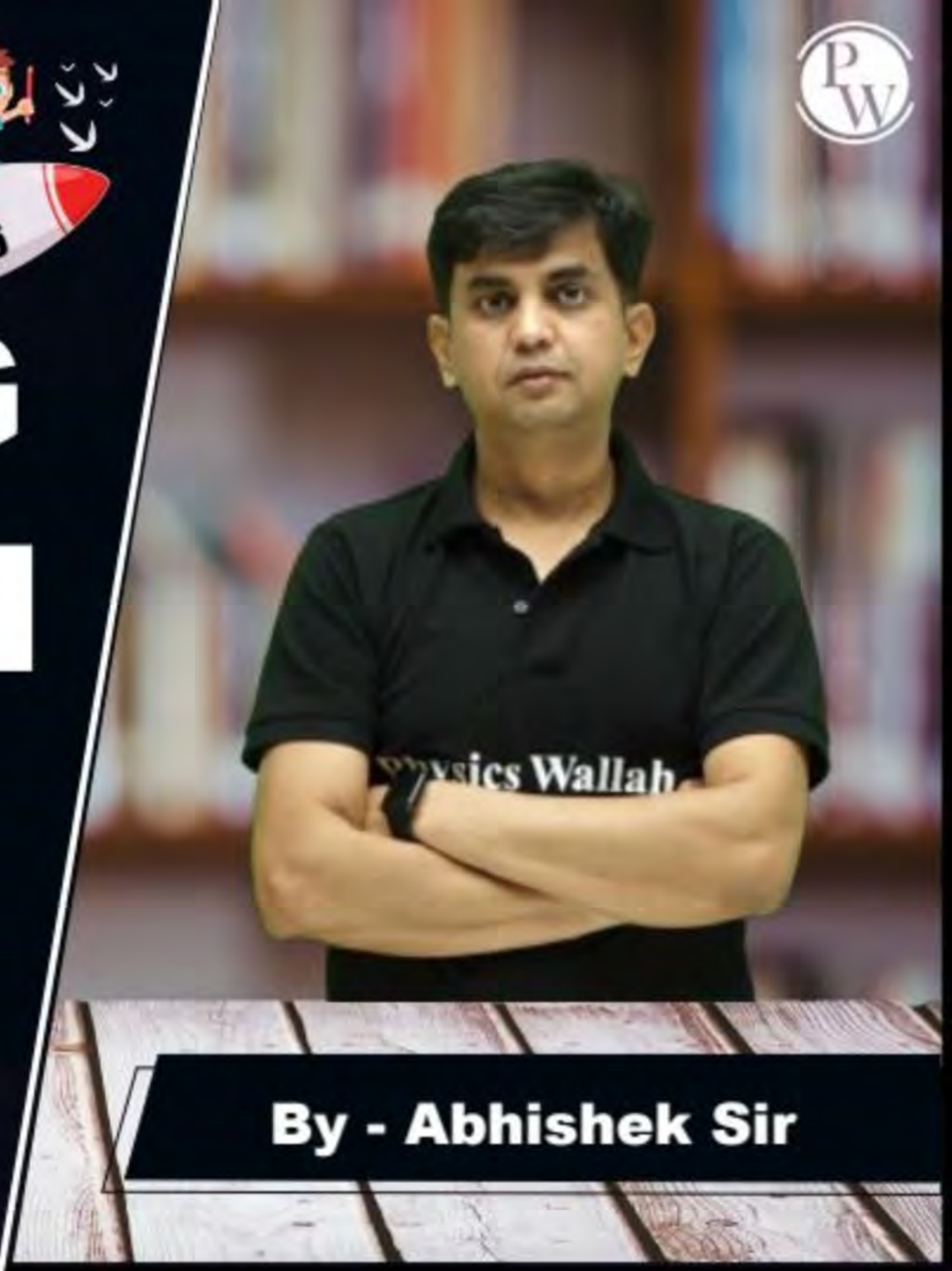
CS & IT ENGINEERING

Computer Network - 2

Network Layer

Lecture No. - 04



By - Abhishek Sir

Recap of Previous Lecture

Topic **Supernetting**

Topics to be Covered

Topic NAT

Topic DHCP

Topic : Supernetting

Example 3 :- Consider following Network Addresses of networks.

210 . 192 . 0 . 0 / 13

210 . 200 . 0 . 0 / 13

210 . 208 . 0 . 0 / 13

210 . 216 . 0 . 0 / 13

} 2-bit supernetting

Supernet Address : 210.192.0.0/11

Topic : Supernetting

Example 3 :-

Network Address 1 : 210 . 192 . 0 . 0 / 13

First IP = 210 . 192 . 0 . 0 / 13, Last IP = 210 . 199 . 255 . 255 / 13

Network Address 2 : 210 . 200 . 0 . 0 / 13

First IP = 210 . 200 . 0 . 0 / 13, Last IP = 210 . 207 . 255 . 255 / 13

Network Address 3 : 210 . 208 . 0 . 0 / 13

First IP = 210 . 208 . 0 . 0 / 13, Last IP = 210 . 215 . 255 . 255 / 13

Network Address 4 : 210 . 216 . 0 . 0 / 13

First IP = 210 . 216 . 0 . 0 / 13, Last IP = 210 . 223 . 255 . 255 / 13

Topic : Supernetting

Example 3 :-

13 bit prefix

19 bit HostID

210.110.00000.00000000.00000000/13 ⟹ 2^{19} Address

210.110.01000.00000000.00000000/13 ⟹ 2^{19} —//—

210.110.10000.00000000.00000000/13 ⟹ 2^{19} —//—

210.110.11000.00000000.00000000/13 ⟹ 2^{19} —//—

Supernet Address : 210.192.0.0/11

210.110.00000.00000000.00000000/11 ⟹ 2^{21} Address

11 bit prefix

21 bit HostID

Topic : Supernetting

Example 4 :- Consider following Network Addresses of networks.

10 . 90 . 0 . 0 / 16 $\Longrightarrow 2^{16}$ Address

10 . 90 . 64 . 0 / 18 $\Longrightarrow 2^{14}$ Address

10 . 90 . 192 . 0 / 18 $\Longrightarrow 2^{14}$ Address

delete

Supernet Address : 10.90.0.0/16

Topic : Supernetting

Example 4 :-

Network Address 1 : 10 . 90 . 0 . 0 / 16

First IP = 10 . 90 . 0 . 0 / 16, Last IP = 10 . 90 . 255 . 255 / 16

Network Address 2 : 10 . 90 . 64 . 0 / 18

First IP = 10 . 90 . 64 . 0 / 18, Last IP = 10 . 90 . 127 . 255 / 18

Network Address 3 : 10 . 90 . 192 . 0 / 18

First IP = 10 . 90 . 192 . 0 / 18, Last IP = 10 . 90 . 255 . 255 / 18

Topic : Supernetting

Example 4 :-

16 bit prefix

16 bit Host ID

10 . 90 . 0 0 0 0 0 0 0 0 . 0 0 0 0 0 0 0 0 / 16 $\Longrightarrow 2^{16}$ Address

10 . 90 . 0 1 0 0 0 0 0 0 . 0 0 0 0 0 0 0 0 / 18 $\Longrightarrow 2^{14}$ Address

10 . 90 . 1 1 0 0 0 0 0 0 . 0 0 0 0 0 0 0 0 / 18 $\Longrightarrow 2^{14}$ Address

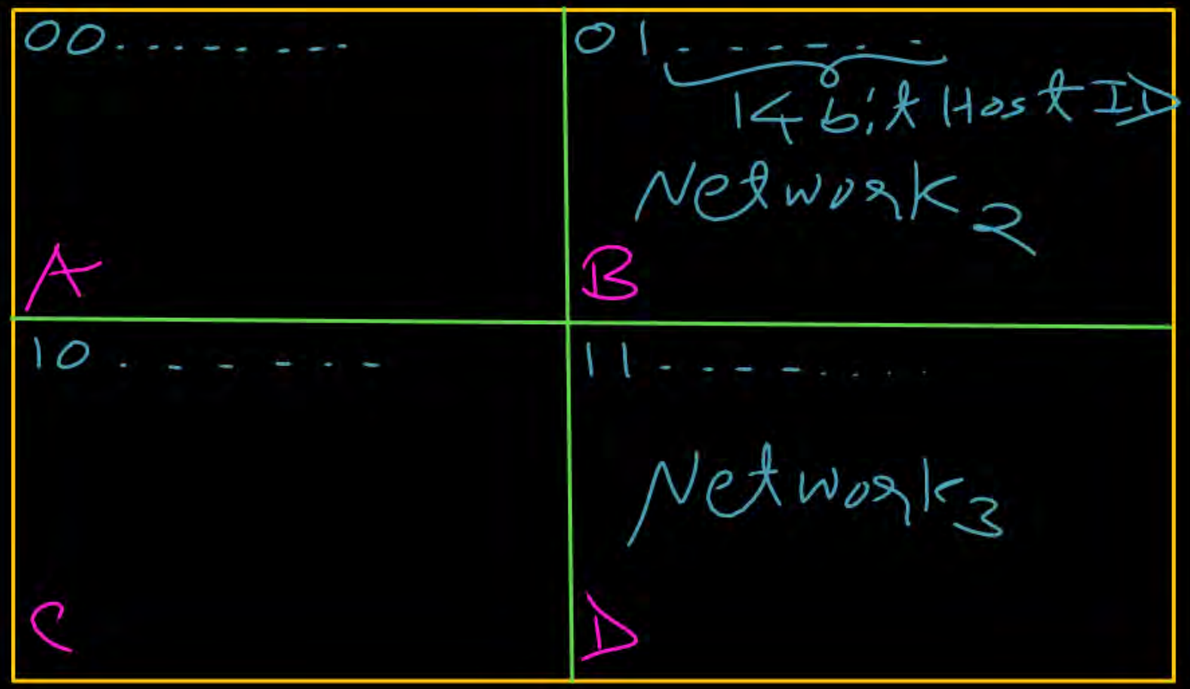
18 bit prefix

14 bit Host ID

Supernet Address : 10 . 90 . 0 . 0 /

10 . 90 . 0 0 0 0 0 0 0 0 . 0 0 0 0 0 0 0 0 /

Net Add. = 10.90.0.0/16



Possible

(A+B)

(C+D)

(A+B+C+D)

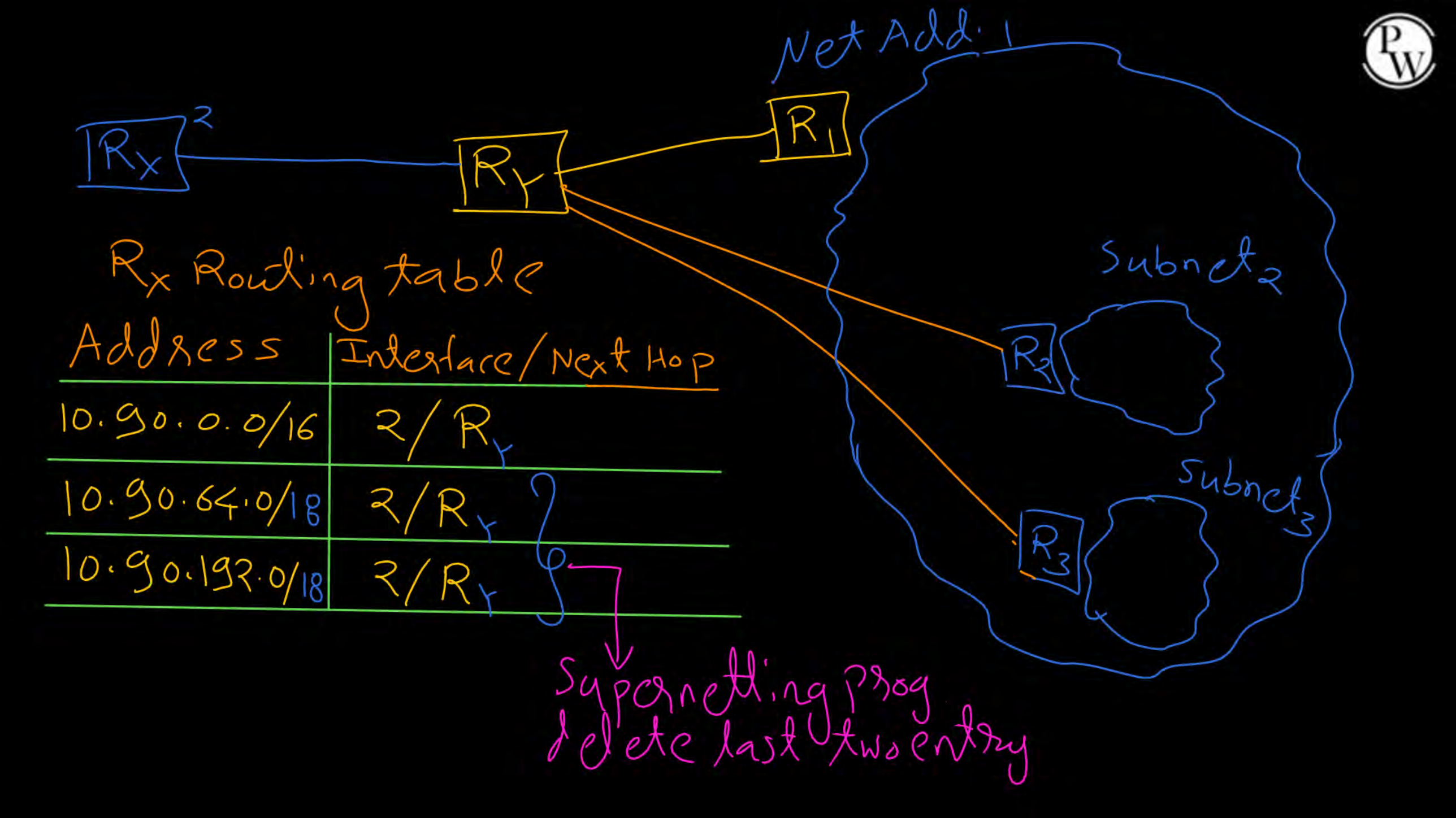
Not possible

(A+D)

(A+C)

(B+C)

(B+D)



R_x Routing table

Address	Interface / Next Hop
10.90.0.0/16	2 / R_y
10.90.64.0/18	2 / R_y
10.90.192.0/18	2 / R_y

Supernetting Prog
delete last two entry

[MSQ] IIT-KGP [GATE-2022][2 Mark]

#Q. Consider routing table of an organization's router shown below:

Subnet Number	Subnet Mask	Next Hop / Interface
12.20.164.0/22	255.255.252.0	R1 / Int 1
12.20.170.0/23	255.255.254.0	R2 / Int 0
12.20.168.0/23	255.255.254.0	Interface 0 / R_2
12.20.166.0/23	255.255.254.0	Interface 1 / R_1 → delete
default		R3 ⟹ As it is

Which of the following prefixes in CIDR notation can be collectively used to correctly aggregate all of the subnets in the routing table?

A 12.20.164.0/20

B 12.20.164.0/22

C 12.20.164.0/21

D 12.20.168.0/22

Ans: B & D

12.20.164.0/22

12.20.10100100.00000000/22

12.20.10100|--.----------/22

22 bit prefix | 10 bit host ID

No. of addresses = 2^{10}

12.20.166.0/23

12.20.10100110.00000000/23

12.20.10100|11--.---------/23

23 bit prefix | 9 bit host ID

No. of addresses = 2^{9}

12.20.164.0/22 → keep it

12.20.166.0/23 → Remove it

12.20.168.0/23
12.20.10101000.000000000/23
12.20.10101100 ---------/23

23 bit prefix — 9 bit Host ID

No. of addresses = 2^9

12.20.170.0/23
12.20.10101010.000000000/23
12.20.101010 1 ---------/23

23 bit prefix — 9 bit host ID

No. of addresses = 2^9

CIDR prefix :- After 1-bit supernetting.

12.20.101010 ----------/22

22-bit prefix — 10 bit host ID

No of Addresses = 2^{10}

12.20.10101000.000000000/22 ⟹ 12.20.168.0/22

12.20.164.0/22
12.20.10100100.00000000/22
12.20.101001----------/22

22-bit prefix | 10 bit host ID

No. of addresses = 2^{10}

12.20.168.0/22
12.20.10101000.00000000/22
12.20.101010----------/22

22 bit prefix | 10 bit host ID

No. of addresses = 2^{10}

*CIDR aggregation is not possible of above two supernet.

Final Routing Table

Subnet Number	Subnet Mask	Next Hop
12.20.164.0/22	255.255.255.252	R_1 / Interface 1
12.20.168.0/22	255.255.255.252	R_2 / Interface 0
default →		R_3 ✓

Topic : IPv4 Address

→ Solution for IPv4 address (32-bits) range problem.

1. Network Address Translation (NAT)
   [Short-term solution]

2. IPv6 address (128 bits)
   [Permanent solution]

Topic : NAT

→ NAT : Network Address Translation

→ Internet : Public Network ⟹ Public IP (classless IP)

→ Every network is considered as a private network ⟹ Private IP (classless IP)

LAN

Topic : NAT

→ Every connected network is identified by unique public IPv4 Address [Assigned by ISP]

→ Total number of network can be exist (world wide) is 2^{32}

→ All hosts inside a network is identified by private IPv4 Address

and all hosts of a network share assigned public IP to communicate over Internet

Topic : Private IPv4 Address

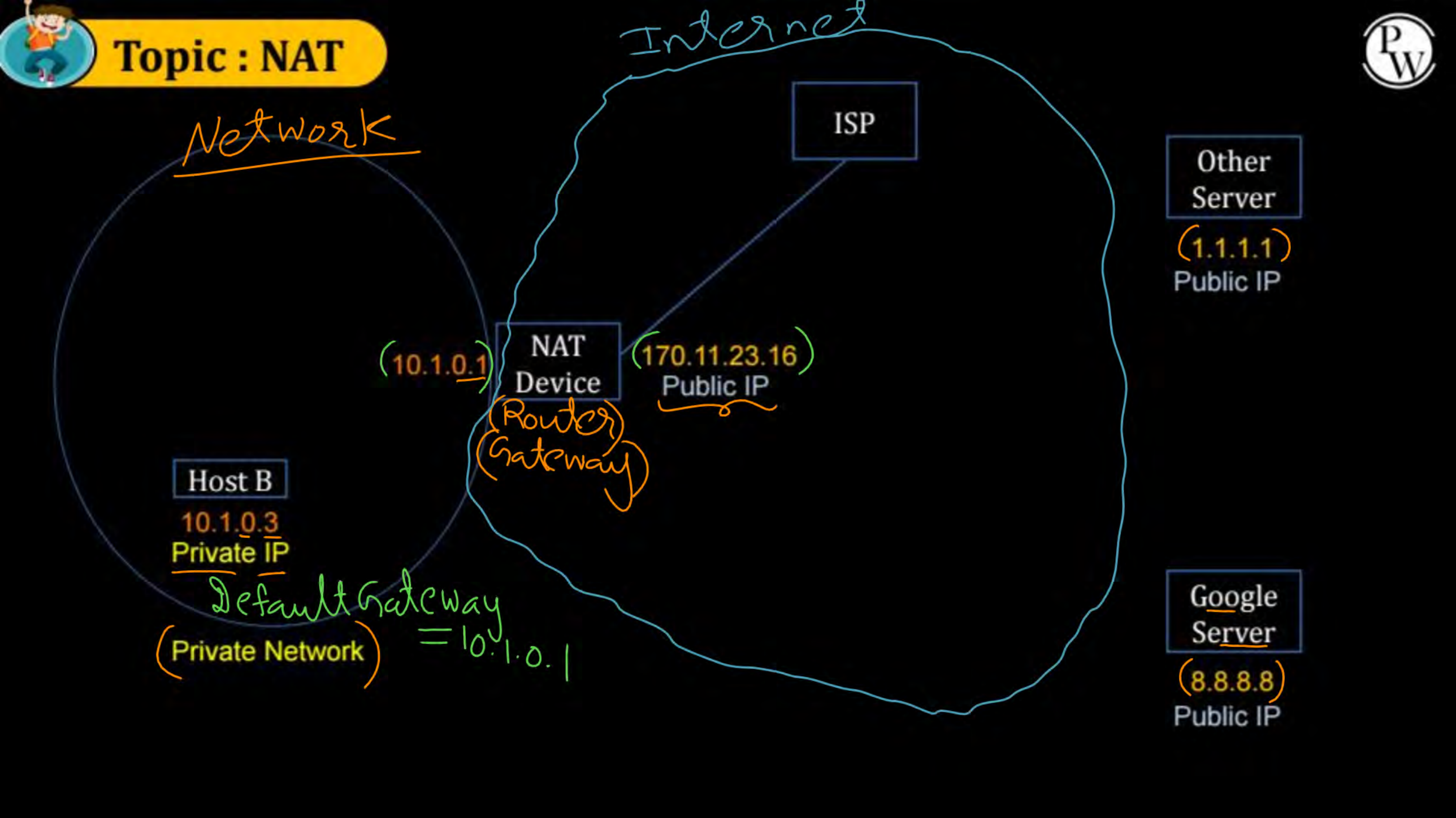
→ Network addresses for private IPv4 Networks :

10.0.0.0/8 ⟹ 2^{24} private IP (8 bit subnetting) (/16)

172.16.0.0/12

192.168.0.0/16 ⟹ 2^{16} private IP → with 8 bit subnetting (/24)

Topic : NAT


Internet
Network
ISP
Other Server
(1.1.1.1)
Public IP
(10.1.0.1)
NAT Device
(Router)
(Gateway)
(170.11.23.16)
Public IP
Host B
10.1.0.3
Private IP
Default Gateway = 10.1.0.1
(Private Network)
Google Server
(8.8.8.8)
Public IP

Topic : NAT

→ Host B is sending one IP packet to Google server

Source IP Address	:	10.1.0.3 [Private IP]	170.11.23.16 (Public IP) (NAT Device)
Destination IP Address	:	8.8.8.8	

Topic : NAT Table

→ NAT device maintain, (NAT Log)
NAT table for address translation of incoming datagram

Local Private IPv4 Address [Source IP Add.]	Global Public IPv4 Address [Destination IP]
10.1.0.3	8.8.8.8

Topic : NAT

→ Google server is sending one IP packet to Host B

Source IP Address : 8 . 8 . 8 . 8

Destination IP Address : 170 . 11 . 23 . 16
[Public IP]

10.1.0.3
[Private IP]
NAT Device

Topic : NAT Device

→ For every outgoing datagram,
it modify Source IP address from private IP address to public IP address

→ For every incoming datagram,
it modify Destination IP address from public IP address to private IP address

[MSQ] [GATE-2024, Set-1, 1 Mark] IISc, (H.W.)

#Q. Which of the following fields is/are modified in the IP header of a packet going out of a network address translation (NAT) device from an internal network to an external network ?

(A) Header Checksum

(B) Source IP

(C) Destination IP

(D) Total Length

2 mins Summary

Topic NAT →

Topic [redacted]

DHCP

TrafficShaping

THANK - YOU