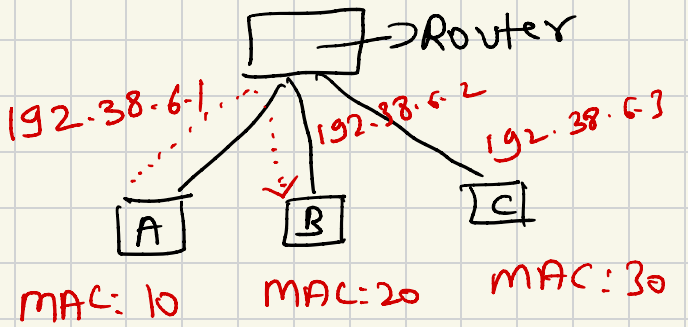
F = 1111

↳ 15

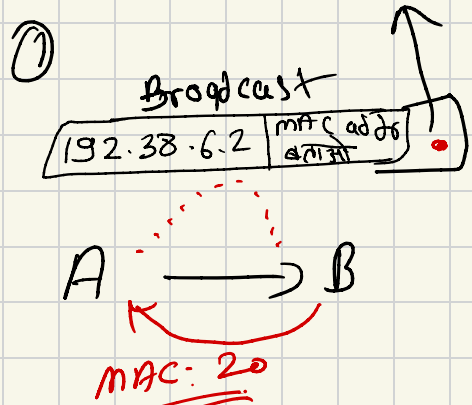


192.0.0.0 → Network addr.

192.255.255.255 → Broadcast addr.

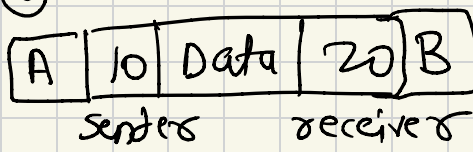


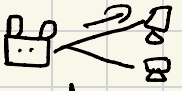
→ private IP addr

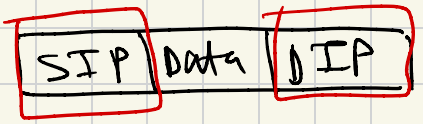


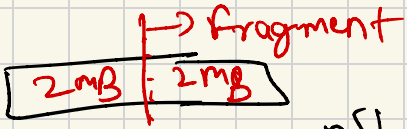
ARP: Address resolution Protocol

IP → MAC address



③ Network layer
① Logical address (IP address)
② Routing  (direction)
③ Fragmentation & Reassembly
④ Congestion control
(traffic control) in network

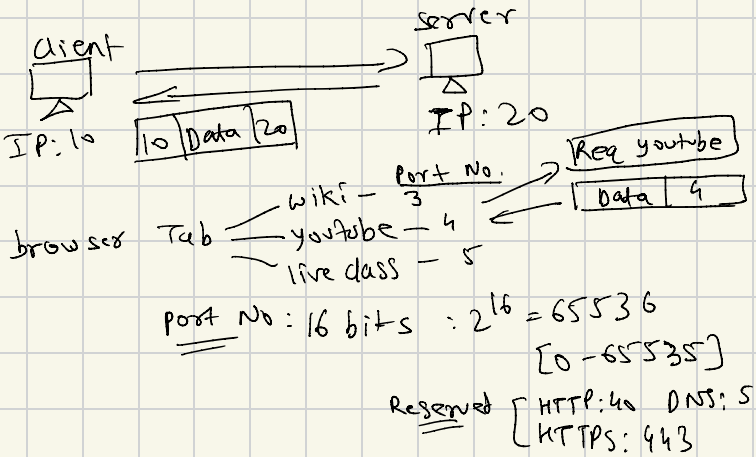


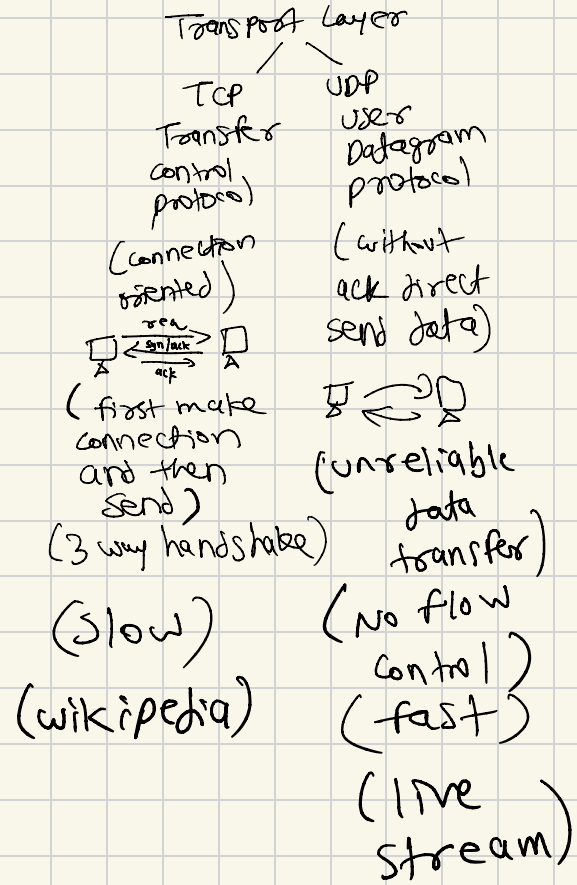


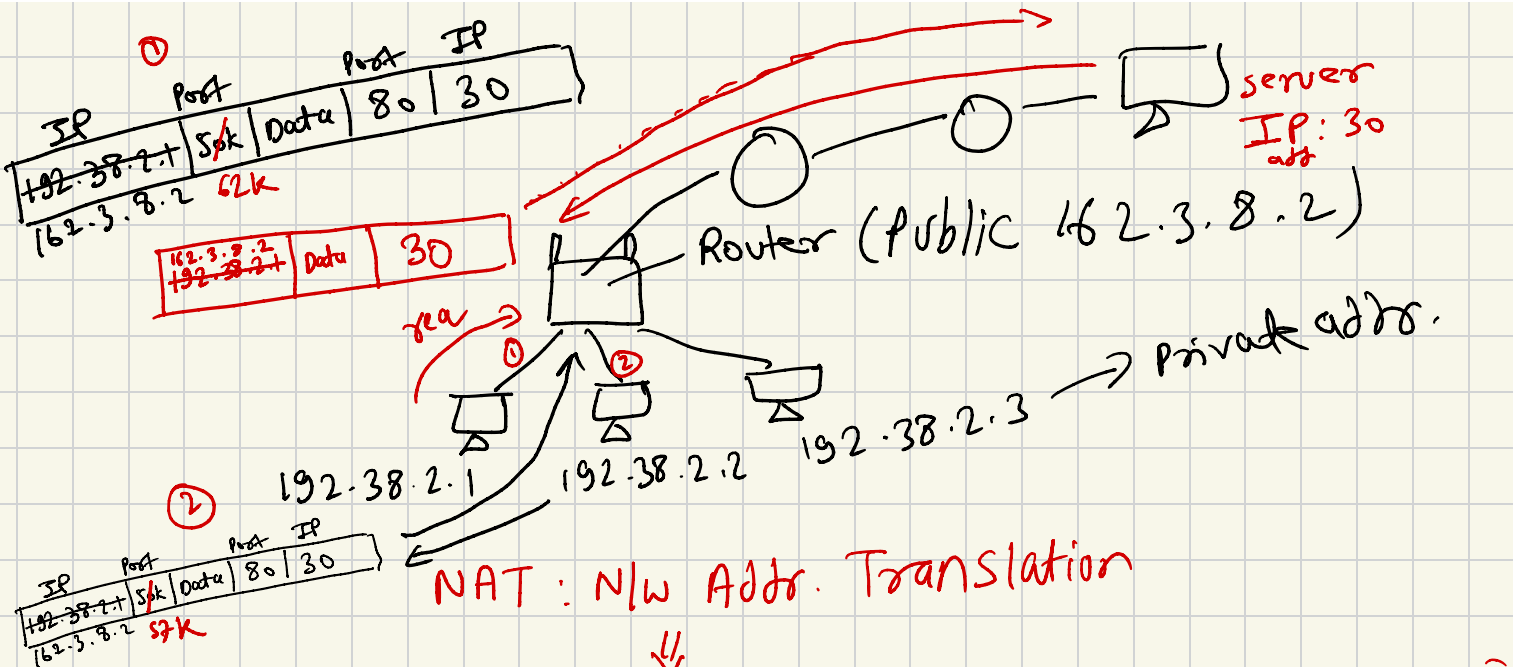
packet in NL
Frame in DLL

Lec 9

④ Transport layer
① End to End Delivery (Port to Port)
② Segmentation & Reassembly
③ TCP & UDP
④ Error Detection & correction
⑤ flow control (send limited packets)







NAT : N/w Addr. Translation

⇓

	Port No.	Port No. (unique given by router)
192.38.2.1	50k	: 62k
192.38.2.2	50k	: 57k

(Note: NAT use for correctly deliver data who req. that data)

⑤ Session layer

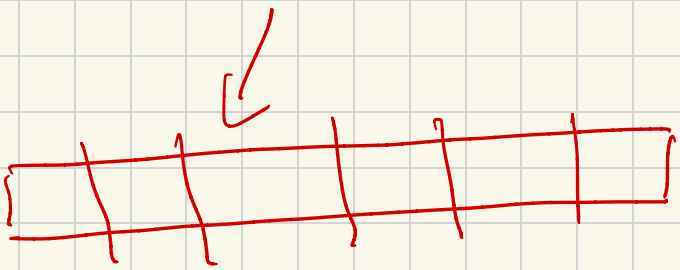
① Session Establishment (create session)

② Authentication & Authorization

③ Checkpoint

↘ sign in
sign out

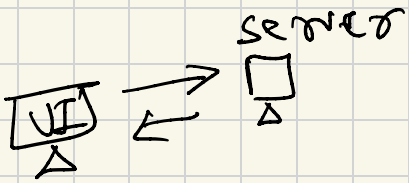
↘ you can view but not change data in bank website.



Checkpoint eg:
download and if connection lost we reconnect and continue.

⑥ Presentation layer
① Encrypt / decrypt
② Data Compression (10MB → 6MB)
③ Data Translation (ASCII → UTF-16)

⑦ Application Layer
① Providing Network Interface
② Application : HTTP, FTP, SMTP, HTTPs
③ Network Transparency



secure
Simple mail transfer protocol

file transfer protocol

Real world use
TCP/IP

OSI (Theortical model)