



# IP

## Static Routing

## dynamic routing

## RIP protocol

Pietro Nicoletti  
[www.studioreti.it](http://www.studioreti.it)



## Copyright note

- These slides are protected by copyright and international treaties. The title and the copyrights concerning the slides (inclusive, but not only, every image, photograph, animation, video, audio, music and text) are the author's (see Page 1) property.
- The slides can be copied and used by research institutes, schools and universities affiliated to the Ministry of Public Instruction and the Ministry of University and Scientific Research and Technology, for institutional purpose, not for profit. In this case there is not requested any authorization.
- Any other complete or partial use or reproduction (inclusive, but not only, reproduction on discs, networks and printers) is forbidden without written authorization of the author in advance.
- The information contained in these slides are believed correct at the moment of publication. They are supplied only for didactic purpose and not to be used for installation-projects, products, networks etc. However, there might be changes without notice. The authors are not responsible for the content of the slides.
- In any case there can not be declared conformity with the information contained in these slides.
- In any case this note of copyright may never be removed and must be written also in case of partial use.

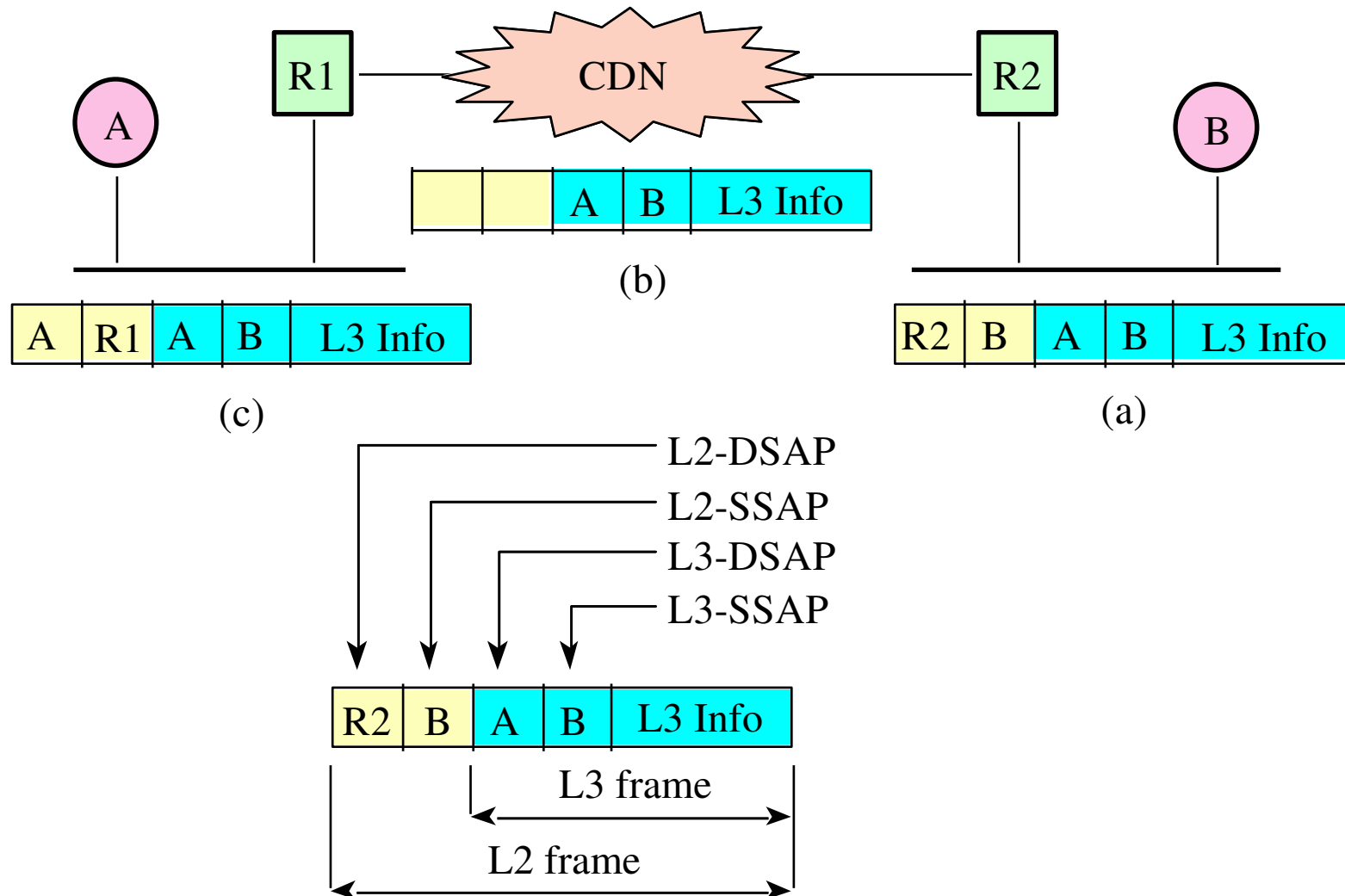


## IP routing table

- Routing table contain one or more *route*
- Route is entry in routing table containing information how to reach IP Network called
  - Network to reach – **netmask** – *next hop* – **metric**
    - *Example:* 10.1.1.0 **255.255.255.0** *10.10.1.2* **5**
- A connected network it's automatically learned by the router:
  - Router deduce the connected network looking at interface network and netmask
  - The connected network is present in the routing table only if the interface is up



# Level 2, level 3 address and routing





# Static routing

- Router may have static routing information on a *Routing Table*
  - The *static route* are configured by network manager and stored in the configuration file
    - The configuration file it's loaded at router bootstrap in RAM and the routing information are loaded in the routing table

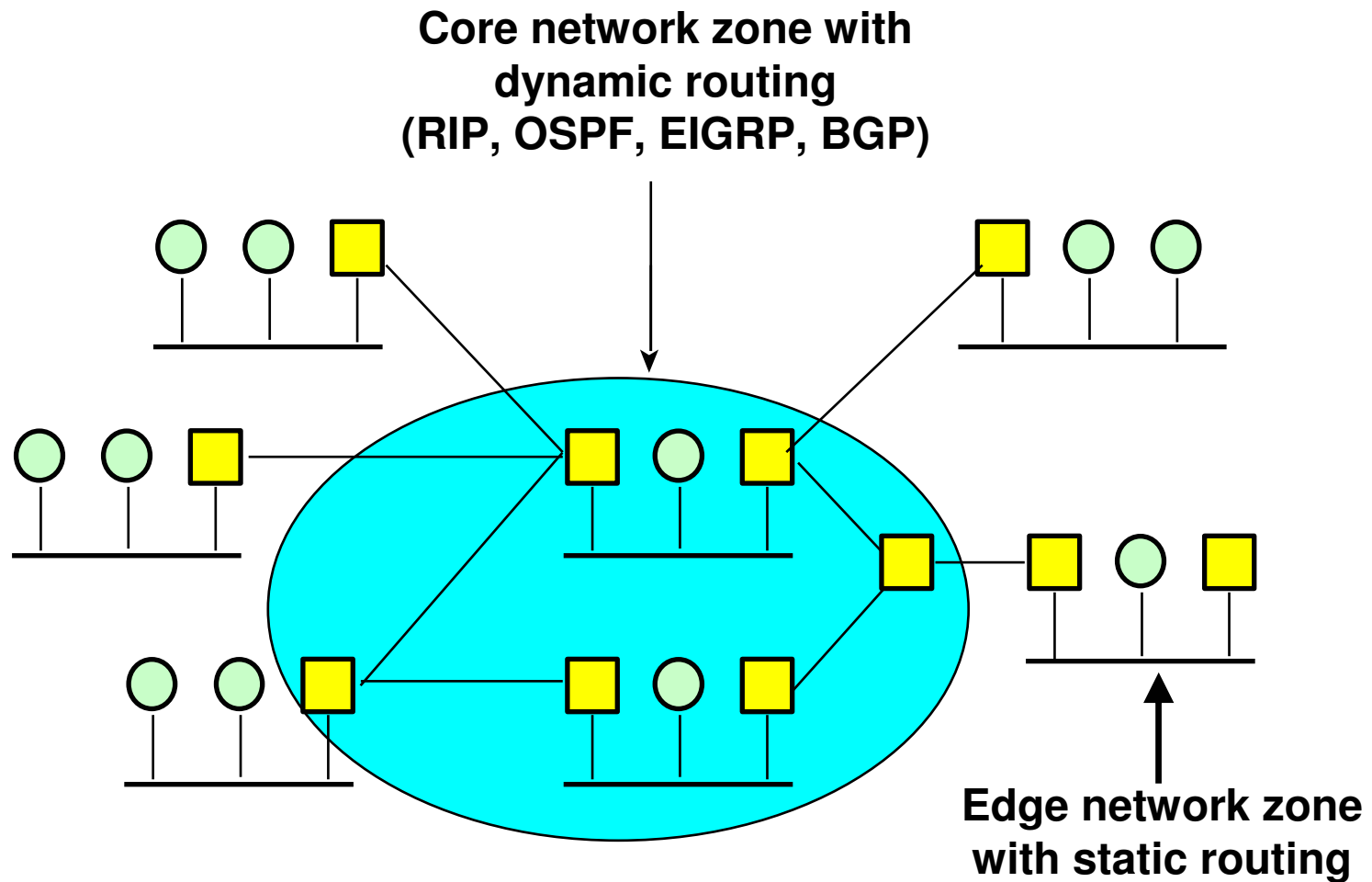


## Dynamic routing

- Router may have dynamic routing information's on a *Routing Table*
  - A specific routing protocol send routing information's on the active interfaces that are necessary to establish the route to reach the networks
    - The routing algorithm contain the rules how to determine the route
- Dynamic routing algorithm
  - Distance Vector
  - Link State Packet



# Static & Dynamic Routing



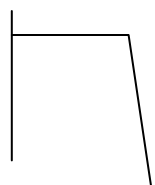


# Static route configuration example

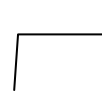
```
2503a#config term
```

```
Enter configuration commands, one per line. End with CNTL/Z.
```

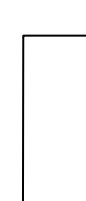
Static route  
configuration  
command



Network to  
reach



Netmask



next hop  
address

```
2503a(config)#ip route 192.168.64.0 255.255.255.0 192.168.3.9
```

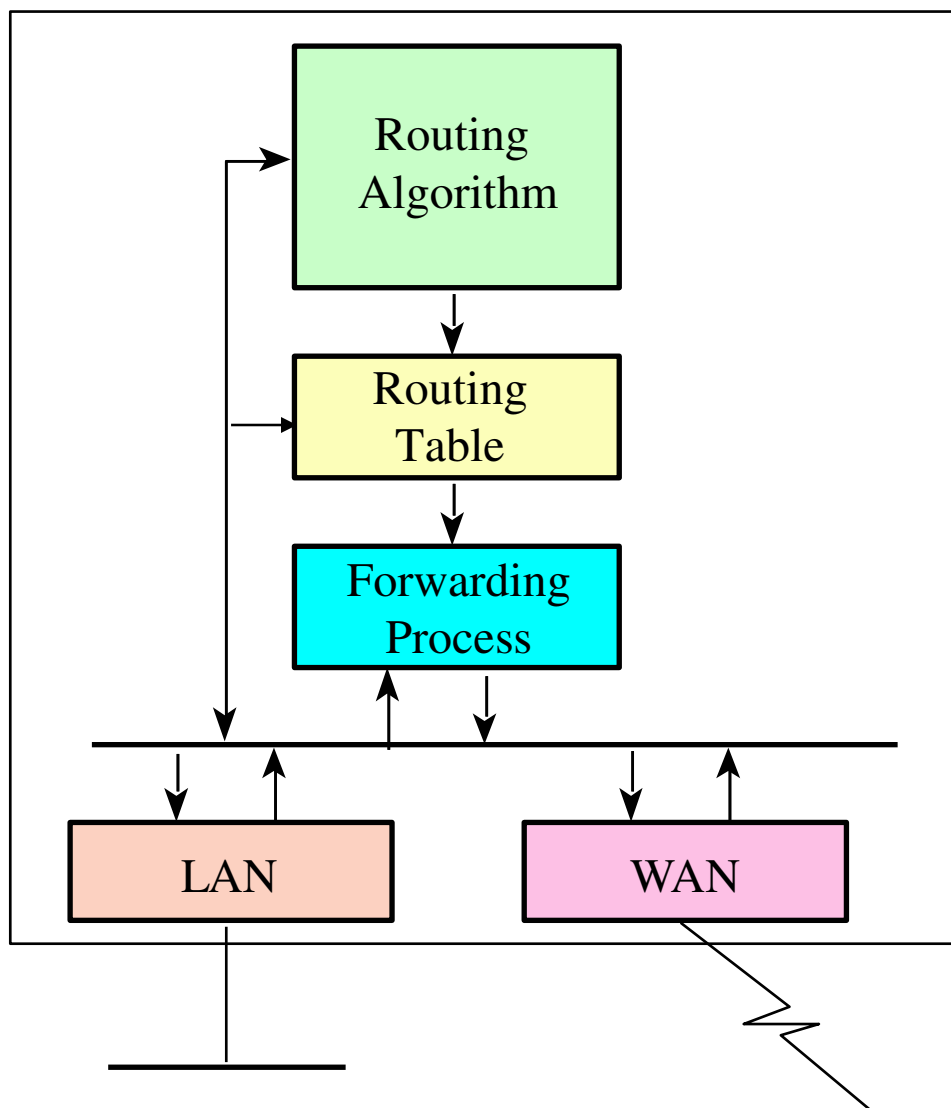
```
2503a(config)#ip route 192.168.67.0 255.255.255.0 192.168.3.9
```

```
2503a(config)#ip route 192.168.16.0 255.255.255.0 192.168.3.9
```

```
2503a(config)#ip route 192.168.2.0 255.255.255.0 192.168.1.2
```



# Router architecture



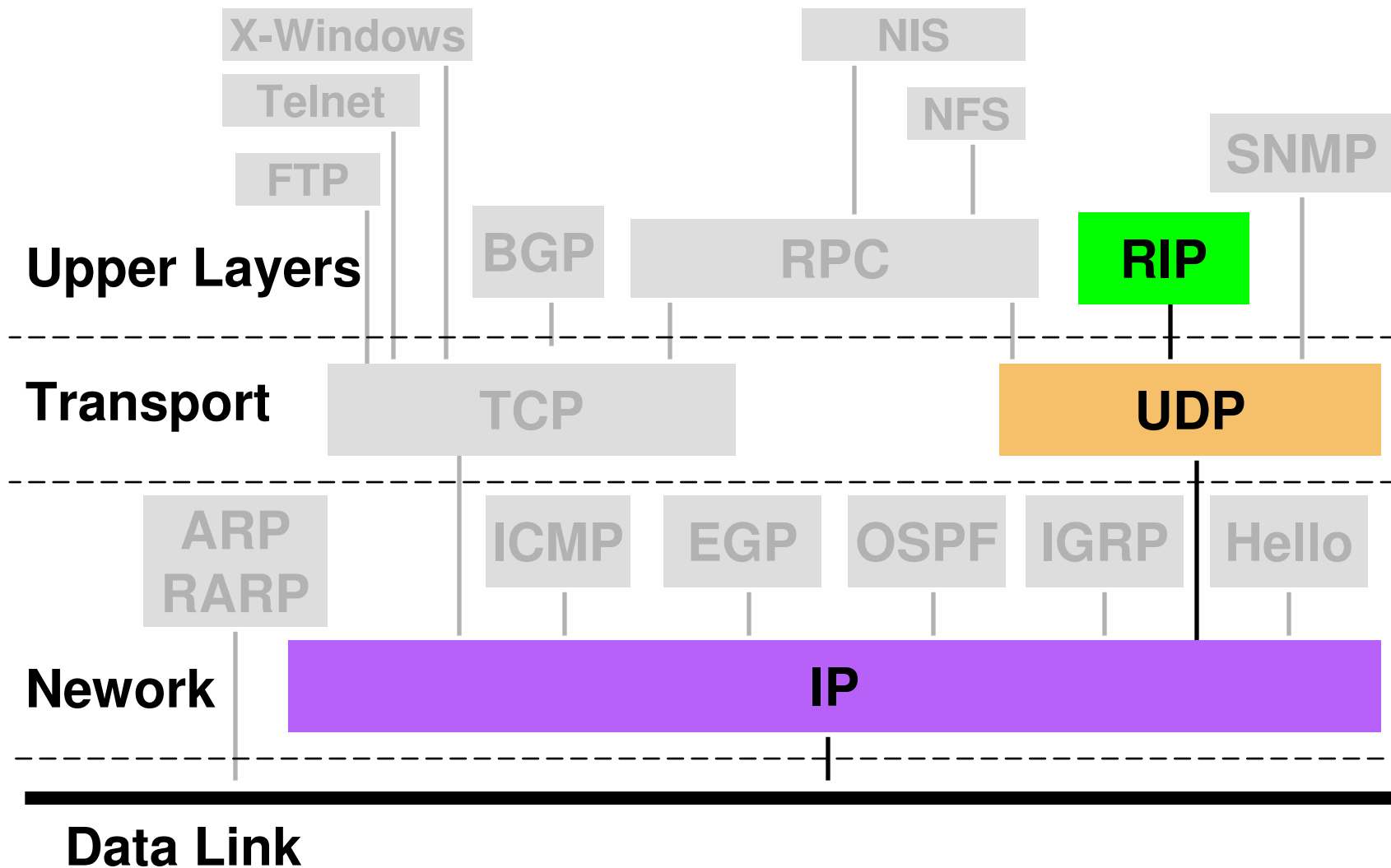


## Distance Vector

- Know as Bellman-Ford algorithm
- Any node when modify own routing table send a distance vector to the adjacent node
- Distance vector it's a pairs assembly containing
  - [network address – distance]
- Distance use classic metric like hop and cost
- Any node or router store the last distance vector received on any interface



# RIP routing protocol and stack IP





# RIP

- Developed by Xerox for XNS
- Modified in 1982 il RIP to work with TCP/IP
- Distance vector routing protocol hop based
- RIP defined by IETF on RFC 1058 in 1988 and RFC 1388 in 1993



# RIP

- Metric based on hop count
  - Maximum 15 hop admitted
    - Metric 16 = network unreachable
- Any router count as 1 hop
- Update routing message: any 30 s
- In case of link failure or topology change a router send immediately a routing update
- Convergence routing time typical 5 minutes

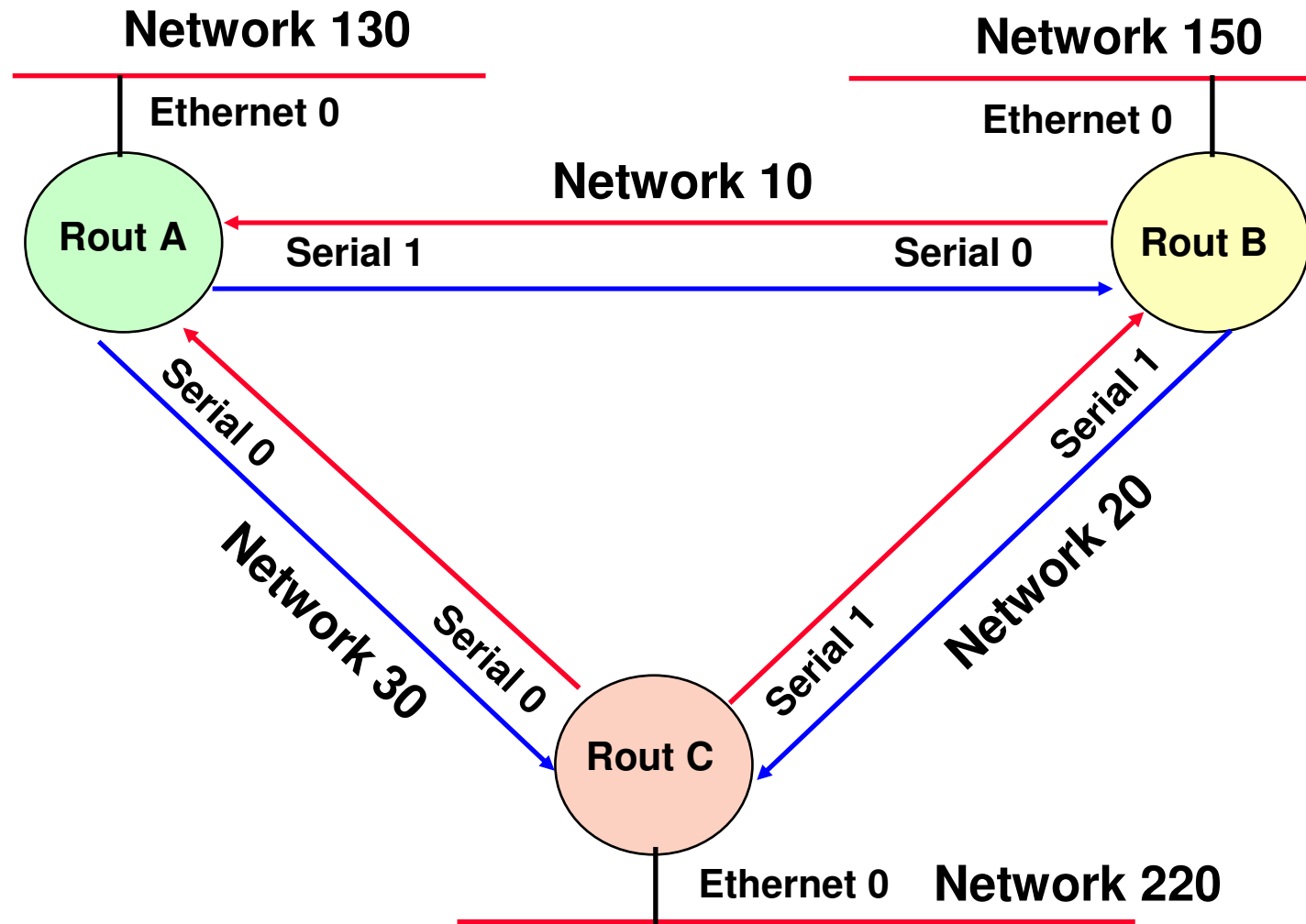


## RIP v1, Routing & netmask

- RIP v1 protocol do not transport netmask information
  - limits:
    - All subnet of the same network class must have the same netmask
    - It's not possible use a IP address planning based on variable subnetting
- Broadcast routing protocol message



# WAN example with RIP





# Router A: cold start and announces

Address	Cost
130	1
10	1
30	1

**Serial 0**

**Router A  
routing  
table**

Address	Cost	Line
130	1	Conn.
10	1	Conn.
30	1	Conn.

**Serial 1**

Address	Cost
130	1
10	1
30	1

**Ethernet 0**

Address	Cost
130	1
10	1
30	1



# Router B: cold start and announces

Address	Cost
150	1
10	1
20	1

**Serial 0**

**Router B  
routing  
table**

Address	Cost	Line
150	1	Conn.
10	1	Conn.
20	1	Conn.

**Serial 1**

Address	Cost
150	1
10	1
20	1

**Ethernet 0**

Address	Cost
150	1
10	1
20	1



# Router C: cold start and announces

Address	Cost
220	1
20	1
30	1

**Serial 0**

**Router C  
routing  
table**

Address	Cost	Line
220	1	Conn.
20	1	Conn.
30	1	Conn.

**Serial 1**

Address	Cost
220	1
20	1
30	1

**Ethernet 0**

Address	Cost
220	1
20	1
30	1



## Router A: routing announces received by B

**Router A  
routing  
table**

Address	Cost	Line
130	1	Conn.
10	1	Conn.
30	1	Conn.
20	2	Ser.1
150	2	Ser.1
220	3	Ser.1

**Serial 1**

Address	Cost
130	2
10	1
20	1
30	2
150	1
220	2





## Router A: routing announces received by C

Address	Cost
220	1
20	1
30	1
10	2
130	2
150	2

**Serial 0**

**Router A  
routing  
table**



Address	Cost	Line
130	1	Conn.
10	1	Conn.
30	1	Conn.
20	2	Ser.1
150	2	Ser.1
220	2	Ser.0



## Router B: routing announces received by A

Address	Cost
130	1
10	1
30	1
20	2
150	2
220	2

**Serial 0**

**Router B  
routing  
table**

Address	Cost	Line
150	1	Conn.
10	1	Conn.
20	1	Conn.
130	2	Ser.0
30	2	Ser.1
220	2	Ser.1

} Route previously  
learned by  
router C



## Router B: routing announces received by C

**Router B  
routing  
table**

Address	Cost	Line
150	1	Conn.
10	1	Conn.
20	1	Conn.
130	2	Ser.0
30	2	Ser.1
220	2	Ser.1

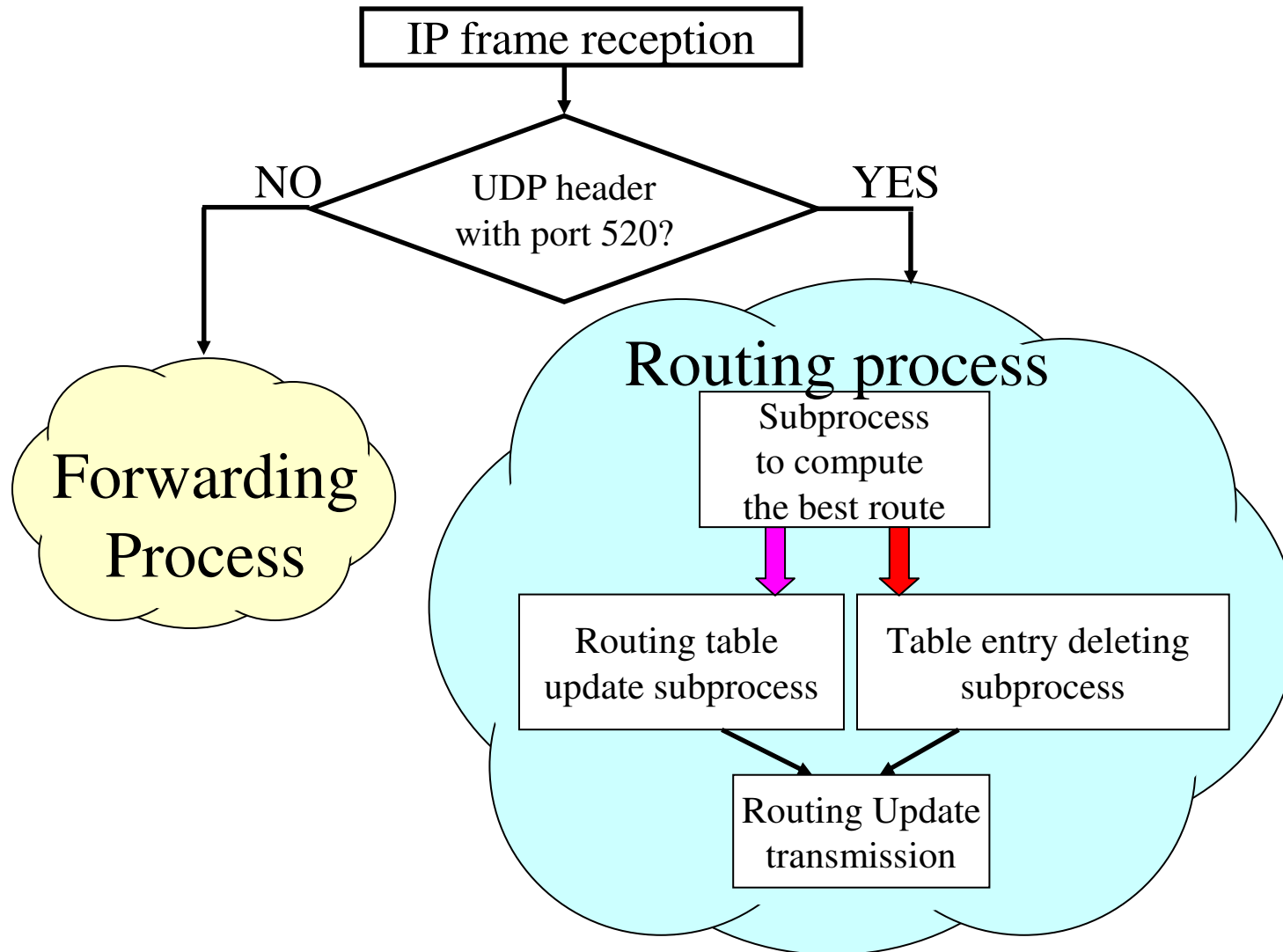
**Serial 1**

Address	Cost
220	1
20	1
30	1
150	2
10	2
130	2





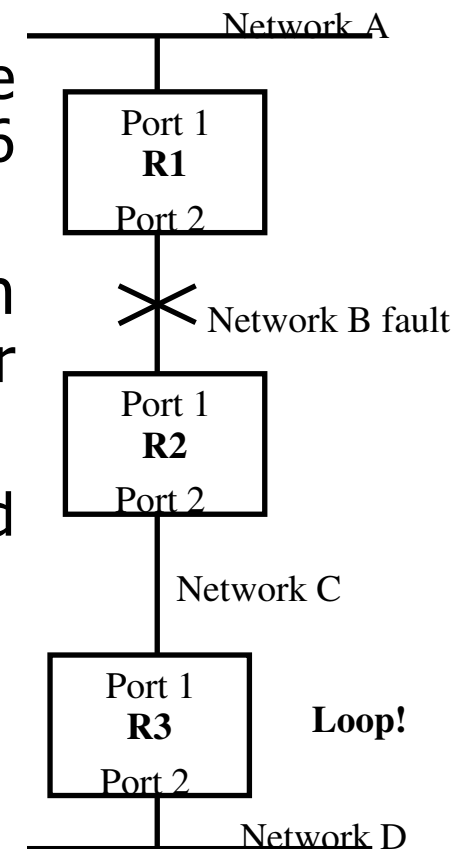
# Router RIP





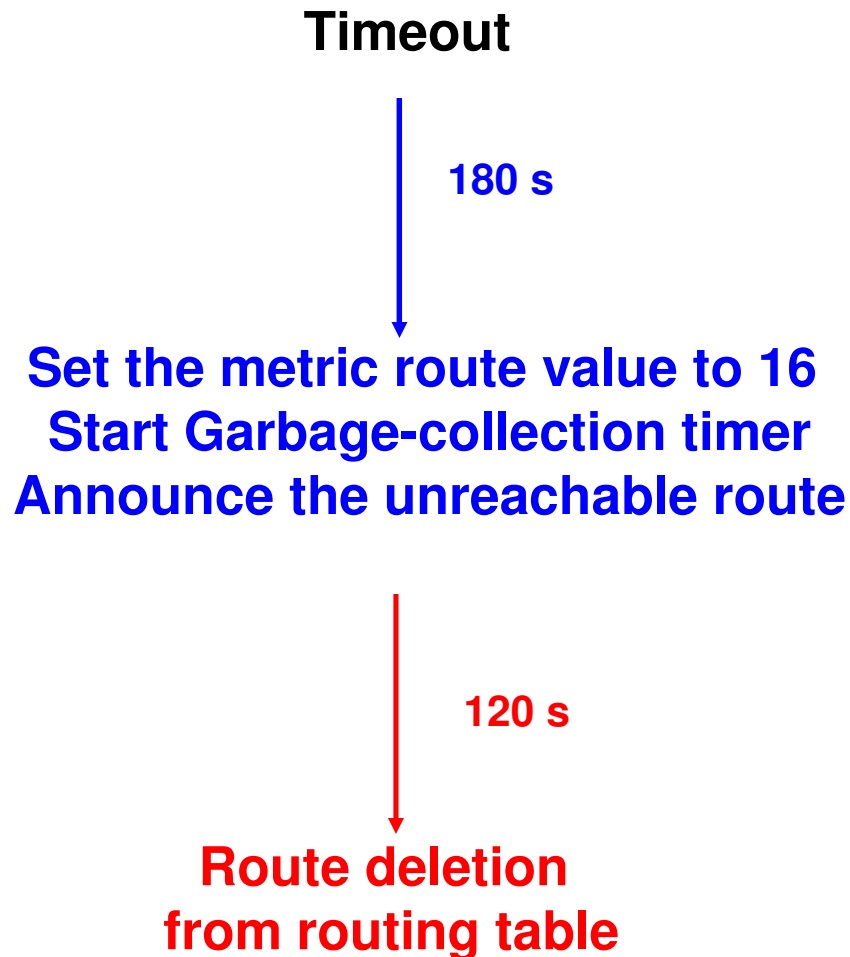
## Fault and lost Routing Update

- When fault happen:
  - adjacent routers to faulty line set the route of faulty network to metric = 16 (unreachable)
- When router do not receive information about a route and the associated timer expire (timeout)
  - Router consider the route unreachable and set a metric to value 16





# Lost Routing Update

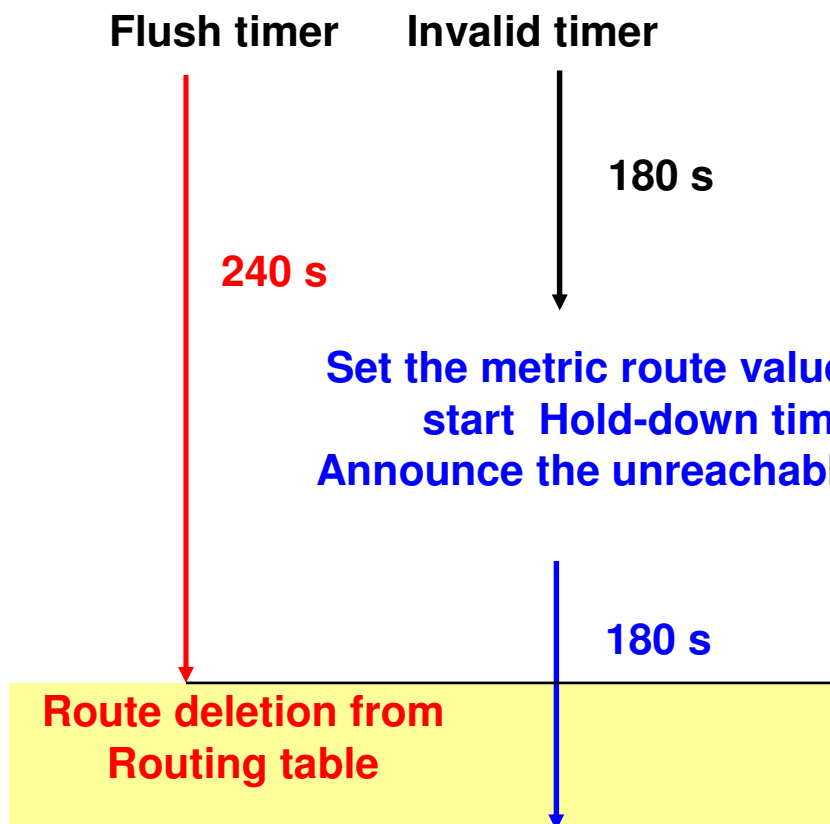


- Timeout or *route-timer* or *invalid timer*
  - Maximum time for valid route
- Garbage-collection timer or *hold-down-timer*
  - Time period to announce a route with metric 16
  - Time to wait route deletion

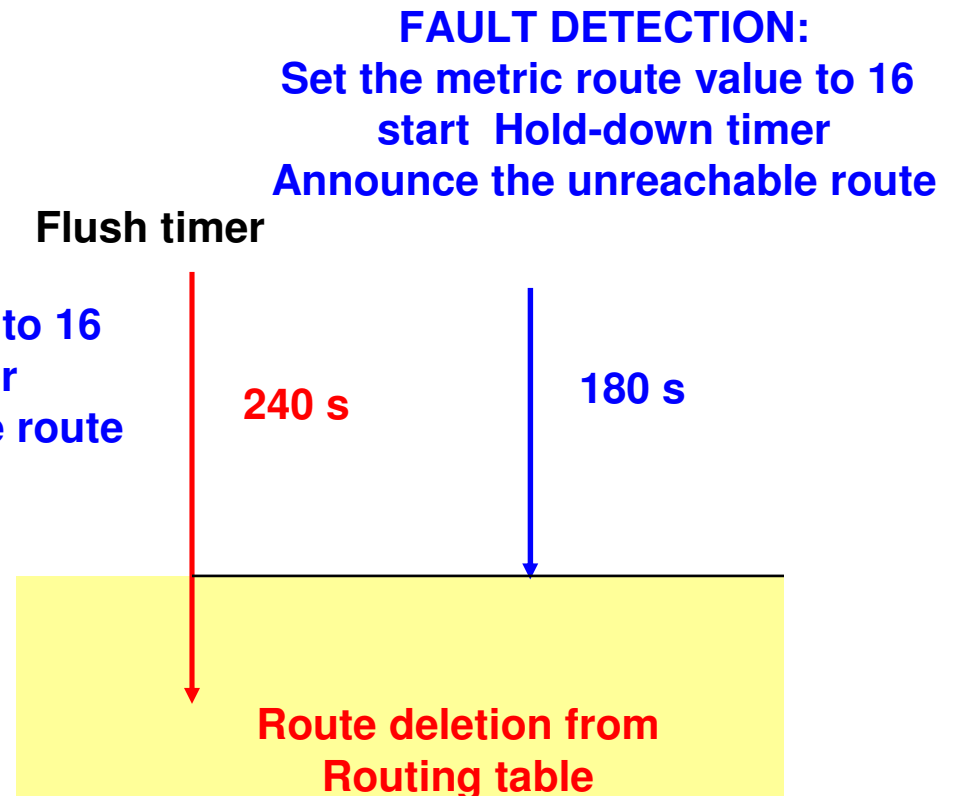


# Router Cisco and RIP timer

**Lost routing information for a route**



**Router adjacent to faulty network**





## Split horizon

- Do not send route information's learned from that link
- Prevent loop
- Speed-up the convergence



## Split Horizon with poisonous reverse

- Router send the route learned from that link with  $\infty$  Cost (metric =16)
- Prevent loop
- Speed-up the convergence
- Better convergence loop prevention than simple split horizon function



## RIPv1 packet format

<b>command</b>	<b>version</b>	<b>must be zero</b>
<b>address family identifier</b>		<b>must be zero</b>
<b>IP address</b>		
<b>must be zero</b>		
<b>must be zero</b>		
<b>metric</b>		

**Address Family ID & Metric can be repeated up to 25 times**



## RIP v1 packet fields

- Command
  - request = 1
    - Used during cold start to request distance vector
  - response = 2
    - Used to distribute distance vector
- Version = 1
- Address Family
  - IP = 2



## RIP packet transport

- Maximum packet length = 512 octets
- Transport UDP header
  - port 520
- Broadcast destination address



## RIPv2

- RFC 1723
- Same algorithm than RIP-1 just change the packet information's
  - Netmask transport information's
  - Router can operate with both RIP version just use different RIP packet depending by RIP version of adjacent router



## RIPv2 packet format

<b>command</b>	<b>version</b>	<b>routing domain</b>
<b>address family identifier</b>		<b>route tag</b>
<b>IP address</b>		
<b>subnet mask</b>		
<b>next hop</b>		
<b>metric</b>		

**Address Family ID & Metric can be repeated up to 25 times**

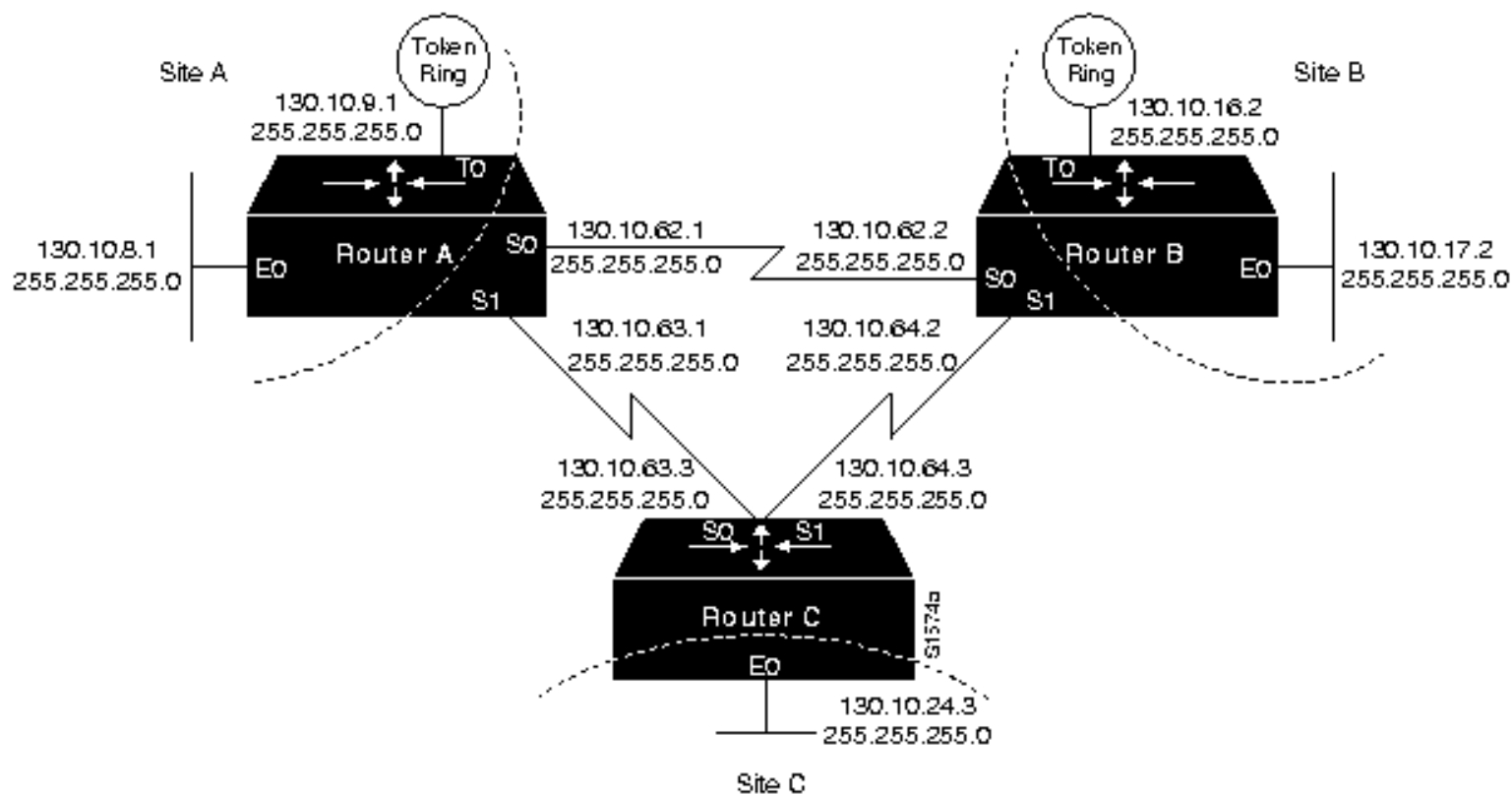


## Il pacchetto RIPv2

- Version = 2
- Address Family
  - New information "authentication data"
- Routing Domain
  - AS number
  - Can operate with more AS on the same network
- Routing Tag
  - For external router using EGP or BGP
- Multicast destination address
  - 224.0.0.9



# Network example with RIP





## Router A configuration

```
interface serial 0
ip address 130.10.62.1 255.255.255.0
!
interface serial 1
ip address 130.10.63.1 255.255.255.0
!
interface ethernet 0
ip address 130.10.8.1 255.255.255.0
!
interface tokenring 0
ip address 130.10.9.1 255.255.255.0
!
router rip
network 130.10.0.0
```



## Router B configuration

```
interface serial 0
ip address 130.10.62.2 255.255.255.0
!
interface serial 1
ip address 130.10.64.2 255.255.255.0
!
interface ethernet 0
ip address 130.10.17.2 255.255.255.0
!
interface tokenring 0
ip address 130.10.16.2 255.255.255.0
!
router rip
network 130.10.0.0
```



## Router C configuration

```
interface serial 0
ip address 130.10.63.3 255.255.255.0
!
interface serial 1
ip address 130.10.64.3 255.255.255.0
!
interface ethernet 0
ip address 130.10.24.3 255.255.255.0
!
router rip
network 130.10.0.0
```

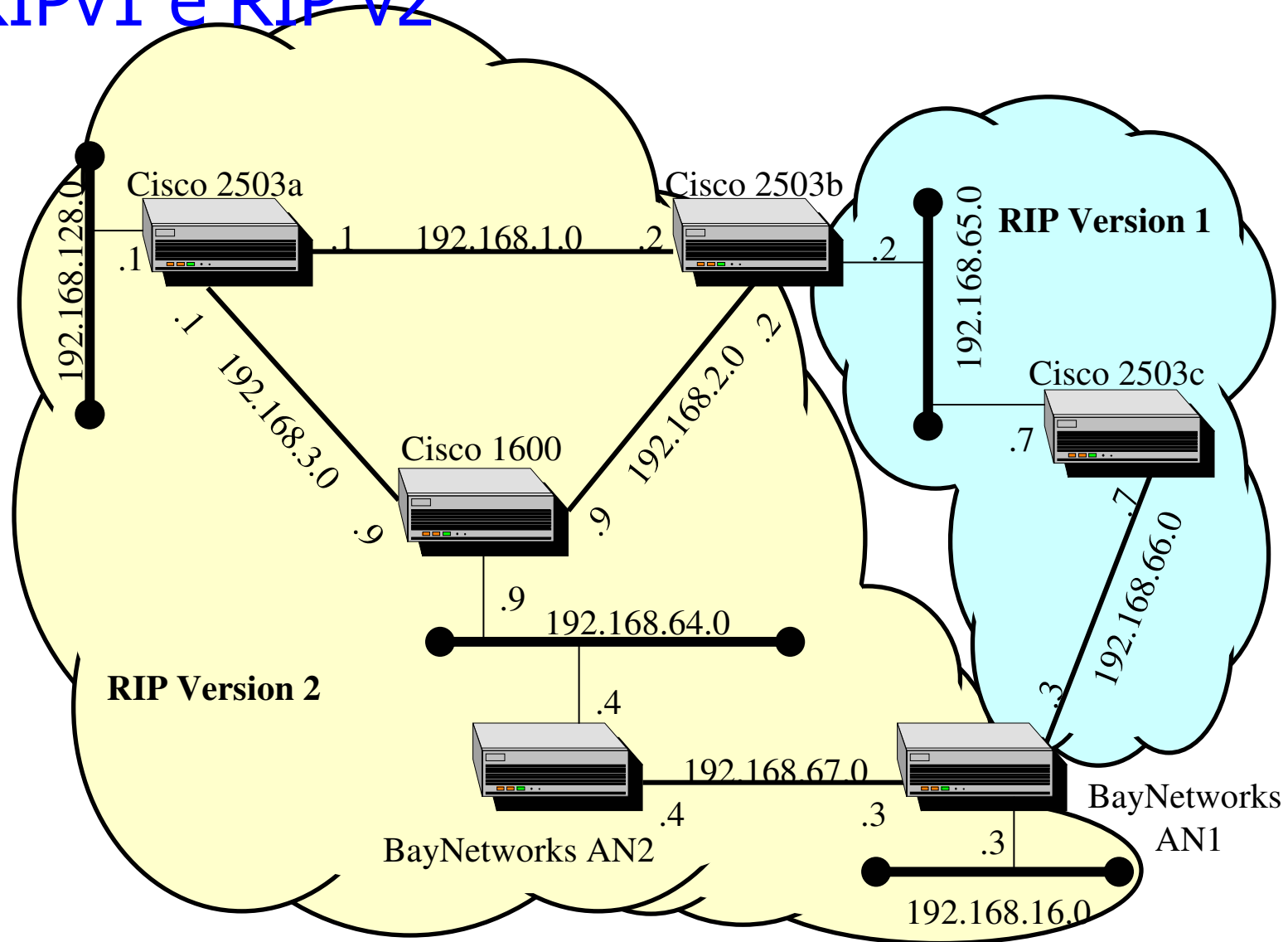


# RIPv2 configuration example

```
key chain flintstone
  key 1
    key-string fred
  key 2
    key-string barney
    accept-lifetime 00:00:00 Dec 5 1995 23:59:59 Dec 5 1995
    send-lifetime 06:00:00 Dec 5 1995 18:00:00 Dec 5 1995
!
interface Ethernet0
  ip address 172.19.104.75 255.255.255.0 secondary
  ip address 171.69.232.147 255.255.255.240
  ip rip authentication key-chain flintstone
!
interface Fddi0
  ip address 2.1.1.1 255.255.255.0
  no keepalive
!
interface Fddi1
  ip address 3.1.1.1 255.255.255.0
  ip rip send version 1
  ip rip receive version 1
!
router rip
  version 2
  network 172.19.0.0
  network 2.0.0.0
  network 3.0.0.0
```



# RIPv1 e RIPv2



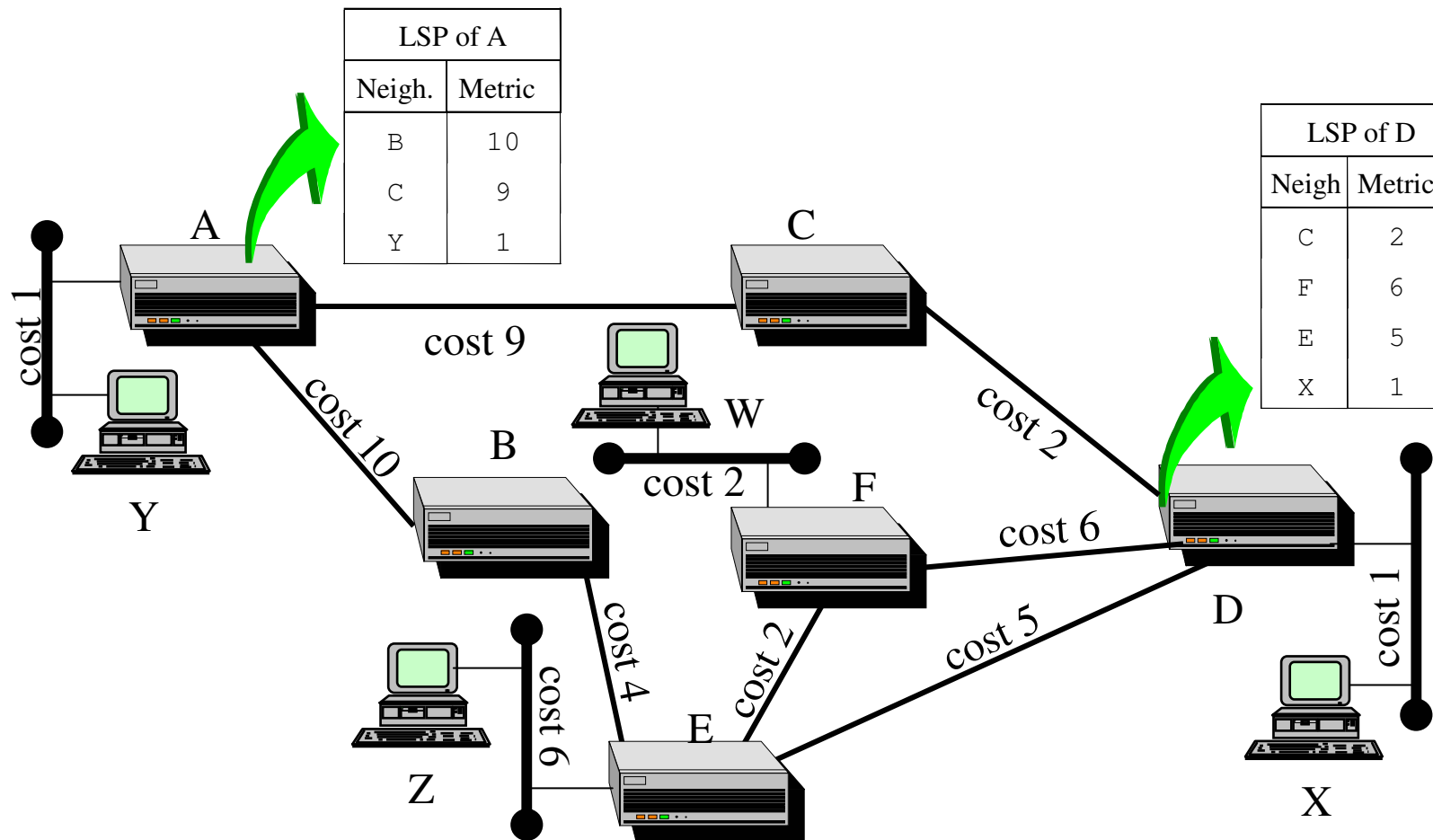


## Link State

- Any router learn locally: adjacent router and link that connect them
  - Continuous transmission of hello packet to know the adjacency
- Transmit adjacency information to the connected router through Link State Packet (LSP)
- Router store LSP in a Database and use the information to build up the network map
- Router use the information's regarding network map to define the route and insert in the routing table



# Link state packet example



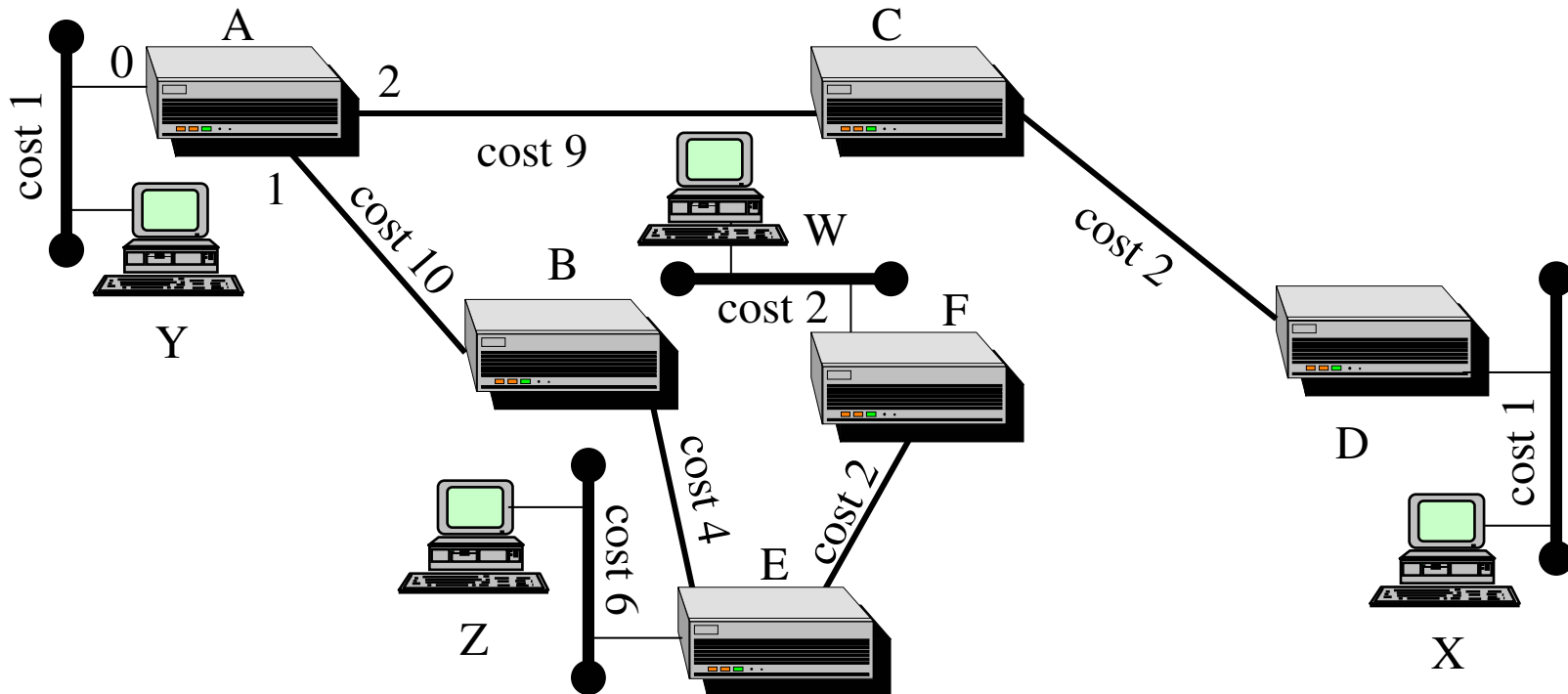


## LSP data base

Source	Node/Cost
A	B/10 C/9 Y/1
B	A/10 E/4
C	A/9 D/2
D	C/2 E/5 F/6 X/1
E	B/4 F/2 Z/6 D/5
F	D/6 E/2 W/2

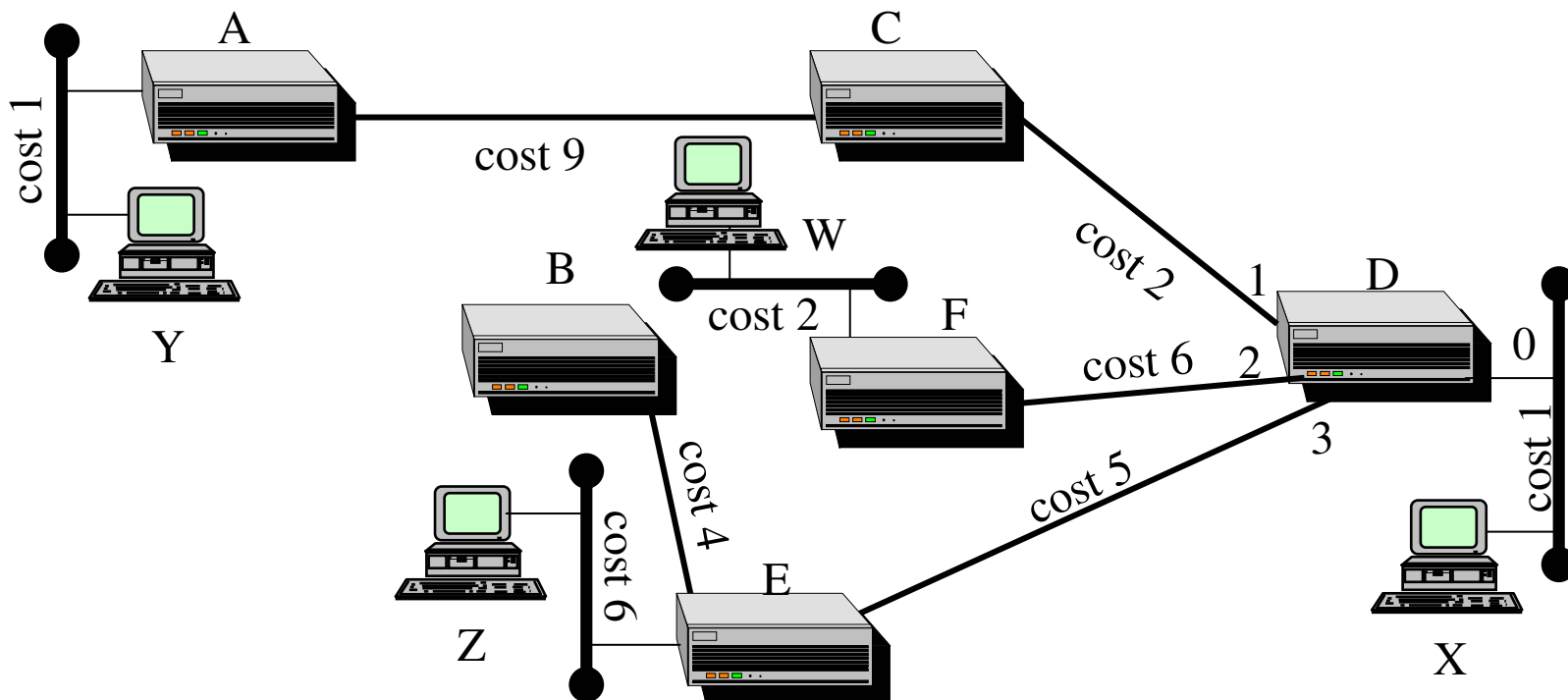


# Shortest path tree computed by router A





# Shortest path tree computed by router D





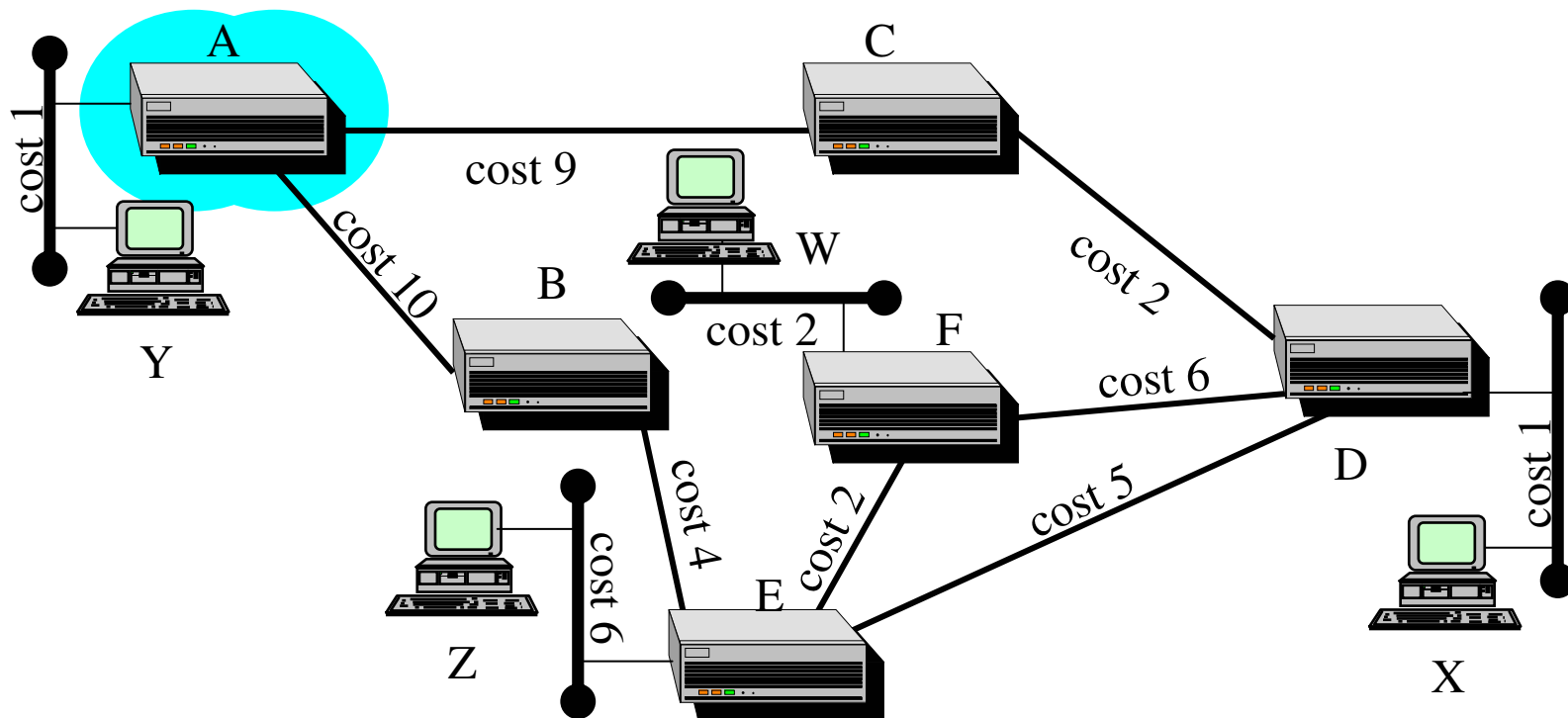
## Routing table of router A e D

Routing table of A		
Address	Interf.	Cost
B	1	10
C	2	9
D	2	11
E	1	14
F	1	16
X	2	12
Y	0	1
W	1	18
Z	1	20

Routing table of D		
Address	Interf.	Cost
A	1	11
B	3	9
C	1	2
E	3	5
F	2	6
X	0	1
Y	1	12
W	2	8
Z	3	11

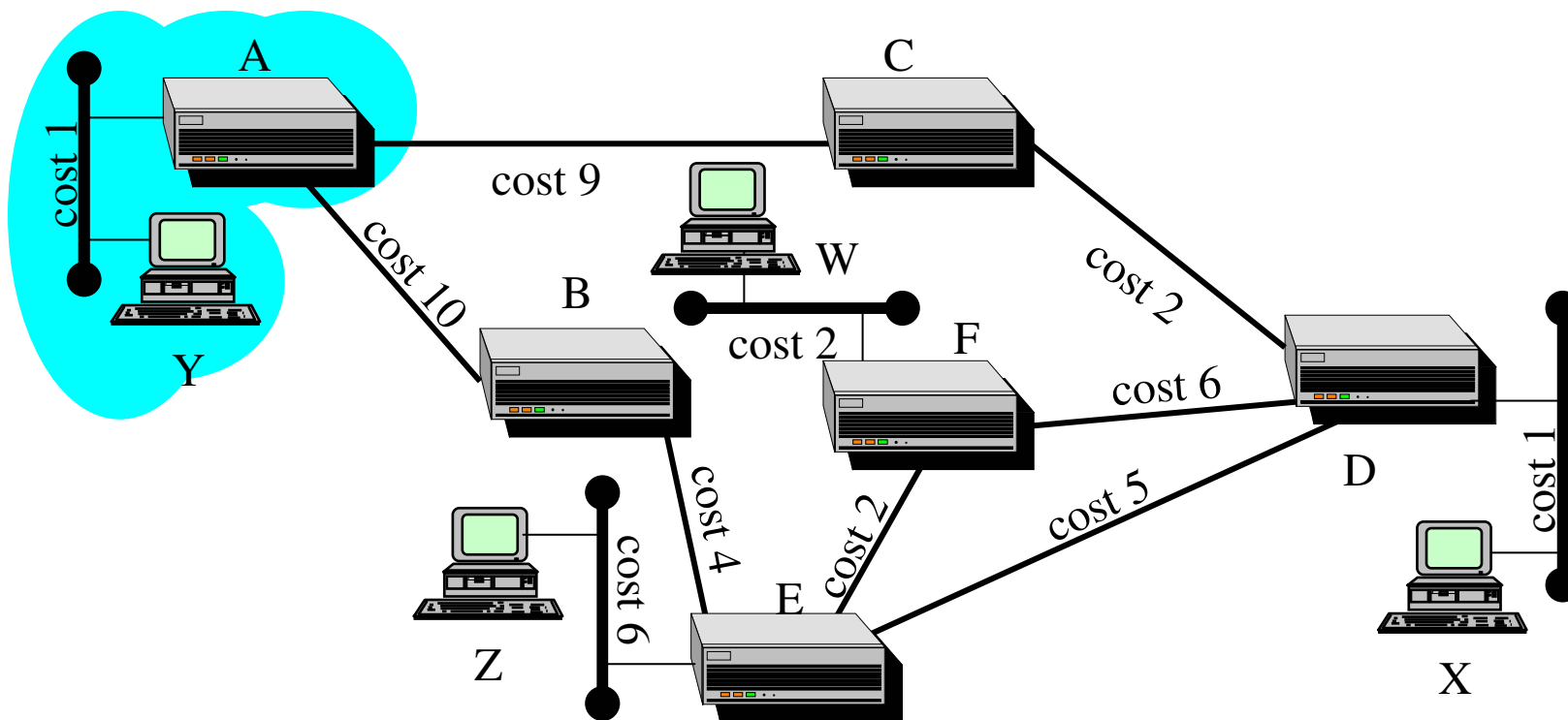


# 1<sup>0</sup> step to compute shortest path tree di A



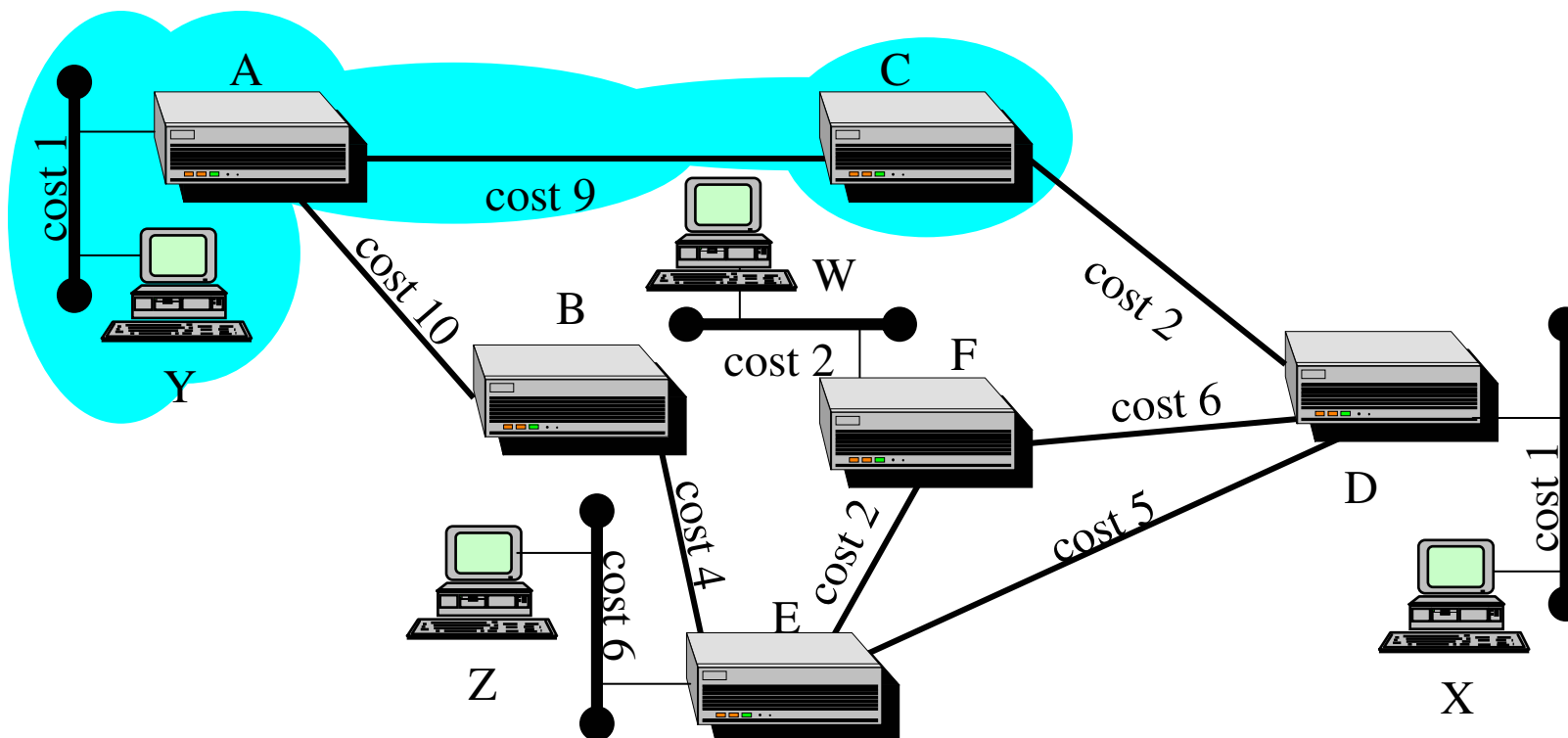


# 2<sup>0</sup> step to compute shortest path tree di A



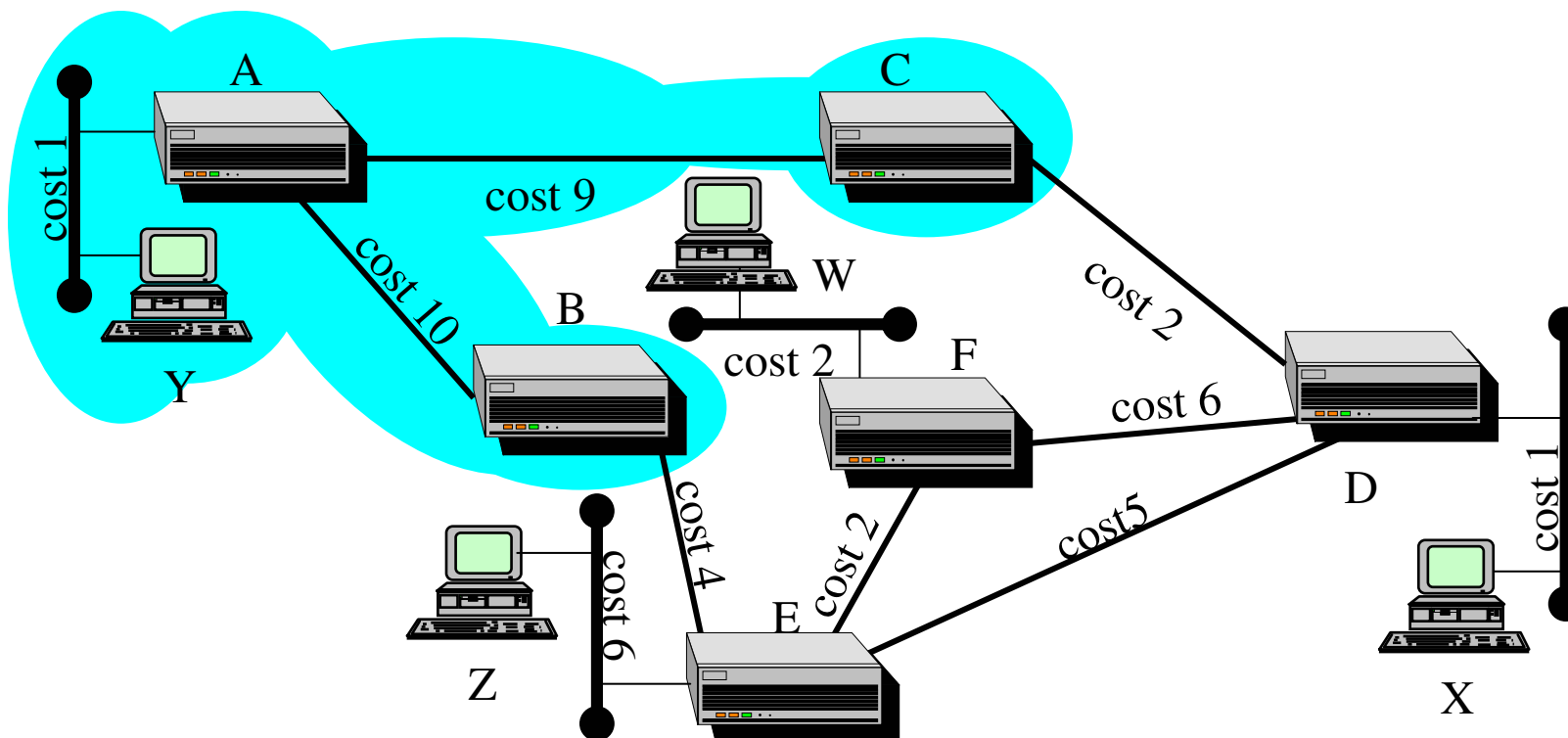


# 3<sup>o</sup> step to compute shortest path tree di A



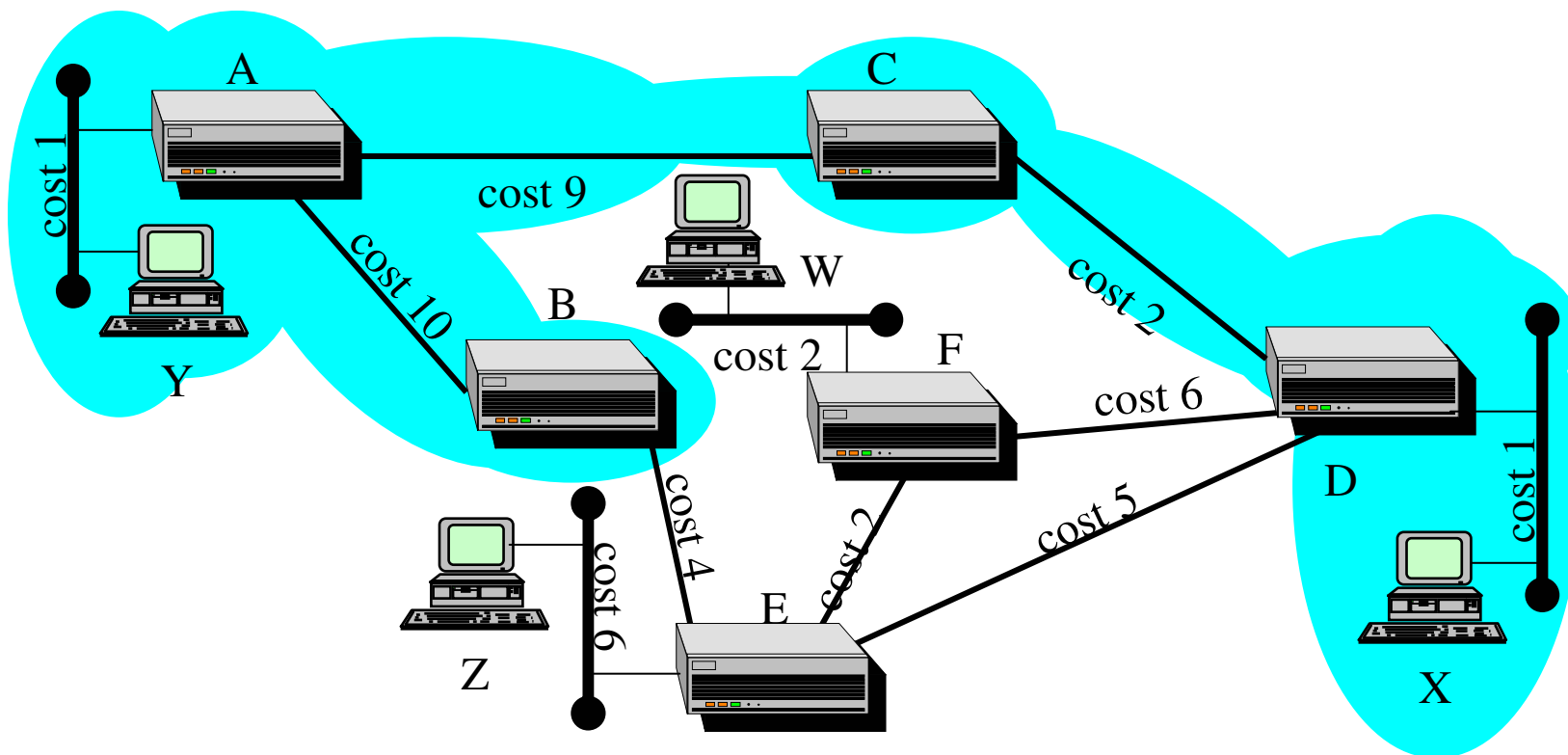


# 4<sup>0</sup> step to compute shortest path tree di A



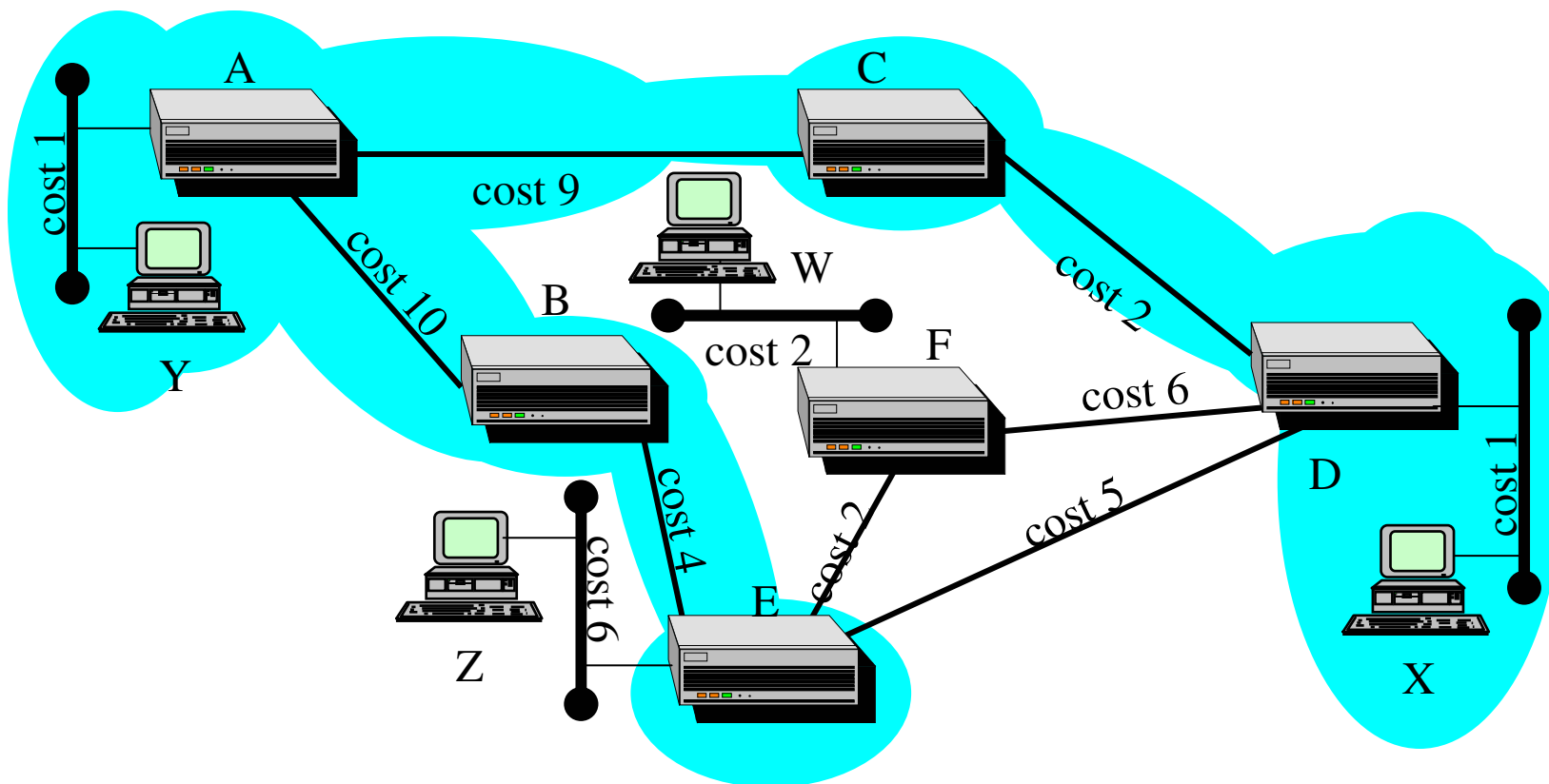


# 5<sup>o</sup> step to compute shortest path tree di A



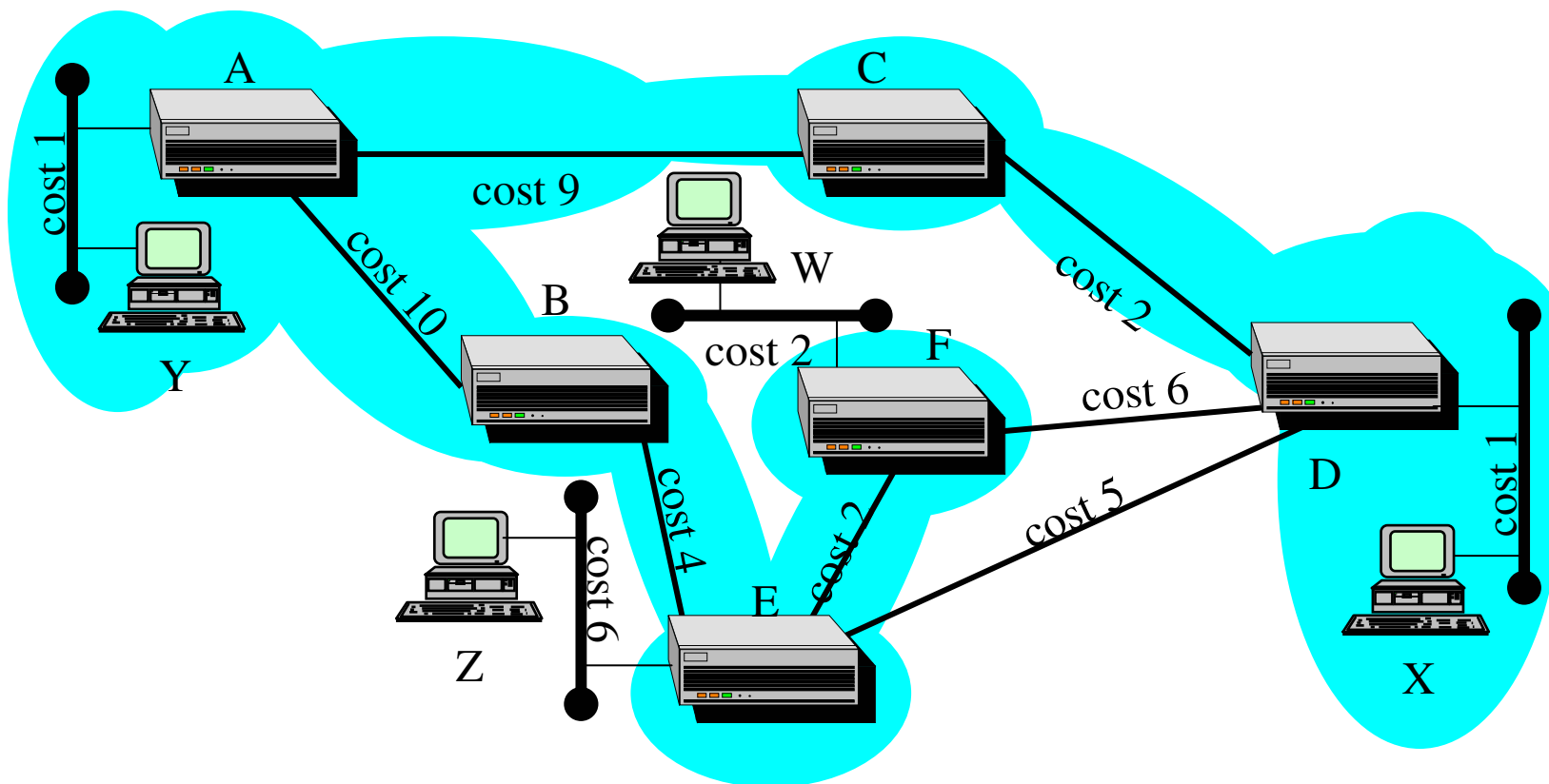


# 6<sup>o</sup> step to compute shortest path tree di A





# 7<sup>o</sup> step to compute shortest path tree di A





# 8<sup>0</sup> step to compute shortest path tree di A

