Introduction to Dynamic Routing Protocol

Routing Protocols and Concepts

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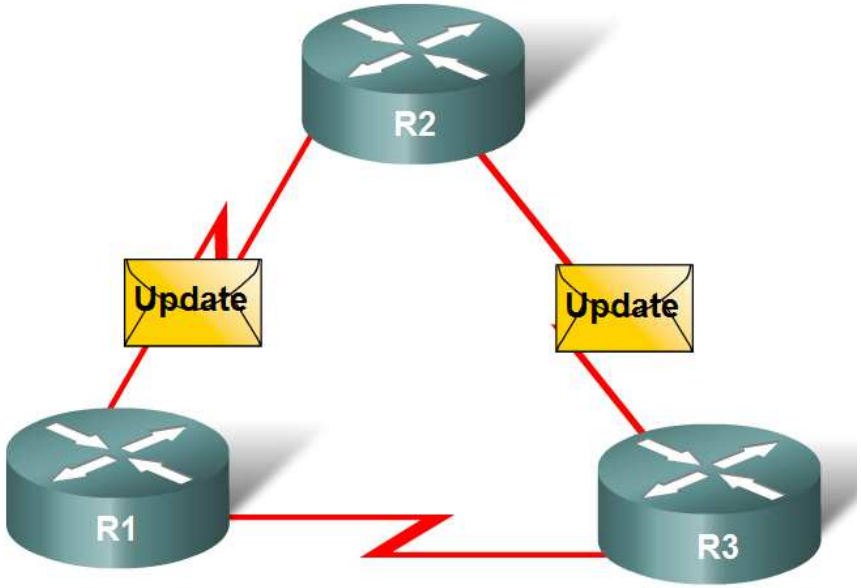
Objectives

- Describe the role of dynamic routing protocols and place these protocols in the context of modern network design.
- Identify several ways to classify routing protocols.
- Describe how metrics are used by routing protocols and identify the metric types used by dynamic routing protocols.
- Determine the administrative distance of a route and describe its importance in the routing process.
- Identify the different elements of the routing table.

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.

Routers Dynamically Pass Updates



Dynamic Routing Protocols

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- 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.

Dynamic Routing Protocols

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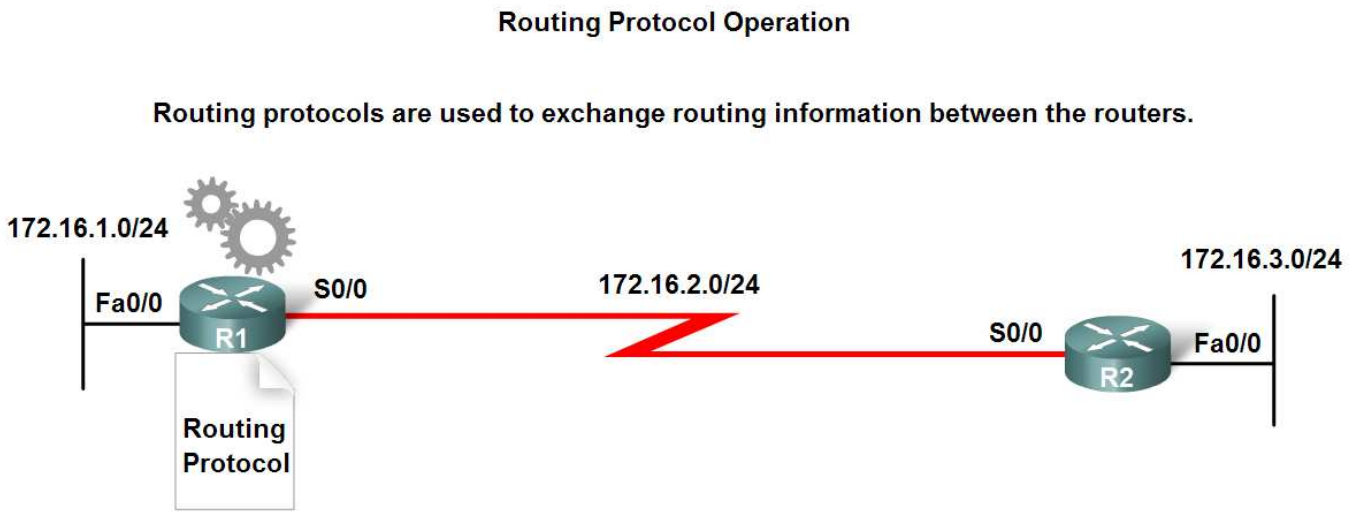
- **Components of a routing protocol**
  - **Algorithm**
    - In the case of a routing protocol algorithms are used for facilitating routing information and best path determination
  - **Routing protocol messages**
    - These are messages for discovering neighbors and exchange of routing information

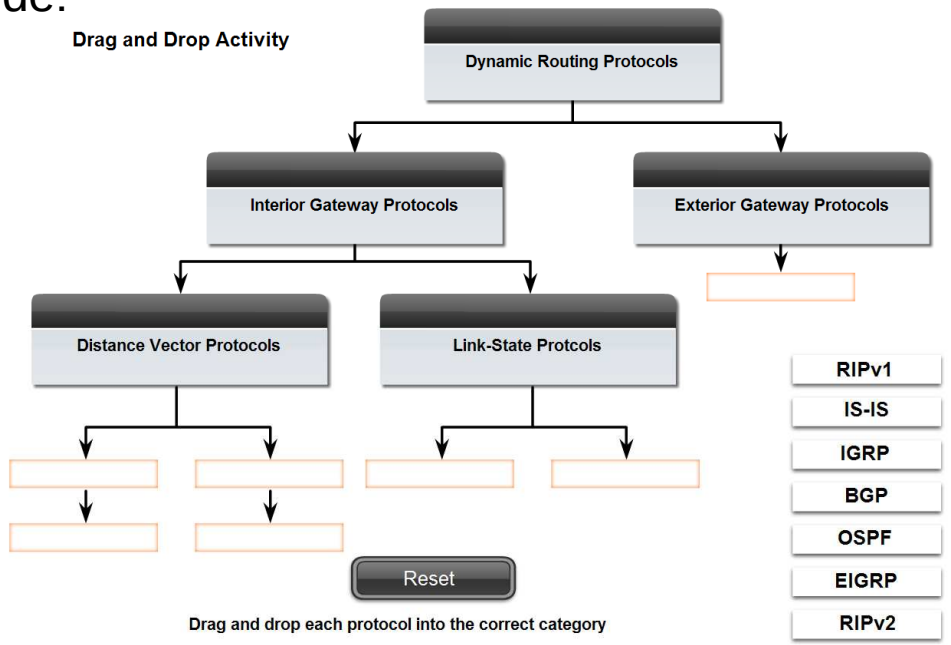


Dynamic Routing Protocols

- Advantages of **static routing**
  - It can backup multiple interfaces/networks on a router
  - Easy to configure
  - No extra resources are needed
  - More secure
- Disadvantages of **static routing**
  - Network changes require manual reconfiguration
  - Does not scale well in large topologies

Classifying Routing Protocols

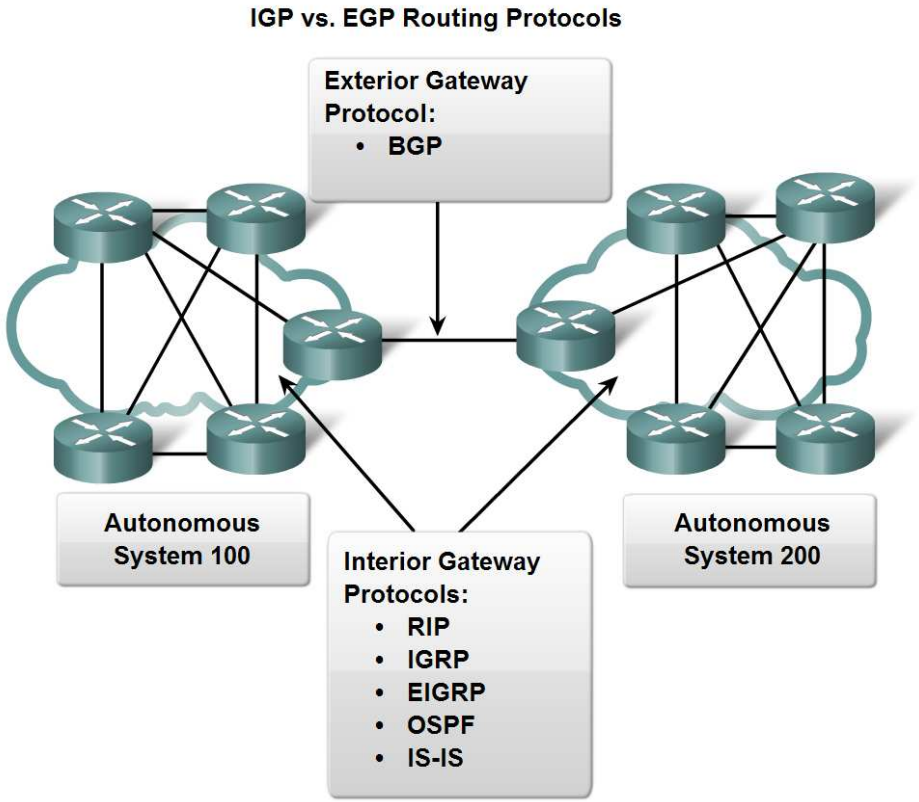
- **Dynamic routing protocols** are grouped according to characteristics. Examples include:
  - RIP
  - IGRP
  - EIGRP
  - OSPF
  - IS-IS
  - BGP



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

Classifying Routing Protocols

- **Types of routing protocols**:
  - **Interior Gateway Protocols** (IGP)
  - **Exterior Gateway Protocols** (EGP)
  -



Classifying Routing Protocols

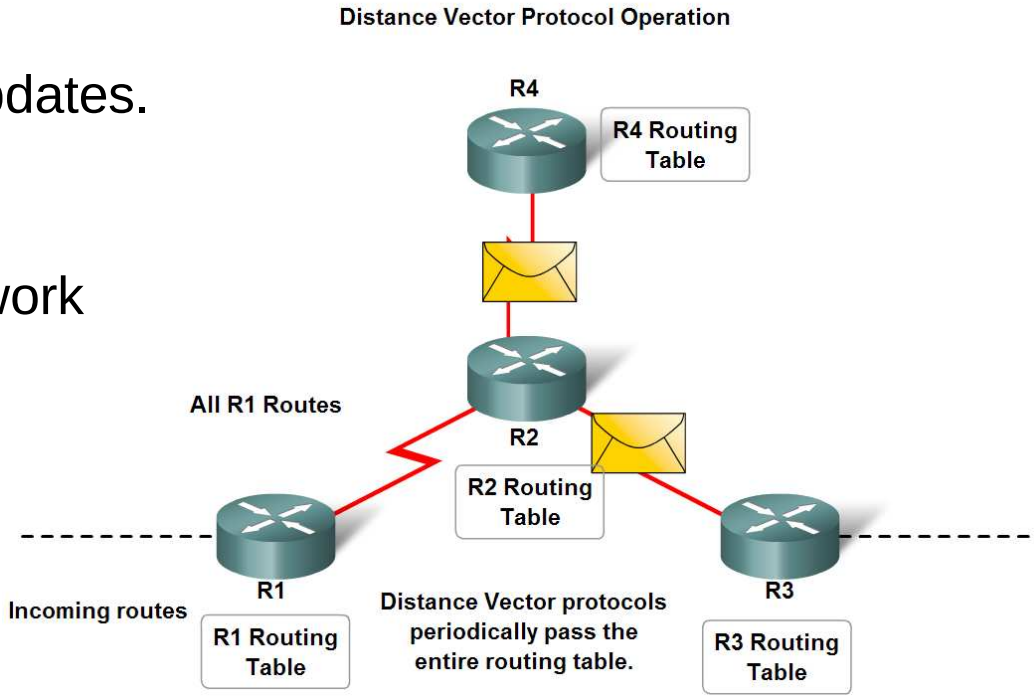
- **Interior Gateway Routing Protocols (IGP)**
  - Used for routing inside an autonomous system & used to route within the individual networks themselves.
  - Examples: RIP, EIGRP, OSPF
- **Exterior Routing Protocols (EGP)**
  - Used for routing between autonomous systems
  - Example: BGPv4

Classifying Routing Protocols

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

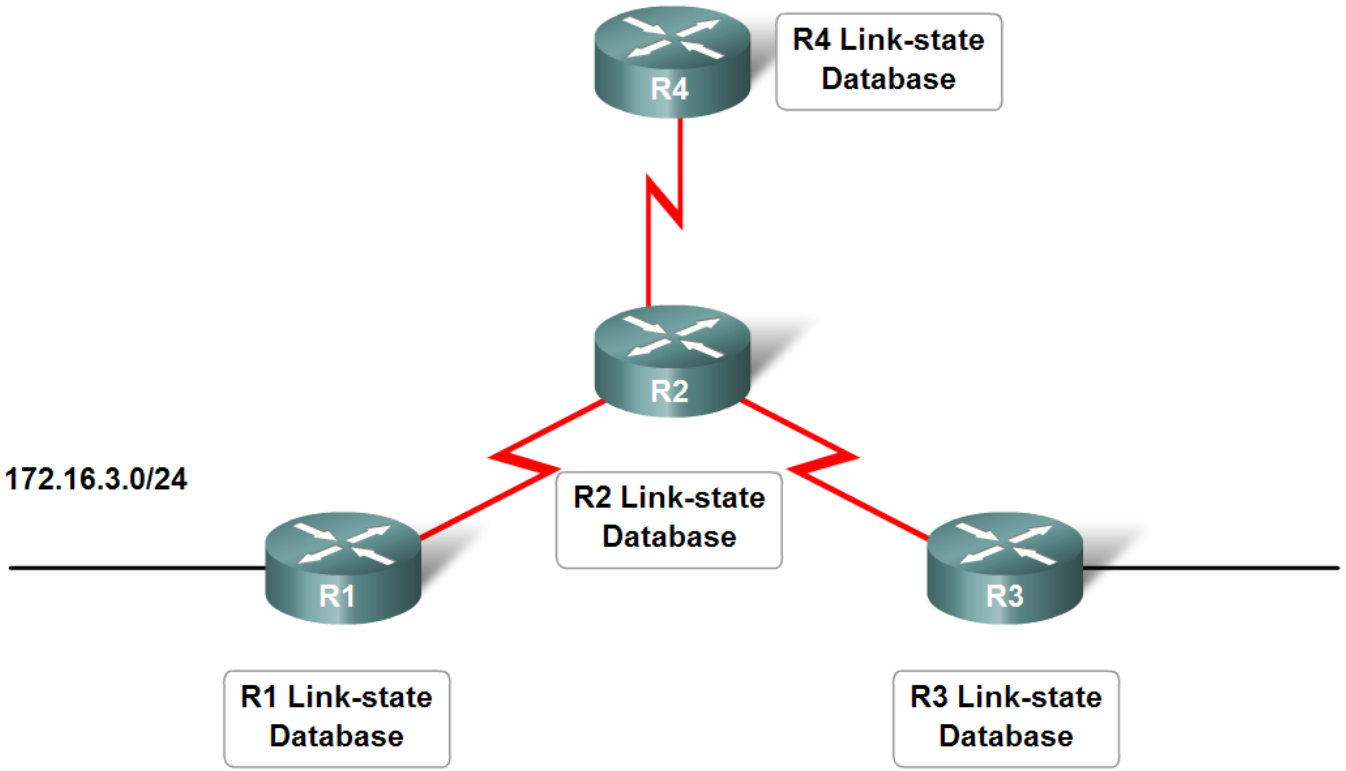
  - **Distance vector**
    - routes are advertised as vectors of distance & direction.
    - Incomplete view of network
    - topology
    - Generally, periodic updates.

  - **Link state**
    - complete view of network
    - topology is created.
    - updates are not
    - periodic.



Classifying Routing Protocols

Link-state Protocol Operation

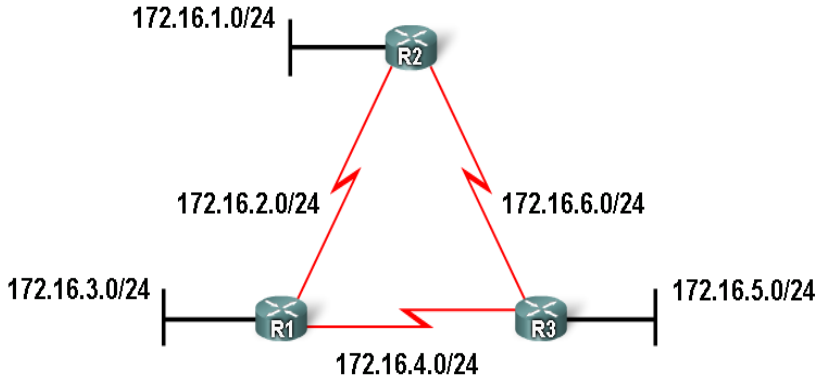


Link-state protocols pass updates when a link's state changes.

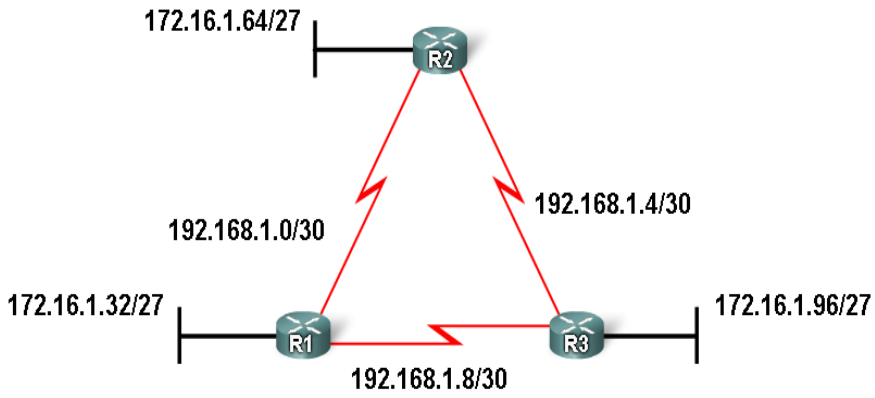
Classifying Routing Protocols

- **Classful routing protocols**
  - Do NOT send subnet mask in routing updates
- **Classless routing protocols**
  - Do send subnet mask in routing updates.

Classful vs. Classless Routing



Classful: Subnet mask is the same throughout the topology



Classless: Subnet mask can vary in the topology

Classifying Routing Protocols

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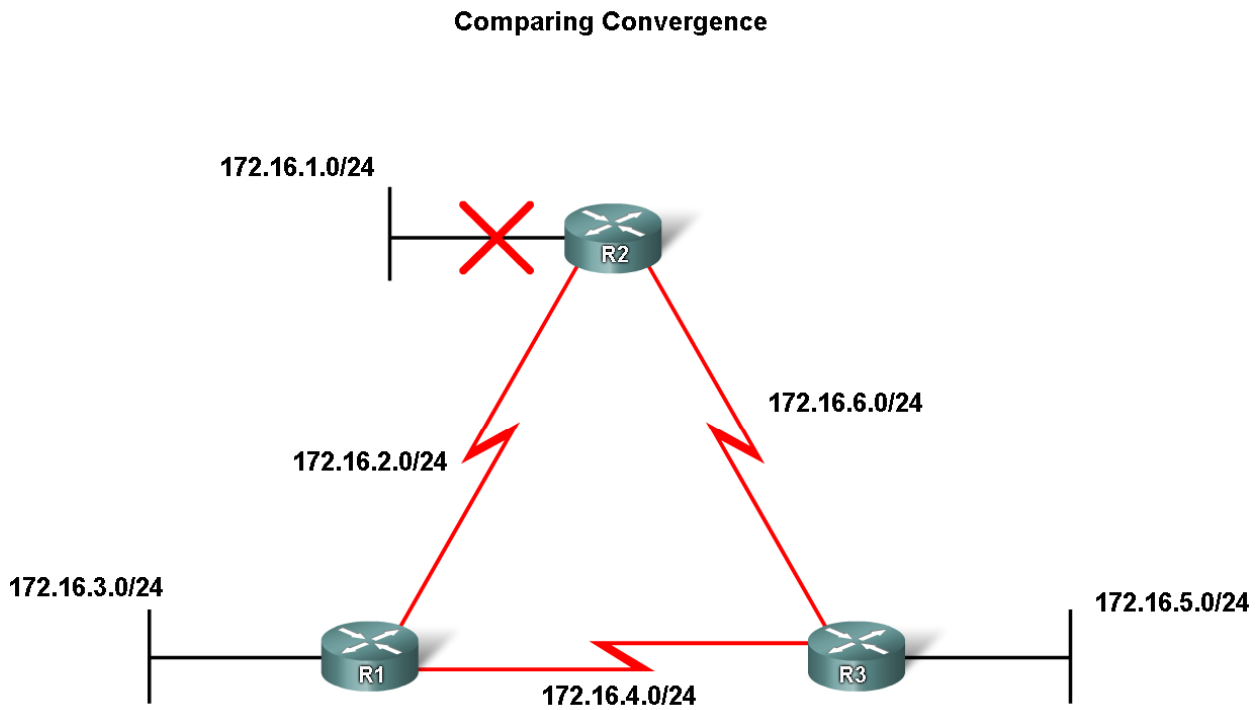
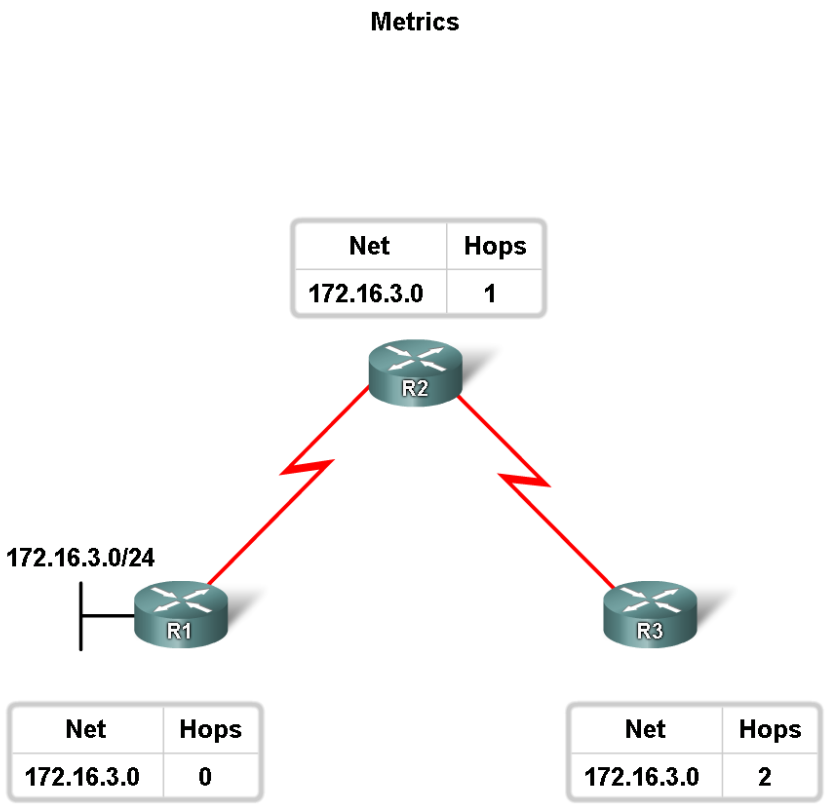
- **Convergence** is defined as when all routers' routing tables are at a state of consistency



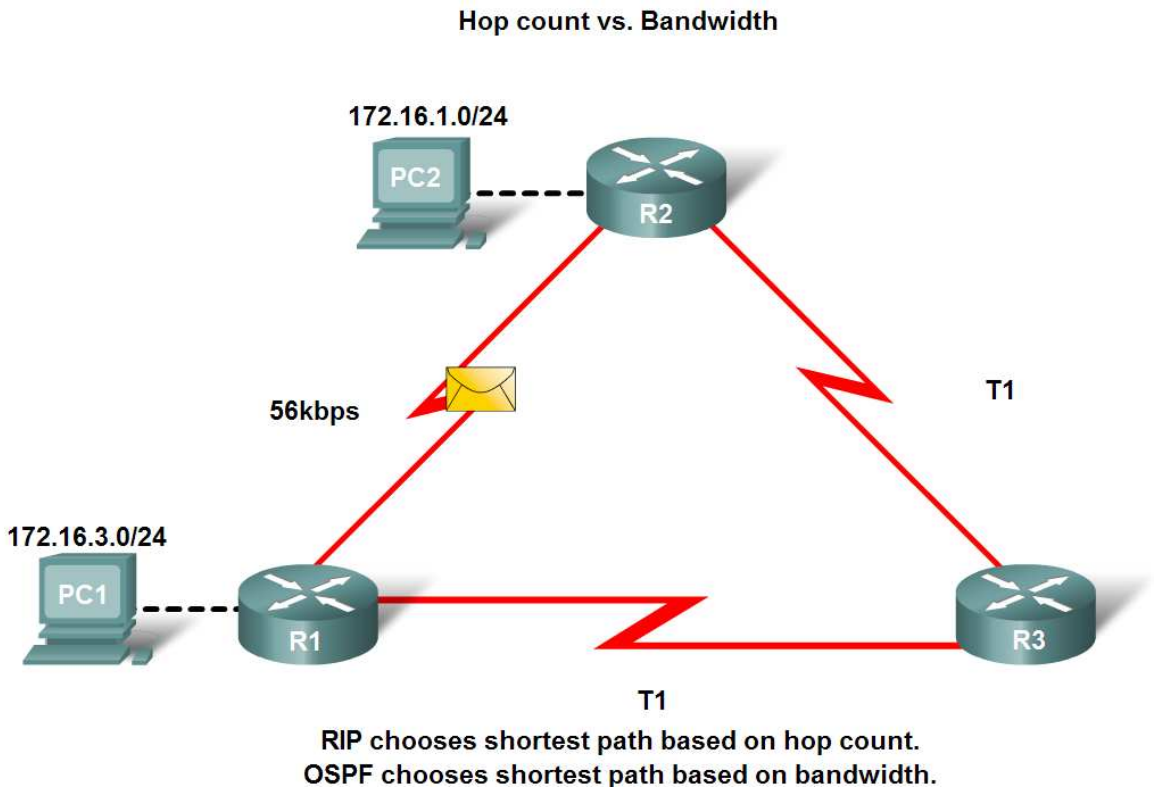
Routing Protocols Metrics

- **Metric**
  - A value used by a routing protocol to determine which routes are better than others.



Routing Protocols Metrics

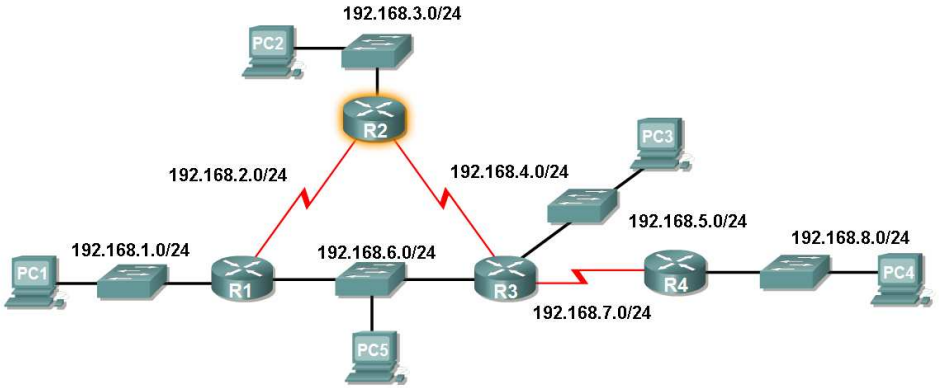
- **Metrics used in IP routing protocols**
  - Bandwidth
  - Cost
  - Delay
  - Hop count
  - Load
  - Reliability



Routing Protocols Metrics

Metric in the Routing Table

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




```
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

Routing Protocols Metrics

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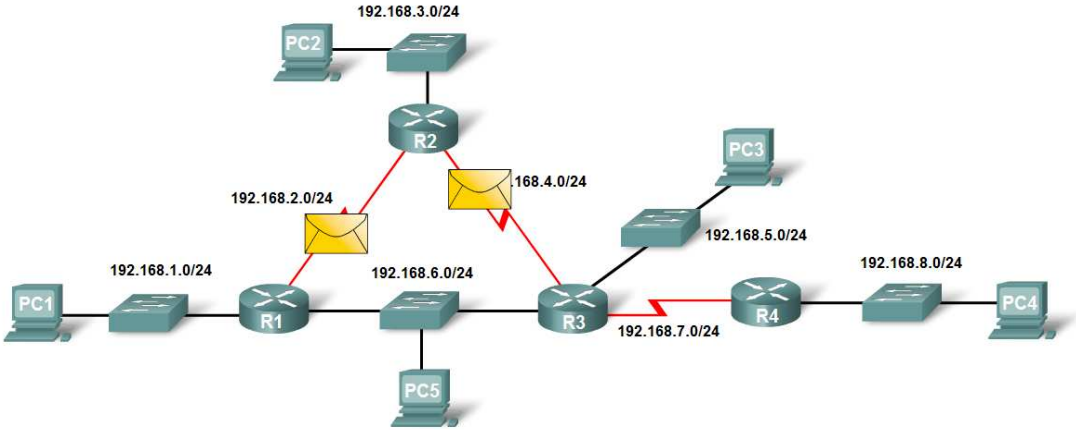
- **Load balancing**
  - This is the ability of a router to distribute packets among multiple same cost paths

Load Balancing Across Equal Cost Paths

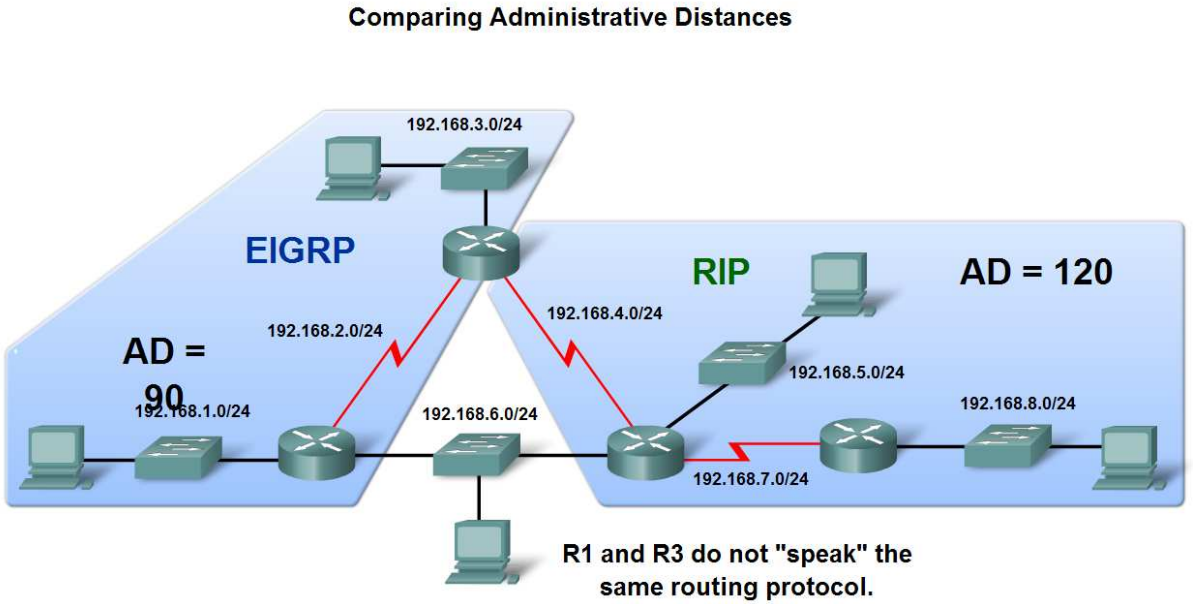



```
R2#show ip route
<output omitted>

R    192.168.6.0/24 [120/1] via 192.168.2.1, 00:00:24, Serial0/0/0
                    [120/1] via 192.168.4.1, 00:00:26, Serial0/0/1
```

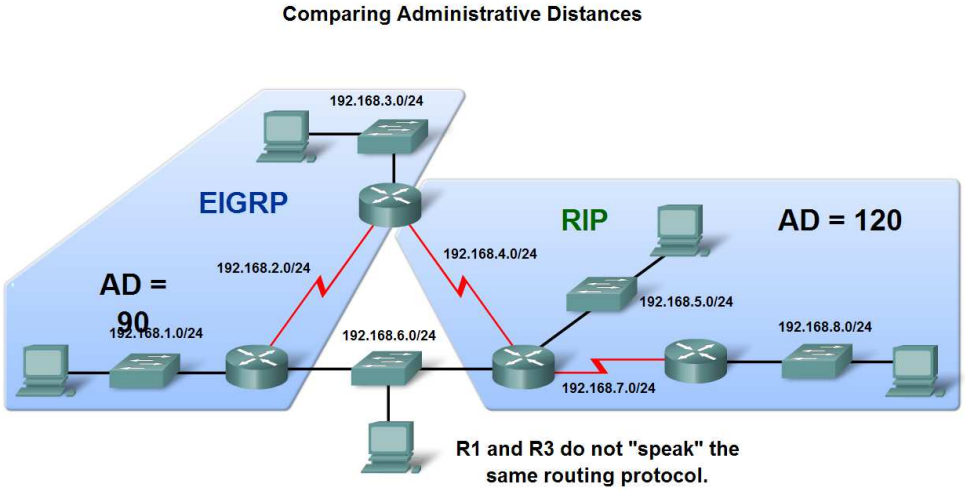
Administrative Distance of a Route

- **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

- **Identifying the Administrative Distance** (AD) in a routing table
  - It is the first number in the brackets in the routing table




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


Gateway of last resort is not set

D    192.168.1.0/24 [90/2172416] via 192.168.2.1, 00:00:24, Serial0/0/0
C    192.168.2.0/24 is directly connected, Serial0/0/0
C    192.168.3.0/24 is directly connected, FastEthernet0/0
C    192.168.4.0/24 is directly connected, Serial0/0/1
R    192.168.5.0/24 [120/1] via 192.168.4.1, 00:00:08, Serial0/0/1
D    192.168.6.0/24 [90/2172416] via 192.168.2.1, 00:00:24, Serial0/0/0
R    192.168.7.0/24 [120/1] via 192.168.4.1, 00:00:08, Serial0/0/1
R    192.168.8.0/24 [120/2] via 192.168.4.1, 00:00:08, Serial0/0/1
```

```
R2#show ip rip database
192.168.3.0/24    directly connected, FastEthernet0/0
192.168.4.0/24    directly connected, Serial0/0/1
192.168.5.0/24
    [1] via 192.168.4.1, Serial0/0/1
192.168.6.0/24
    [1] via 192.168.4.1, Serial0/0/1
192.168.7.0/24
    [1] via 192.168.4.1, Serial0/0/1
192.168.8.0/24
    [2] via 192.168.4.1, Serial0/0/1
```

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

Administrative Distance of a Route

- **Directly connected routes**
  - Have a default **AD of 0**
- **Static Routes**
  - Administrative distance of a static route has a **default value of 1**

```
R2#show ip route 172.16.3.0
Routing entry for 172.16.3.0/24
Known via "static", distance 1, metric 0 (connected)
  Routing Descriptor Blocks:
  * directly connected, via Serial0/0/0
      Route metric is 0, traffic share count is 1
```

Administrative Distance of a Route

- **Directly connected routes**
  - -Immediately appear in the routing table as soon as the interface is configured

```
R2#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

     172.16.0.0/24 is subnetted, 3 subnets
C       172.16.1.0 is directly connected, FastEthernet0/0
C       172.16.2.0 is directly connected, Serial0/0/0
S       172.16.3.0 is directly connected, Serial0/0/0
C    192.168.1.0/24 is directly connected, Serial0/0/1
S    192.168.2.0/24 [1/0] via 192.168.1.1
```

Summary

- **Dynamic routing protocols** fulfill the following functions
  - Dynamically share information between routers
  - Automatically update routing table when topology changes
  - Determine best path to a destination
- **Routing protocols are grouped as either**
  - Interior gateway protocols (IGP)**Or**
  - Exterior gateway protocols(EGP)
- **Types of IGPs include**
  - Classless routing protocols - these protocols include subnet mask in routing updates
  - Classful routing protocols - these protocols do not include subnet mask in routing update

Summary

- **Metrics** are used by dynamic routing protocols to calculate the best path to a destination.
- **Administrative distance** is an integer value that is used to indicate a router's "trustworthiness"
- **Components of a routing table** include:
  - Route source
  - Administrative distance
  - Metric