Unicast and Multicast Routing

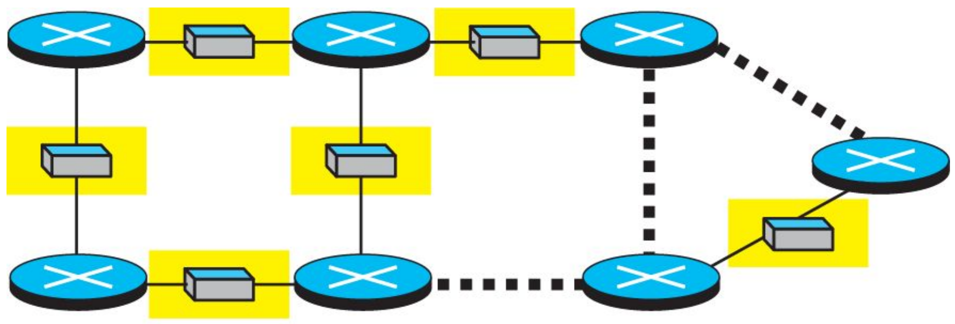
Topics of Discussion

In this session we will learn the following

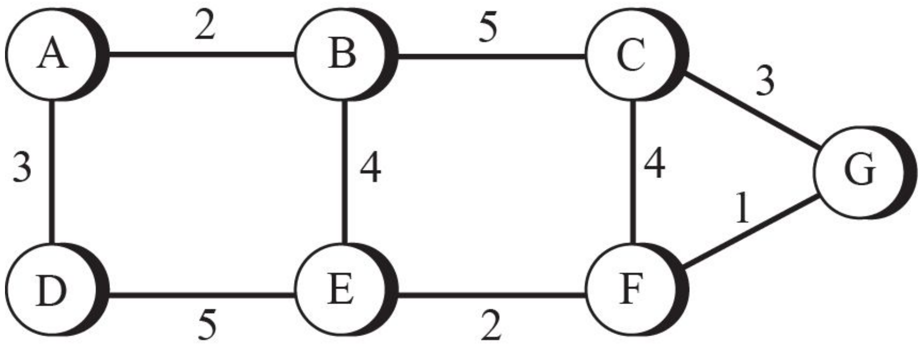
- ✔ Routing Concept on Internet
- ✔ Distance Vector and Link State Protocols
- ✔ RIP and OSPF protocols
- ✔ Unicast routing
- ✔ Multicast routing

Routing Concept on Internet

- An internet is modeled as a weighted graph.
- One of the ways to interpret the best route from the source router to the destination router is to find the least cost between the two.
- In other words, the source router chooses a route to the destination router in such a way that the total cost for the route is the least cost among all possible routes.

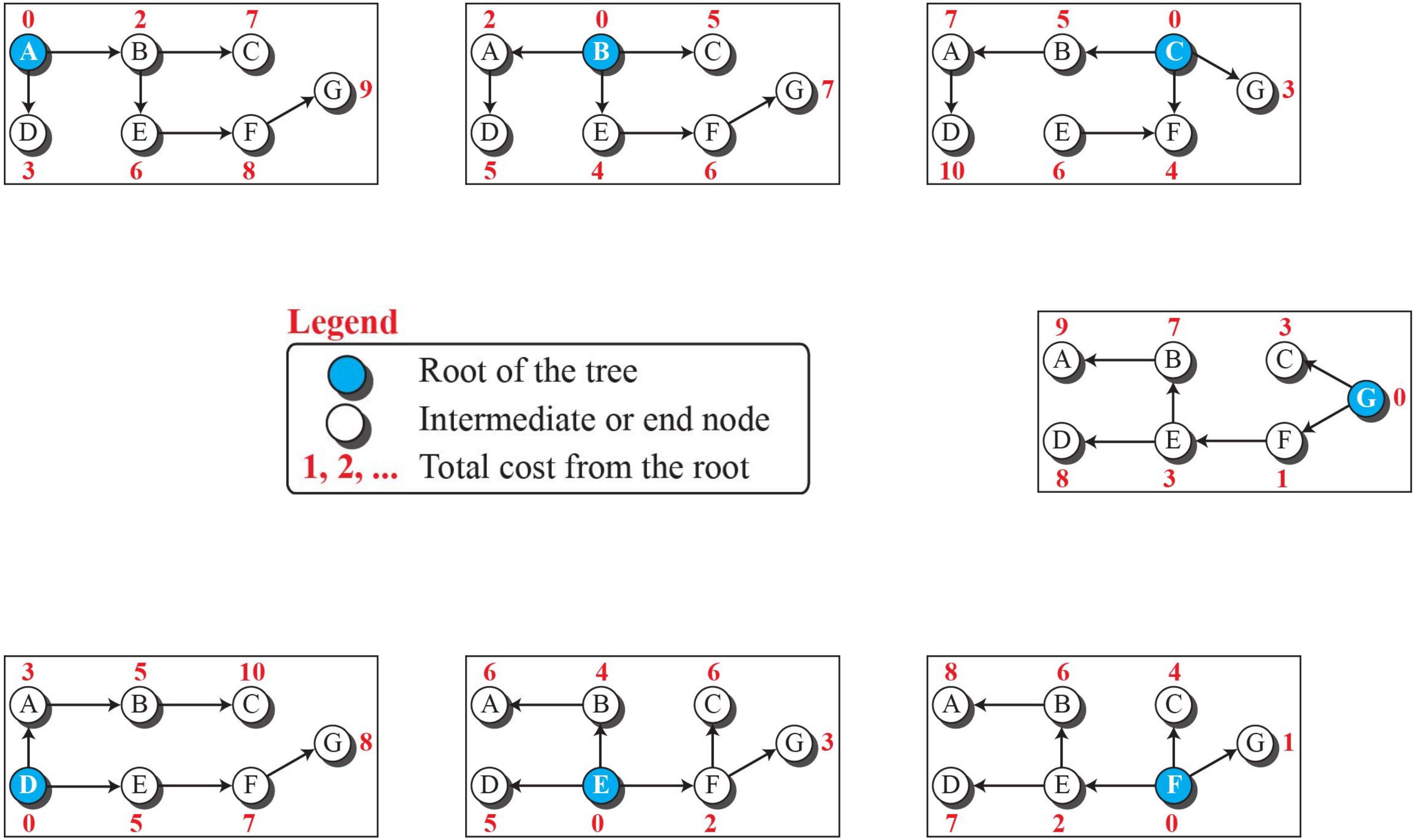


a. An internet



b. The weighted graph

Figure 1: Least-cost trees for nodes in the internet



Routing Algorithms

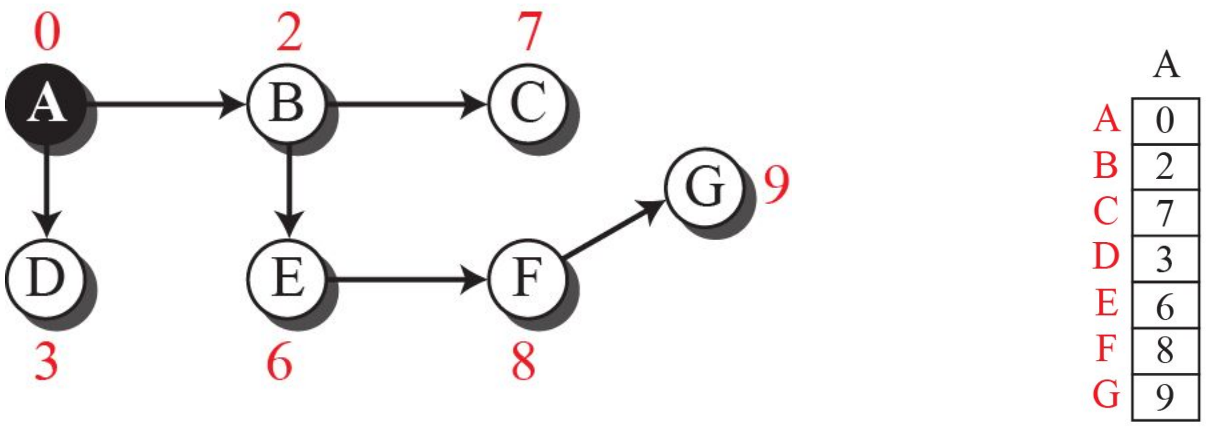
The routing methods differs in the way they interpret the least cost and the way they create the least-cost tree for each node. In this section, we discuss the common algorithms.

Distance Vector Routing

•The distance-vector (DV) routing uses weights to find the best route.

•In distance-vector routing, the first thing **each node creates is its own least-cost tree** with the rudimentary information it has about its immediate neighbors.

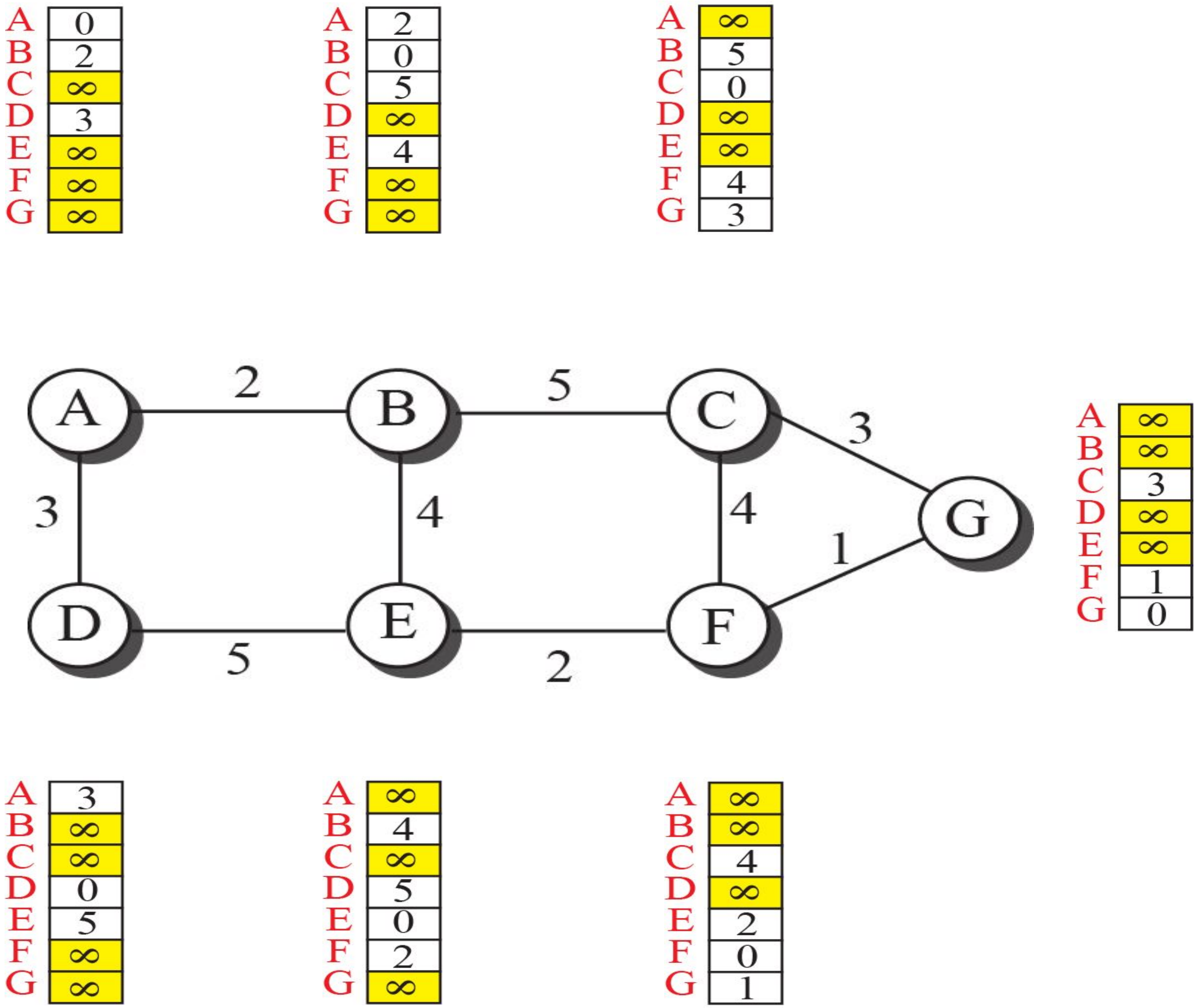
•The **incomplete trees are exchanged** between immediate neighbors to make the trees more and more complete and to represent the whole internet.



a. Tree for node A

b. Distance vector for node A

Example 1: Distance vector for an Internet, Step 1



Example 1.1: Updating Distance vectors, Step 2

	New B	Old B	A
A	2	2	0
B	0	0	2
C	5	5	∞
D	**5**	∞	3
E	4	4	∞
F	∞	∞	∞
G	∞	∞	∞

B[ ] = min (B[ ] , 2 + A[ ])

a. First event: B receives a copy of A's vector.

Note:
X[ ]: the whole vector

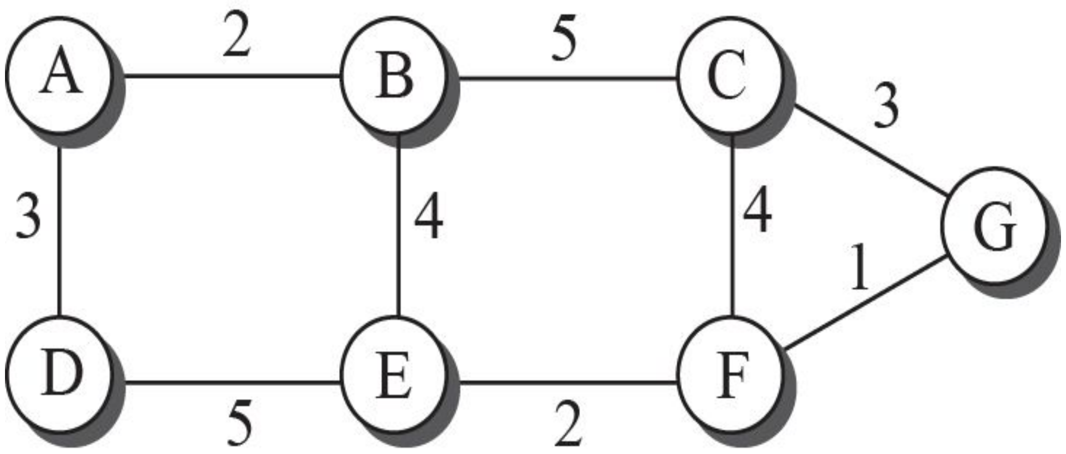
	New B	Old B	E
A	2	2	∞
B	0	0	4
C	5	5	∞
D	5	5	5
E	4	4	0
F	**6**	∞	2
G	∞	∞	∞

B[ ] = min (B[ ] , 4 + E[ ])

b. Second event: B receives a copy of E's vector.

Link State Routing

- This method uses the term **link-state** to define the characteristic of a **link (an edge)** that represents a network in the internet.
- In this algorithm the **cost associated with an edge** defines the state of the link.
- Links with lower costs are preferred to links with higher costs; if the cost of a link is infinity, it means that the link does not exist or has been broken.



a. The weighted graph

	A	B	C	D	E	F	G
A	0	2	∞	3	∞	∞	∞
B	2	0	5	∞	4	∞	∞
C	∞	5	0	∞	∞	4	3
D	3	∞	∞	0	5	∞	∞
E	∞	4	∞	5	0	2	∞
F	∞	∞	4	∞	2	0	1
G	∞	∞	3	∞	∞	1	0

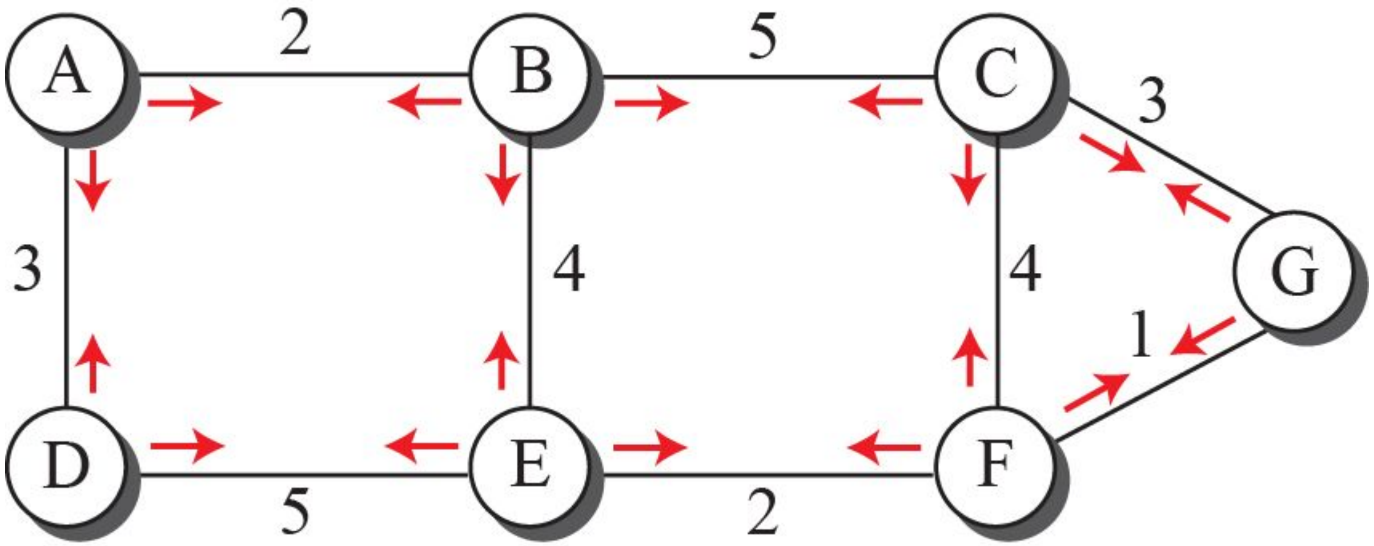
b. Link state database

Example 2: Link State setup for a network

Node	Cost
B	2
D	3

Node	Cost
A	2
C	5
E	4

Node	Cost
B	5
F	4
G	3



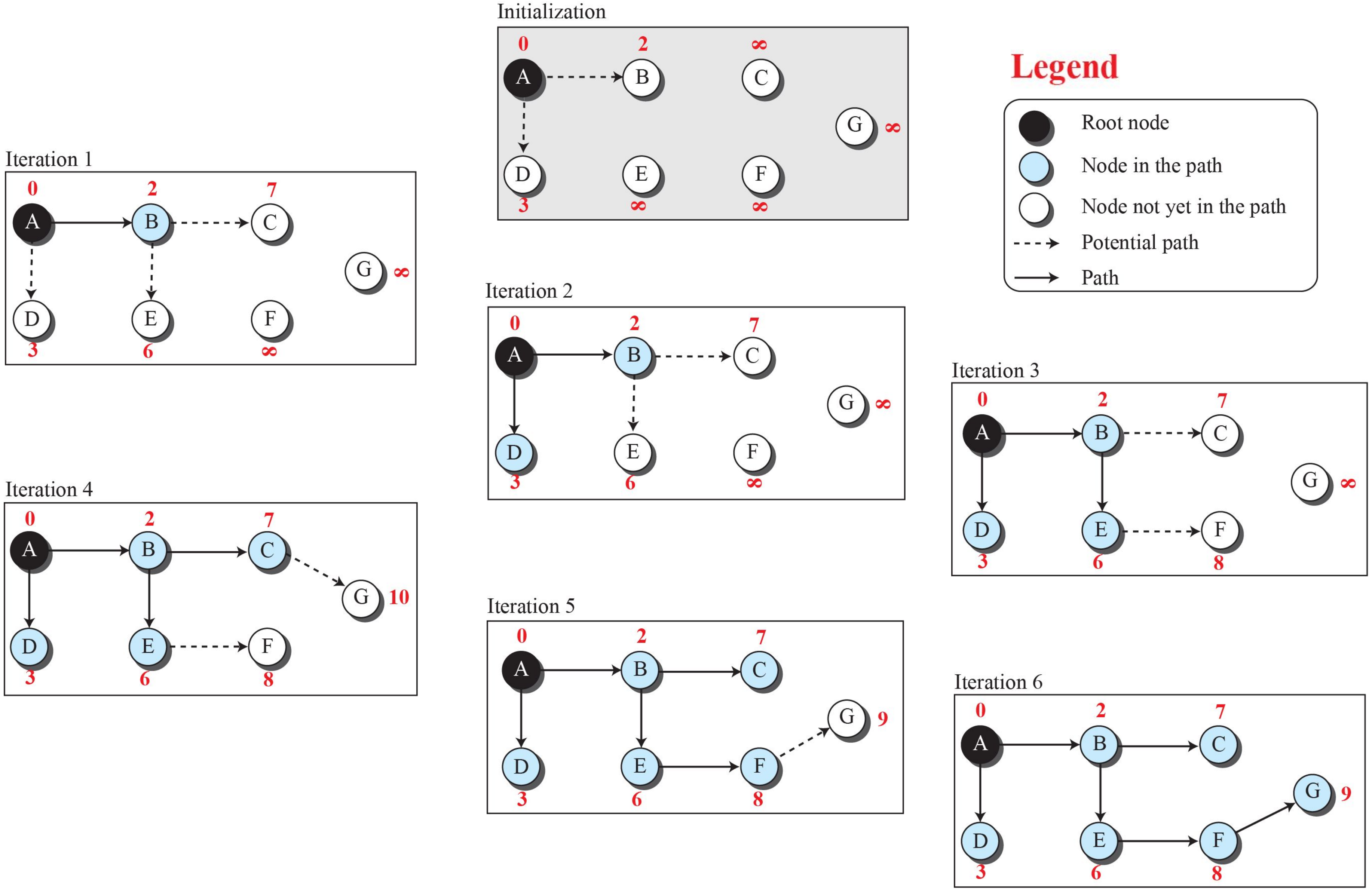
Node	Cost
C	3
F	1

Node	Cost
A	3
E	5

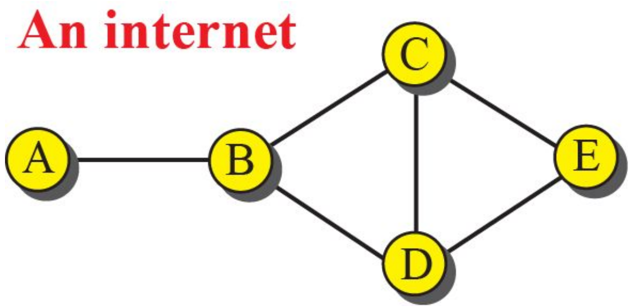
Node	Cost
B	4
D	5
E	2

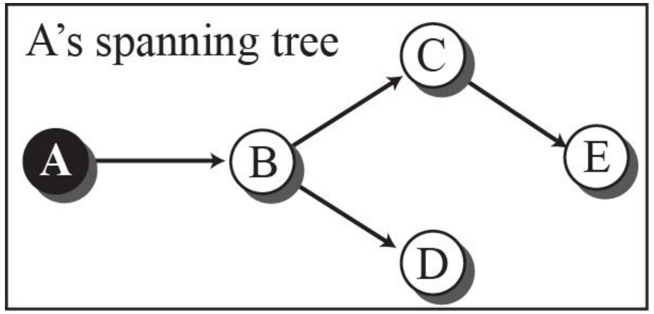
Node	Cost
C	4
E	2
G	1

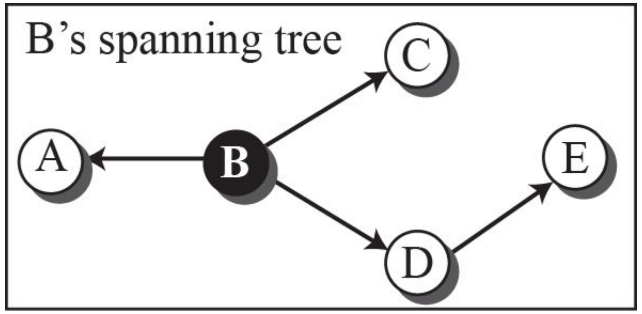
Example 3: Finding Least cost tree (Dijkstra Algorithm)

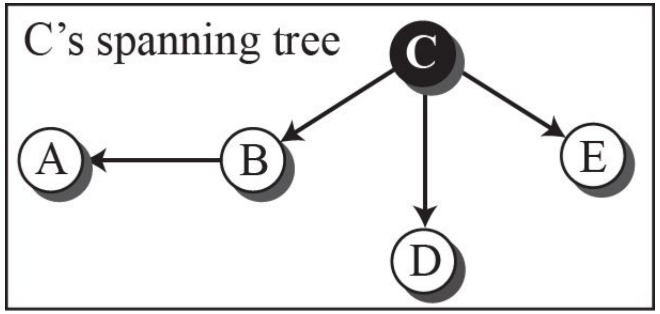


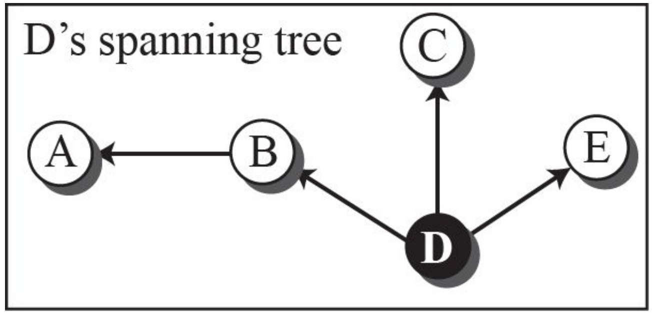
Example 4: Creating Spanning Tree

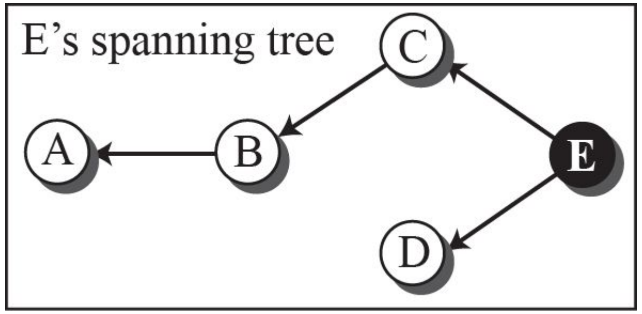










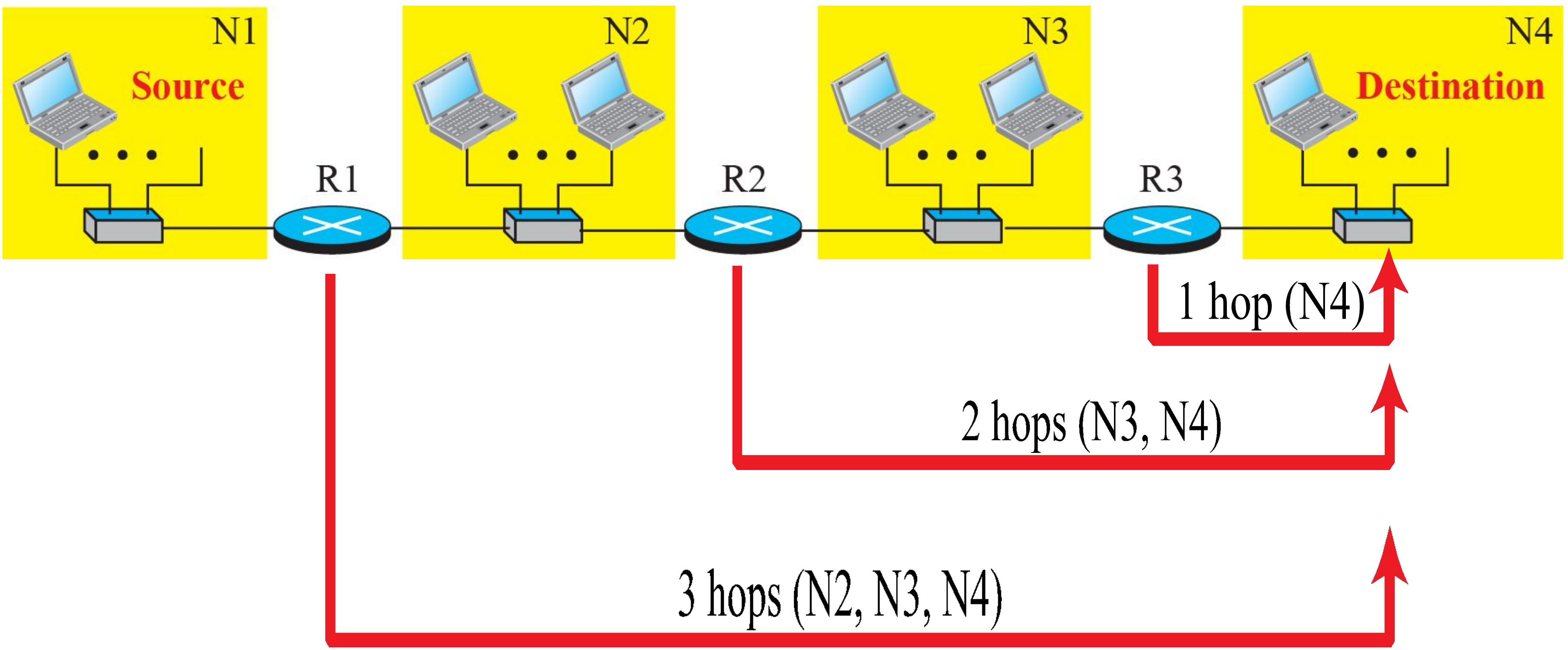


Unicast Routing

- In unicast routing, a packet is routed, **hop by hop**, from its source to its destination by the help of forwarding tables.
- The source host **needs no forwarding table** because it delivers its packet to the default router in its local network.
- The **destination host needs no forwarding** table either because it receives the packet from its default router in its local network.
- This means that only the routers that glue together the networks in the internet need forwarding tables.
- ***Examples*** :
    - Routing Information Protocol (RIP): **distancee-vector algorithm**
    - Open Shortest Path First (OSPF): based on **the link-state algorithm**.

Routing Information Protocol (RIP)

The Routing Information Protocol (RIP) is one of the most widely used intra domain routing protocols based on the distance-vector routing algorithm.



Hop Count and Message Format in RIP

Forwarding table for R1

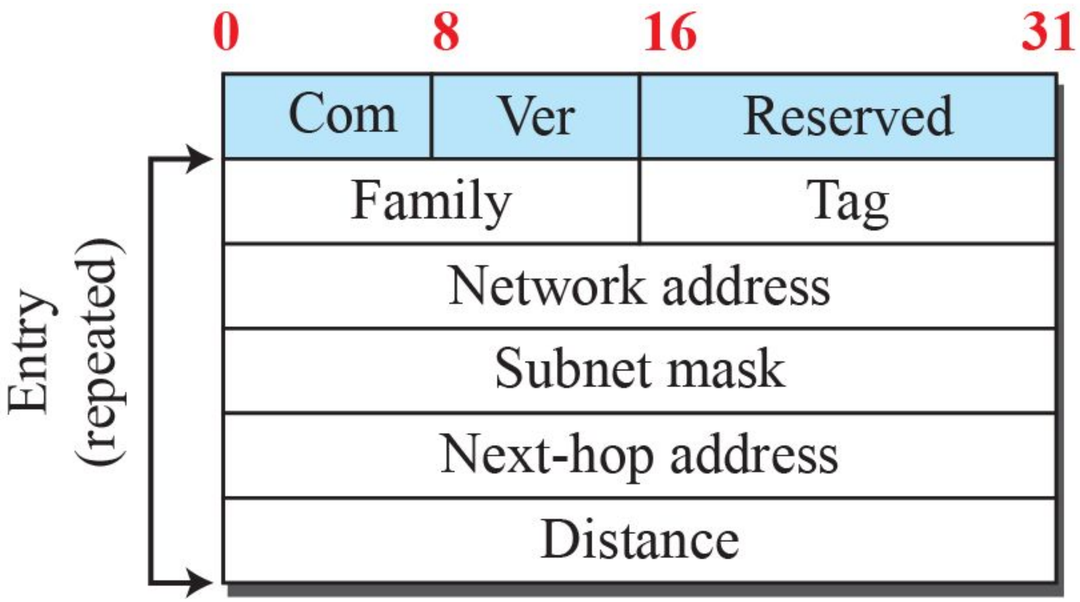
Destination network	Next router	Cost in hops
N1	——	1
N2	——	1
N3	R2	2
N4	R2	3

Forwarding table for R2

Destination network	Next router	Cost in hops
N1	R1	2
N2	——	1
N3	——	1
N4	R3	2

Forwarding table for R3

Destination network	Next router	Cost in hops
N1	R2	3
N2	R2	2
N3	——	1
N4	——	1

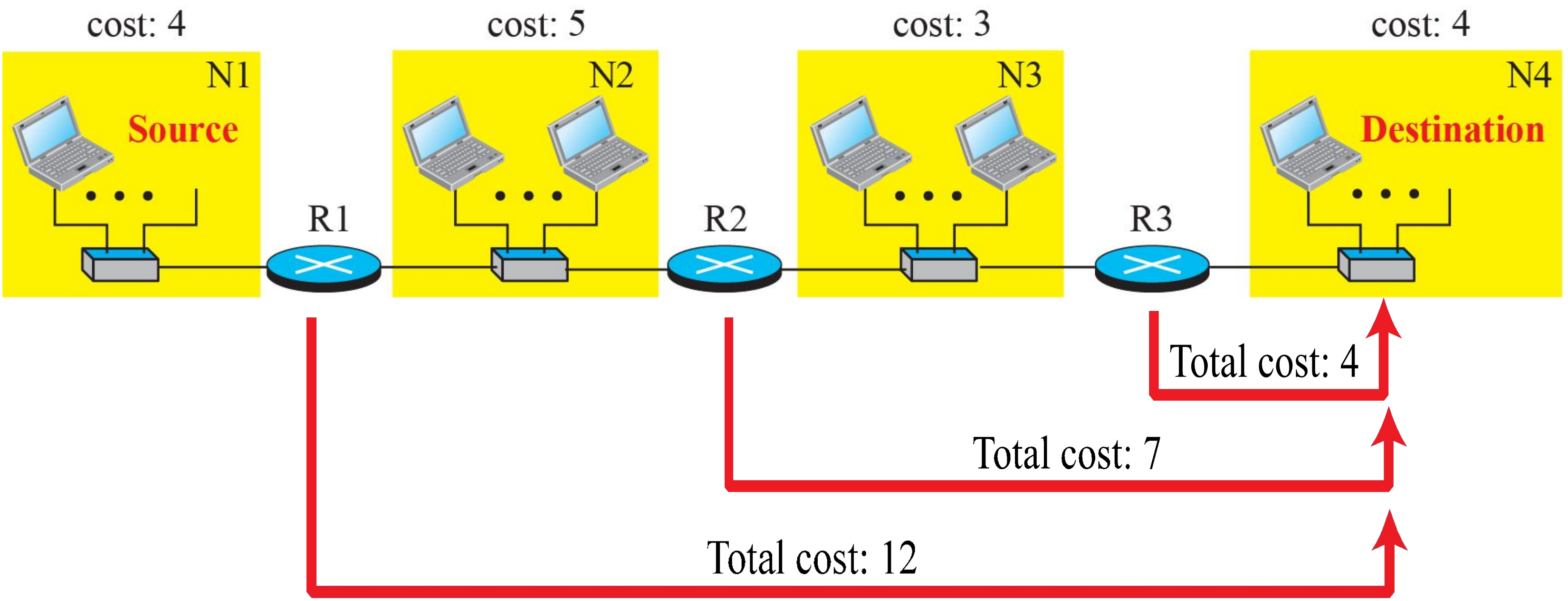


Fields

Com: Command, request (1), response (2)
Ver: Version, current version is 2
Family: Family of protocol, for TCP/IP value is 2
Tag: Information about autonomous system
Network address: Destination address
Subnet mask: Prefix length
Next-hop address: Address length
Distance: Number of hops to the destination

Open Shortest Path First (OSPF) Protocol

Open Shortest Path First (OSPF) is also an intradomain routing protocol like RIP, but it is based on the link-state routing protocol. OSPF is an open protocol, which means that the specification is a public document.



Forwarding Table and Message Format in OSPF

Forwarding table for R1

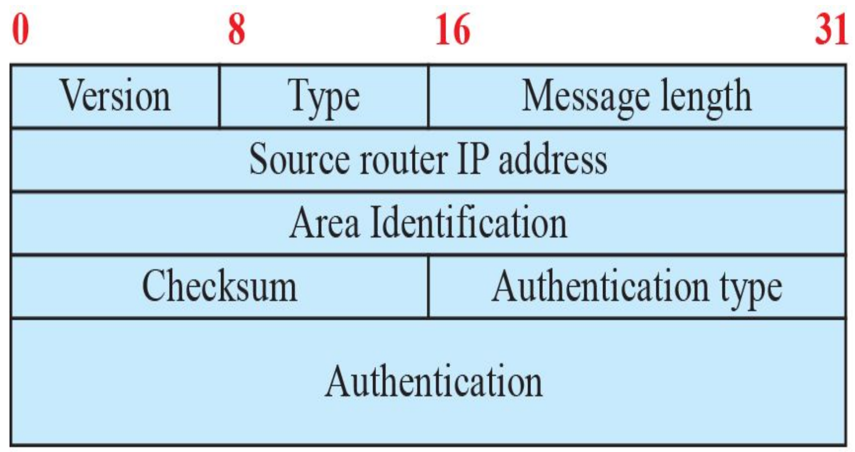
Destination network	Next router	Cost
N1	——	
N2	——	
N3	R2	
N4	R2	12

Forwarding table for R2

Destination network	Next router	Cost
N1	R1	9
N2	——	5
N3	——	3
N4	R3	7

Forwarding table for R3

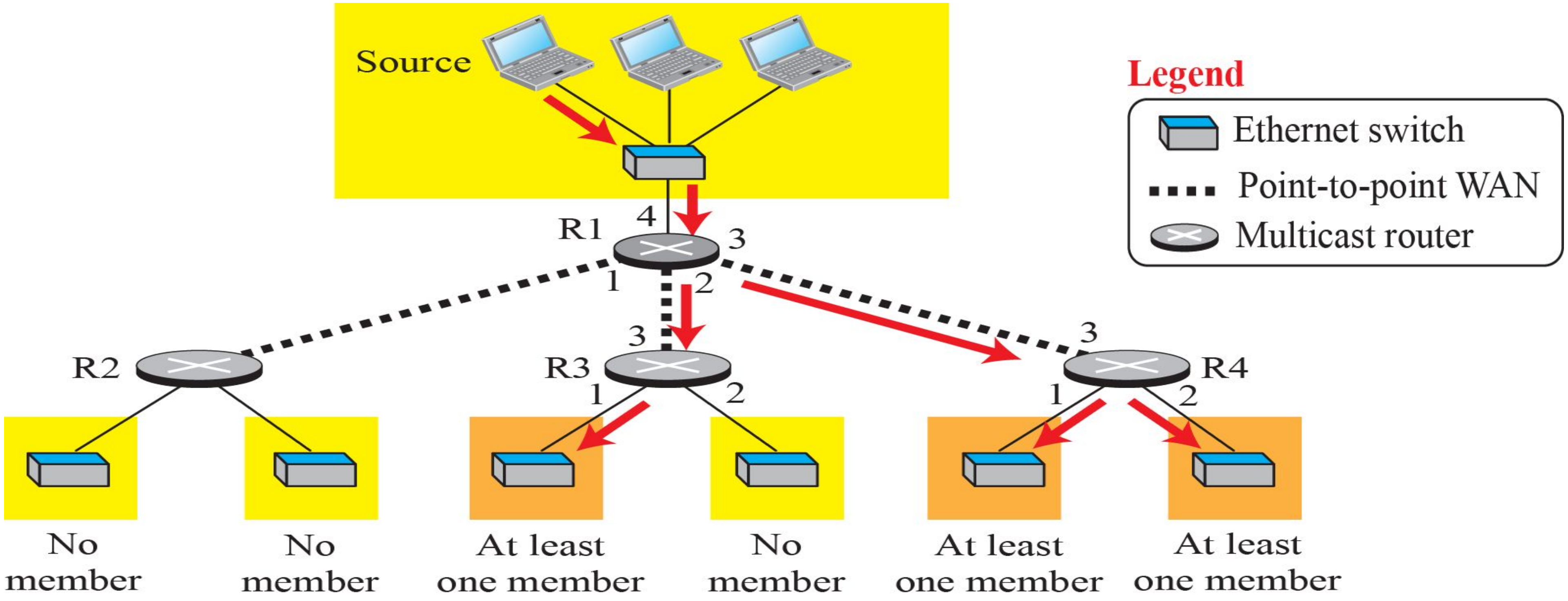
Destination network	Next router	Cost
N1	R2	12
N2	R2	8
N3	——	3
N4	——	4



OSPF common header

Multicast Routing

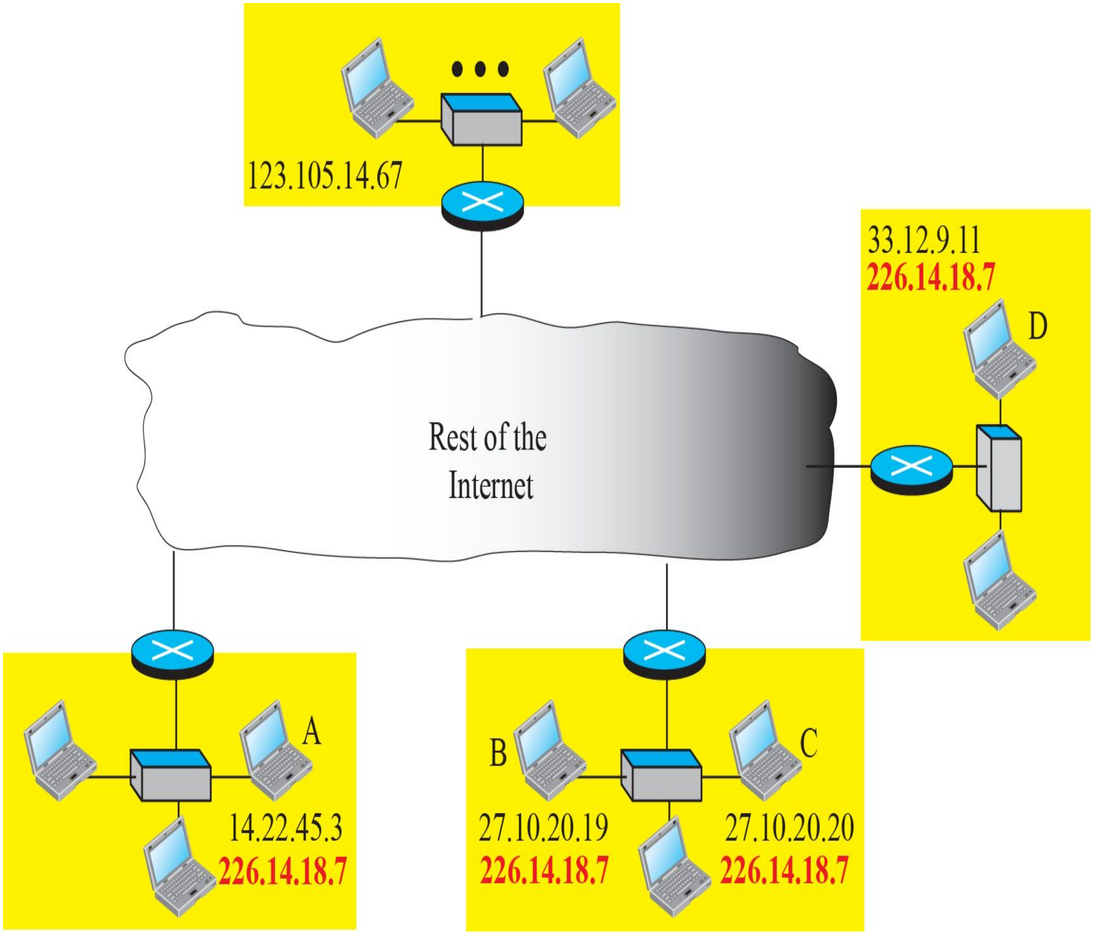
- In multicasting, there is **one source and a group** of destinations.
- The relationship is **one to many**.
- In this type of communication, the **source address is a unicast address**, but the **destination address is a group address**, a group of one or more destination networks in which there is at least one member of the group that is interested in receiving the multicast datagram.



Multicast Basics

Multicasting Needs:

- multicast addressing,
- collecting information about multicast groups,
- multicast optimal trees.
- **We cannot include the addresses of all recipients in the packet.**
- The destination address of a packet, as described in the Internet Protocol (IP) should be only one.
- For this reason, we need multicast addresses. ***A multicast address defines a group of recipients, not a single one***. In other words, a multicast address is an identifier for a group.



Summary

In this section we have discussed the following:

- ✔ Concept of Routing
- ✔ RIP and OSPF protocols
- ✔ Unicast and multicast routing

Thank you!