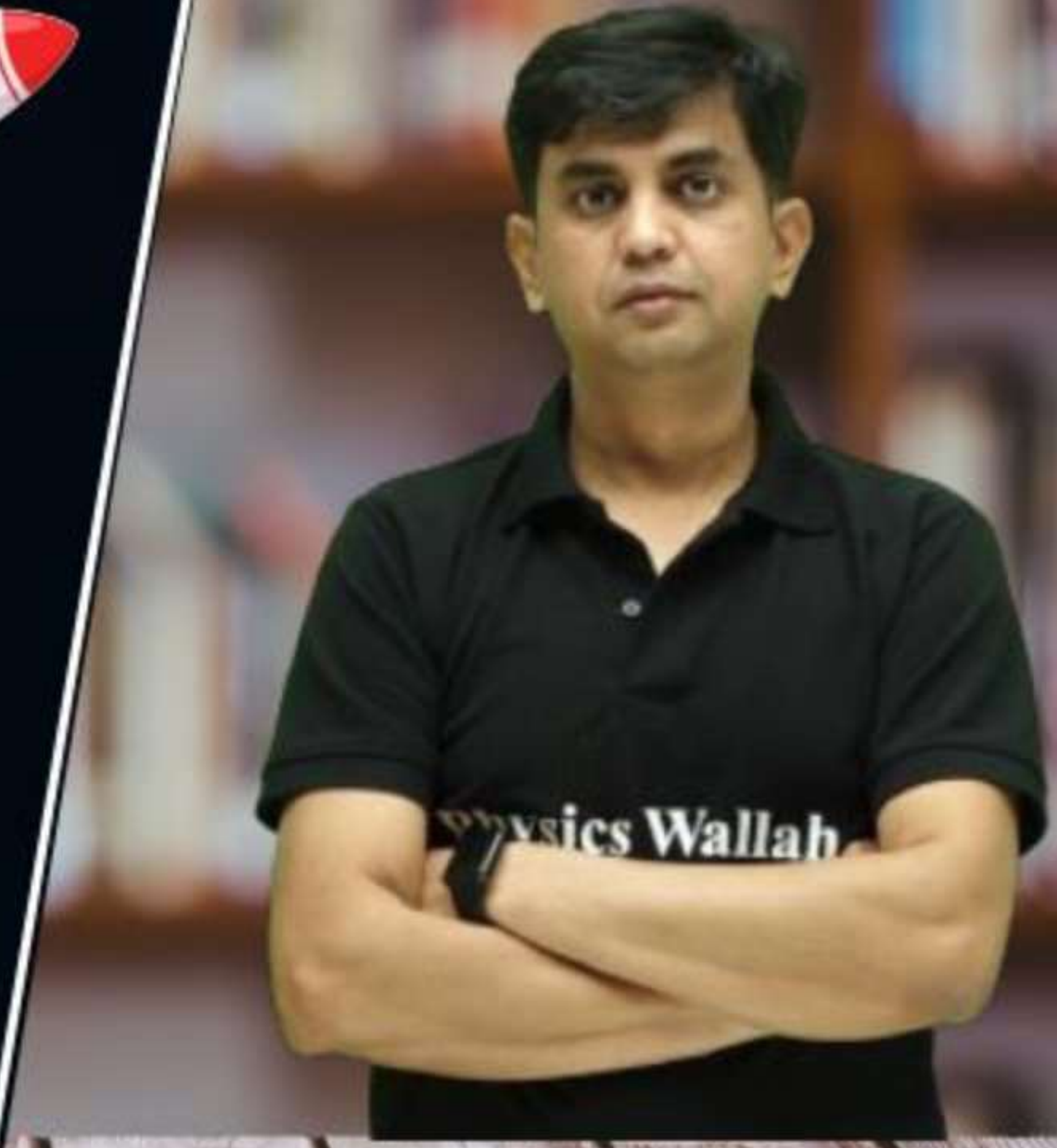
CS & IT ENGINEERING

Computer Network

Switching & Routing



Lecture No. - 02

By - Abhishek Sir

Recap of Previous Lecture

Topic Switching

Topic Circuit Switching

Topics to be Covered

- **Topic** Packet Switching
- **Topic** Virtual Circuit Switching
- **Topic** Routing

ABOUT ME

Hello, I'm Abhishek

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- 12 years of GATE CS teaching experience

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Topic : Message Switching

→ Application processes doing communication by exchanging "messages"

→ No any dedicated path required between sender and receiver [Unlike circuit switching]

→ Store and Forward

→ Entire message is transmitted as single unit

Topic : Optimal Packet Size

→ Consider negligible propagation delay

→ Transmission delay (in each link) = t_x

$$t_x = \frac{\text{Packet Size}}{\text{Bandwidth}} = \frac{(H+P)}{\text{Bandwidth}}$$

$$\text{Number of packets } (N) = \left\lceil \frac{\text{Message Size}}{\text{Payload Size}} \right\rceil = \left\lceil \frac{M}{P} \right\rceil$$

Given $\begin{cases} K = \text{Number of Links} \\ M = \text{Message Size} \\ H = \text{Packet Header Size} \end{cases}$

P = Packet Payload Size

$P = ?$

Topic : Optimal Packet Size

→ Total time required to transmit one message completely from Sender to Receiver

$$\text{Total Time (T)} = [N * t_x + t_p] + (K - 1) * [t_x + t_p]$$

$$\boxed{t_p = 0}$$

$$= \boxed{(N + K - 1) * t_x}$$

$$T = \boxed{\frac{(N + K - 1) * (H + P)}{\text{Bandwidth}}} = \boxed{\frac{\left(\frac{M}{P} + K - 1\right) * (H + P)}{\text{Bandwidth}}}$$

For what value of P, T should be minimum

$$\frac{dT}{dP} = 0$$

$$T = \frac{\left(\frac{M}{P} + K - 1\right) * (H + P)}{\text{Bandwidth}}$$

$$\frac{dT}{dP} = \left(\frac{1}{\text{Bandwidth}}\right) \frac{d}{dp}\left[\left(\frac{M}{P} + K - 1\right) * (H + P)\right] = 0$$

$$\left(\frac{1}{\text{Band}}\right)\left[\left(\frac{M}{P} + K - 1\right) * \frac{d}{dp}(H + P) + (H + P) * \frac{d}{dp}\left(\frac{M}{P} + K - 1\right)\right] = 0$$

$$\left(\frac{M}{P} + K - 1\right) * 1 + (H + P) * \left(\frac{-M}{P^2}\right) = 0$$

$$\left(\frac{M + P * (k-1)}{P}\right) = \frac{MH + PM}{P^2}$$

$$PM + P^2 * (k-1) = MH + PM$$

$$P^2 = \frac{MH}{(k-1)}$$

$$\boxed{P = \sqrt{\frac{MH}{(k-1)}}}$$

Topic : Optimal Packet Size

$$\text{Total Time } (T) = (N + K - 1) * t_x$$

$$= \frac{(N + K - 1) * (H + P)}{\text{Bandwidth}}$$

→ For what value of P, total time T should be minimum :

$$\boxed{\frac{dT}{dP} = 0}$$

$$\boxed{P = \sqrt{\frac{MH}{(K-1)}}}$$

$$\boxed{P > H}$$

$$\boxed{\text{Optimal packet size} = (H + P)}$$

[MCQ]

#Q. In a packet switching network, packets are routed from source to destination along a single path having two intermediate nodes. If the message size is 24 bytes and each packet contains a header of 3 bytes, then the optimum packet size is:

$K = 3,\ M = 24\text{ bytes},\ H = 3\text{ bytes}$

[GATE 2005]

IIT-B

(A) 4

(B) 6

(C) 7

(D) 9

$$P = \sqrt{\frac{MH}{(K-1)}} = \sqrt{\frac{24\text{ byte} * 3\text{ byte}}{(3-1)}}$$

$$= \sqrt{\frac{72(\text{byte})^2}{2}} = \sqrt{36(\text{byte})^2} = 6\text{ byte}$$

$\boxed{\text{Payload size} = P}$

$\boxed{\text{Ans: D}}$

Optimum packet size $= (H + P) = (3 + 6) = 9$ byte

$$T = \frac{(N+K-1)*(H+P)}{\text{Bandwidth}} + K*t_p$$

$$\boxed{T = \frac{(N+2)*(P+3)}{\text{Bandwidth}} + 3t_p}$$

① $(H+P) = 4$, $P = (4-3) = 1$, $N = \frac{M}{P} = \frac{24}{1} = 24$

$$T_1 = \frac{(24+2)*4}{\text{Bandwidth}} + 3t_p$$

② $T_2 = ?$

③ $T_3 = ?$

④ $(H+P) = 9$, $P = (9-3) = 6$, $N = \frac{M}{P} = \frac{24}{6} = 4$ | $T_4 = \frac{6*9}{\text{Bandwidth}} + 3t_p$

Topic : Packet Switching

→ Message is divided into smaller size packets (Datagram)
[Packets may be same or different size]

→ Store and Forward [Datagram Network]
[No any established circuit required between sender and receiver]

→ Efficent utilization of network resources
[Lead to better utilization of bandwidth resource]

→ Example : Internet

Topic : Packet Switching

→ Every packet is treated independently at every intermediate router

→ More per packet processing overhead at intermediate router

→ Congestion may occur during routing

→ Packets may follow different routing paths

→ Packets may have different end-to-end delay

Topic : Types of services

→ Based on order of delivery of data (or packets) at reciver

→ Types of network services :

1. Connection Oriented Services (In order delivery)

   [Order of delivery of data (or packets) is same as transmitter transmitted]

2. Connection Less Services

   [Data (or packets) can be delivered in any order to receiver]

Topic : Types of services

→ Circuit switching provide Connection Oriented and Reliable services
→ Packet switching provide Connection Less and Unreliable services

(No any ACK)

[Unreliable : Packets may be lost]

→ Sometimes packet switching may require reordering of packets at receiver

IP : [Packet switched Network]
[Best Effort Delivery]
Provide connection less and unreliable services

[MCQ]

#Q. Which one of the following statements is FALSE?

IIT-D

[GATE 2004]

(A) ~~Packet switching leads to better utilization of bandwidth resources than circuit switching~~ TRUE

(B) Packet switching results in less variation in delay than circuit switching FALSE

(C) ~~Packet switching requires more per-packet processing than circuit switching~~ TRUE

(D) ~~Packet switching can lead to reordering unlike in circuit switching~~ TRUE

$\boxed{\text{Ans: B}}$

Topic : Virtual Circuit Switching

→ Need to establish virtual circuit over packet switched network between sender and receiver before transmission

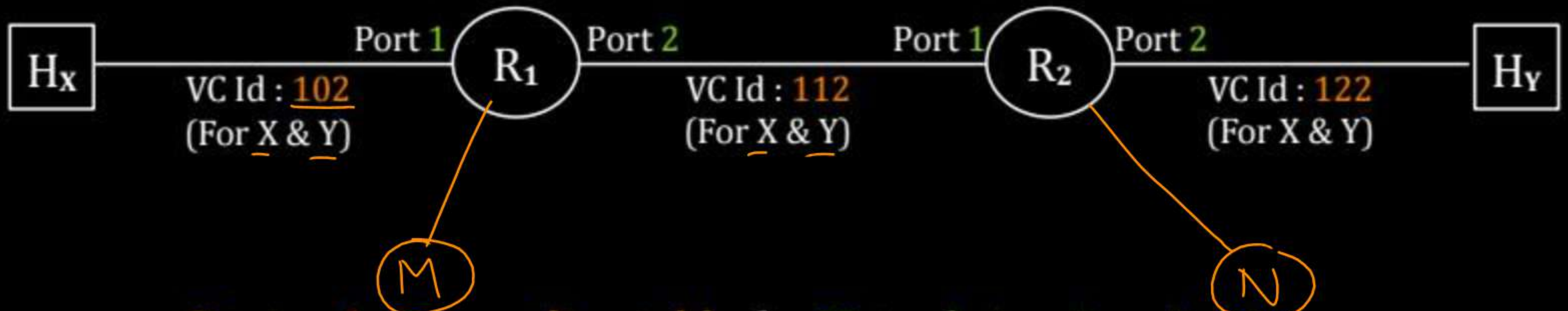
→ Virtual Circuit consists :

1. Path : Series of links and routers, between sender and receiver
2. VC Id : One number for each link along the path
3. Entries in forwarding table in each router along the path

→ Each packet carry VC Id (virtual circuit number) in packet header [Moving along the path from sender to receiver, no any IP Address]

→ VC Id in packet header, updated by each intermediate router along the path

Topic : Virtual Circuit Switching



Router 1, Forwarding table for Virtual circuit switching

Input Port No.	Input VC Id	Output Port No.	Output VC Id
1	102	2	112
2	112	1	102

Topic : Virtual Circuit Switching

→ 3 phase in virtual circuit switching :

1. VC setup : Call request and call accept packets
    - → Transport layer specify receiver's IP Address
    - → Network layer determines the path between sender and receiver
    - → Also determine VC Id for each link along the path
    - → Adds an entry in the forwarding table in each router

2. Data Transfer : One number for each link along the path

3. VC teardown :
    - → Sender (or receiver) initiate call termination
    - → Update the forwarding table in each router along the path

Topic : Virtual Circuit Switching

→ Entire routing path of packets is determined before transmission
[Entire routing path is fixed for duration of virtual circuit]

→ Every packets follow each other on predefined path

→ Packets may have different end-to-end delay

→ Connection Oriented Packet Switching

→ Congestion may occur during routing

Topic : Forwarding

Data Plane :

-> Determine how datagram is forwarded
[Forwarding table]

-> Move packet from a router's input link to appropriate router's output link

Topic : Routing

Control Plane :

-> Determine how datagram routed among routers
[Routing tables of each router's over the path]

-> Determine route taken by packets from source to destination
[Routing algorithms]

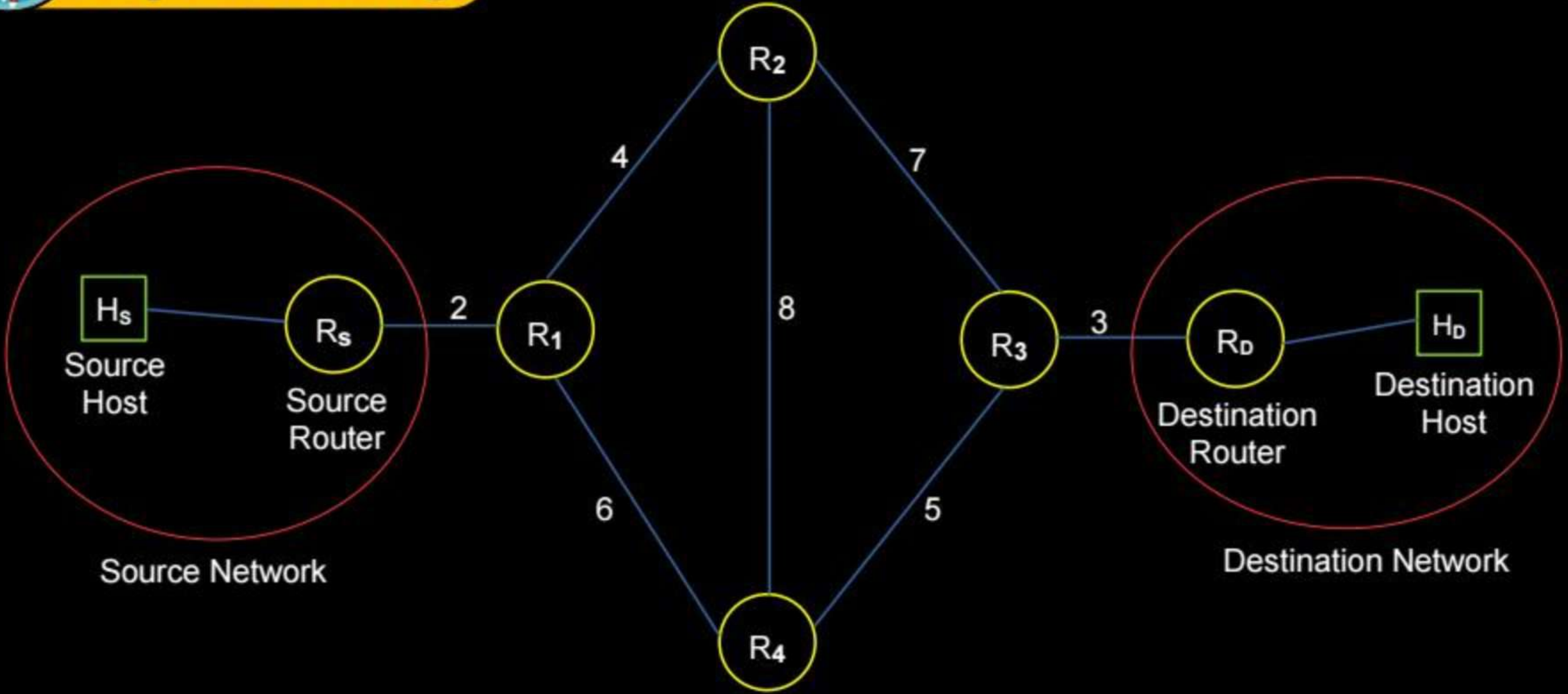
Topic : Routing

→ Identify optimal (best) path between Source and Destination.

→ Types of Routing :

1. Static Routing
   → Non-adaptive Routing
2. Dynamic Routing
   → Adaptive Routing
   → Load sensitive or Load insensitive

Topic : Routing



2 mins Summary

Topic Packet Switching

Topic Virtual Circuit Switching

Topic Routing

THANK - YOU