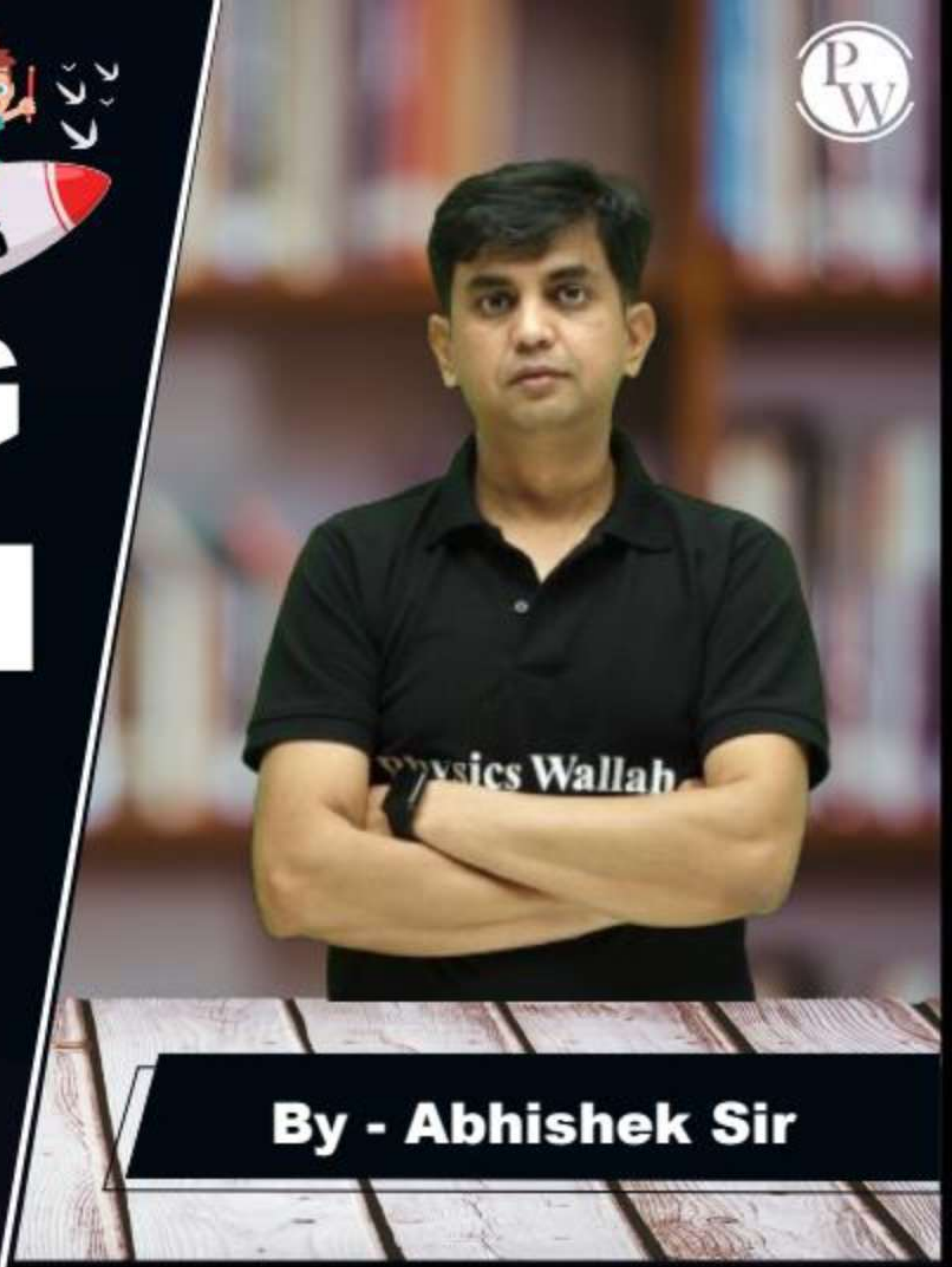
CS & IT ENGINEERING

Computer Network

Switching & Routing

Lecture No. - 03



By - Abhishek Sir

Recap of Previous Lecture

Topic Packet Switching

Topic Virtual Circuit Switching

Topic Routing

Topics to be Covered

Topic Routing

Topic Link State Routing

Topic Distance Vector Routing

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

@ABHISHEKSIRCS_PW

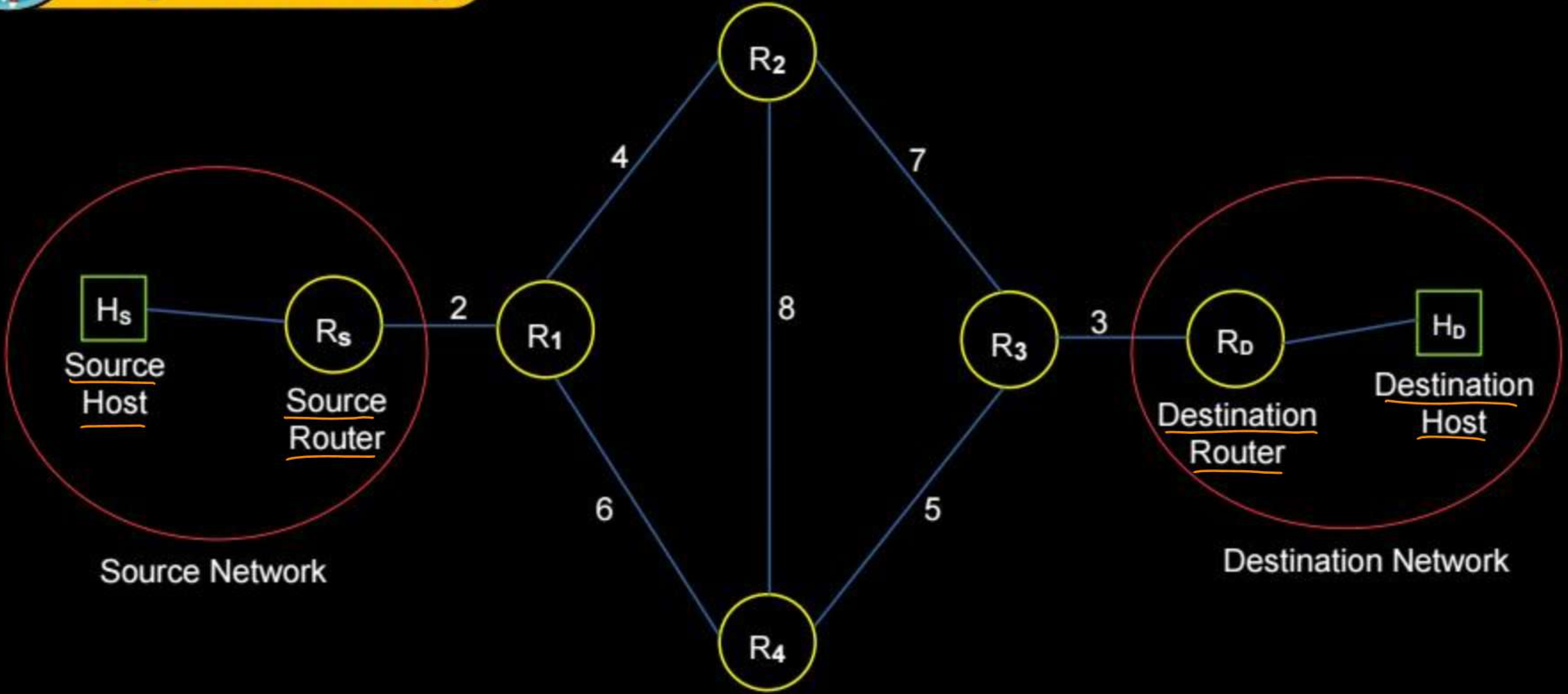
Topic : Routing

→ 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



Topic : Link Cost

→ Metric to compare link :

1. Distance (Hop Count)
2. Delay
3. Bandwidth

$\text{Cost} \propto \text{Distance}$

$\text{Cost} \propto \text{Delay}$

$\text{Cost} \propto \frac{1}{\text{Bandwidth}}$

Topic : Static Routing

→ Non-adaptive Routing

→ Types of Static Routing :

1. Shortest Path Algorithm ⟹ Input
   1. Graph [Matrix/List]
   2. Source
2. Flooding
   → Broadcast

Topic : Dynamic Routing

→ Adaptive Routing

→ Types of Routing Algorithm:

1. Dijkstra's Link State Routing Algorithm
2. Bellman Ford Distance Vector Routing Algorithm

Topic : Routing Protocols

Two categories :

1. Interior Gateway Protocol (IGP) [With in ISP(A.S.)]

    1.1 Routing Information Protocol (RIP)

    → Distance Vector Routing (RIP-DV)

    1.2 Open Shortest Path First (OSPF)

    → Link State Routing [OSPF-LS]

2. Exterior Gateway Protocol (EGP) [Between ISPs (A.S.)]

    2.1 Border Gateway Protocol (BGP)

    → Path Vector Routing

[MCQ]

#Q. Which one of the following is TRUE about interior Gateway routing protocols - Routing Information Protocol (RIP) and Open Shortest Path First (OSPF) ?

[GATE-2014, Set-2, 1-Mark]

RIP-DV OSPF-LS

(A) RIP uses distance vector routing and OSPF uses link state routing

(B) OSPF uses distance vector routing and RIP uses link state routing

(C) Both RIP and OSPF use link state routing

(D) Both RIP and OSPF use distance vector routing

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

Topic : Routing

→ Routing Algorithm Classification :

1. Decentralized Routing : [Distributed Routing]
2. Global Routing : [Centralized Routing]

Topic : Decentralized Routing

→ Distributed Routing Algorithm

→ Iterative process of computation

→ Exchange of information with neighbors

→ Routers initially only know link costs to attached neighbors

→ "Distance Vector" Routing Algorithm

Topic : Global Routing

→ Centralized Routing Algorithm

→ All routers have complete topology link cost information

→ "Link State" Routing Algorithm

Topic : Link State Routing

→ Centralized Routing Algorithm

→ Link State Routing is divided into three steps :

1. Maintain Link State information
2. Link State broadcast
3. Share updated Link State information → make algo. adaptive

Topic : Link State Routing

1. Maintain Link State information

→ Every router maintain separate "Link State" information

→ Maintain information about adjacent link only [Adjacent (neighbor) routers only]

OSPF protocol in every Router

i) Link state info construct

ii) Pass this LS info to IP

Source IP Add. = Own IP Add.

Dest. IP Add. = Class D Special IP Add. (Broadcast)

OSPF → IP

Topic : Link State Routing

2. Link State broadcast

→ Every router flood (broadcast) its "Link State" information [To all other routers in the network]

→ Every router have "Link State" information of all other routers [Complete information about the network topology]

→ Every router construct "Adjacency Matrix" or "Adjacency List"

→ Every router execute "Dijkstra's Algorithm" locally [To find optimal distance and path to all other routers]

Topic : Link State Routing

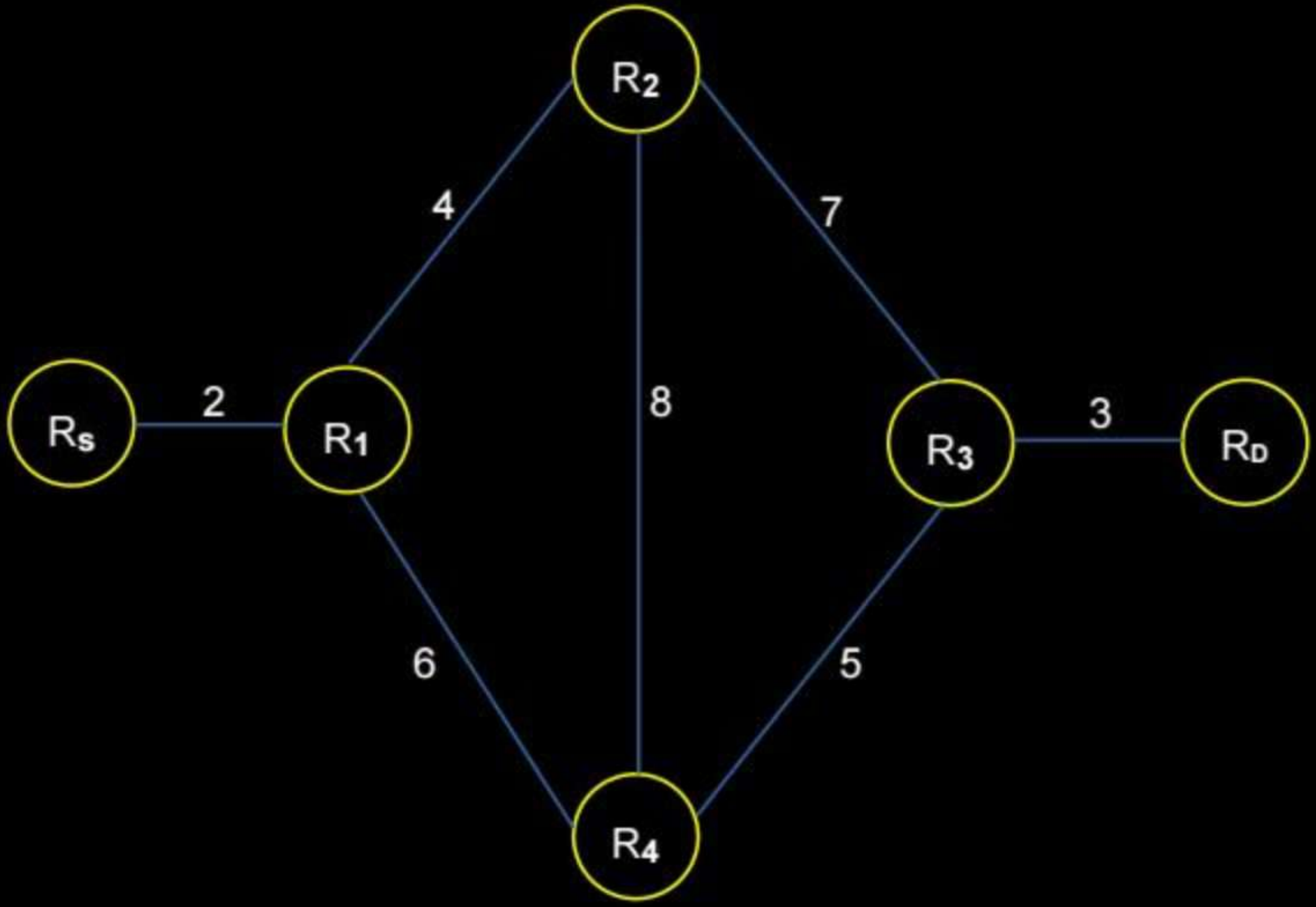
3. Share updated Link State information

→ Whenever changes occur in the network topology,
[Relevant routers update their "Link State" information accordingly]

→ Only those routers broadcast their updated "Link State" information
[To all other routers in the network]

→ Whenever a router receive any updated "Link State" information,
it construct new "Adjacency Matrix / List" accordingly and
re-execute "Dijkstra's Algorithm" locally

Topic : Link State Routing



Topic : Link State Routing

R_S Link State Info	
R_1	2

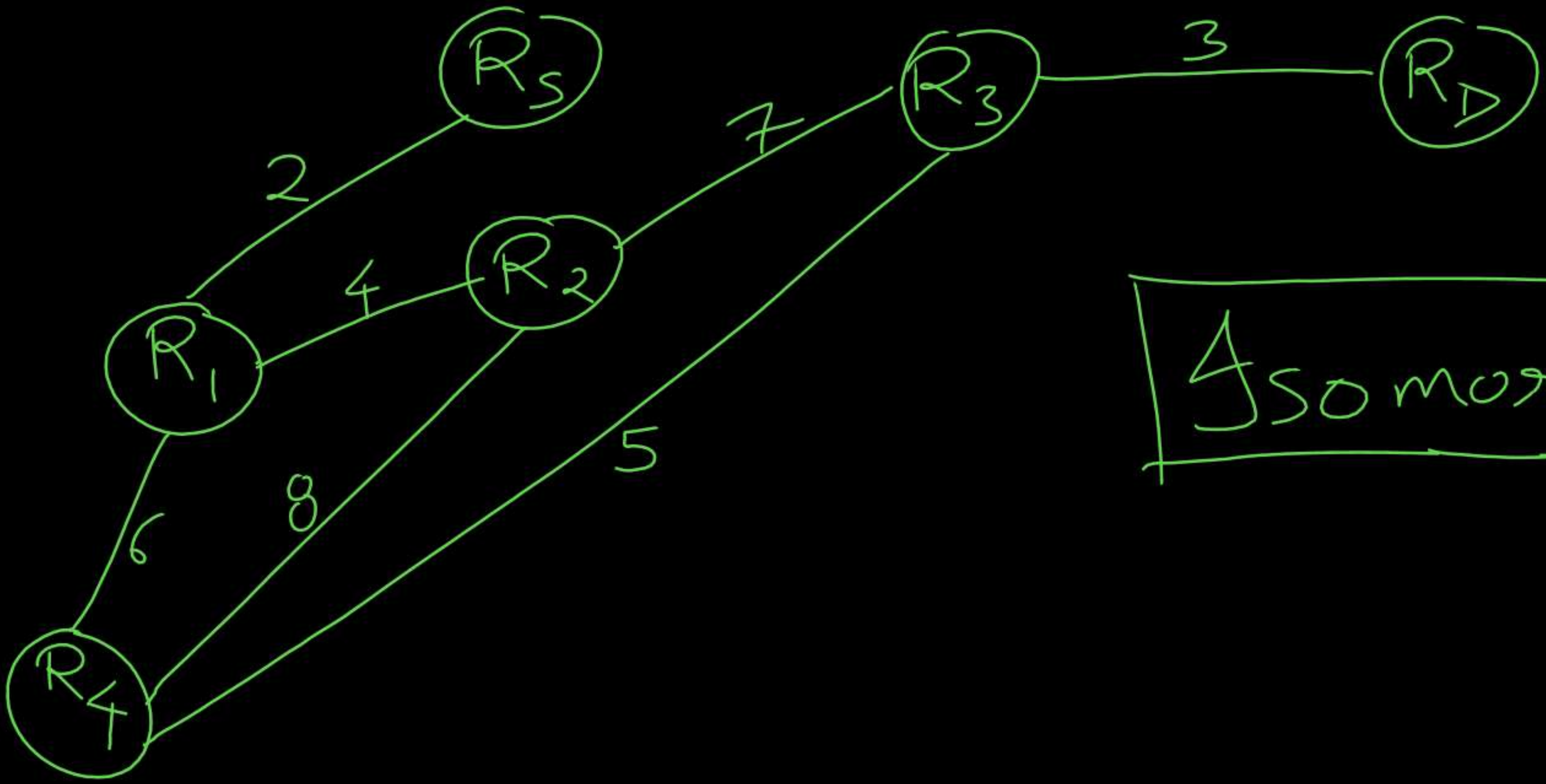
R_D Link State Info	
R_3	3

R_1 Link State Info	
R_S	2
R_2	4
R_4	6

R_4 Link State Info	
R_1	6
R_2	8
R_3	5

R_2 Link State Info	
R_1	4
R_3	7
R_4	8

R_3 Link State Info	
R_D	3
R_2	7
R_4	5



$\boxed{\text{Isomorphic}}$

Topic : Dijkstra's Algorithm

→ Single Source Shortest Path Algorithm

→ Dijkstra's Algorithm is divided into two steps :

1. Initialization
2. Iterative distance calculation

Topic : Dijkstra's Algorithm

Graph
[Adjacency Matrix or List]

Source

→ **Dijkstra Algorithm** → Shortest path to all other nodes

Forwarding Table

Dest.	Next Hop

Source = R_1

Dest.	cost	Next Hop
R_1	0	R_1
R_2		
⋮		
R_5		
R_{10}		

Topic : Dijkstra's Algorithm

Dijkstra's Algorithm time complexity (per node/router)

→ Number of nodes = n

→ Total n iteration

→ Total number of comparisons = $O(n^2)$

Topic : Link State Routing

Message Complexity :

→ Number of nodes = n

→ Each router must broadcast its Link State information to all other router

→ Each router's message crosses O(n) links

→ Overall message complexity = $O(n^2)$

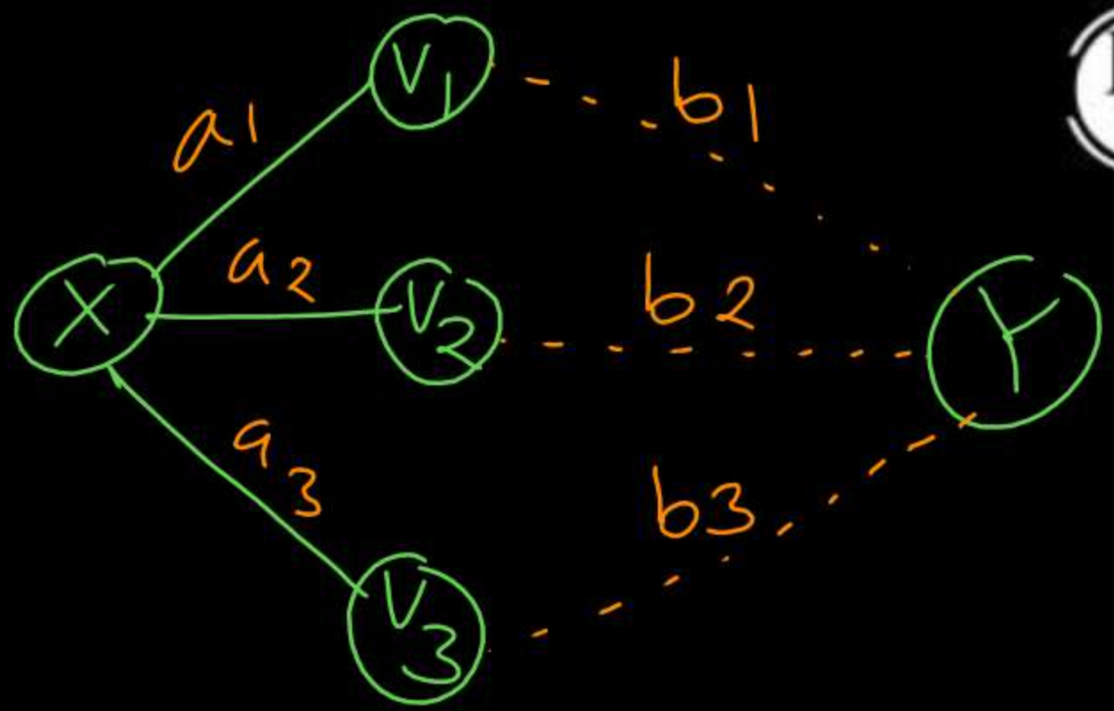
Topic : Link State Routing

→ High number of packets per network (Disadv.)

→ Adapt network topology very fast (Adv.)

Topic : Distance Vector Routing

→ Based on Bellman-Ford equation
[Dynamic programming]



→ Bellman-Ford equation

Let $D_x(Y)$: Cost of the least-cost path from X to Y

$$\boxed{D_x(y) = \min_V \{ C(X, V) + D_V(Y) \}}$$

→ Minimum taken over all neighbors V of X

$C(X, V)$: Direct cost of link from X to V

$D_V(Y)$: V's estimated least-cost path cost to Y

$$D_X(Y) = \min\left[\{C(X,V_1)+D_{V_1}(Y)\}, \{C(X,V_2)+D_{V_2}(Y)\}, \{C(X,V_3)+D_{V_3}(Y)\} \right]$$

$$= \min[a_1+b_1, a_2+b_2, a_3+b_3]$$

Topic : Distance Vector Routing

→ Each router maintain separate "Distance Vector" estimate
[Best known minimum distance to all other routers]

→ Each router sends their own "Distance Vector" estimate to their neighbor routers only

→ When a router receives new "Distance Vector" estimate from any neighbor, It update its own "Distance Vector" using Bellman-Ford equation

2 mins Summary

Topic Routing

Topic Link State Routing

Topic Distance Vector Routing

THANK - YOU