UNIT 3

Network layer.

* **Problems with CN.**

① Communication problem. — Use of protocols.
② Identification " — a) Identify the n/w.
— logical
b) Identify the host in n/w.
— Physical.
c) Identify process within the host. — Service points
③ Connection "

Responsibilities of N/W layer.

1. Logical addressing system.
2. Congestion control.
3. Routing.
4. Feedback messages.

Logical Addressing: → Classes

* Classes of n/w. — A, B, C, D, E

$\boxed{1} . \boxed{2} . \boxed{3} . \boxed{4}$

octets → Network Id. (NID)

→ Host Id. (HID).

A : $\underbrace{\boxed{}}_{NID} . \underbrace{\boxed{} . \boxed{} . \boxed{}}_{HID}$

8   24

2^8 N/ws 2^{24} Hosts

= 256 N/ws   = 16777216

B: $\underbrace{\square \;.\; \square}_{\text{NID}} \;.\; \underbrace{\square \;.\; \square}_{\text{HID}}$

NID	HID
16	16
2^{16} N/ws	2^{16} Hosts.
= 65536	= 65536

C: $\underbrace{\square \, . \, \square \, . \, \square}_{\text{NID}} \, . \, \underbrace{\square}_{\text{HID}}$

NID	HID
24	8
2^{24} N/ws	2^{8} Hosts.
$= \underline{16777216}$	$= 256$

$\boxed{\text{ISP}}$ — Internet Service Provider.

Range of Classes.

1 – 126 — A.

128 – 191 — B

192 – 223 — C

224 – 239 — D

240 – 255 — E

127 — loopback address

192.168.1.1 — C

10.1.2.7 — A

NOTE:- Having all 0's & all 1's in NID / HID is ruled out — special purposes.

Class A.

- first bit is always 0

N/w	Host
$(2^7 - 2)$ N/w.	$(2^{24} - 2)$

$\to$ 0 & 127 neglected

Class B — first 2 bits are 10

N/w.	Host.
2^{14} N/w	$(2^{16}-2)$

Class C — first 3 bits are 110

N/w	Host.
2^{21}	$2^{8}-2$

Defined by ISPs.

Class D — first 4 bits are 1110

Class E — first 4 bits are 1111.

Reserved for special purposes

Total IP Addresses.

$$\left.\begin{array}{l} A : (2^7 - 2) * (2^{24} - 2) \\ B : (2^{14}) * (2^{16} - 2) \\ C : 2^{21} * (2^8 - 2) \end{array}\right\} \text{Summation.}$$

4 - Billions. — Due to the use of IPV4.

IPV4	IPV6.
32-bit	128-bit.

* Types of communication.

① Unicasting (one-to-one)

② Multicasting (one-to-many)

③ Broadcasting (one-to-all) < Direct / Limited

④ Any cast

Note:-

① Limited broadcasting — msg passing within the same n/w.

② IP is used for class A, B & C.

IGMP is used for multicasting.

* **Mask.** (default mask)

A – 1 byte   C – 3 bytes

B – 2 byte   D, E – concept does not apply.

– It is a 32-bit number made up of contiguous 1's followed by 0's.

– Used to find NID & HID.

11111111 rest 0's

Class	Binary	Decimal Notation
A	11111111 rest 0's	255.0.0.0
B	11111111 11111111 rest 0's	255.255.0.0
C	11111111 11111111 11111111 rest 0's	255.255.255.0

CIDR → Classless Inter Domain Routing.

Classless Notation

/8

/16

/24 → slash Notation.

10.77.16.0/8

Mask — A mask is a 32-bit number in which n leftmost bits are 1's & (32-n) rightmost bits are 0's.

— In classless addressing, the mask for a block can take any value from 0-32.

ipv4 — $\boxed{x.y.z.t/n}$ — Representation.

* **First Address.** — setting 32-n rightmost bits in binary notation of address to 0's.

* **Last Address.** — getting $32-n$ rightmost bits in binary notation of address to 1's.

* **No. of addresses.** — 2^{32-n}

Eg:- A block of address is granted to a small organization. One of the addresses is 205.16.37.39/28. What is first address of block? → x.y.z.t/n

Soln :- 205 . 16 . 37 . 39 . $n = 28$

11001101 00010000 00100101 00100111

$32 - n = 32 - 28 = 4$

<u>Mask.</u> 11001101 00010000 00100101 00100000

205 16 37 32

F.A = 205.16.37.32

<u>Last Address.</u>

11001101 00010000 00100101 00101111

205 16 37 47

L.A = 205.16.37.47.

No. of Addresses $= 2^{32-n} = 2^4 = 16$

Alternative sol^n.

* FA — AND op^n b/w address & mask.
* LA — OR op^n b/w address & complement of mask.
* NOA — Complementing the mask, interpret it as a decimal no. & add 1 to it.

Eg:- /28 → 11111111 11111111 11111111 11110000

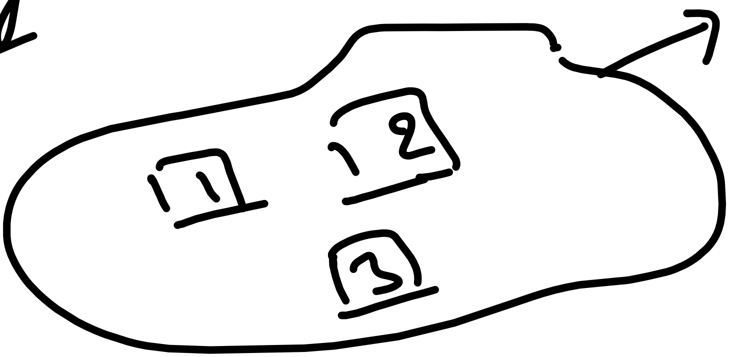
NOA → 00000000 00000000 00000000 00001111

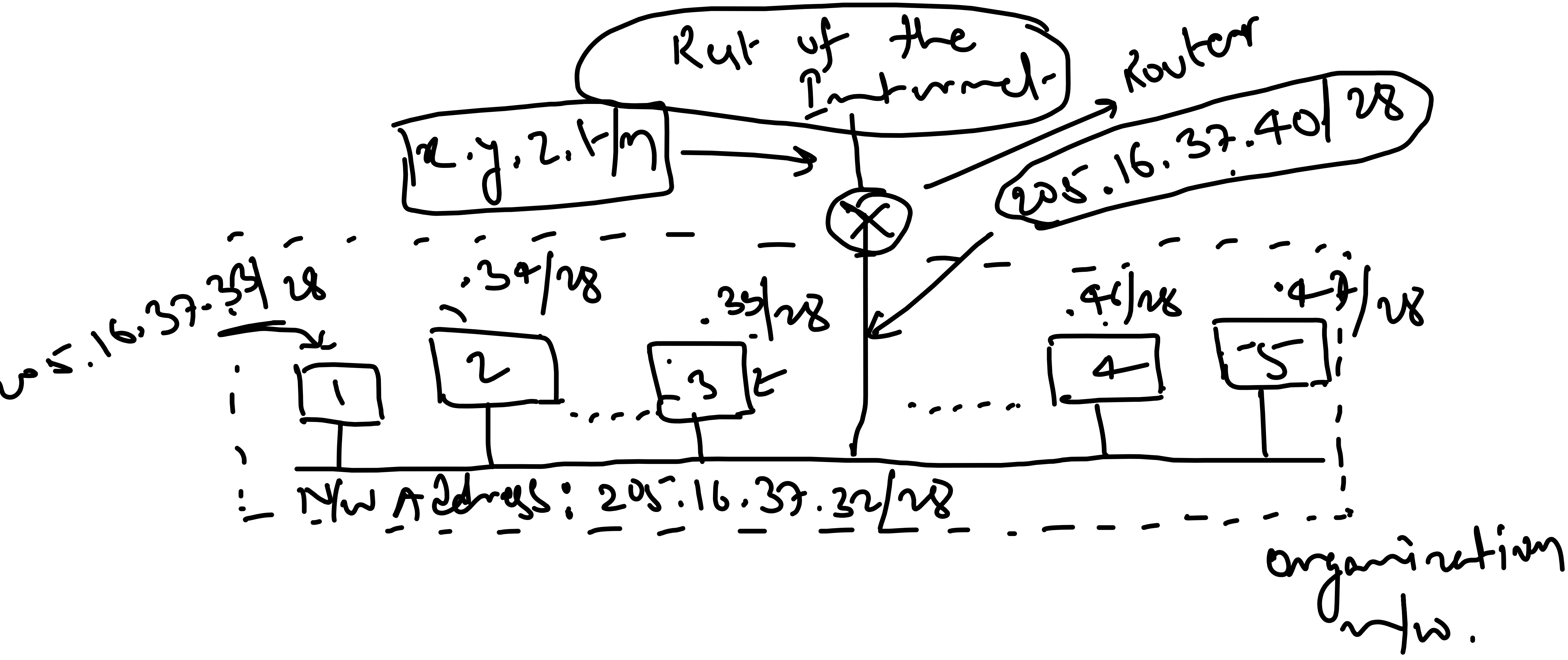
15 + 1 = 16

N/W Address.

- 1st address defines the organization address.

$\boxed{205.16.37.32}$





Rest of the Internet
x.y.2.1/m
Router
205.16.37.40/28
205.16.37.33/28
.34/28
.35/28
.46/28
.47/28
1
2
3
4
5
N/w Address: 205.16.37.32/28
organization n/w.

Hierarchies.

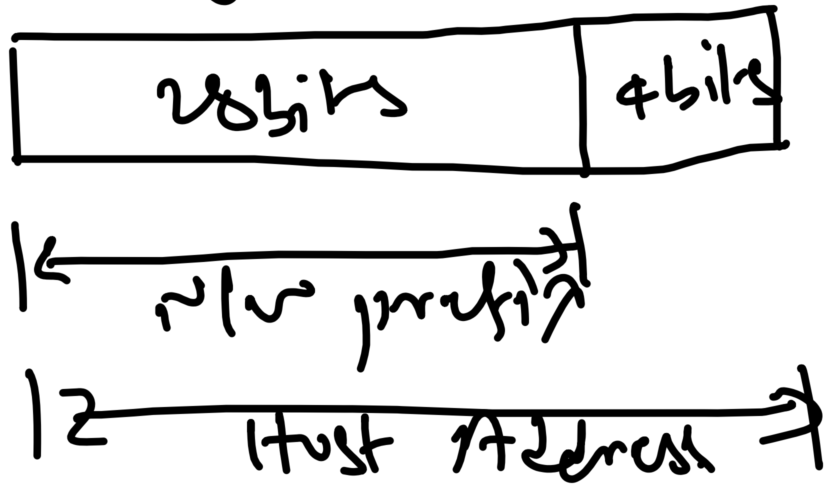
(1) **Two-level Hierarchy** :- No subnetting required.

- n leftmost bits of x.y.z.t/n defines the n/w.
- 32-n right-most bits defines the particular host.

Prefix

suffix

Graphically $n=28$.



32
28 - 4

② <u>3-level Hierarchy</u>. — Subnetting required.

- Organization has its own mask
- Subnets have their own masks.

<u>Eg:-</u> An organization is given the block 17.12.14.0/26 which consists of 64 addresses. There are 3 offices with three subblocks as 32, 16, 16 addresses.

New Masks.

① Mask for 1st subnet is n_1

$\Rightarrow 2^{32-n_1} = 32 \Rightarrow n_1 = 27$ ✓

② $n_2 \Rightarrow 2^{32-n_2} = 16 \Rightarrow n_2 = 28$ ✓

③ $n_3 = 28$ ✓

Subnet : 17.12.14.0

Subnet 1 : 17.12.14.29/27.

Host : 00010001 00001100 00001110 00011101

Mask : 11111111 11111111 11111111 11100000

Subnet : 00010001 00001100 00001110 00000000

17 12 14 0

Address Allocation.

* Global Authority — ICANN
  ↓
  Internet Corporation for Assigned Names & Addresses

ISP — Internet Service Provider.

Eg :- A block of addresses starting with 150.100.0.0/16 (65536). Distribution is done in 3 groups :-

a) 1st group — 64 customers each 256 addresses.
b) 2nd group — 128 customers each 128 "
c) 3rd " — 128 " " 64 "

* Design the subblocks & find out how many addresses are available after allocations.

Sol^n :- Group 1

Addresses = 256

No. of bits to define a host = $\log_2 256$

= 8 bits.

Prefix length = 32 - 8 = 24 bits.

1st 150.100.0.0/24 .... 150.100.0.255/24.

2nd 150.100.1.0/24 .... 150.100.1.255/24.

64th 150.100.63.0/24 .... 150.100.63.255/24

Total = 64×256 = 16384.

<u>Group 2</u> : Address = 128

Bits = $\log_2 128$ = 7 bits.

Prefix = 32-7 = 25 bits.

1st 150.100.64.0/25 - - - - - 150.100.64.127/25

2nd 150.100.64.128/25 - - - - - 150.100.64.255/25

⋮

128th 150.100.127.128/25 - - - - 150.100.127.255/25

Total = $\underline{128 \times 128}$ = 16384.

Groups 3 :- Address = 64.

Bits = 6.

Prefix = 26.

1st 150.100.128.0/26 - - - - 150.100.128.63/26

⋮

128th 150.100.159.192/26 - - - - 150.100.159.255/26

Total = 128×64

= 8192

Used = 16384 + 16384 + 8192

= 40960

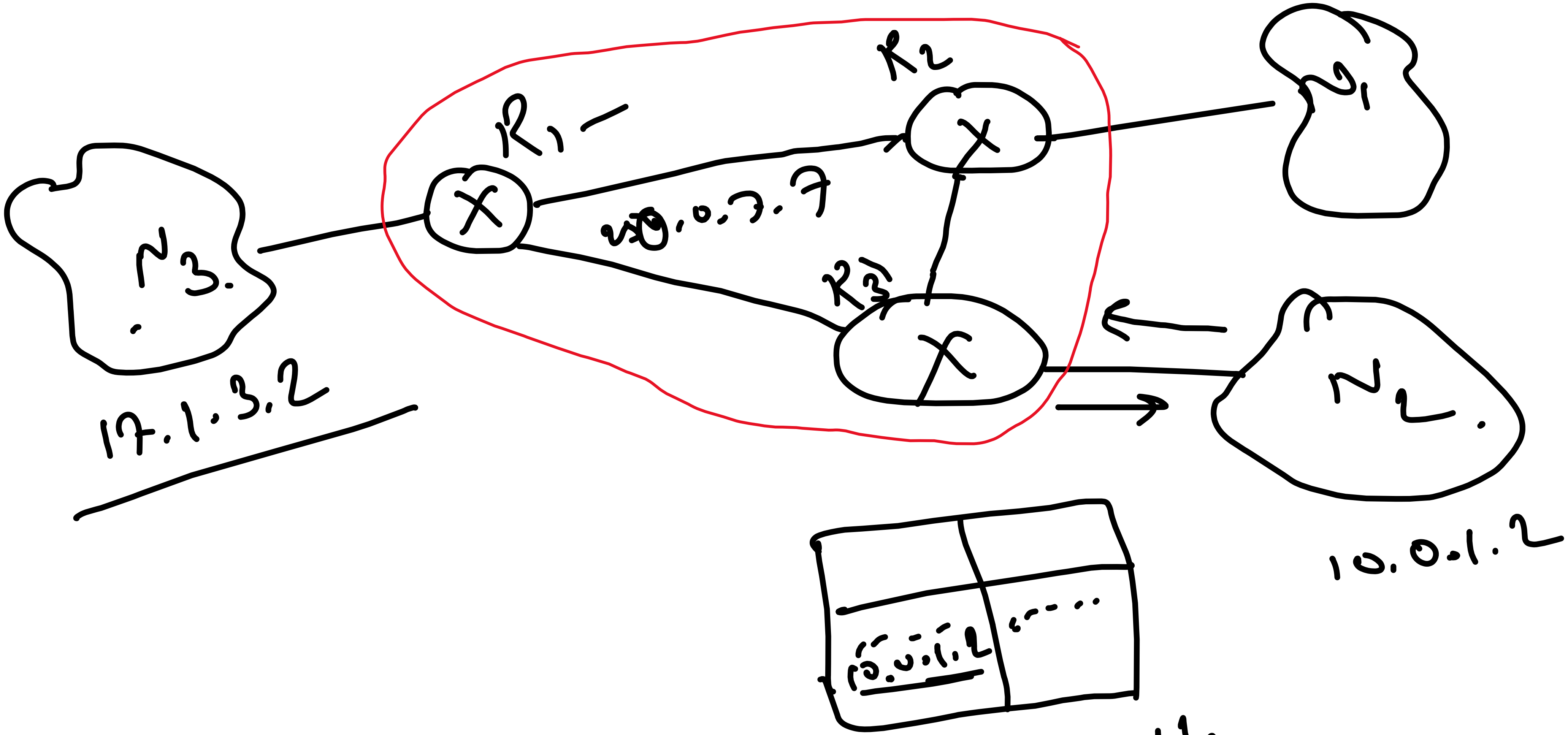
Granted = 65536

Available = 65536 − 40960

= 24576

NAT.

Network Address Translation



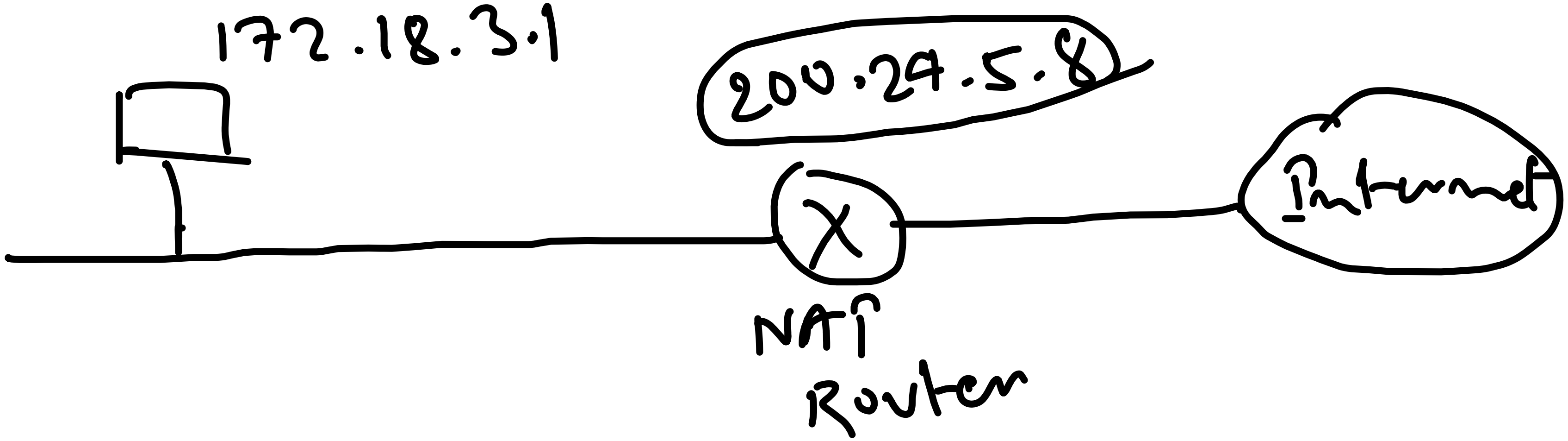
NAT Table

Addresses for Private N/W.

Range	Total.
1. 10.0.0.0 to 10.255.255.255	2^{24}
2. 172.16.0.0 to 172.31.255.255	2^{20}
3. 192.168.0.0 to 192.168.255.255	2^{16}

Ways of NAT.

① One IP Address



Private	External
172.18.3.1	25.8.2.1

Destination

2 Pool of IP Addresses.

Multiple IPs.

172.18.3.1

Host

FTP HTTP

x_1

x_2

x_3

x_4

Limitation

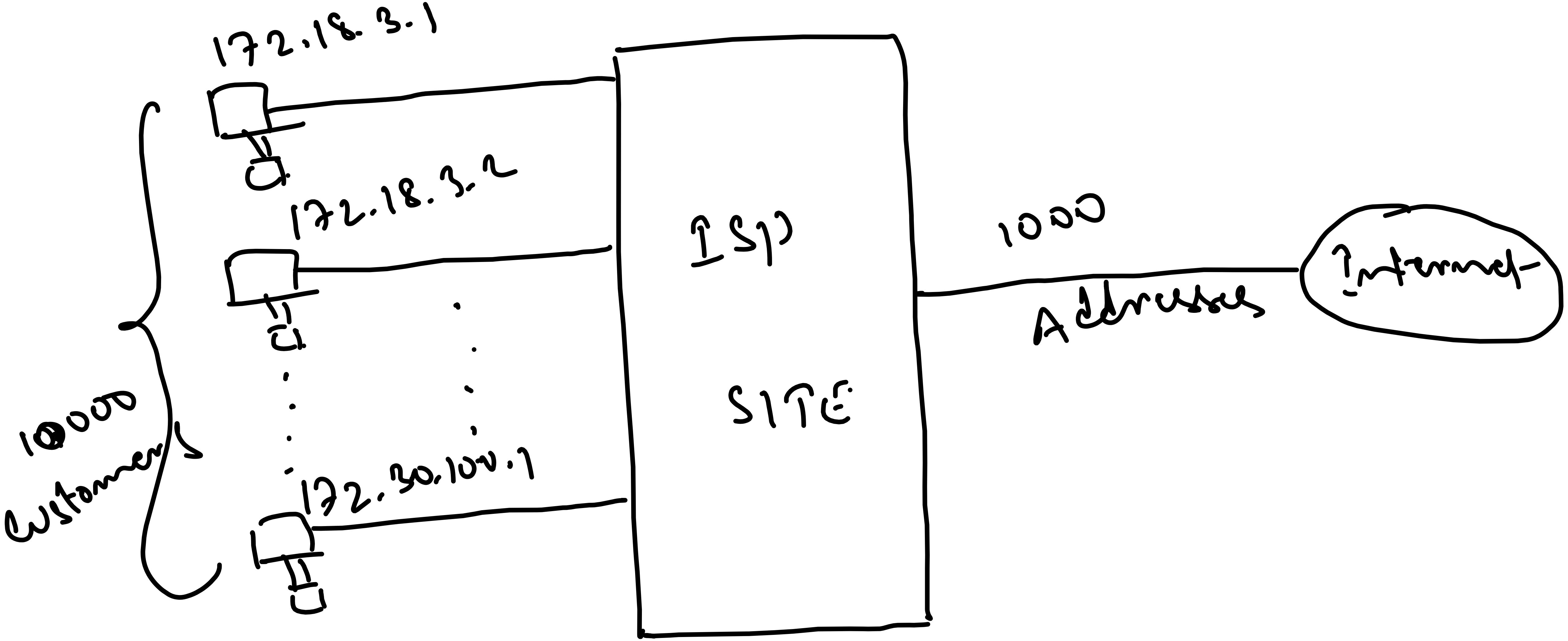
1. Table size increases
2. Global access of anyone.

(3) Using both IP & port.

Private	Private Port	External	External Port	Transport Protocol
172.18.3.1	1400	25.8.3.2	80	TCP
172.18.3.2	1401	25.8.3.2	80	TCP

unique

* NAT VS ISP.


172.18.3.1
172.18.3.2
172.30.100.1
10000 customers
ISP
SITE
1000
Addresses
Internet

IPv6 Address.

16 bytes (octets) — 128 bits.

FDEC : 0074 : 0000 : 0000 : 0000 : B0FF : 0000 : FFFF

32 Hex digits = 16 bytes

Abbreviations.

FDEC : 74 : 0 : 0 : 0 : B0FF : 0 : FFFF

↓

FDEC : 74 : : B0FF : 0 : FFFF

Eg:- Expand 0:15::1:12:1213

Sol:- 0000:0015:0000:0000:0000:0001:0012:1213