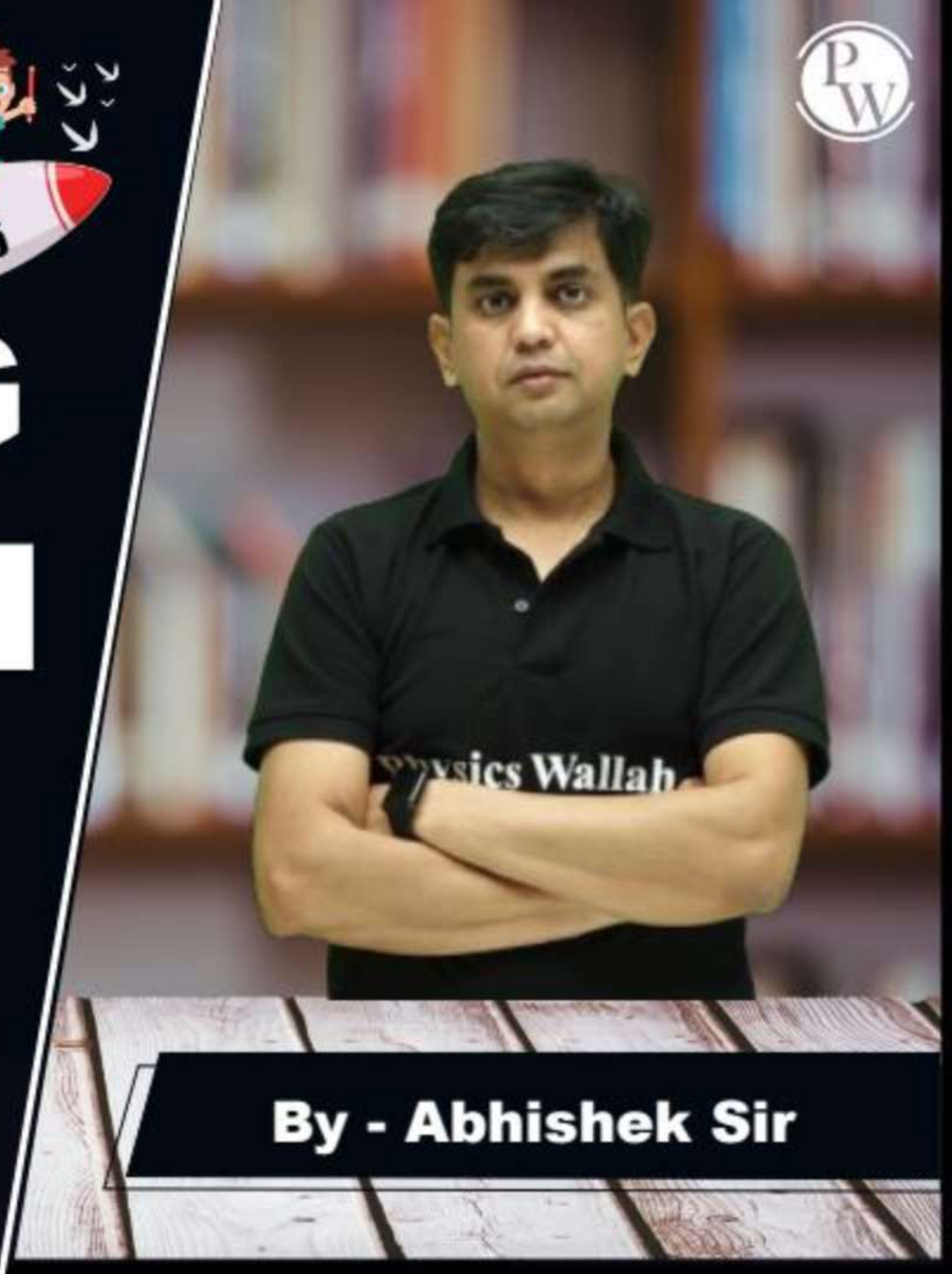
CS & IT ENGINEERING

Computer Network

Switching & Routing

Lecture No. - 01



Recap of Previous Lecture

Topic ARP

Topic NAT

Topics to be Covered

- Topic: Switching
- Topic: Circuit Switching
- Topic: Packet Switching

ABOUT ME

Hello, I'm Abhishek

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

Telegram Link : https://t.me/abhisheksirCS_PW

#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?

IISC
[GATE-2008]

(A) 192 . 168 . 1 . 67

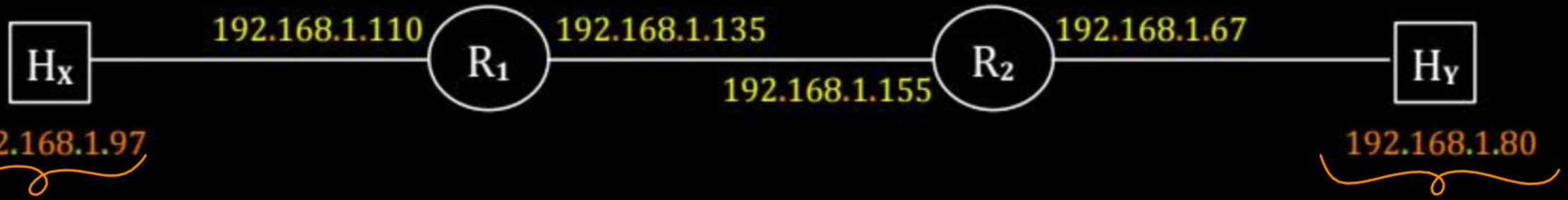
(B) 192 . 168 . 1 . 110

(C) 192 . 168 . 1 . 135

(D) 192 . 168 . 1 . 155

Ans: B

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]

(A) 1

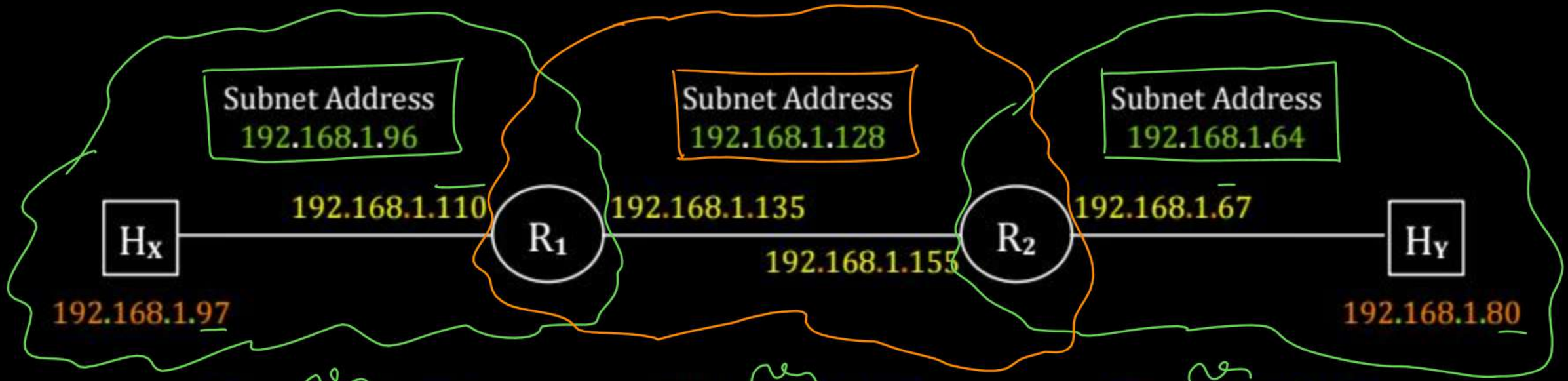
(B) 2

(C) 3

(D) 6

Ans: C

Netmask = 255 . 255 . 255 . 224 (27 bit mask)



97 = 01100001
110 = 01101110

135 = 10000111
155 = 10011011

67 = 01000011
80 = 01010000

96 = 01100000

128 = 10000000

64 = 01000000

MSQ

#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

(A) The destination IP address is the IP address of R

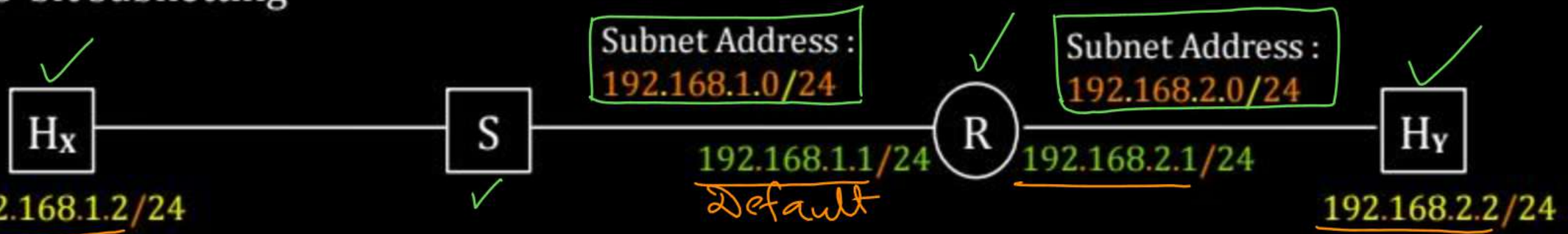
(B) The destination IP address is the IP address of Y

(C) The destination MAC address is the MAC address of S

(D) The destination MAC address is the MAC address of Y

Ans: B

Network Address : 192 . 168 . 0 . 0 / 16
With 8-bit subnetting



Source IP Address	: 192 . 168 . 1 . 2	H_X
Destination IP Address	: 192 . 168 . 2 . 2	H_Y

IP Datagram

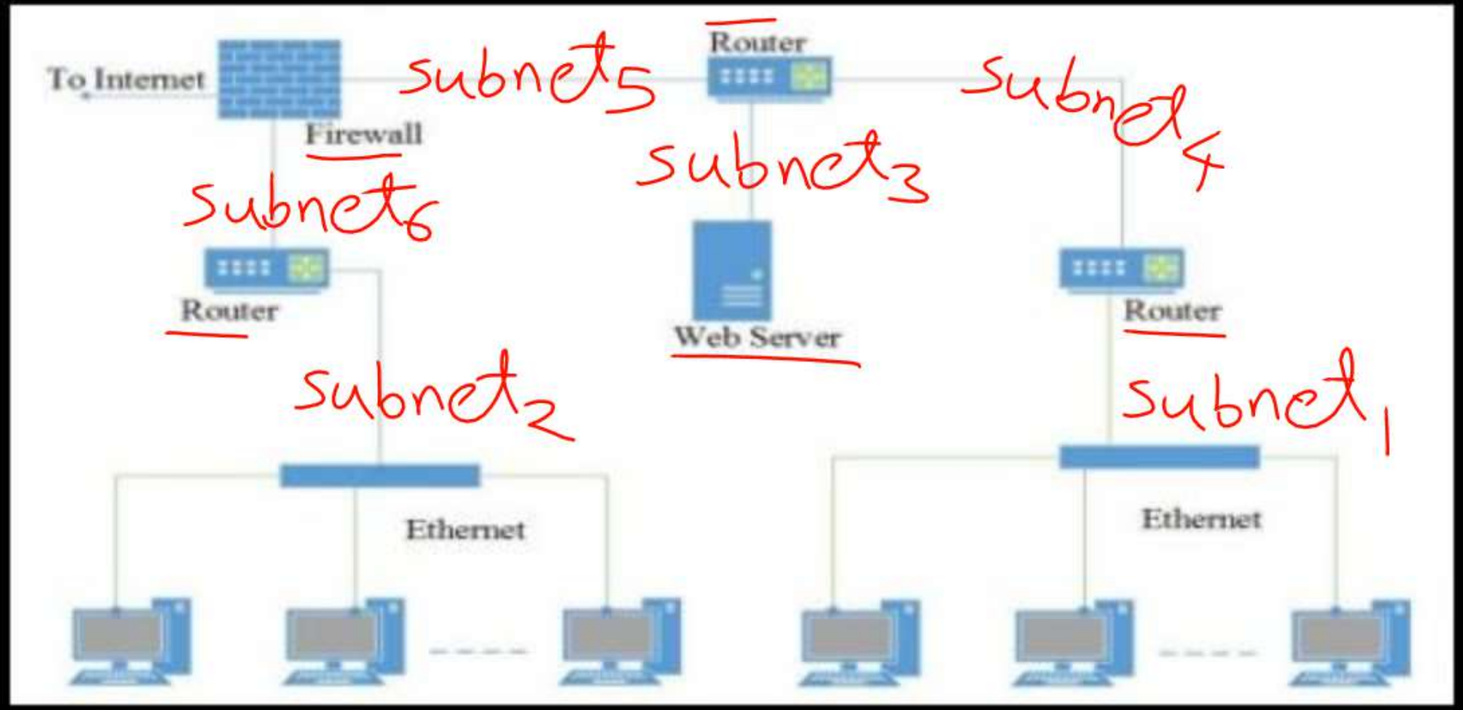
→ Host X (source host) finds destination host IP (Host Y) belongs to different subnet

→ Host X uses ARP Protocol to find MAC Address of default gateway [192 . 168 . 1 . 1]

→ Host X send frame to Router [The frame encapsulates the IP datagram]

Source MAC Address	: Host X MAC Address
Destination MAC Address	: Router MAC Address

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



Ans: C

What is the number of subnets inside the enterprise network?

[GATE-2022, 1-Mark]

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

#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?

[GATE-2019]

(A) X sends an ARP request packet with broadcast IP address in its local subnet FALSE

(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 FALSE

(C) X sends an ARP request packet with broadcast MAC address in its local subnet TRUE

(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

Ans: C

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

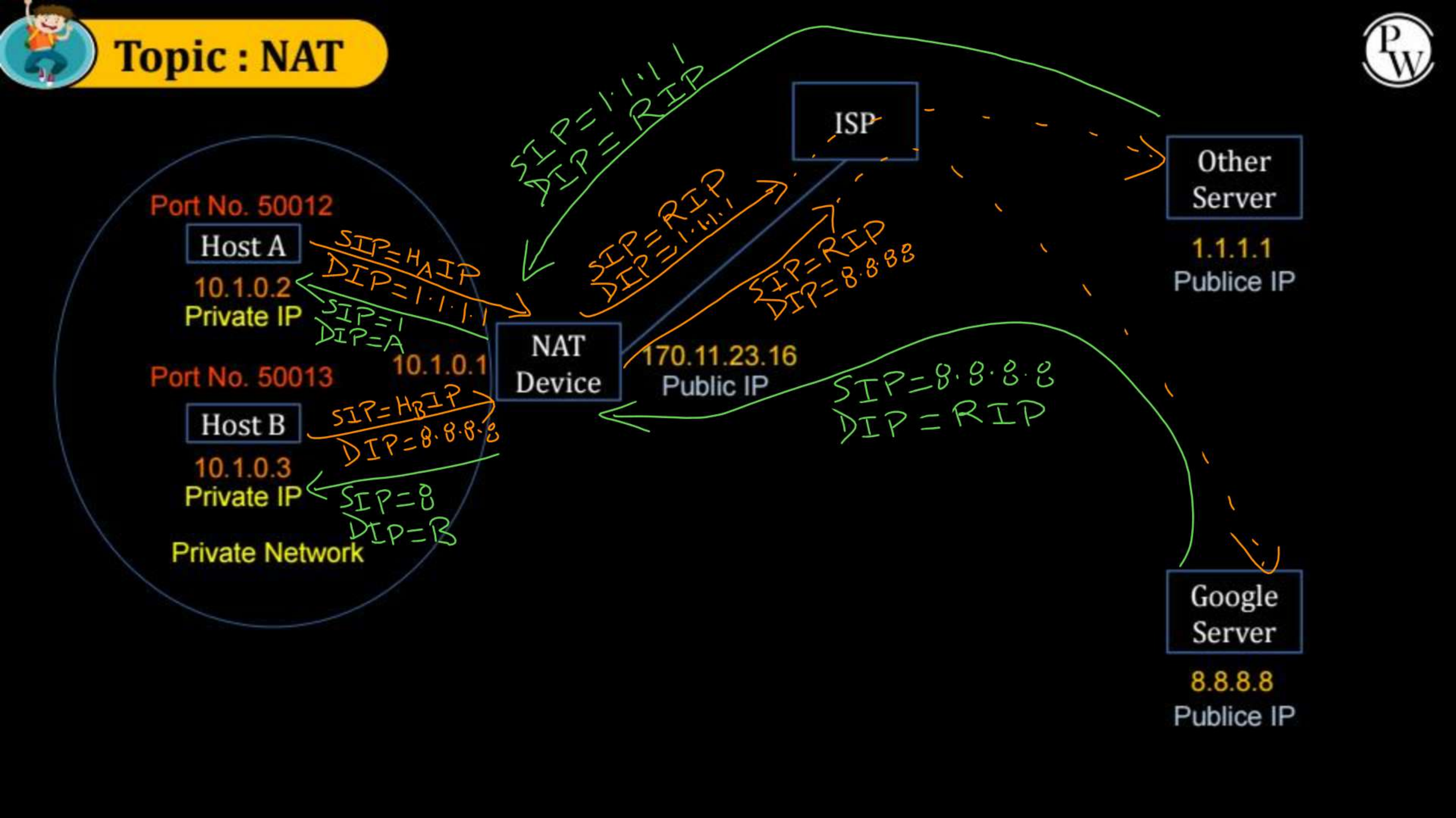
→ Every connected network is identified by unique public IPv4 Address [Assigned by ISP]

→ 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

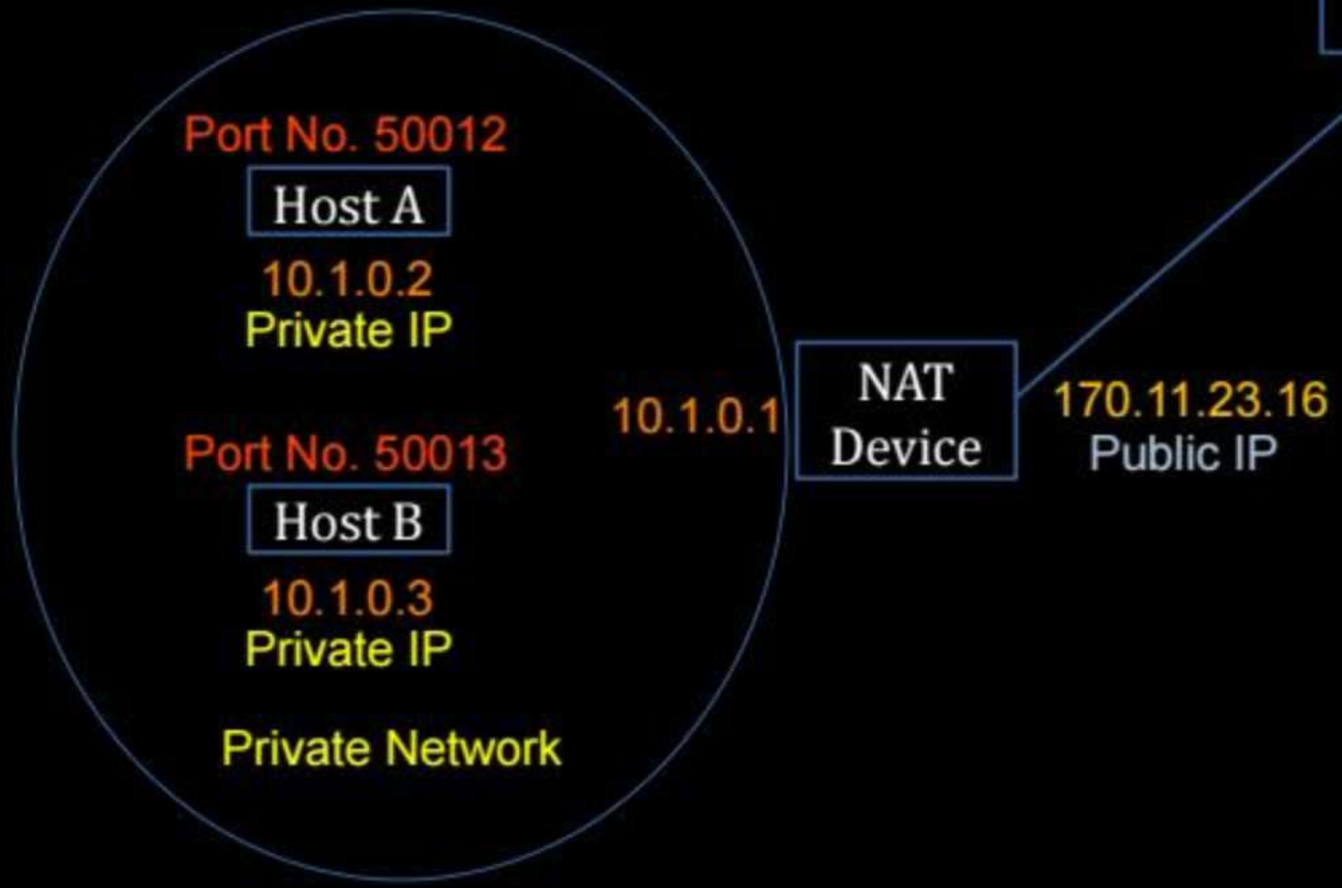

ISP
Other Server
1.1.1.1
Publice IP
Port No. 50012
Host A
10.1.0.2
Private IP
SIP=HAIP
DIP=1.1.1.1
SIP=1
DIP=A
SIP=1.1.1.1
DIP=RIP
SIP=RIP
DIP=1.1.1.1
SIP=RIP
DIP=8.8.8.8
10.1.0.1
NAT Device
170.11.23.16
Public IP
Port No. 50013
Host B
10.1.0.3
Private IP
SIP=HBIP
DIP=8.8.8.8
SIP=8
DIP=B
SIP=8.8.8.8
DIP=RIP
Private Network
Google Server
8.8.8.8
Publice IP

Topic : NAT Table

→ NAT device maintain,
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


ISP
Port No. 50012
Host A
10.1.0.2
Private IP
Port No. 50013
Host B
10.1.0.3
Private IP
Private Network
10.1.0.1
NAT
Device
170.11.23.16
Public IP
Google
Server
8.8.8.8
Publice IP

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
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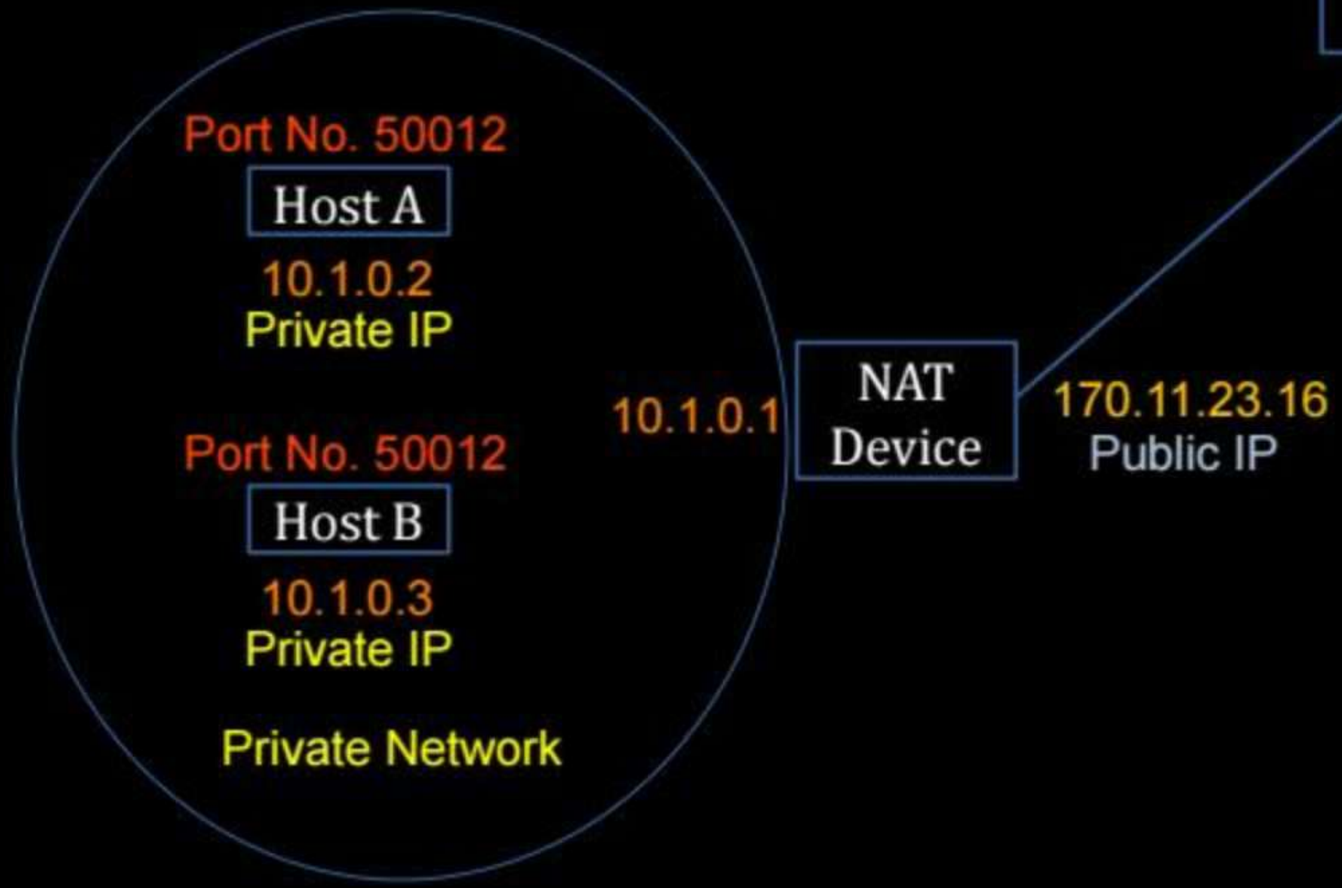
Topic : NAT


ISP
Port No. 50012
Host A
10.1.0.2
Private IP
Port No. 50012
Host B
10.1.0.3
Private IP
Private Network
10.1.0.1
NAT
Device
170.11.23.16
Public IP
Google
Server
8.8.8.8
Publice IP

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

Topic : Switching

→ Process to move data (or packets) towards destination over the network

→ Types of switching techniques :

1. Circuit Switching
2. Packet Switching
   i) Datagram Network (Default) (Internet)
   ii) Virtual Circuit

Topic : Circuit Switching

→ Establishes dedicated circuit between sender and receiver, before transmission
[Over the links of the network]

→ Phases of Circuit Switching :

1. Circuit establishment
2. Data transfer
3. Circuit disconnect

→ Example : Telephone Networks
[PSTN : Public Switched Telephone Network]

Topic : Circuit Switching

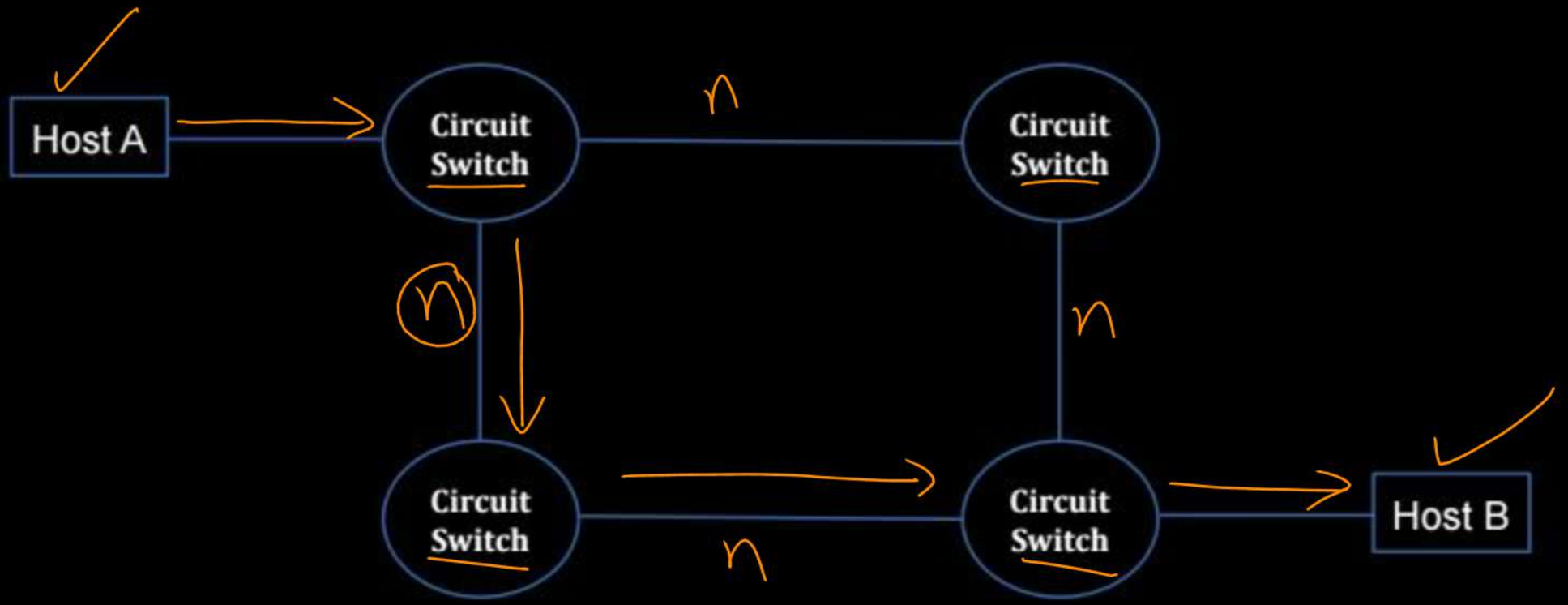
=> Circuit in a link implemented with

1. Frequency Division Multiplexing [FDM]
   - → Frequency spectrum of a link
   - → Analog circuit switching

2. Time Division Multiplexing [TDM]
   - → Time is divided into frames of fixed duration
   - → Each frame is divided into fixed number of time slots
   - → Digital circuit switching

=> Each link contains n "circuits" [TDM or FDM]

Topic : Circuit Switching



Topic : Circuit Switching

→ Inefficient utilization of network resources

→ Congestion may occur during circuit establishment

[No any congestion occur, during data transfer]

→ All data (or ~~packets~~) follow each other on reserved path (In order delivery at receiver)

[Data (or ~~packets~~) having same end-to-end delay]

→ Expensive (per min) (per sec)

→ Reliable communication (No chance of data lost) (No any Ack)

2 mins Summary

Topic Switching

Topic Circuit Switching

Topic ~~Packet Switching~~

THANK - YOU