Chapter 07
Routing Basics and Static Routing

What is Routing?

- Routing Means: finding all possible paths to destination networks and selecting the best path

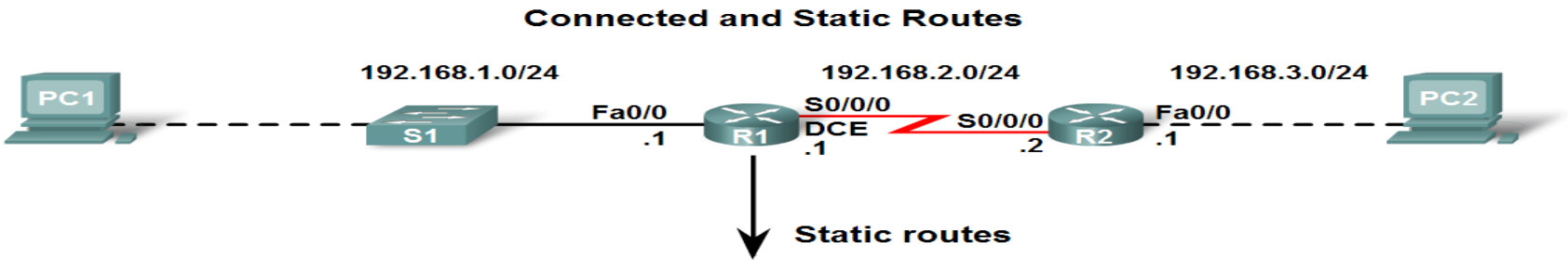
- Routing methods:
  - Static Routing
  - Dynamic Routing

Routing Table Structure

- Routing Table is stored in RAM and contains information about:
  - Directly connected networks - this occurs when a device is connected to another router interface
  - Remotely connected networks - this is a network that is not directly connected to a particular router
  - Detailed information about the networks include source of information, network address & subnet mask, and IP address of next-hop router
- show ip route command is used to view a routing table

Router interfaces

- Each router interface is a member of a different network
- Activated using the *no shutdown* command




```
R1#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, FastEthernet0/0
C    192.168.2.0/24 is directly connected, Serial0/0/0
S    192.168.3.0/24 [1/0] via 192.168.2.2
```

Dymanic Routing

- Maintaining routing tables

  -Dynamic routing protocols are used to share routing information with other router & to maintain and up date their own routing table.

- IP routing protocols. Example of routing protocols include:

  -RIP

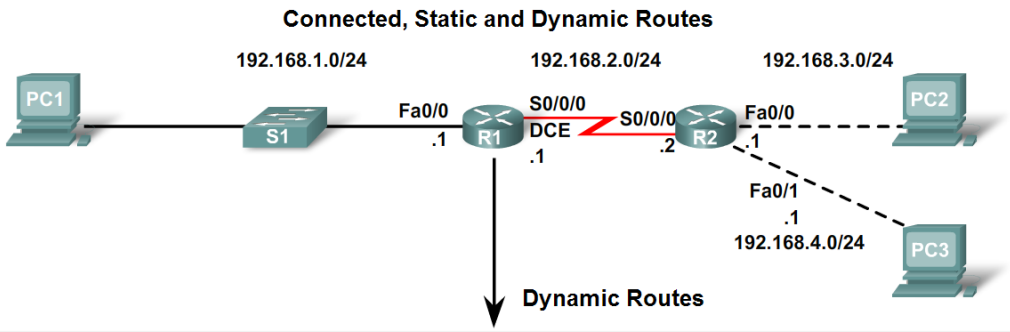
  -IGRP

  -EIGRP

  -OSPF

  -IS-IS

  -BGP

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S    192.168.3.0/24 [1/0] via 192.168.2.2
R    192.168.4.0/24 [120/1] via 192.168.2.2, 00:00:20, Serial0/0/0
```

Routing Table Structure

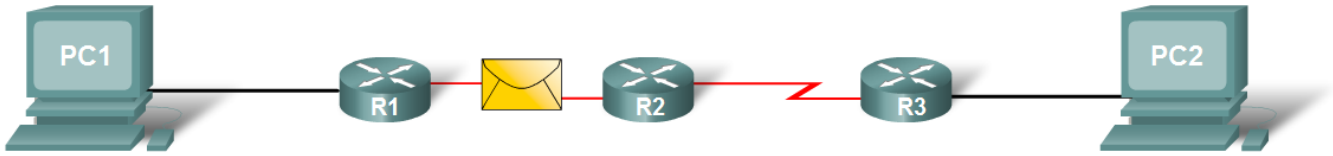
- Routing Table Principles

  - 3 principles regarding routing tables:

    - Every router makes its decisions alone, based on the information it has in its routing table.
    - Different routing table may contain different information.
    - A routing table can tell how to get to a destination but not how to get back.

Routing Principle 3 in Action

R1 has a route to PC2's network.

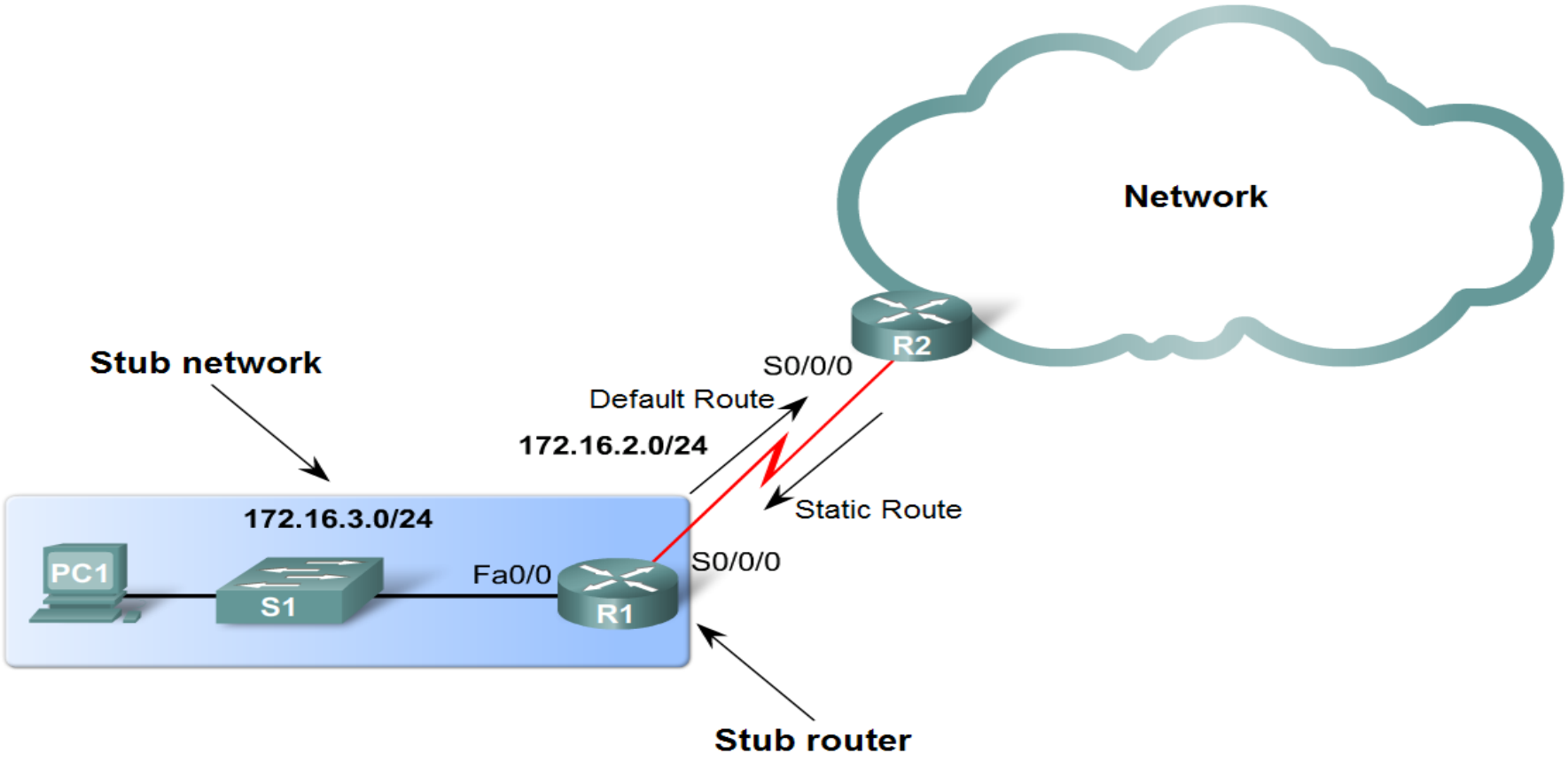


Static Routing

Static Routes with Exit Interfaces

- **Purpose of a static route**

  A manually configured route used when routing from a network to a stub network



Static Routes with Exit Interfaces

- **IP route command**
  - To configure a static route use the following command: ip route
  - Example:

    -Router(config)# ip route network-address subnet-mask {ip-address | exit-interface }

```
Router(config)# ip route network-address subnet-mask
{ip-address | exit-interface }
```

Parameter	Description
network-address	Destination network address of the remote network to be added to the routing table.
subnet-mask	Subnet mask of the remote network to be added to the routing table. The subnet mask can be modified to summarize a group of networks.
ip-address	Commonly referred to as the next-hop router's IP address.
exit-interface	Outgoing interface that is used to forward packets to the destination network.

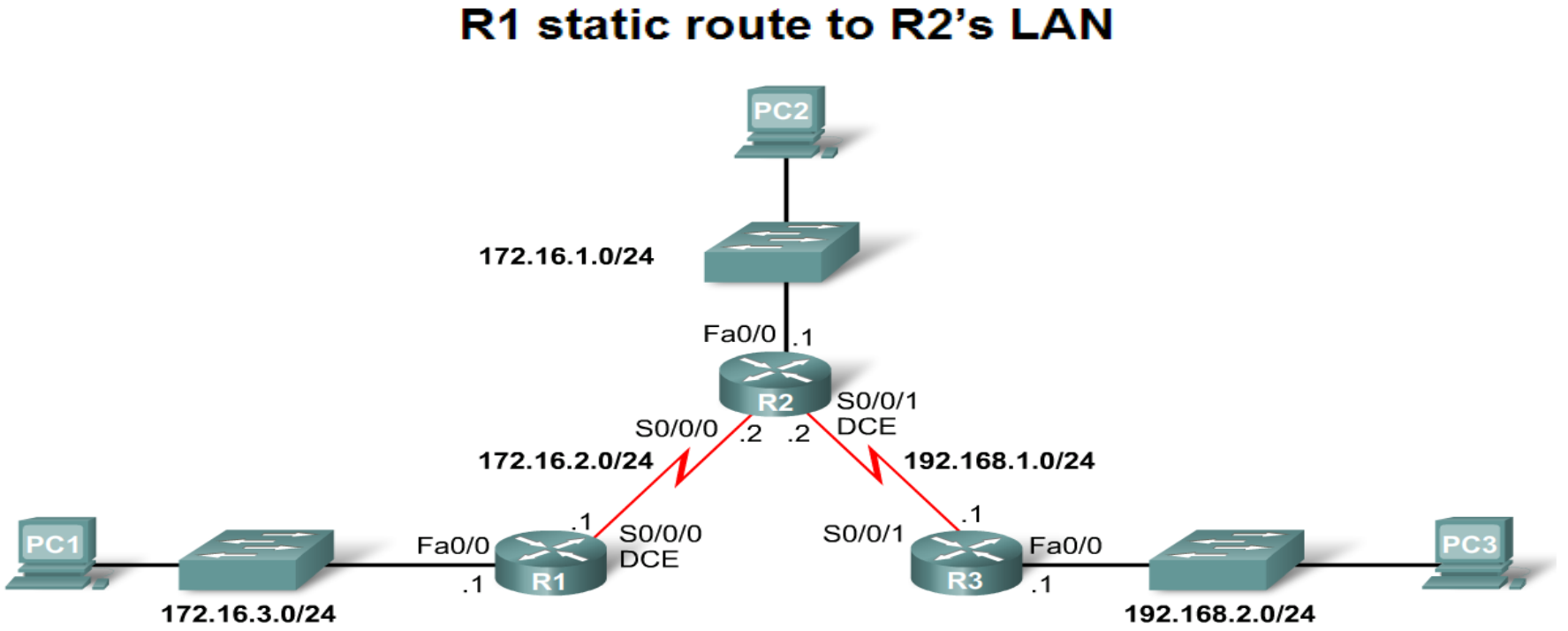
Static Routes with Exit Interfaces

- **Configuring routes to 2 or more remote networks**

  Use the following commands for R1

  -R1(config)#ip route 192.168.1.0 255.255.255.0 172.16.2.2

  -R1(config)#ip route 192.168.2.0 255.255.255.0 172.16.2.2

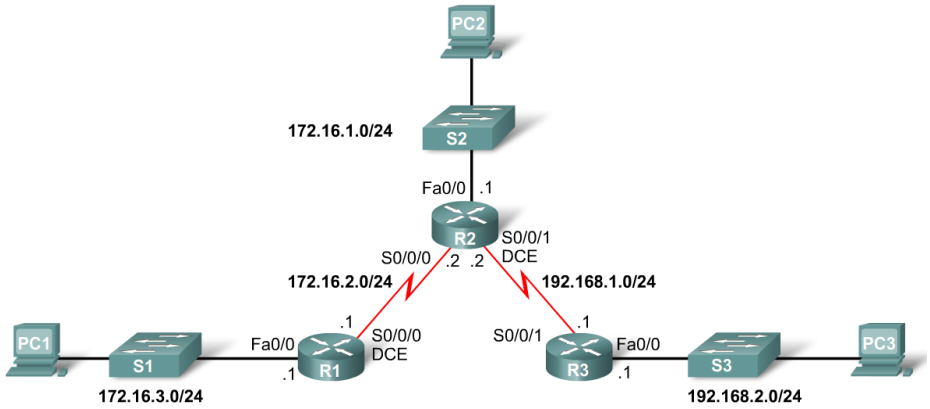


Static Routes with Exit Interfaces

- **Verifying the Static Route Configuration**

  -Use the following commands

  - Step 1 show running-config
  - Step 2 verify static route has been entered correctly
  - Step 3 show ip route
  - Step 4 verify route was configured in routing table
  - Step 5 issue ping command to verify packets can reach destination and that Return path is working

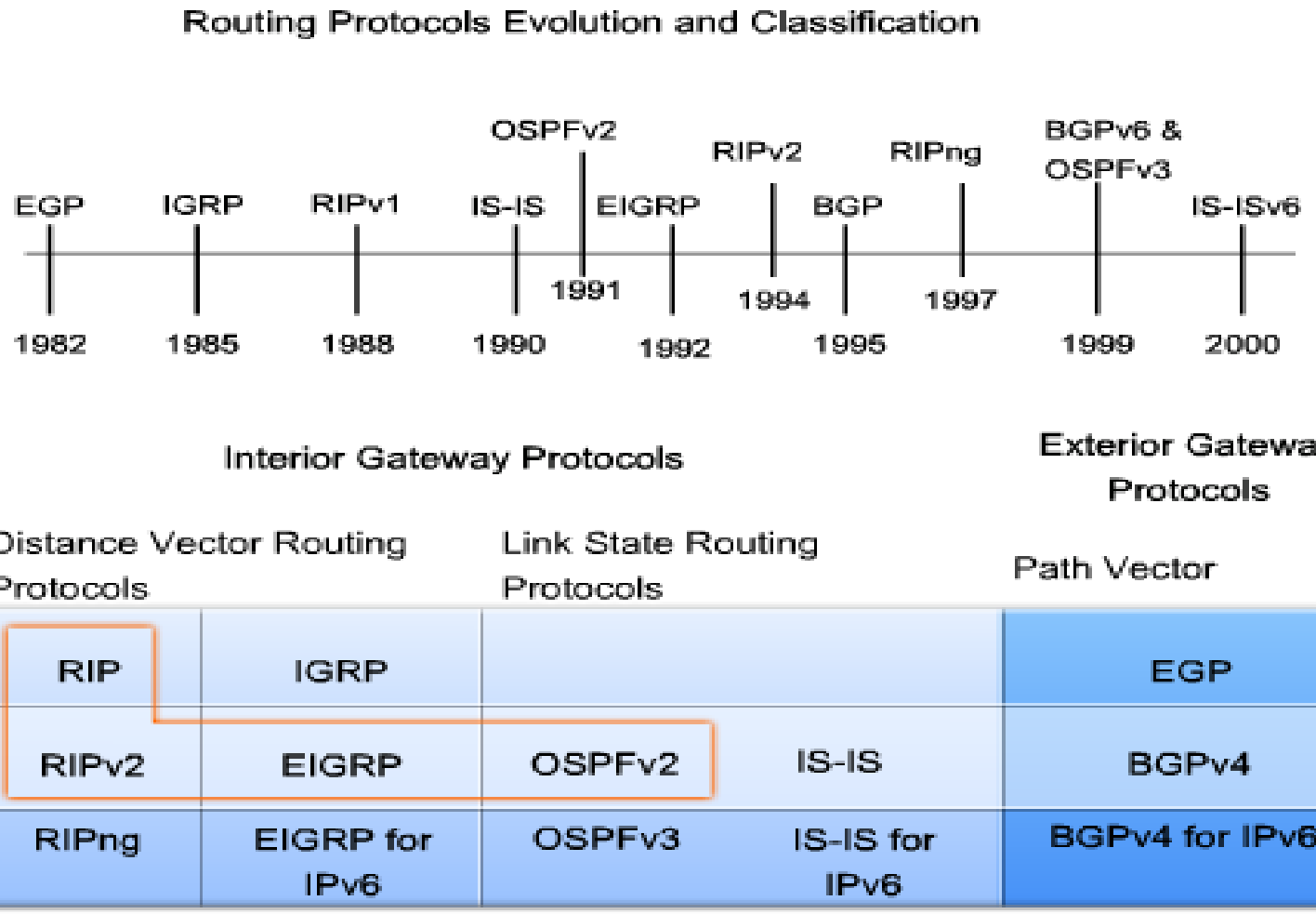


Summary and Default Route

- **Default Static Route**
  - This is a route that will match all packets. Stub routers that have a number of static routes all exiting the same interface are good candidates for a default route.
    - -Like route summarization this will help reduce the size of the routing table
- **Configuring a default static route**
  - Similar to configuring a static route. Except that destination IP address and subnet mask are all zeros
  - Example:
    - -Router(config)# ip route 0.0.0.0 0.0.0.0 [exit-interface | ip-address]

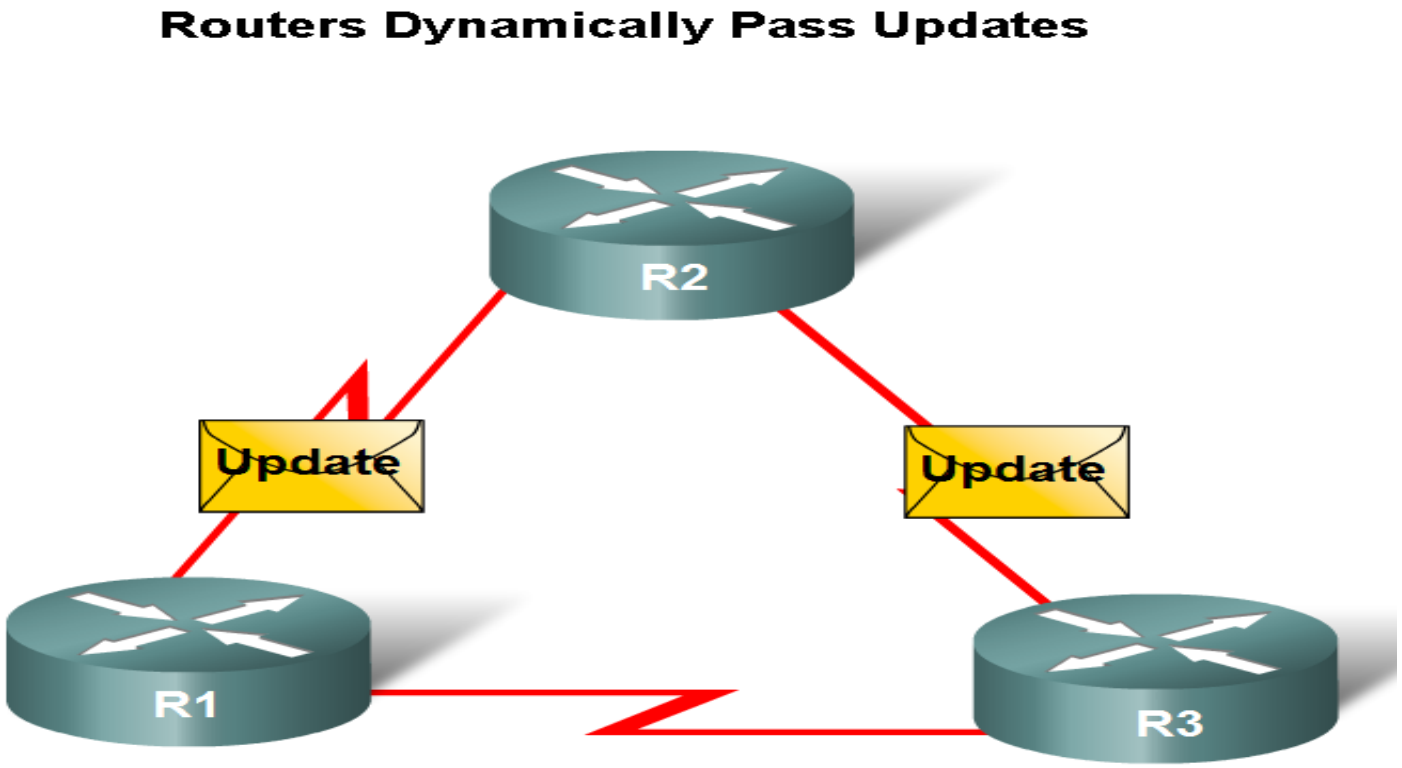
Introduction to Dynamic Routing Protocol

Dynamic Routing Protocols



Dynamic Routing Protocols

- Function(s) of Dynamic Routing Protocols:
  - -Dynamically share information between routers.
  - -Automatically update routing table when topology changes.
  - -Determine best path to a destination.

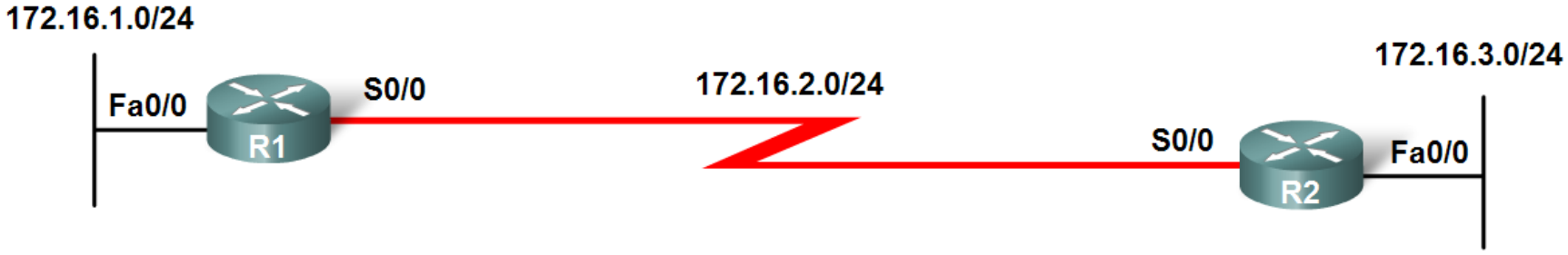


Dynamic Routing Protocols

- The **purpose of a dynamic routing protocol** is to:
  - -Discover remote networks
  - -Maintaining up-to-date routing information
  - -Choosing the best path to destination networks
  - -Ability to find a new best path if the current path is no longer available

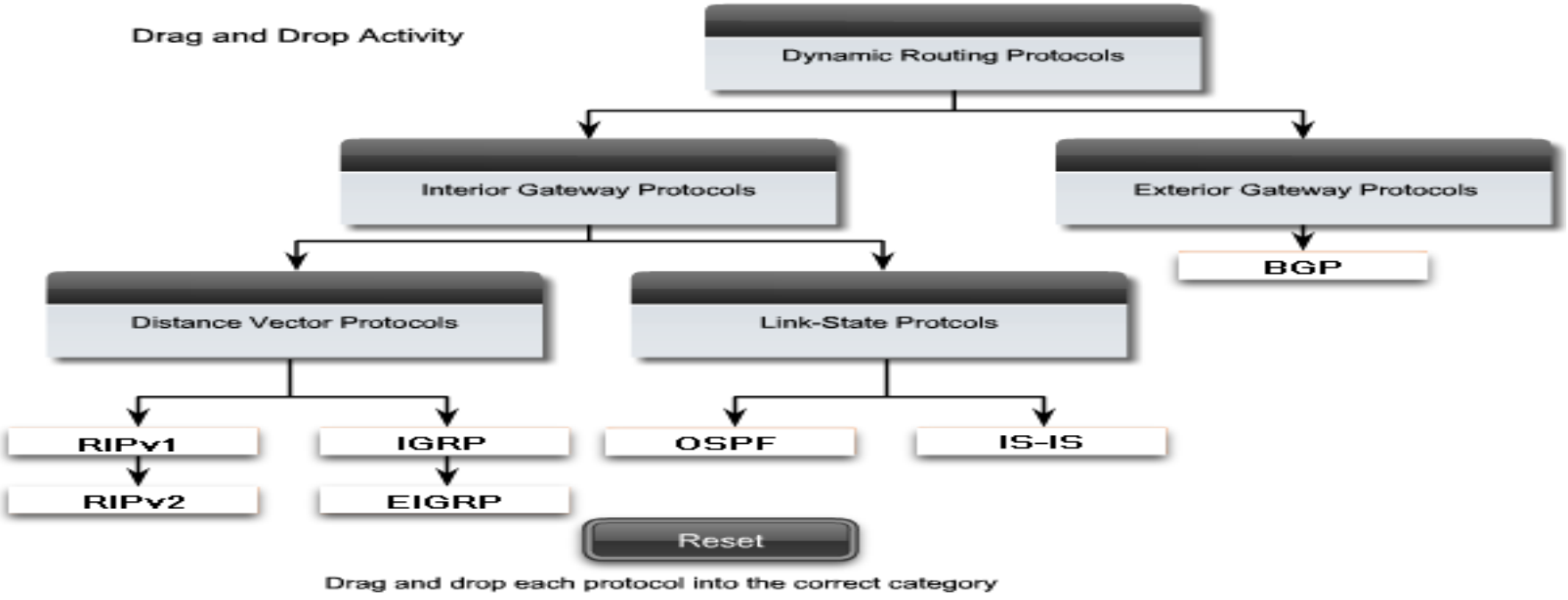
Routing Protocol Operation

Routing protocols are used to exchange routing information between the routers.



Classifying Routing Protocols

- **Dynamic routing protocols** are grouped according to characteristics. Examples include:



- **Autonomous System** is a group of routers under the control of a single authority.

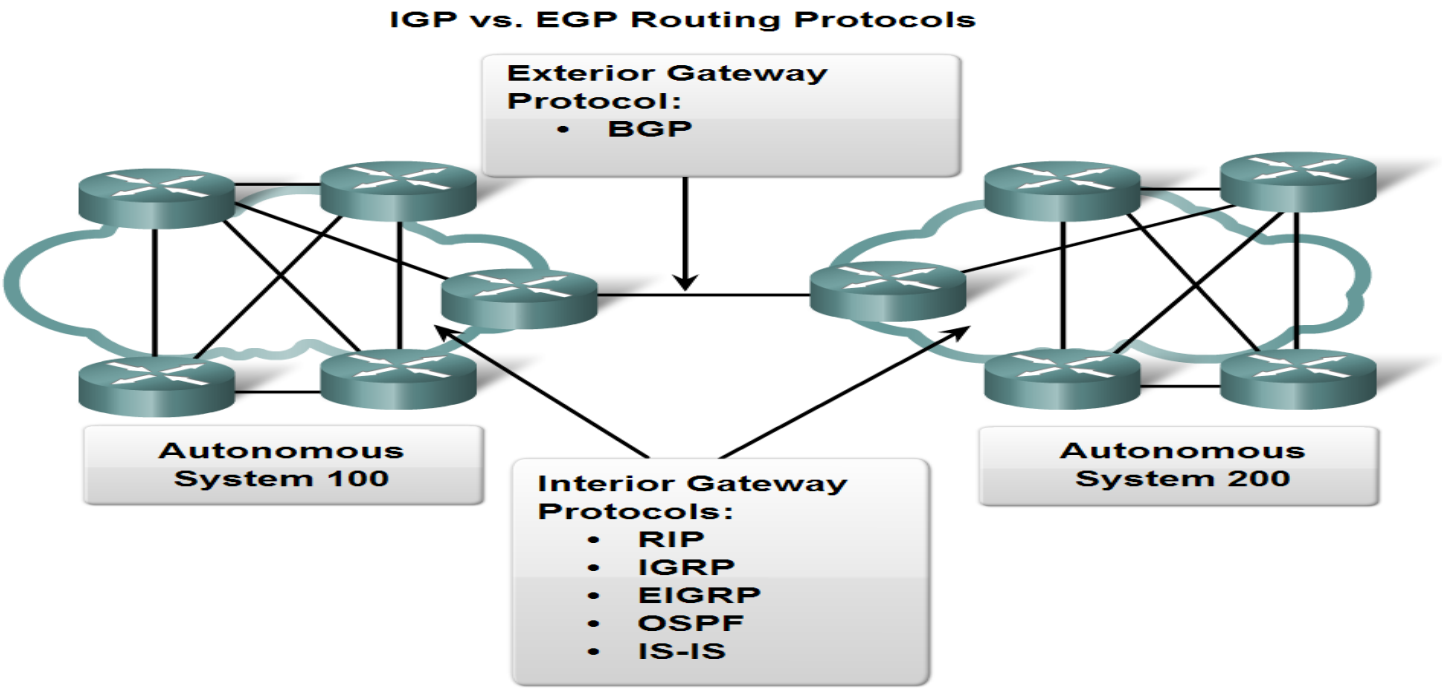
Classifying Routing Protocols

- **Interior Gateway Protocols** (IGP)

  Used for routing inside an autonomous system & used to route within the individual networks themselves.

- **Exterior Gateway Protocols** (EGP)

  Used for routing between autonomous systems



Classifying Routing Protocols

- IGP: **Comparison of Distance Vector & Link State** Routing Protocols

Distance vector

– Routing updates from / to neighbors only.

– incomplete view of network topology.

– Generally, periodic updates.

Link state

– complete view of network topology is created.

– updates are not periodic.

Routing Protocols Metrics

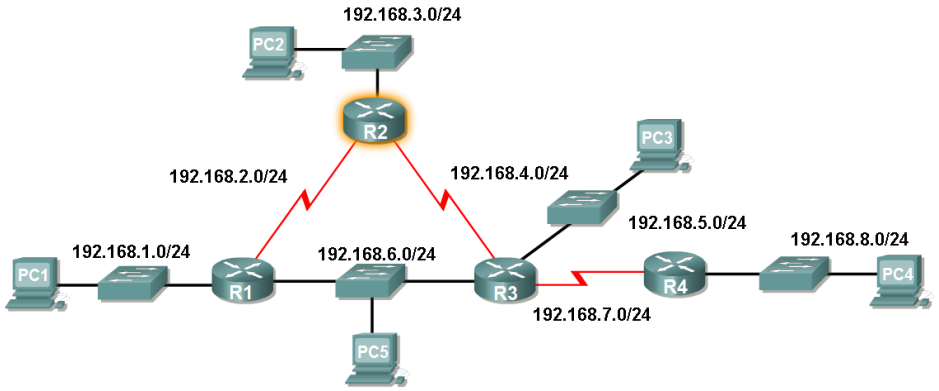
- The Metric Field in the Routing Table
- **Metric** used for each routing protocol

  -RIP - hop count

  -IGRP & EIGRP - Bandwidth (used by default), Delay (used by default), Load, Reliability,MTU

  -IS-IS & OSPF – Cost (Bandwidth (Cisco's implementation))

Metric in the Routing Table




```
R2#show ip route
<output omitted>

Gateway of last resort is not set

R    192.168.1.0/24 [120/1] via 192.168.2.1, 00:00:24, Serial0/0
C    192.168.2.0/24 is directly connected, Serial0/0
C    192.168.3.0/24 is directly connected, FastEthernet0/0
C    192.168.4.0/24 is directly connected, Serial0/1
R    192.168.5.0/24 [120/1] via 192.168.4.1, 00:00:26, Serial0/1
R    192.168.6.0/24 [120/1] via 192.168.2.1, 00:00:24, Serial0/0
                            [120/1] via 192.168.4.1, 00:00:26, Serial0/1
R    192.168.7.0/24 [120/1] via 192.168.4.1, 00:00:26, Serial0/1
R    192.168.8.0/24 [120/2] via 192.168.4.1, 00:00:26, Serial0/1
```

It is 2 hops from R2 to 192.168.8.0/24

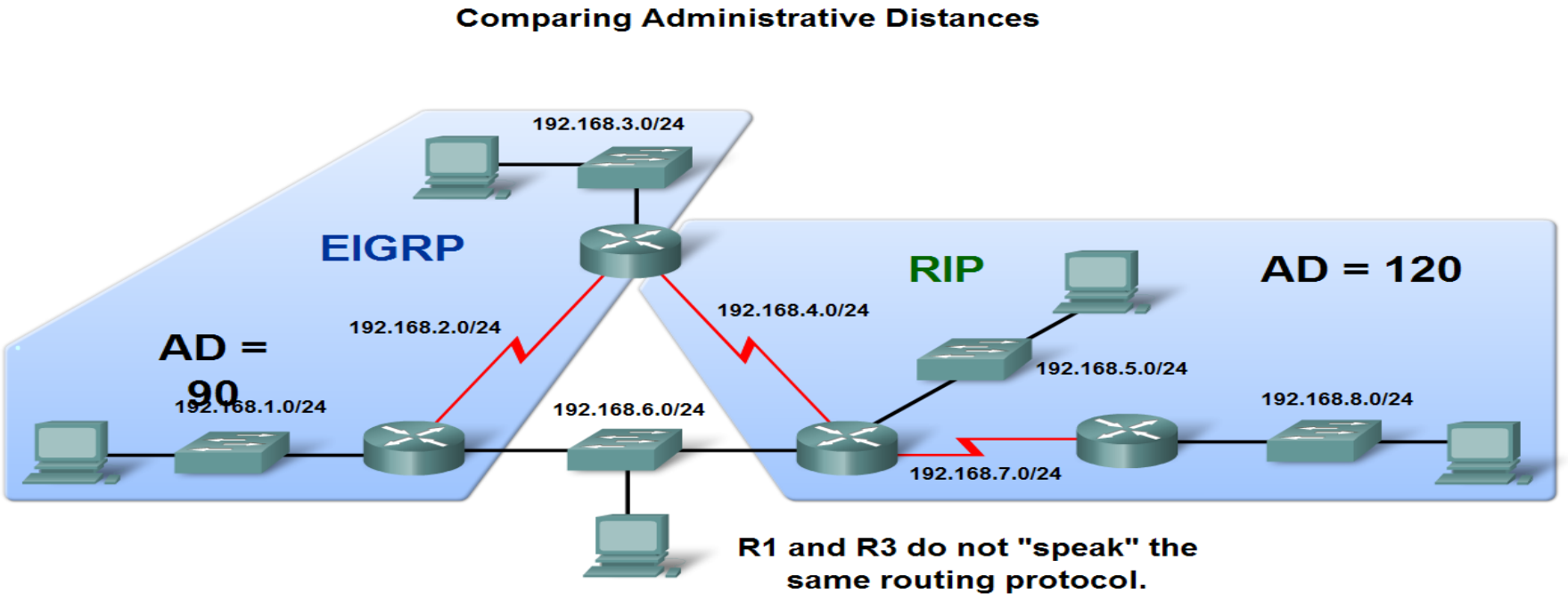
Administrative Distance of a Route

- **Purpose of a metric**

  It's a calculated value used to determine the best path to a destination

- **Purpose of Administrative Distance**

  It's a numeric value that specifies the preference of a particular route



Administrative Distance of a Route

- **Dynamic Routing Protocols**

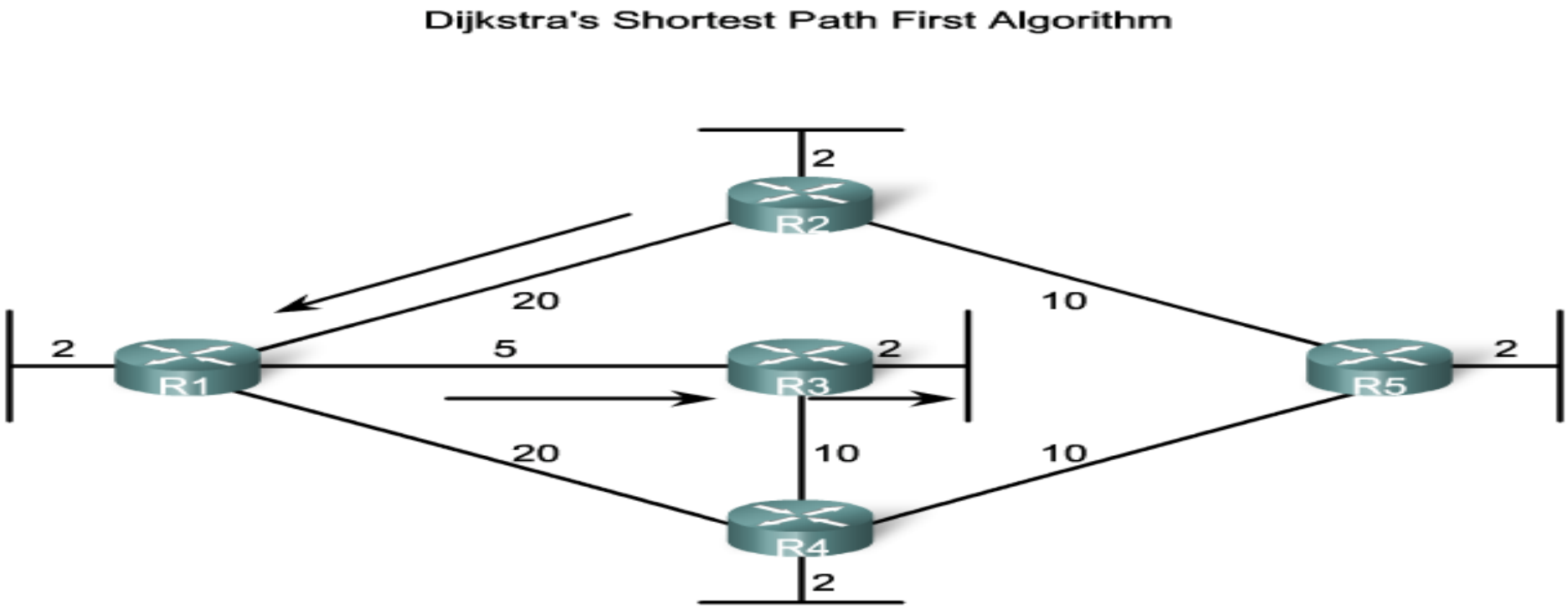
Default Administrative Distances

Route source	Default AD
Connected interface	0
Static	1
EIGRP summary route	5
eBGP	20
EIGRP (Internal)	90
IGRP	100
OSPF	110
IS - IS	115
RIP	120
EIGRP (External)	170
iBGP	200
Unknown	255

Link-State Routing Protocols

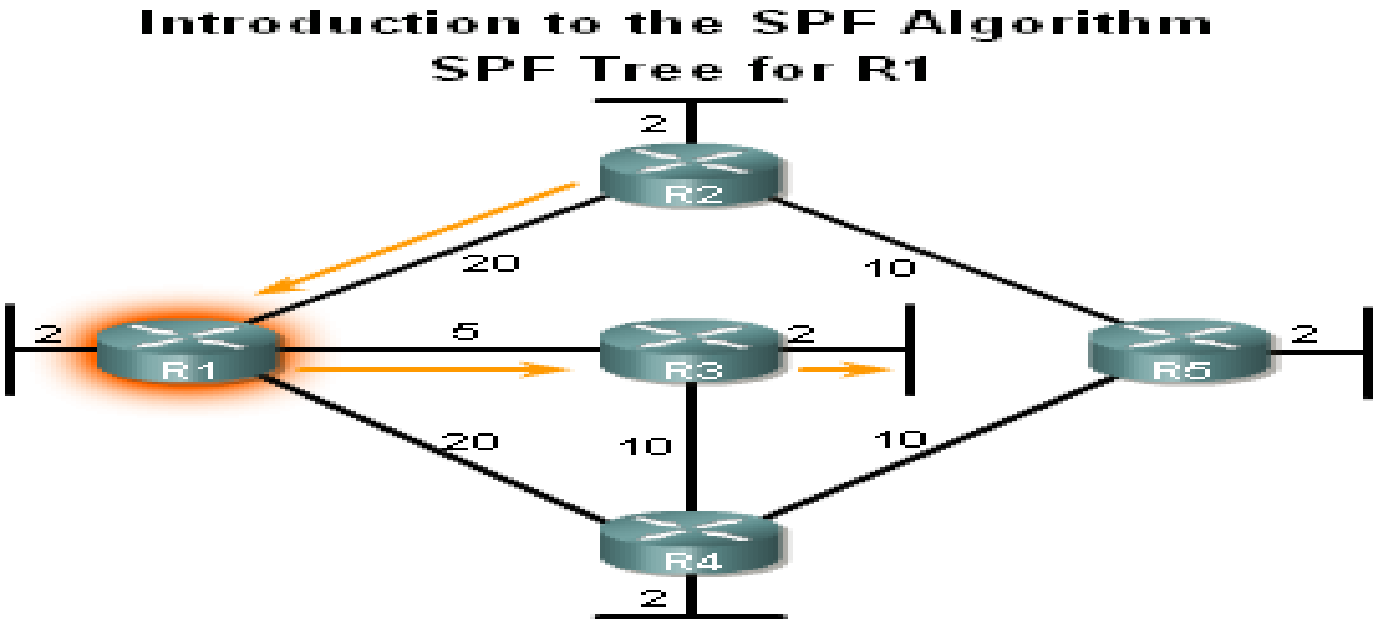
Link-State Routing

Dikjstra's algorithm also known as the shortest path first (SPF) algorithm



Link-State Routing

- The shortest path to a destination is not necessarily the path with the least number of hops



Destination	Shortest Path	Cost
R2 LAN	R1 to R2	22
R3 LAN	R1 to R3	7
R4 LAN	R1 to R3 to R4	17
R5 LAN	R1 to R3 to R4 to R5	27