IPv4 ADDRESSING

IP — Internet Protocol

v4 — Version 4 (32 bit)

192.168.0.1

11000000.10101000.00000000.00000001

8bit 8bit 8bit 8bit

* Total 32 bit, seperated by dot

Types of IPv4 address

- Class Less
  - VLSM
- Class Based
  - Class A
    - 8 bit Net ID
    - 28 bit Host
  - Class B
    - 16 bit Net ID
    - 16 bit Host ID
  - Class C
    - 28 bit Net ID
    - 8 bit Host ID

Class A

Range → 1.$\overline{0.0.0}^{\text{Host}}$ – 126.$\overline{255.255.255}^{\text{Host}}$ (1-126)

Subnet Mask → 255.0.0.0

Structure → Network.Host.Host.Host

Class B

Range → $\overbrace{128.0}^{\text{Net}}.\overbrace{0.0}^{\text{Host}} - \overbrace{191.255}^{\text{Net}}.\overbrace{255.255}^{\text{Host}}$ (128–191)

Subnet Mask → 255.255.0.0

Structure → Network . Network . Host . Host

Class C

Range → $192.0.0.\overbrace{0}^{\text{Host}} - 223.255.255.\overbrace{255}^{\text{Host}}$ (192-223)

subnet mask → 255.255.255.0

Structure → Network . Network . Network . Host

CLASSLESS

- Variable length subnet mask (VLSM)
- /prefix is used to denote network portion

198.168.0.1/28 → network id 28 bits

host id (32-28) = 4 bits

← 32bit →

Network	Host
28 bit	4bit

for 100 hosts →
- $2^8 = 256-2$ (too large)
- $2^7 = 128-2$ (sufficient)
- $2^6 = 64-2$ (too small)

Network	Host
25	7

* Improves address allocation efficiency as its allocates host ID based on number of hosts.

SUBNET MASK

- 32 bit
- Separates network ID from Host ID
- 1 for Net ID, 0 for Host ID

255.255.255.0

11111111	11111111	11111111	00000000
Net	Net	Net	Host

EXAMPLE (Class Based)

Given, IP Address = 192.168.16.10

Find, Network ID = ?

First Host ID = ?

Last Host ID = ?

Broadcast Address = ?

192.168.16.10

Class C (192–255)

Network			Host
192	168	16	10

* For class C

Subnet Mask → 255.255.255.0 * For class C

Network ID → Bitwise AND of IP and subnet mask

IP 11000000.10101000.00010000.00001010

Mask 11111111.11111111.11111111.00000000

Network ID 11000000.10101000.00010000.00000000

* Bitwise AND

192.168.16.0

Network ID

Broadcast address
→ Flip the host bits of Network ID

11000000.10101000.00010000.11111111

Flipped Host Bits

192.168.16.255

Broadcast address

First Host ID
→ Network ID + 1

192.168.16.1

First Host ID

Last Host ID
→ Broadcast A. − 1

192.168.16.254

Last Host ID

Network ID	0	
$2^8 - 2 = 254$ → Available Hosts	1 … 254	$2^8 = 256$
Broadcast Ad.	255	

* Among 2^8 host, two address is reserved for Network ID and Broadcast Address

EXAMPLE (classless)

Given,

IP Address = 192.168.16.1

Needed hosts = 100

So, host bits, $2^{7} = 128 - 2$

Network bits, $(32-7) = 25$

Network	Host
25 bit	7 bit

→ 192.168.16.1/25

→ classless

Network portion

> ***NOTE**
>
> For 100 hosts,
>
> $2^6 = 64 - 2 = 62$ → not enough
>
> $2^8 = 256 - 2 = 254$ → too much
>
> (-2) for reserved network ID and Broadcast address

subnet Mask → 25 ones and 7 zeros

11111111.11111111.11111111.10000000

255.255.255.128

Subnet Mask

Network ID → IP Address AND Subnet mask

		Host bits
IP →	192.168.16.0	0000001
MASK →	255.255.255.1	0000000
Network ID →	192.168.16.0	0000000
Broadcast Ad. →	192.168.16.0	1111111

Binary

Flipped host bits for Broad cast address

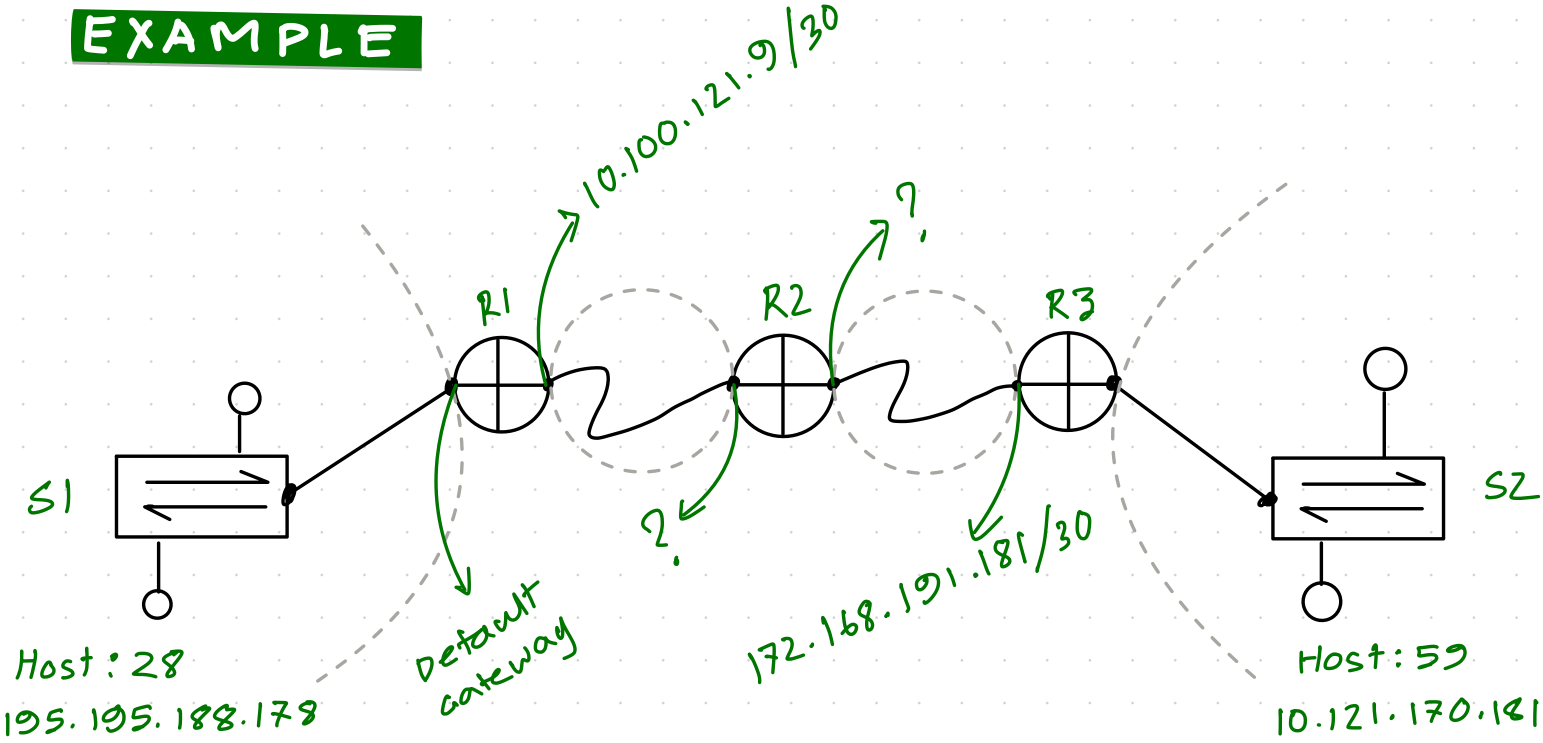
Network ID → 192.168.16.0/25

First host ID → 192.168.16.1/25

Last host ID → 192.168.16.126/25

Broadcast → 192.168.16.127/25

EXAMPLE



Find :-

1. Network address/ID
2. Broadcast Address
3. Default gateway
4. 1st host
5. Last host

*** Note**
we can choose any of the host id as default gateway. Convention is to pick the 1st one.
For 28 total hosts, we need

$$\underbrace{28 + 1}_{\text{Default Gateway}} + \underbrace{2}_{\text{NA and BA}} = 31 \approx 2^{\overbrace{5}^{\text{Required host bits}}}$$

S1

Required host bits = $2^5 = 32$ $[28+1+2=31]$

Network	Host
27 bit	5 bit

$\longrightarrow$ 195.195.188.178/27

IP $\longrightarrow$	195.195.188.101	10010
MASK $\longrightarrow$	255.255.255.111	00000
N.A $\rightarrow$	195.195.188.101	00000
B.A $\rightarrow$	195.195.188.101	11111

N.A. $\longrightarrow$ 195.195.188.160
D.G $\longrightarrow$ 195.195.188.161
1st Host $\longrightarrow$ 195.195.188.162
Last Host $\longrightarrow$ 195.195.188.190
B.A $\longrightarrow$ 195.195.188.191

S2

Required host bits = $2^{6} = 64$ $[59+1+2=62]$

Network	Host
26 bit	6 bit

→ 10.121.170.181/26

IP →	10.121.170.10	110101
MASK →	255.255.255.11	000000
N.A →	10.121.170.10	000000
B.A →	10.121.170.10	111111

N.A. → 10.121.170.128

D.G → 10.121.170.129

1st Host → 10.121.170.130

Last Host → 10.121.170.190

B.A → 10.121.170.191

R1 – R2

10.100.121.9/30 → 30 Network bits → 2 Host bits

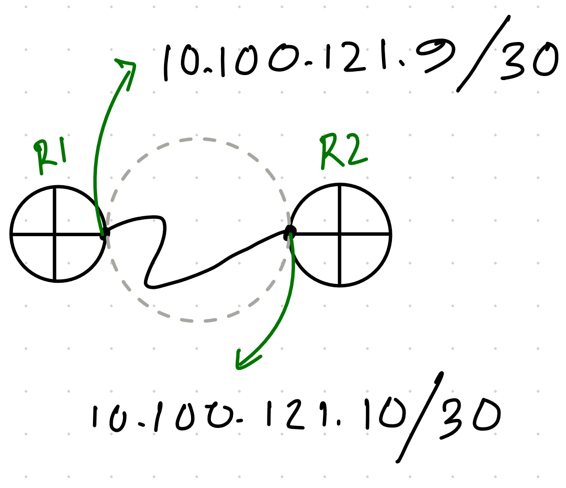
IP →	10.100.121.000010	01
MASK →	255.255.255.111111	00
N.A →	10.100.121.000010	00
B.A →	10.100.121.000010	11

N A → 10.100.121.8

DG 1 → 10.100.121.9

DG 2 → 10.100.121.10

H A → 10.100.121.11

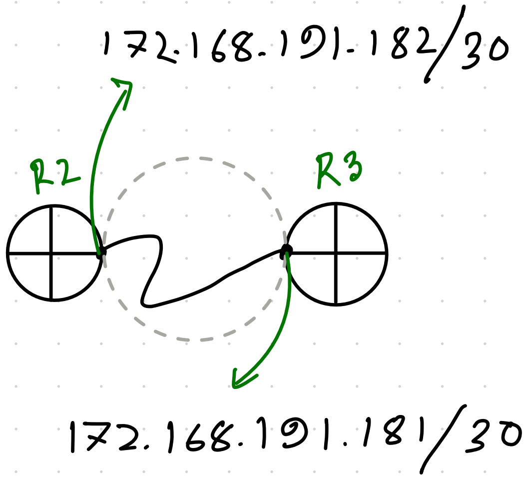


R2 – R3

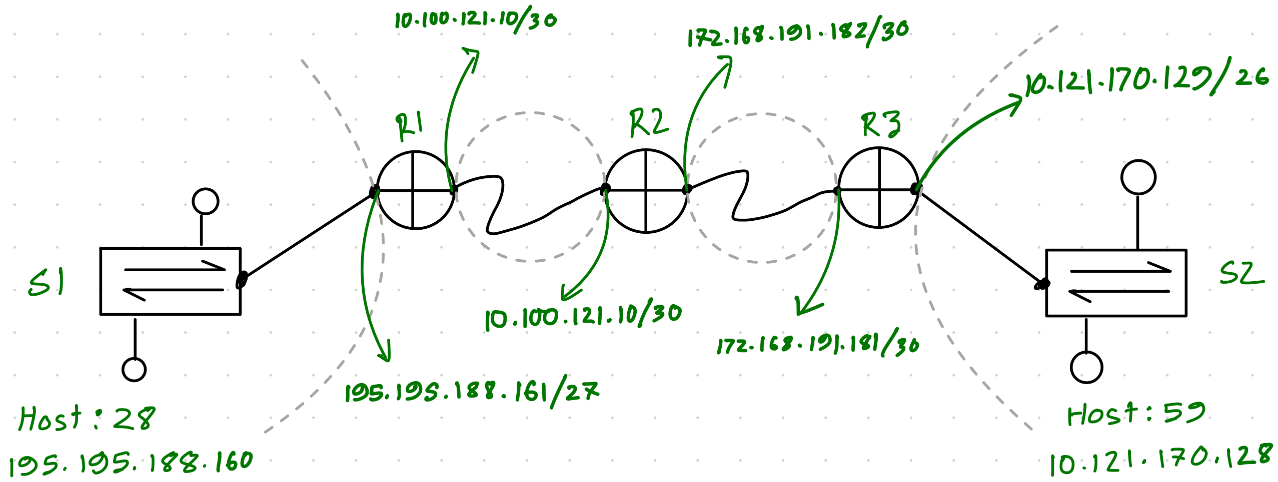
172.168.191.181/30 → 30 Network bits
→ 2 Host bits

IP →	172.168.191.101101	01
MASK →	255.255.255.111111	00
N.A →	172.168.191.101101	00
B.A →	172.168.191.101101	11

N A → 172.168.191.180
DG1 → 172.168.191.181
DG2 → 172.168.191.182
H A → 172.168.191.183



Final Network diagram,



SUBNET

Given IP,

$$100.128.127.191/13 \rightarrow \text{Network ID}$$

Default Mask : /8 (255.0.0.0) → Class A [1-126]

Applied Mask : /13 (255.248.0.0)

Subnet Bits : 13 − 8 = 5 bits → P

$$\overset{8}{\overline{100}}.\overset{5}{\overline{1000\,0}}000.127.191$$

$\underbrace{100.1000\,0}_{13\text{ bits}}$

$$S + P = 13$$

8   5

(I) Available Networks

$$2^{P} / 2^{\text{subnet bits}} = 2^{5} = 32 \rightarrow \text{Total number of sub networks}$$

(II) Network and Broadcast Addresses

Each 32 networks has its own unique networks address and broadcast address. So, total-

Network address : 32
Broadcast address : 32

} So total 64 address is reserved for N.A. & B.A.

Number of host bits = 32 − 13 = 19 → Host bits

Total hosts = 2^{19} = 524288

Available host addresses = 524288 − 64 → Reserved NA and BA
= 524224

Network address →

```
  100.128.127.191
  255.248. 0 . 0
  ---------------
  100.128. 0 . 0
```

→

```
  100.10000000.127.191
  255.11111000. 0 . 0
  --------------------
  100.10000000. 0 . 0
```

Increment for each network address

$$= 256/32$$ → Number of subnets

$$= 8$$ → Increment

1st N.A → 100.0.0.0 → 100.00000|000.0.0

2nd N.A → 100.8.0.0 → 100.00001|000.0.0

3rd N.A → 100.16.0.0 → 100.00010|000.0.0

....

last N.A → 100.248.0.0 → 100.11111|000.0.0

Last B.A → 100.255.255.255 → 100.11111|111.255.255

* convert host bits to 1 to get B.A for each network

EXAMPLE

100.48.128.191/13

For the given IP address, find the Network address, broadcast address and 260th host.

Solution:

Network bits = 13

Host bits = 32-13 = 19

Subnet Mask = 255.248.0.0
[For 13 bit net id]

	100.48.128.191
	255.248.0.0
	100.48.0.0 → Network Address

Network Address = 100.48.0.0

260th Host = N.A. + 260

Binary Addition

	100.48.00000000.00000000 → N.A
+	0.0.00000001.00000100 → 260
	100.48.00000001.00001000

100.48.1.4

So, 260th host IP = 100.48.1.4

EXAMPLE

class A ← 100.48.128.191/13

For the given IP address, find the 139th host of 3rd subnetwork.

Solution:

Network bits = 13

Host bits = 32−13 = 19

Default network/mask bits = 8 [For class A]

Applied network/mask bits = 13−8 = 5 → P

*Also knows as subnet bits

Total subnetworks = $2^{\text{subnet bits}}$ or 2^P

$= 2^5 = 32$

Increment for each subnet = 256/32

= 8

∴ 1st subnetwork address →

100 . 48 . 128 . 191	
255 . 0 . 0 . 0	
100 . 0 . 0 . 0	→ 1st NA

1st NA → 100.0.0.0

2nd NA → 100.8.0.0 (+8 in 2nd octet)

3rd NA → 100.16.0.0 (+8)

Now, 139th host of 3rd subnetwork will be 3rd NA + 139

	100.16.0.00000000	→ 3rd NA
+	0 . 0 . 0 . 10001011	→ 139 in binary
	100.16.0.139	→ 139th host of 3rd NA