

# CS & IT ENGINEERING



## Computer Network

### IPv4 Addressing

Lecture No. - 09

By - Abhishek Sir





# Recap of Previous Lecture



Topic

**Supernetting**

Topic

**ARP**



# Topics to be Covered



Topic

ARP

Topic

NAT

Topic

DHCP





## ABOUT ME

Hello, I'm **Abhishek**

- GATE CS AIR - 96
- M.Tech (CS) - IIT Kharagpur
- 12 years of GATE CS teaching experience



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

Subnet Number	Subnet Mask	Next Hop
12.20.164.0 ✓	255.255.252.0	R1 / Interface 1
12.20.170.0	255.255.254.0	R2 / Interface 0
12.20.168.0	255.255.254.0	Interface 0 / R2
12.20.166.0	255.255.254.0	Interface 1 / R1
Default		R3

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

H.W.

[GATE-2022, 2-Mark]

(A) ~~12.20.164.0 / 20~~

(C) 12.20.164.0 / 21

(B) 12.20.164.0 / 22

(D) 12.20.168.0 / 22

Ans: B &amp; D

12.20.164.0 : 12.20.10100100.00000000 / 22

12.20.166.0 : 12.20.10100110.00000000 / 23

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Supernet Address : 12.20.10100100.00000000 / 22

Supernet Address : 12.20.164.0 / 22 ✓

12.20.168.0 : 12.20.10101000.00000000 / 23

12.20.170.0 : 12.20.10101010.00000000 / 23

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Supernet Address : 12.20.10101000.00000000 / 22

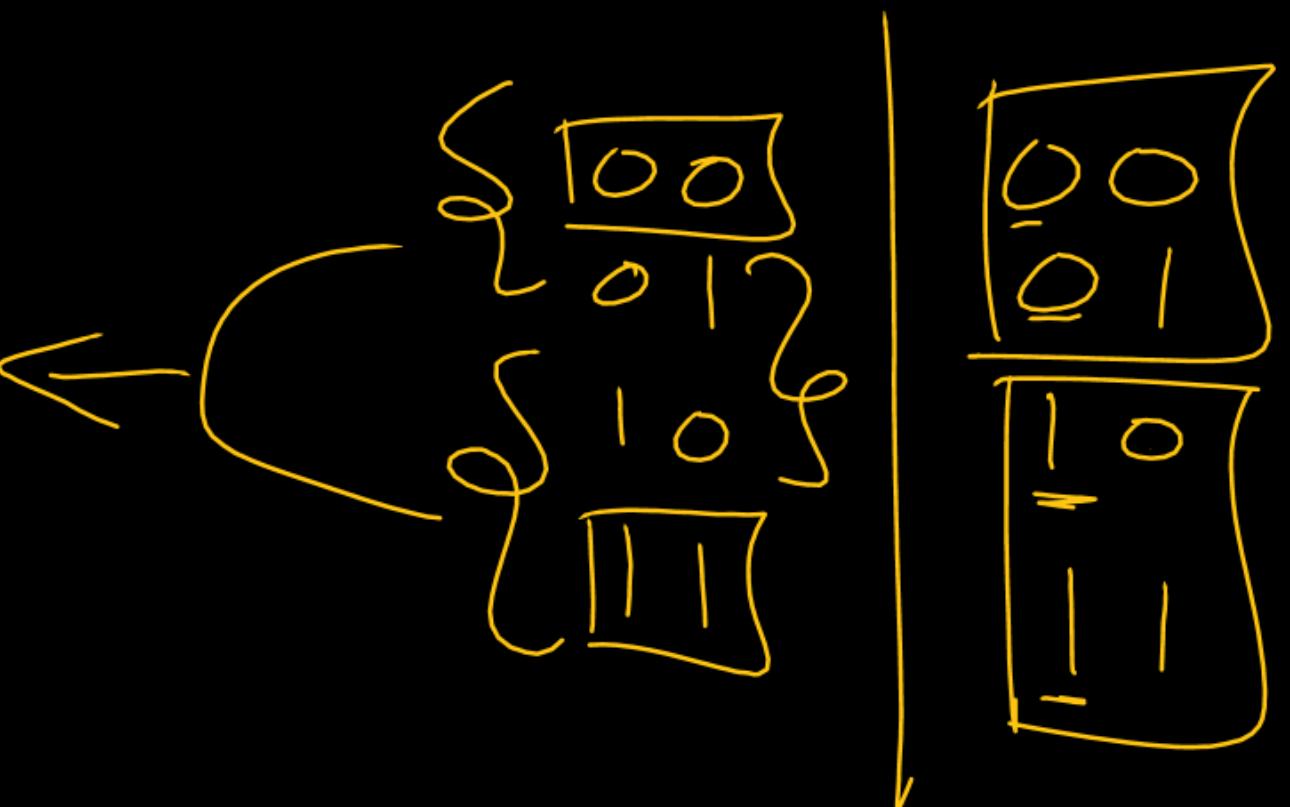
Supernet Address : 12.20.168.0 / 22 ✓

12.20.164.0 /22

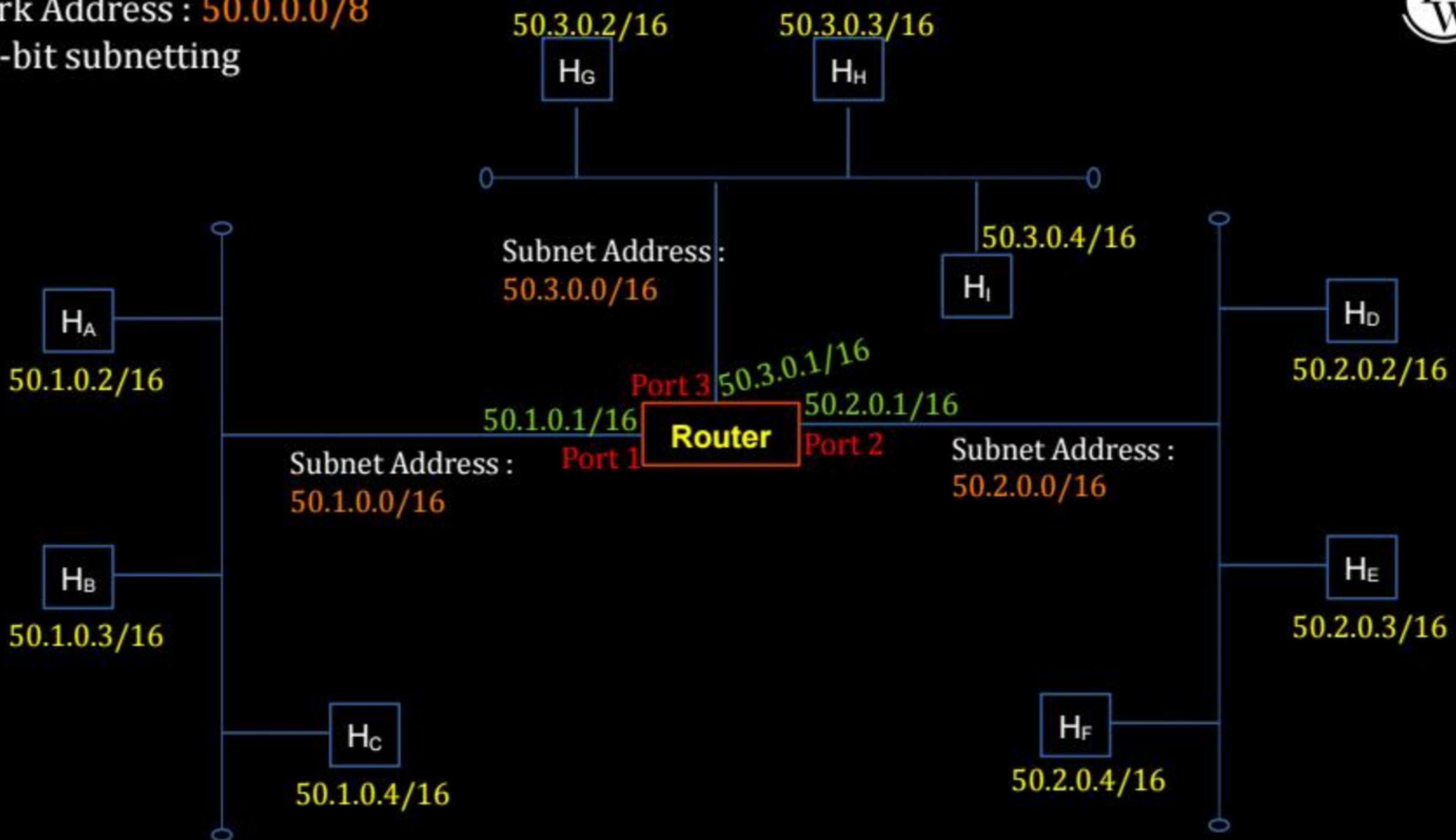
Supernet Address : 12.20.10100100.00000000 / 22

Supernet Address : 12.20.10101000.00000000 / 22

12.20.168.0 /22



Network Address :  $50.0.0.0/8$   
With 8-bit subnetting



## Host A, IPv4 Configuration :-

IPv4 Address : 50.1.0.2

Subnet Mask : 16 or 255.255.0.0

Default Gateway : 50.1.0.1

## Router forwarding table

Subnet Address	Interface ID	Next Hop
50.1.0.0 / 16	1	On Link
50.2.0.0 / 16	2	On Link
50.3.0.0 / 16	3	On Link

**CASE I :**

Source IP Address : 50.1.0.2

Destination IP Address : 50.1.0.3

- Host A (source host) finds destination host IP (Host B) belongs to same subnet
- Host A uses ARP Protocol to find MAC Address of destination host
- Host A send frame to Host B  
[The frame encapsulates the IP datagram]

Source MAC Address : Host A MAC Address

Destination MAC Address : Host B MAC Address

**CASE II :**

Source IP Address : 50.1.0.2

Destination IP Address : 50.2.0.2

- Host A (source host) finds destination host IP (Host D) belongs to different subnet
- Host A uses ARP Protocol to find MAC Address of default gateway [50.1.0.1]
- Host A send frame to Router
  - [The frame encapsulates the IP datagram]

Source MAC Address : Host A MAC Address

Destination MAC Address : Router MAC Address

**CASE II :**

Source IP Address : 50.1.0.2

Destination IP Address : 50.2.0.2

- Router receives the IP datagram
- Finds destination host IP (Host D) belongs to subnet connected via port 2
- Router uses ARP Protocol to find MAC Address of destination host
- Router send frame to Host D  
[The frame encapsulates the IP datagram]

Source MAC Address : Router MAC Address

Destination MAC Address : Host D MAC Address

#Q. Host X has IP address 192.168.1.97 and is connected through two routers R1 and R2 to another host Y with IP address 192.168.1.80, Router R1 has IP addresses 192.168.1.135 and 192.168.1.110, R2 has IP addresses 192.168.1.67 and 192.168.1.155, the netmask used in the network is 255.255.255.224;

Which IP address should X configure its gateway as?

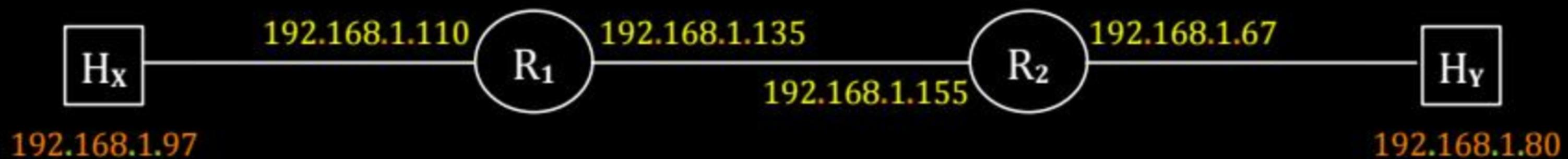
H.W.

[GATE-2008]

IISCE

- (A) 192.168.1.67
- (B) 192.168.1.110
- (C) 192.168.1.135
- (D) 192.168.1.155

Netmask = 255.255.255.224



97 = 01100001  
110 = 01101110

135 = 10000111  
155 = 10011011

67 = 01000011  
80 = 01010000

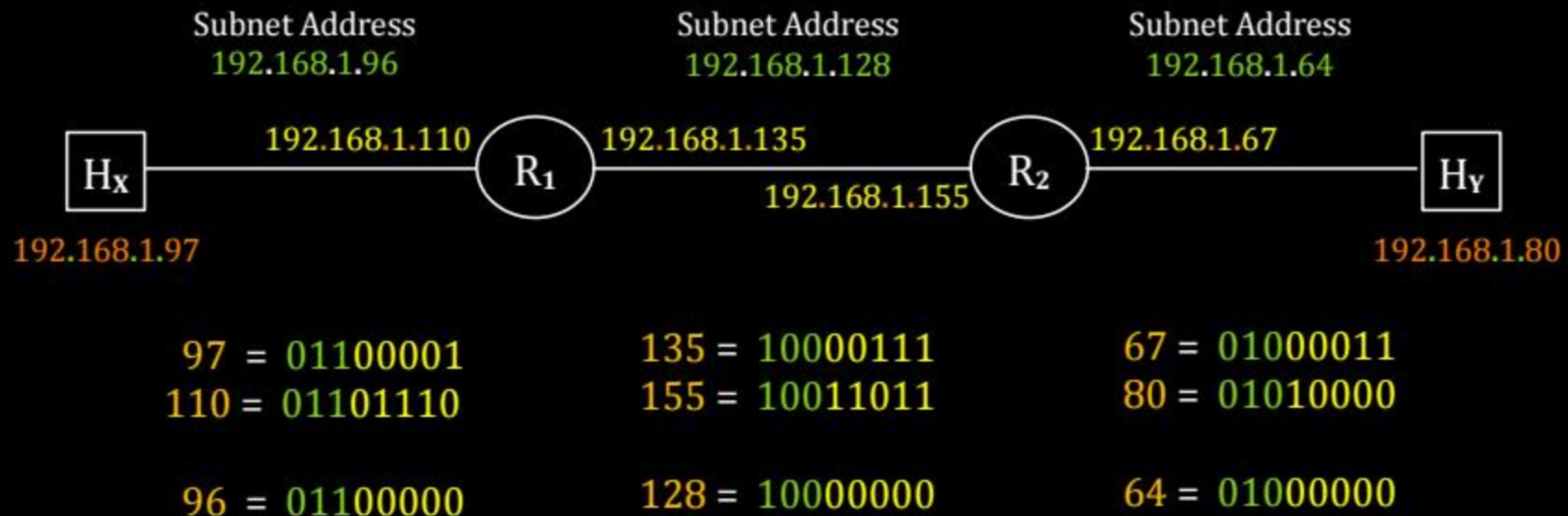
#Q. Given the information in previous question, how many distinct subnets are guaranteed to already exist in the network?

[GATE-2008]

H.W.

- (A) 1
- (B) 2
- (C) 3
- (D) 6

Netmask = 255.255.255.224



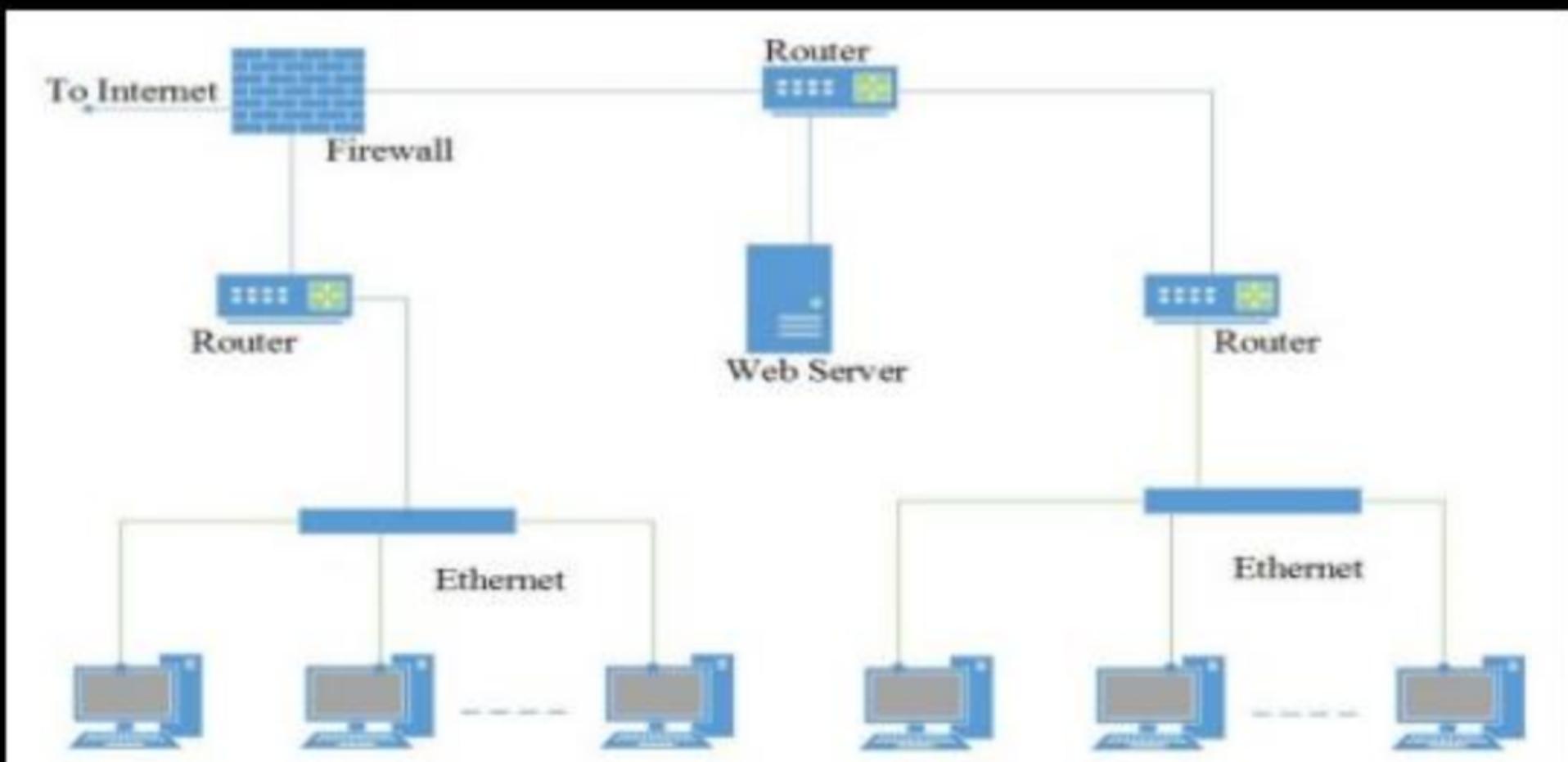
#Q. Node X has a TCP connection open to node Y. The packets from X to Y go through an intermediate IP router R. Ethernet switch S is the first switch on the network path between X and R. Consider a packet sent from X to Y over this connection. Which of the following statements is/are TRUE about the destination IP and MAC addresses on this packet at the time it leaves X?

[GATE-2024, Set-2, 1-Mark]

IISC, H. W.

- (A) The destination IP address is the IP address of R
- (B) The destination IP address is the IP address of Y
- (C) The destination MAC address is the MAC address of S
- (D) The destination MAC address is the MAC address of Y

#Q. Consider an enterprise network with two Ethernet segments, a web server and a firewall, connected via three routers as shown below.



What is the number of subnets inside the enterprise network?

H.W.

[GATE-2022, 1-Mark]

- (A) 3
- (B) 12
- (C) 6
- (D) 8



## Topic : ARP



- ARP : Address Resolution Protocol
- Data Link Layer Protocol / Higher Side of Data Link Layer
- Used to find MAC address of device from IP address
- Map logical address into corresponding physical address



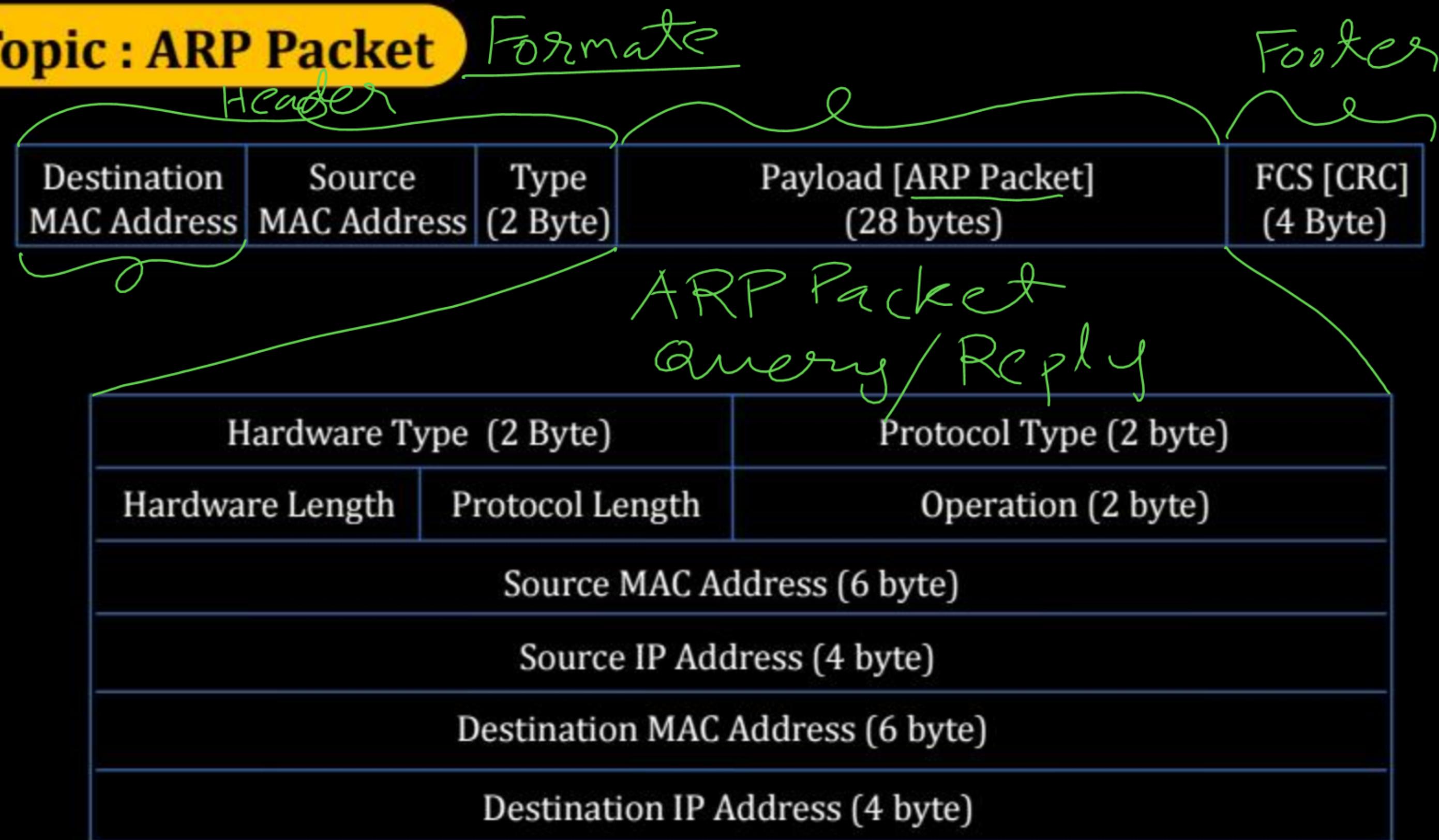


## Topic : ARP Packet

- ARP Packet always encapsulated into payload field of “Frame”
- ARP Query (Request) always broadcast [ Destination MAC address = [ FF:FF:FF:FF:FF:FF ] (All 48 bits are one)  
Broadcast MAC address ]
- ARP Reply always unicast [ Destination MAC address = MAC address of Host who raised ARP query ]



# Topic : ARP Packet





## Topic : ARP Table



→ Used to keep the reply of ARP queries for some time

[Host A] ARP Table

IP Address	MAC Address	Time to Live
H <sub>B</sub> (IP)	H <sub>B</sub> (MAC)	
Router(IP)	Router(MAC)	

#Q. The address resolution protocol (ARP) is used for :

[GATE-2005]

- (A) Finding the IP address from the DNS
- (B) Finding the IP address of the default gateway
- (C) Finding the IP address that corresponds to a MAC address [RARP]
- (D) Finding the MAC address that corresponds to an IP address [ARP]

Ans: D

#Q. Consider the following two statements.

S1: Destination MAC address of an ARP reply is a broadcast address. FALSE

S2: Destination MAC address of an ARP request is a broadcast address. TRUE

Which one of the following choices is correct?

[GATE-2021]

IIT-B

- (A) Both S1 and S2 are true
- (B) S1 is true and S2 is false
- (C) S1 is false and S2 is true
- (D) Both S1 and S2 are false

Ans: C

#Q. Suppose that in an IP-over-Ethernet network, a machine X wishes to find the MAC address of another machine Y in its subnet. Which one of the following techniques can be used for this?

H.W.

[GATE-2019]

IIT-M

- (A) X sends an ARP request packet with broadcast IP address in its local subnet
- (B) X sends an ARP request packet to the local gateway's MAC address which then finds the MAC address of Y and sends to X
- (C) X sends an ARP request packet with broadcast MAC address in its local subnet
- (D) X sends an ARP request packet to the local gateway's IP address which then finds the MAC address of Y and sends to X



# 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]



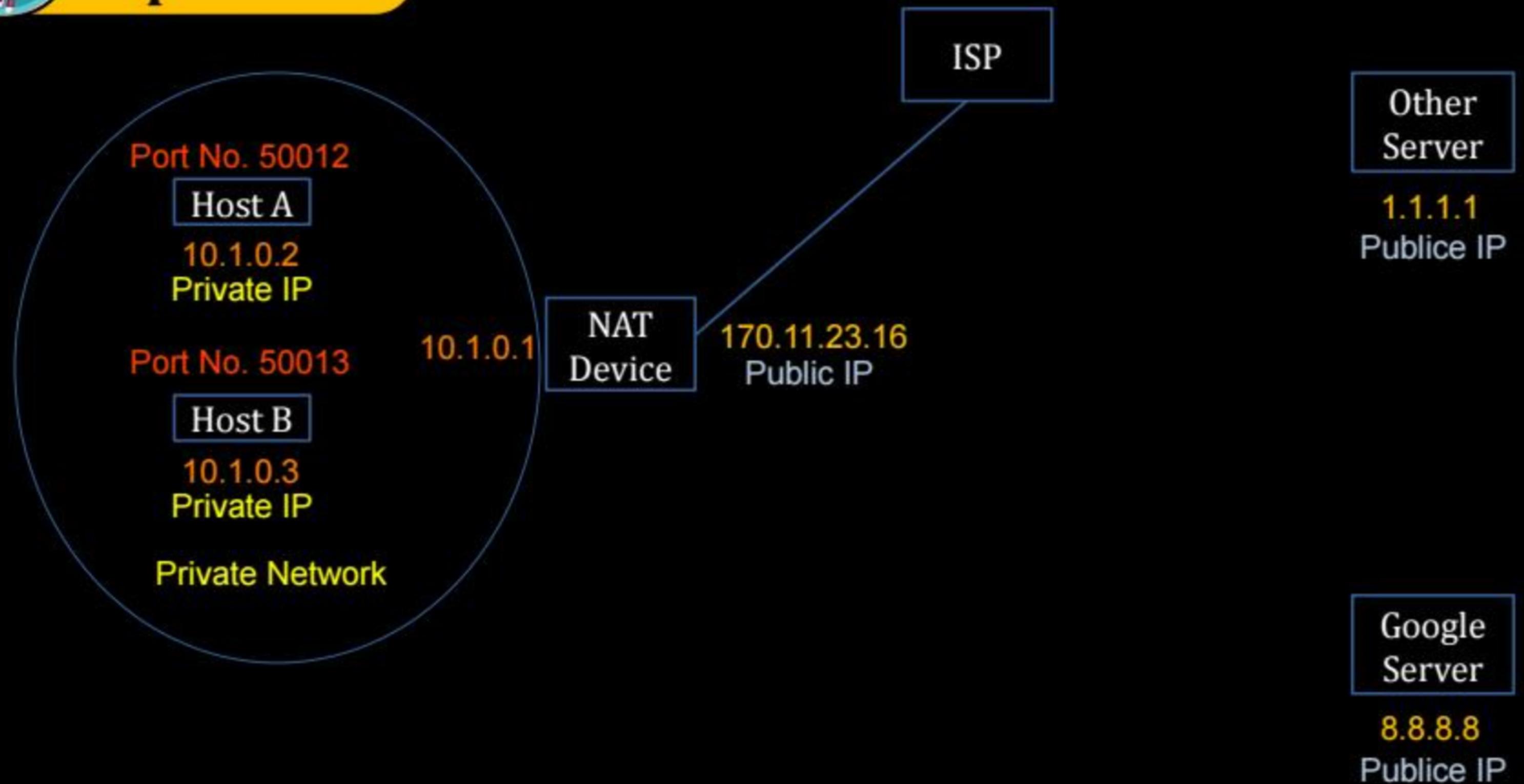
## Topic : NAT



- NAT : Network Address Translation
- Every connected network is identified by unique public IPv4 Address  
[Assigned by ISP]
- Every network is considered as a private network
- All hosts inside a network is identified by private IPv4 Address
- Total number of network can be exist (world wide) is  $2^{32}$



# Topic : NAT





## Topic : NAT Table

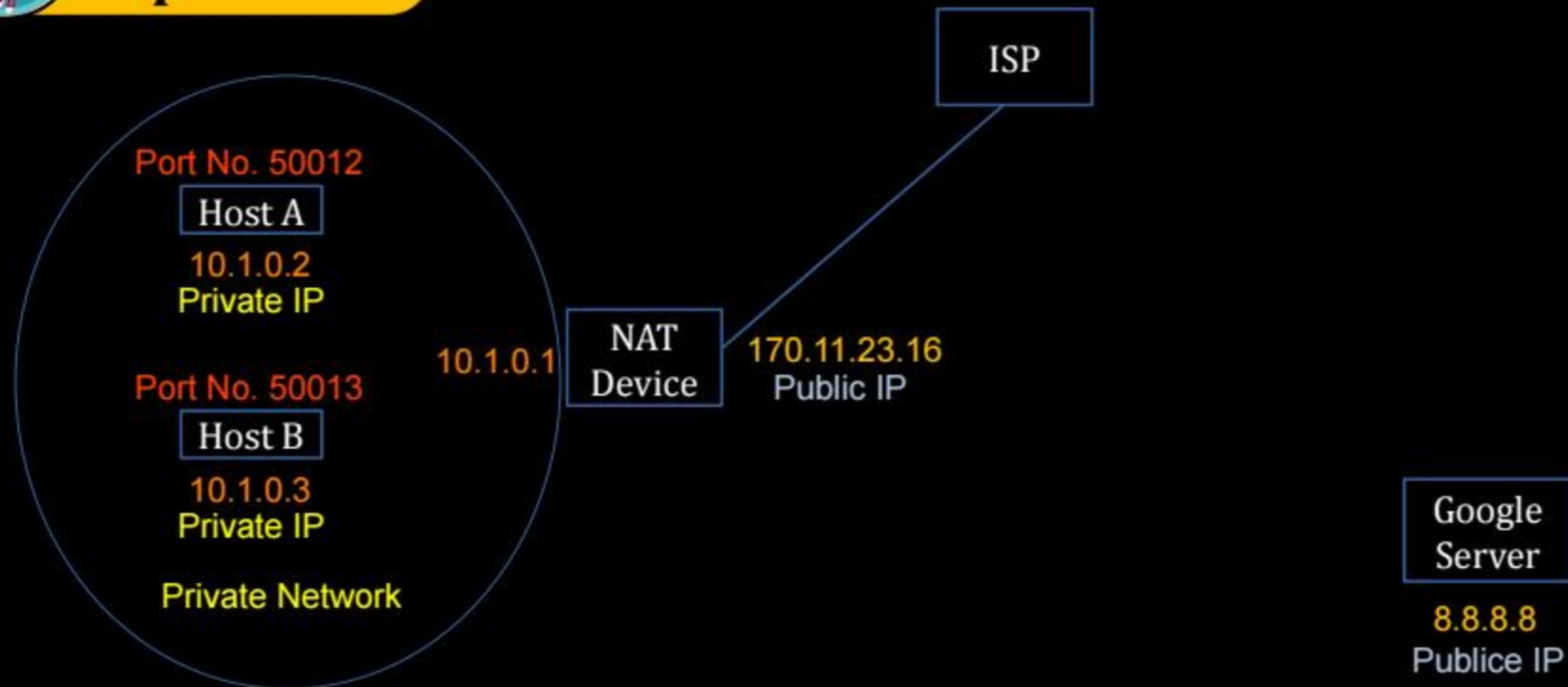


- NAT device maintains,  
NAT table for address translation of incoming datagram

Local Private IPv4 Address [Source IP Add.]	Global Public IPv4 Address [Destination IP]	Source Port Number	Modified Source Port Number
10.1.0.2	1.1.1.1	50012	50012
10.1.0.3	8.8.8.8	50013	50013



# Topic : NAT





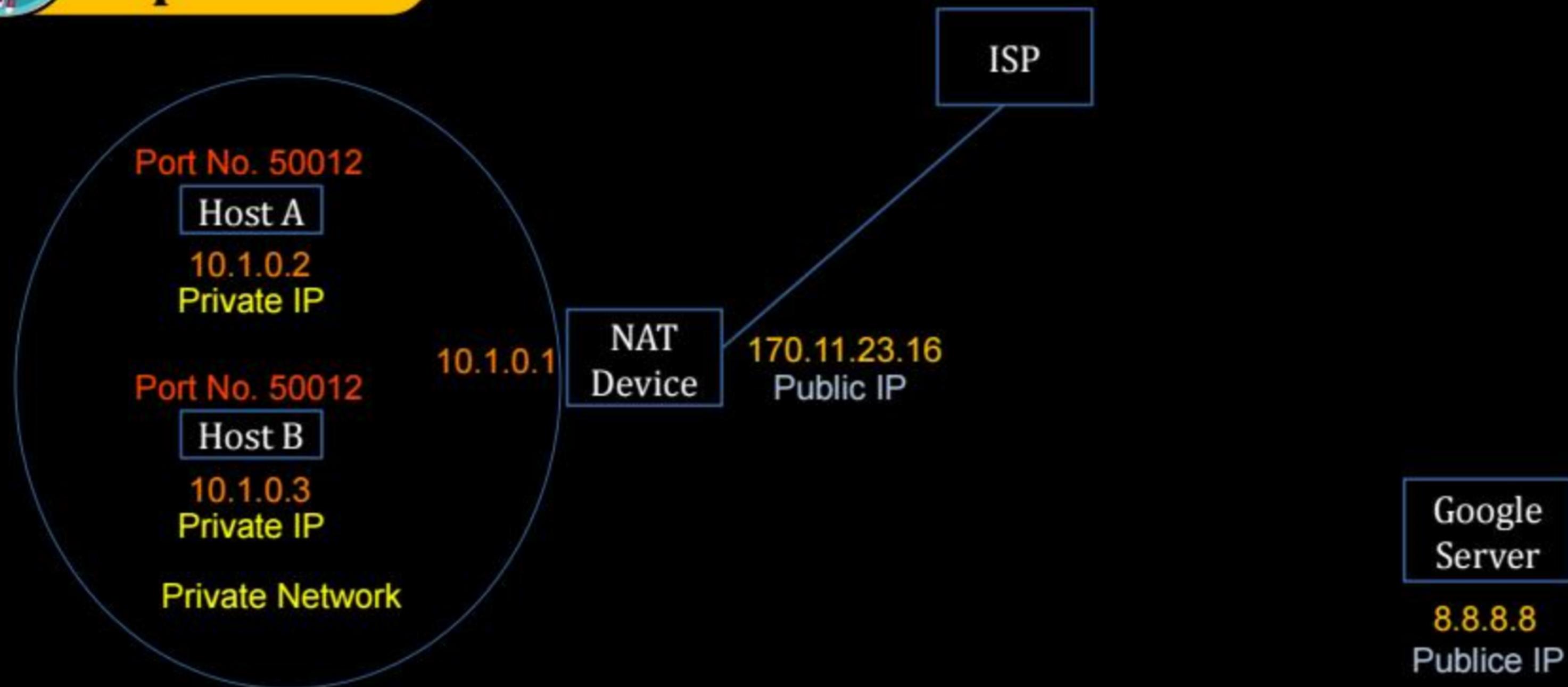
# Topic : NAT Table



Local Private IPv4 Address [Source IP Add.]	Global Public IPv4 Address [Destination IP]	Source Port Number	Modified Source Port Number
10.1.0.2	8.8.8.8	50012	50012
10.1.0.3	8.8.8.8	50013	50013



# Topic : NAT





## Topic : NAT Table



Local Private IPv4 Address [Source IP Add.]	Global Public IPv4 Address [Destination IP]	Source Port Number	Modified Source Port Number
10.1.0.2	8.8.8.8	50012	50012
10.1.0.3	8.8.8.8	50012	50020



## Topic : NAT Device



→ NAT device update address field of every outgoing and incoming datagram

→ 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

→ As per requirement, NAT device can modify  
Source Port Number field for outgoing packet  
and Destination Port Number field for incoming packet



# Topic : Private IPv4 Address

→ Network addresses for private IPv4 Networks:

10 . 0 . 0 . 0 / 8

172 . 16 . 0 . 0 / 12

192 . 168 . 0 . 0 / 16

#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?

[GATE-2024, Set-1, 1-Mark]

NAT, IISc

- (A) Source IP
- (B) Destination IP
- (C) Header Checksum
- (D) Total Length

Ans: A & C



## 2 mins Summary



Topic

ARP



Topic

NAT



Topic



THANK - YOU