Dynamic Routing Protocols

Module : Computer Networks
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Dynamic Routing Protocols

- **A routing protocol**

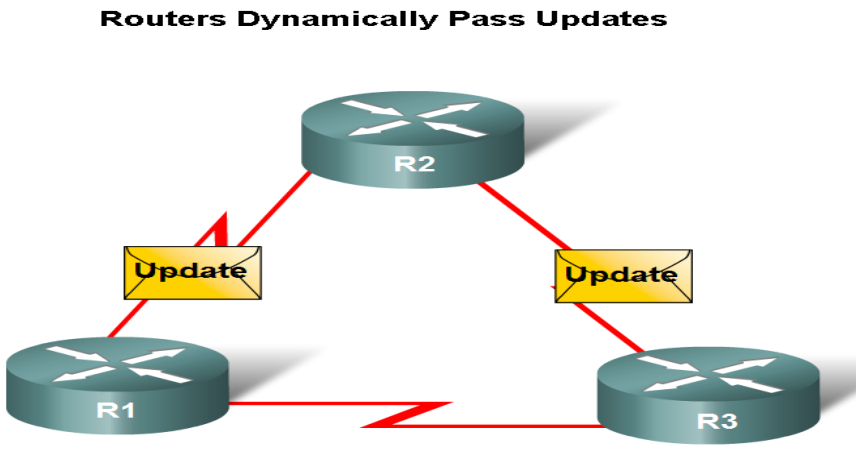
  –is a set of processes, algorithms, and messages that are used to exchange routing information and populate the routing table with the routing protocol's choice of best paths

- 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

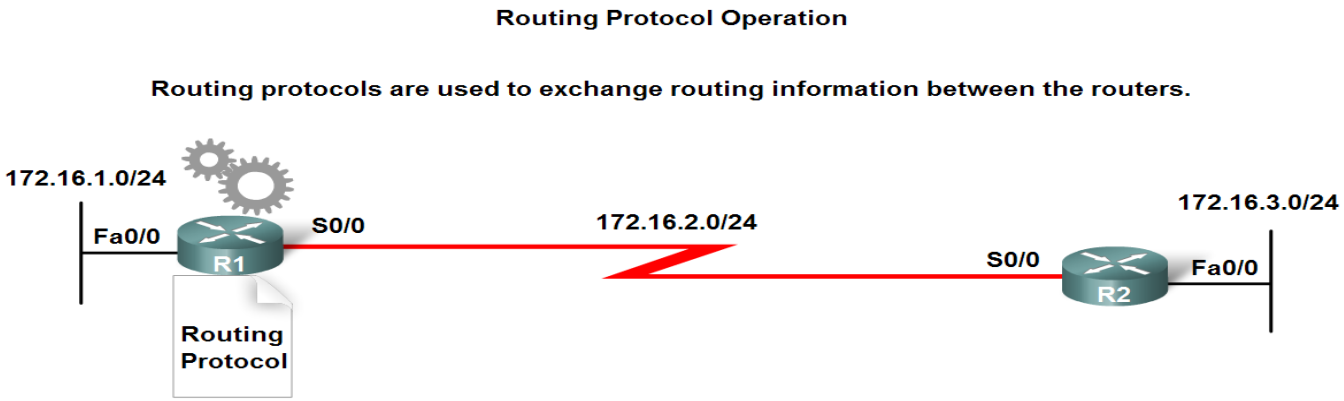
Routing protocols are used to exchange routing information between the routers.

Dynamic Routing Protocols

- **Components of a routing protocol**
  - **Data structures**
    - Some routing protocols use tables and/or databases for its operations. This information is kept in RAM
  - **Algorithm**

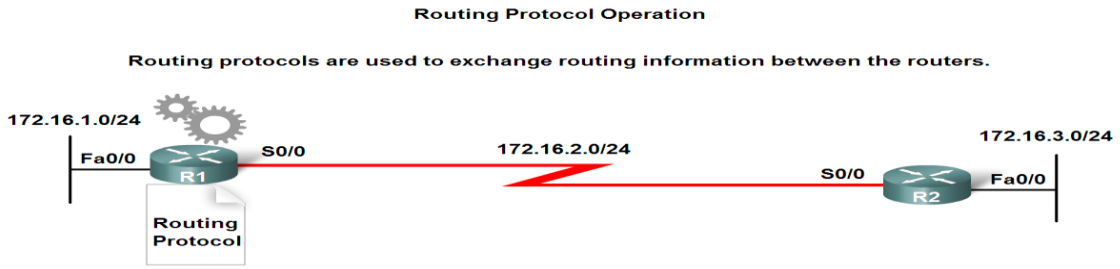
    In the case of a routing protocol algorithms are used for facilitating routing information and best path determination
  - **Routing protocol messages**

    These are messages for discovering neighbors and exchange of routing information



Dynamic Routing Protocol Operation

- All routing protocols have the same purpose - to learn about remote networks and to quickly adapt whenever there is a change in the topology.
- The method that a routing protocol uses to accomplish this depends upon the algorithm it uses and the operational characteristics of that protocol.
- In general, the operations of a dynamic routing protocol can be described as follows:
  - The router sends and receives routing messages on its interfaces.
  - The router shares routing messages and routing information with other routers that are using the same routing protocol.
  - Routers exchange routing information to learn about remote networks.
  - When a router detects a topology change the routing protocol can advertise this change to other routers.

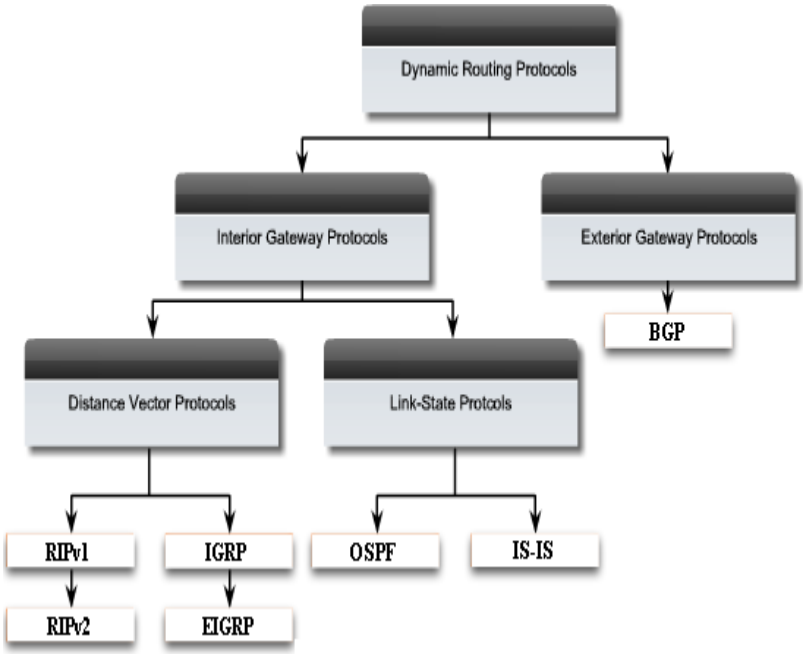


Dynamic Routing Protocols

- Advantages of **static routing**
  - -It can backup multiple interfaces/networks on a router
  - -Minimal CPU processing
  - -Easier for administrator to understand
  - -Easy to configure
  - -No extra resources are needed
  - -More secure
- Disadvantages of **static routing**
  - -Network changes require manual reconfiguration
  - -Configuration and maintenance is time-consuming
  - -Does not scale well in large topologies
  - -Configuration is error-prone, especially in large networks
- Advantages of **dynamic routing**
  - -Administrator has less work maintaining the configuration when adding or deleting networks.
  - -Protocols automatically react to the topology changes.
  - -Configuration is less error-prone.
  - -More scalable, growing the network usually does not present a problem
- Disadvantages of **dynamic routing**
  - -Router resources are used (CPU cycles, memory and link bandwidth).
  - -More administrator knowledge is required for configuration, verification, and troubleshooting.

Classifying Routing Protocols

- **Dynamic routing protocols**:
  - RIP
    - A distance vector interior routing protocol
  - EIGRP
    - The advanced distance vector interior routing protocol developed by Cisco
  - OSPF
    - A link-state interior routing protocol
  - IS-IS
    - A link-state interior routing protocol
  - BGP
    - A path vector exterior routing protocol



Routing Protocol Characteristics

- Other ways to compare routing protocols:

  Time to convergence:

  Faster the better.

  Scalability:

  How large a network the routing protocol can handle.

  Classless or Classful:

  Support VLSM and CIDR.

  Resource usage:

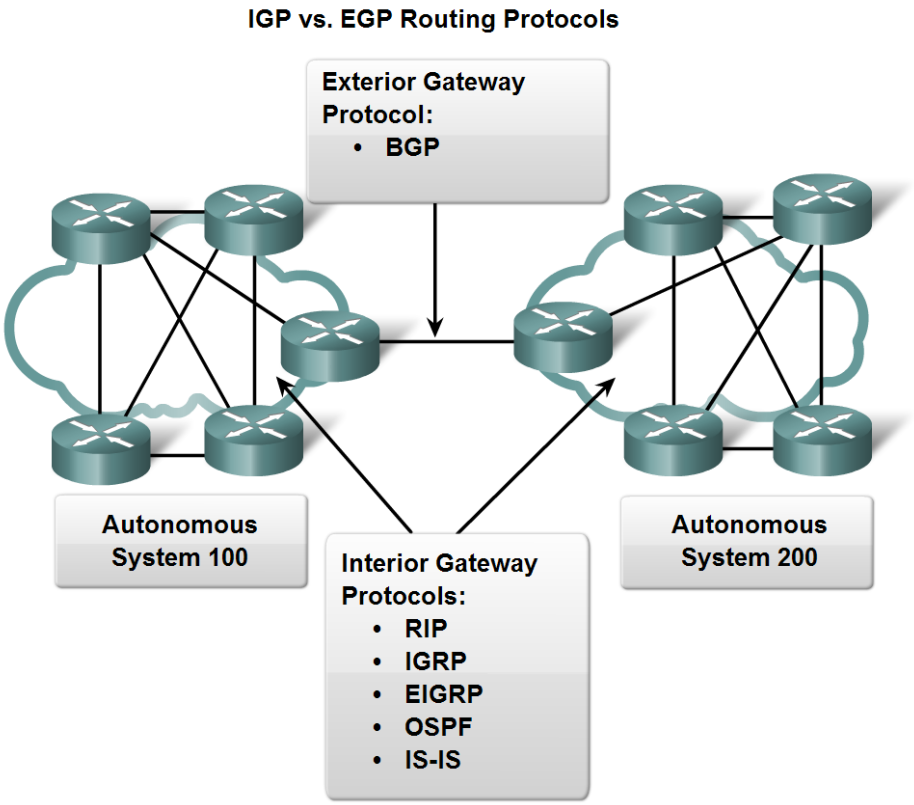
  Routing protocol usage of RAM, CPU utilization, and link bandwidth utilization.

  Implementation and maintenance:

  Level of knowledge of a network administrator.

Classifying Routing Protocols

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



Classifying Routing Protocols

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

Distance vector

– routes are advertised as vectors of distance & direction.

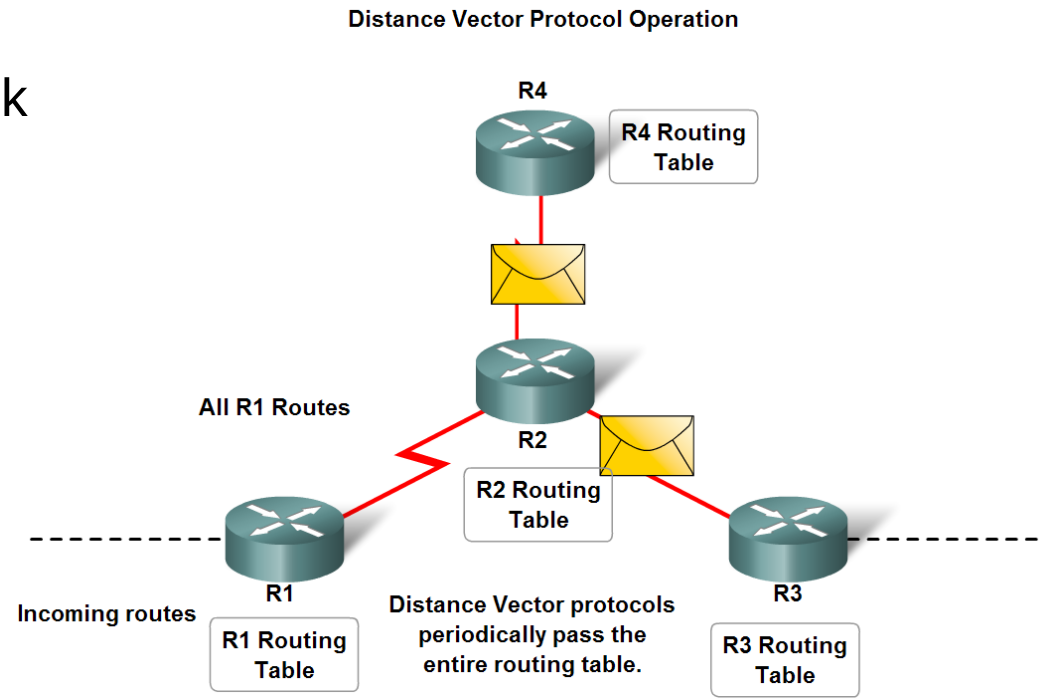
– incomplete view of network topology.

–Generally, periodic updates.

Link state

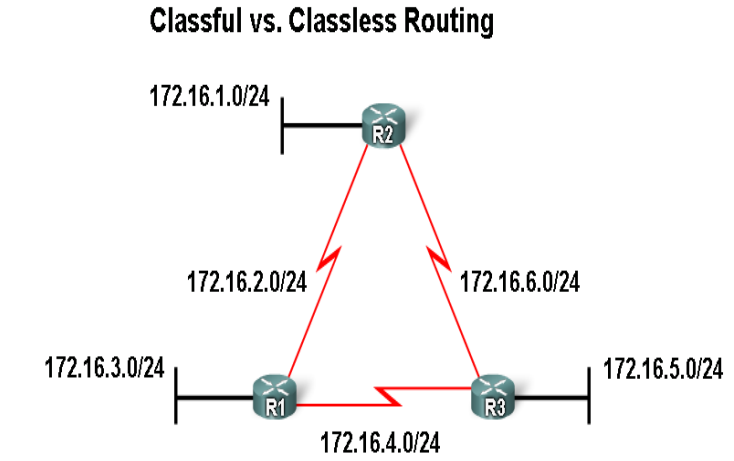
– complete view of network topology is created.

– updates are not periodic.

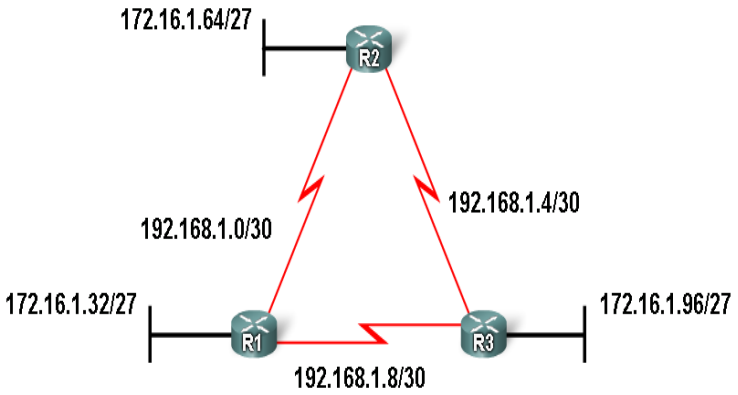


Classifying Routing Protocols

- **Classful routing protocols (Not really used)**
  - –Do NOT send subnet mask in routing updates,
  - –Do NOT support VLSM,
  - –Classful routing protocols cannot be used when a network is subnetted using more than one subnet mask,
  - –Routing protocols such as RIPv1
- **Classless routing protocols**
  - –Do send subnet mask in routing updates.
  - –support variable length subnet masks (VLSM).
    - •In the figure, the classless version of the network is using both /30 and /27 masks in the same topology.
    - •Classless routing protocols are RIPv2, EIGRP, OSPF, IS-IS, BGP.



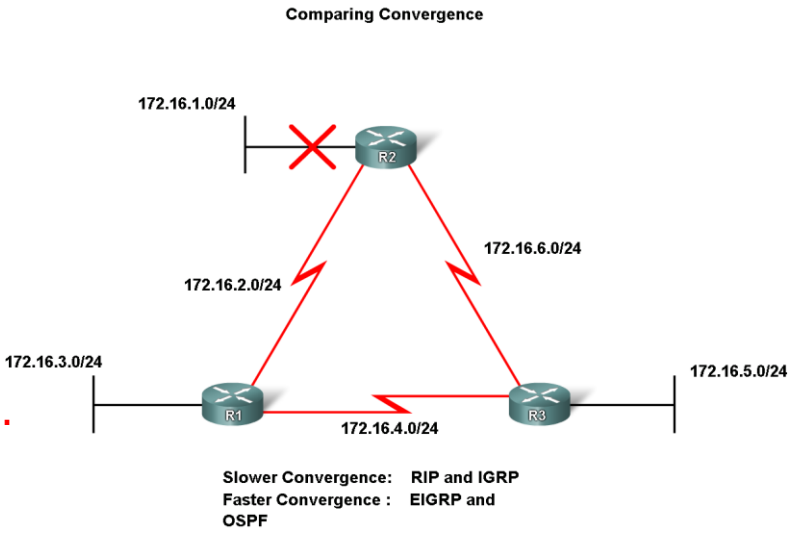
Classful: Subnet mask is the same throughout the topology



Classless: Subnet mask can vary in the topology

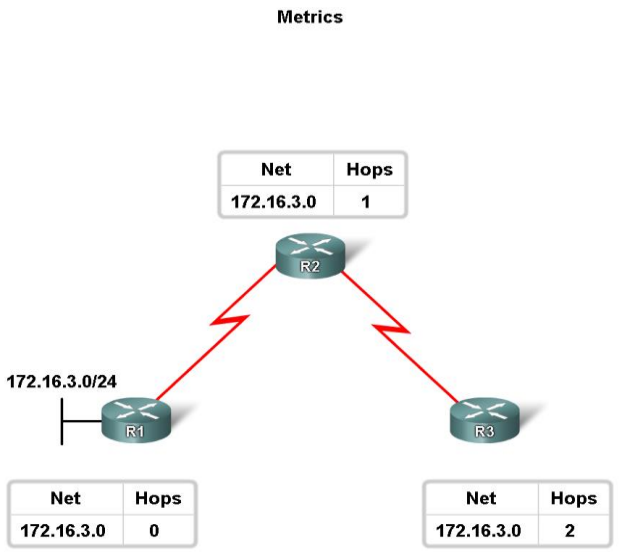
Classifying Routing Protocols

- **Convergence** is defined as when all routers' routing tables are at a state of consistency
  - The network has converged when all routers have complete and accurate information about the network
- Convergence time is the time it takes routers to share information, calculate best paths, and update their routing tables.
- Routing protocols can be rated based on the speed to convergence; the faster the convergence, the better the routing protocol.
  - RIP is slow to converge
  - EIGRP and OSPF are faster to converge.



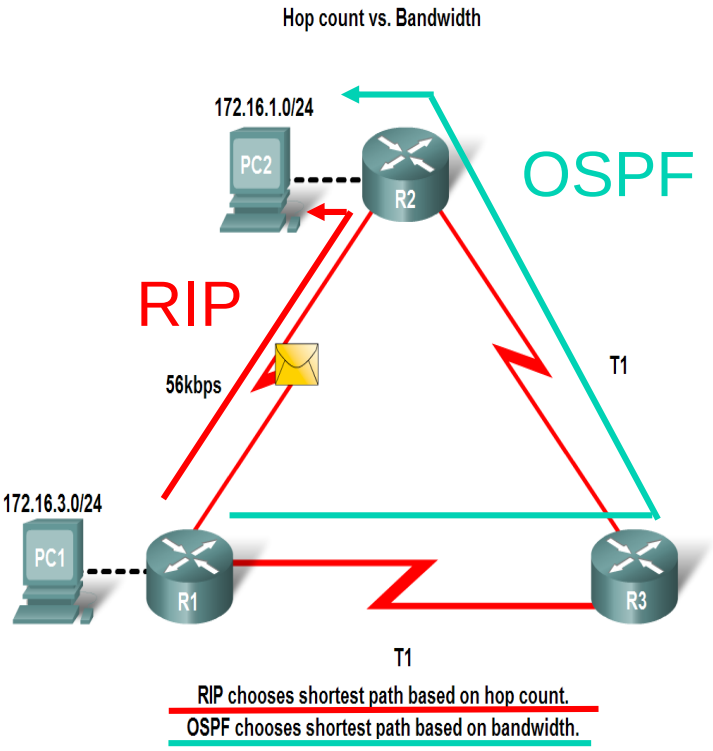
Routing Protocols Metrics

- **To select the best path, the routing protocol must be able to evaluate and differentiate between the available paths. For this purpose a metric is used.**
- **Metric**
  - –A value used by a routing protocol to determine which routes are better than other
- Each routing protocol uses its own metric.
  - –RIP uses hop count,
    - •The hop count refers to the number of routers a packet must cross to reach the destination network.
    - •For R3 in the figure, network 172.16.3.0 is two hops, or two routers away.
  - –EIGRP uses a combination of bandwidth and delay,
  - –OSPF uses bandwidth (cost).



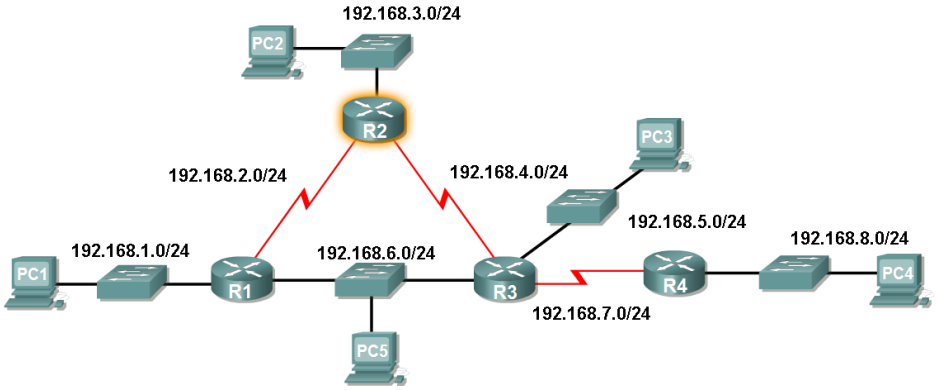
Routing Protocols Metrics

- **Metrics used in IP routing protocols**
  - Bandwidth
    - Influences path selection by preferring the path with the highest bandwidth
  - Cost
    - A value determined either by the IOS or by the network administrator to indicate preference for a route. Cost can represent a metric, a combinatio of metrics or a policy.
  - Delay
    - Considers the time a packet takes to traverse a path
  - Hop count
    - A simple metric that counts the number of route a packet must traverse
  - Load
    - Considers the traffic utilization of a certain link
  - Reliability
    - Assesses the probability of a link failure, calculated from the interface error count or previous link failures



Routing Protocols Metrics

Metric in the Routing Table



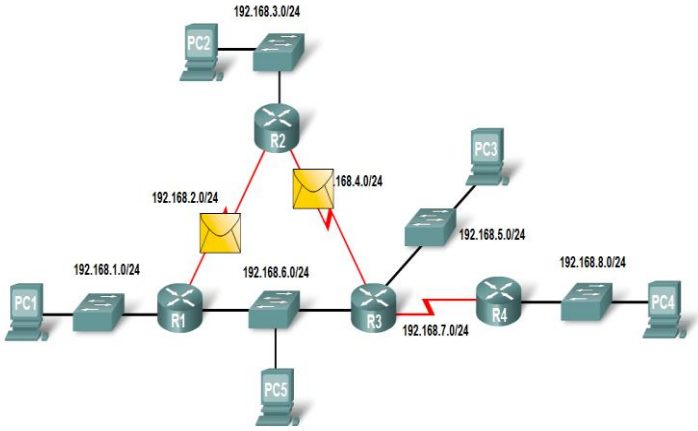

```
R2#show ip route
<output omitted>

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

Routing Protocols Metrics

- **Load balancing**
  - –when two or more routes to the same destination have identical metric values
  - –This is the ability of a router to distribute packets among multiple same cost paths
- Load balancing can be done either per packet or per destination.
  - –How a router actually load balances packets between the equal-cost paths is governed by the **switching process**

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
```

R2 load balances traffic to PC5 over two equal cost paths.

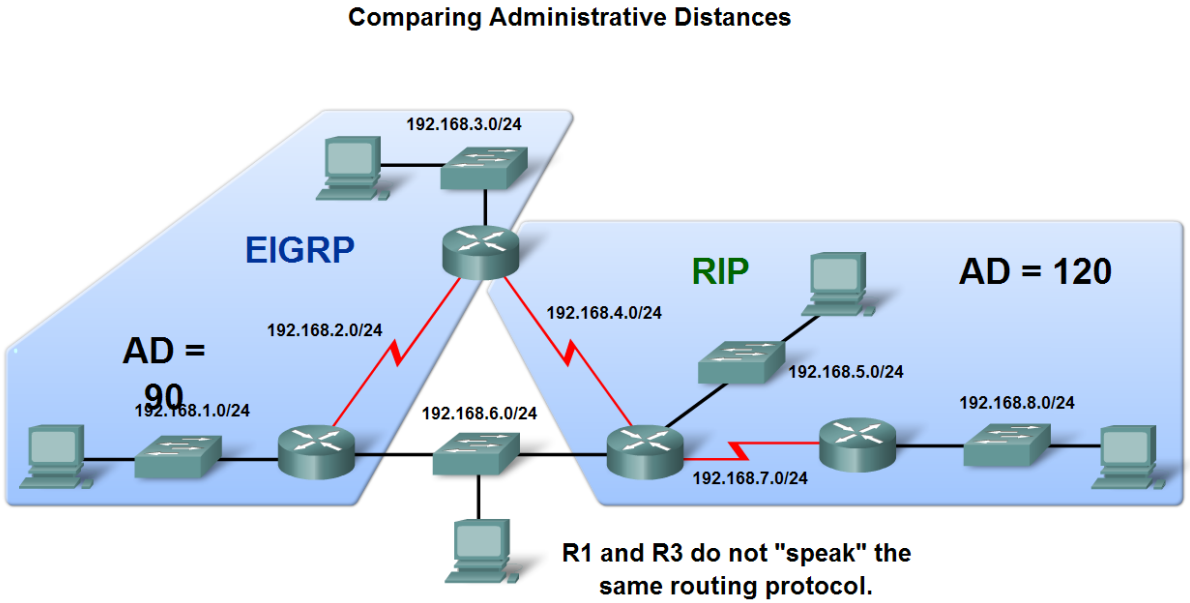
Administrative Distance of a Route

- **Purpose of a metric**

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

- **Purpose of Administrative Distance**

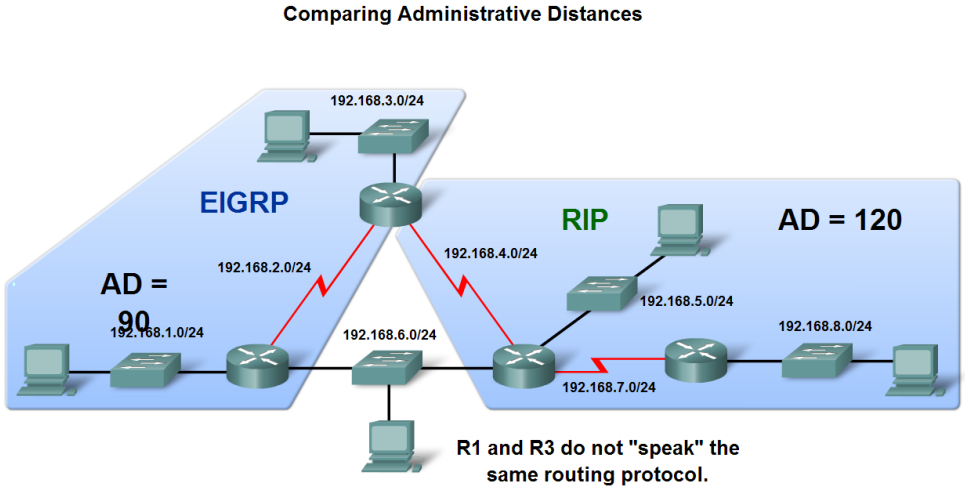
  It's a numeric value that specifies the preference of a particular route



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

  - **Route Summarisation**

Summary: Commands used by RIP

Command	Command's purpose
Rtr(config)#router rip	Enables RIP routing process
Rtr(config-router)#network	Associates a network with a RIP routing process
Rtr#debug ip rip	used to view real time RIP routing updates
Rtr(config-router)#passive-interface fa0/0	Prevent RIP updates from going out an interface
Rtr(config-router)#default-information originate	Used by RIP to propagate default routes
Rtr#show ip protocols	Used to display timers used by RIP