Dynamic Routing

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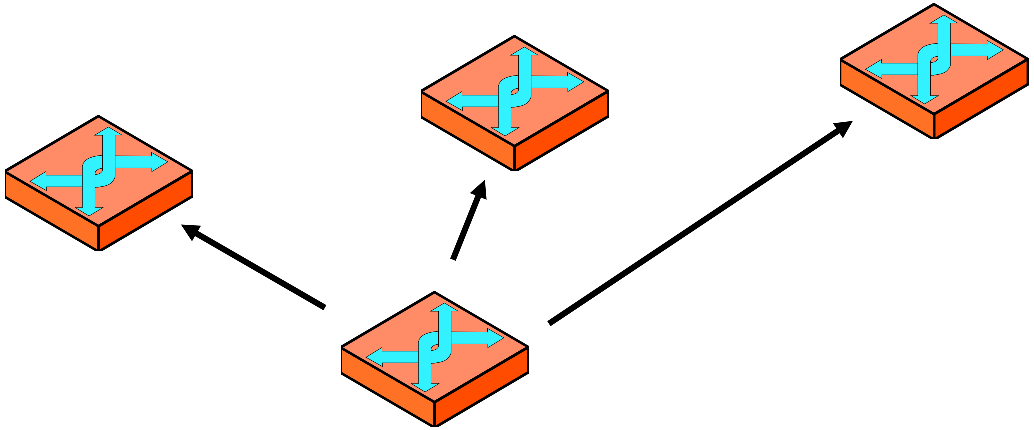
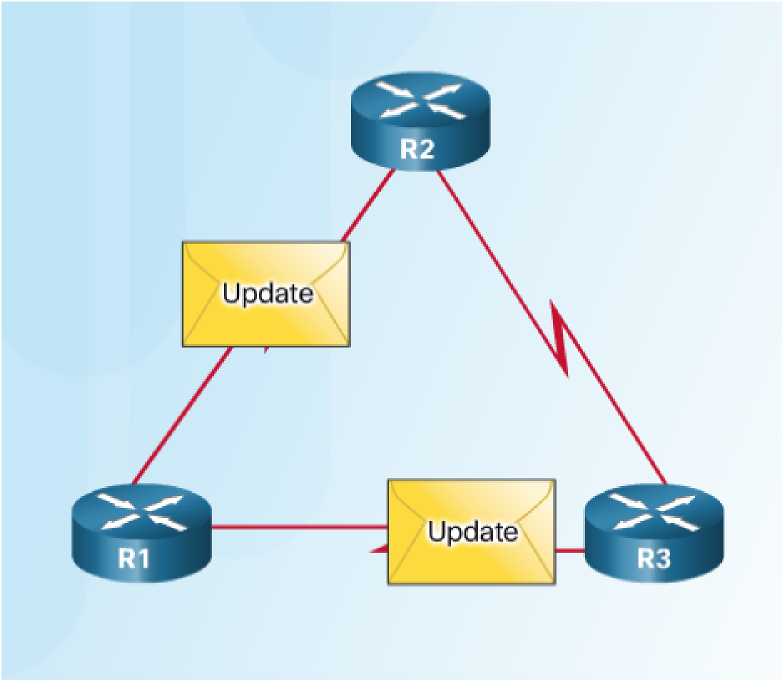
Dynamic Routing Protocols

- Why Dynamic Routing Protocols?
  - Each router acts independently, based on information in its router forwarding table
  - Dynamic routing protocols allow routers to share information in their router forwarding tables



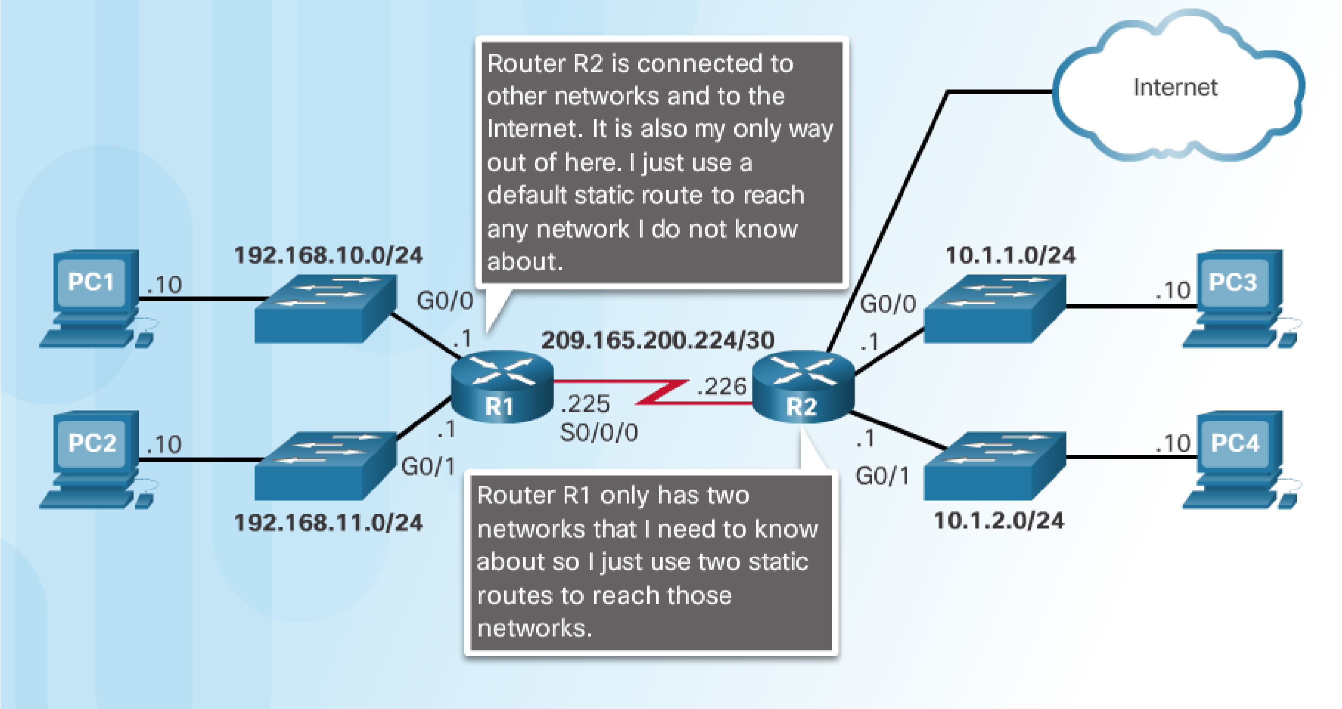
Dynamic Routing Protocol Components

- Purpose of dynamic routing protocols includes:
  - Discovery of 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
- The main components of dynamic routing protocols include:
  - Data structures - tables or databases kept in RAM.
  - Routing protocol messages - to discover neighboring routers, exchange routing information, and maintain accurate information about the network.
  - Algorithms – to facilitate learning routing information and for best path determination.



Dynamic versus Static Routing

- Networks often use both static and dynamic routing.
- Static Routing is used as follows:
  - For easy routing table maintenance in small networks.
  - Routing to and from a stub network.
  - Accessing a single default route.

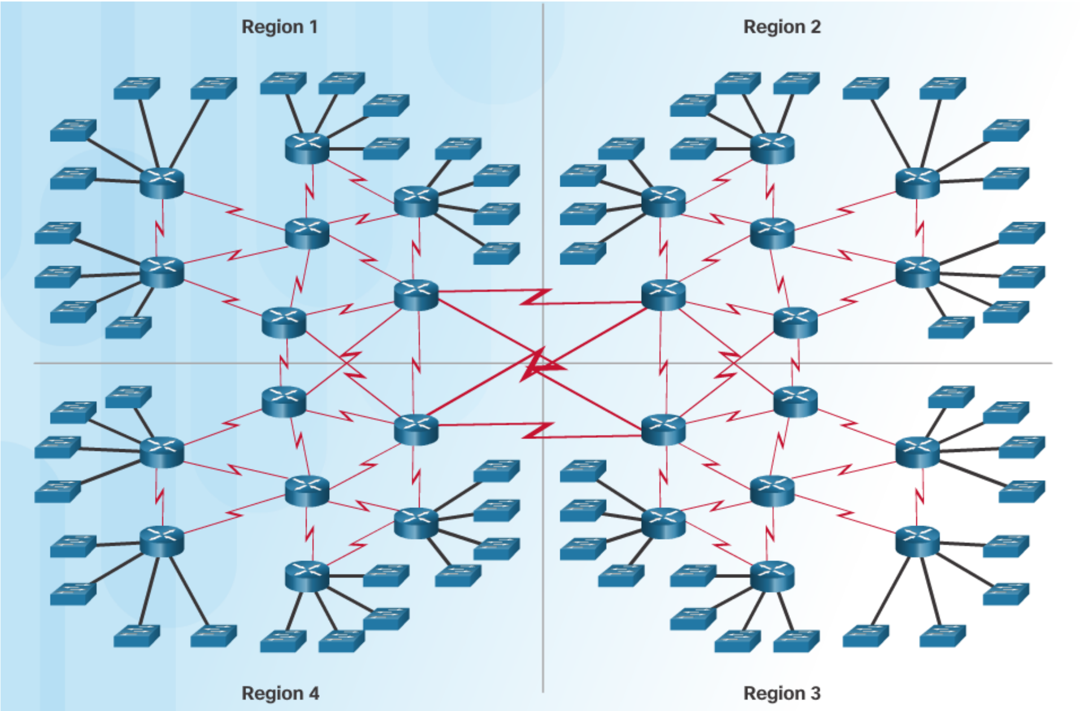


Static Routing Advantages and Disadvantages

Advantages	Disadvantages
Easy to implement in a small network.	Suitable only for simple topologies or for special purposes such as a default static route.
Very secure. No advertisements are sent as compared to dynamic routing protocols.	Configuration complexity increases dramatically as network grows.
Route to destination is always the same.	Manual intervention required to re-route traffic.
No routing algorithm or update mechanism required; therefore, extra resources (CPU or RAM) are not required.	

Dynamic Routing Protocols Uses

- Dynamic routing is the best choice for large networks
- Dynamic routing protocols help the network administrator manage the network:
  - Providing redundant paths
  - Automatically implementing the alternate path when a link goes down.

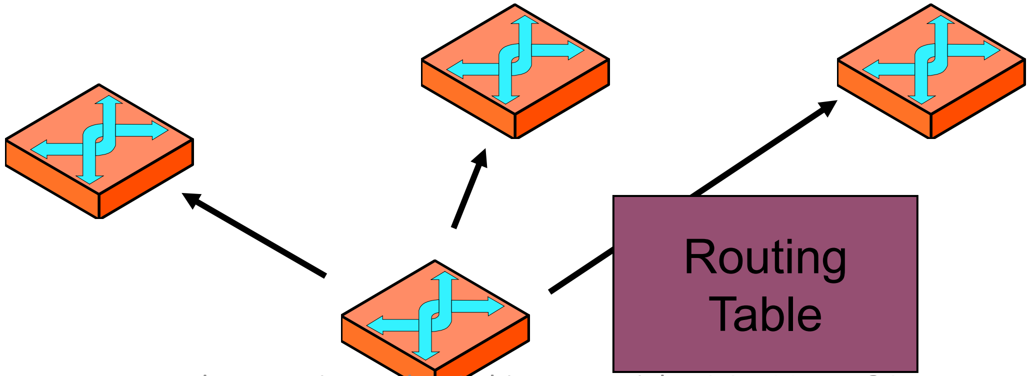


Dynamic Routing Advantages and Disadvantages

Advantages	Disadvantages
Suitable in all topologies where multiple routers are required.	Can be more complex to implement.
Generally independent of the network size.	Less secure. Additional configuration settings are required to secure.
Automatically adapts topology to reroute traffic if possible.	Route depends on the current topology.
	Requires additional CPU, RAM, and link bandwidth.

Routing Information Protocol (RIP)

- RIP is an interior gateway protocol (IGP), which means that it performs routing within a single autonomous system.
- Routing Information protocol (RIP) is the simplest dynamic routing protocol
  - Each router broadcasts its entire routing table frequently
  - Broadcasting makes RIP unsuitable for large networks

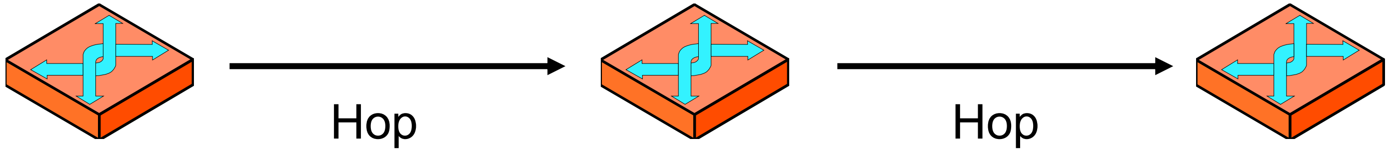


Routing Information Protocol (RIP)

- Routing Information Protocol (RIP) protocol is a dynamic protocol used to find the best route or path from end-to-end (source to destination) over a network by using a routing metric/hop count algorithm.
- RIP was updated to RIPv2 to accommodate growth in the network environment
  - RIPv2 does not scale to current larger network implementations

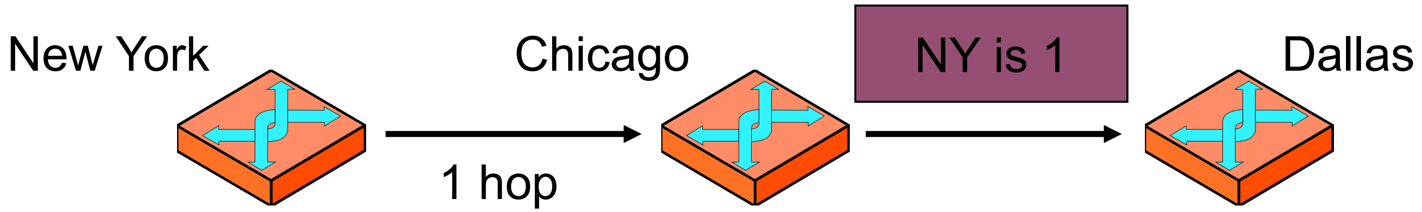
Routing Information Protocol (RIP)

- RIP is Limited
  - RIP routing table has a field to indicate the number of router hops to a distant host
  - The RIP maximum is 15 hops
  - Farther networks are ignored
  - Unsuitable for very large networks



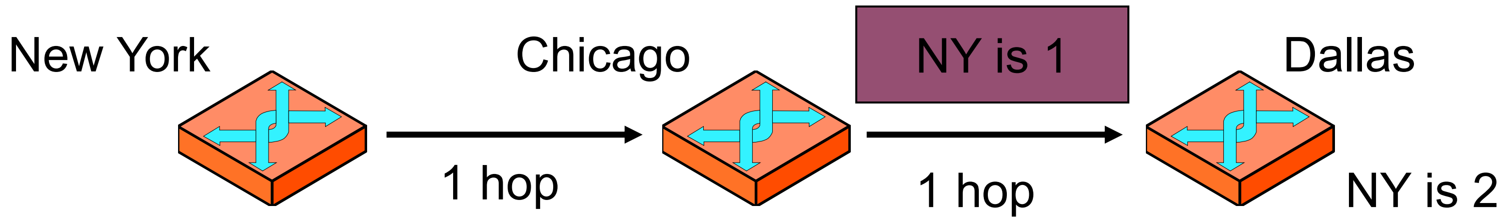
Routing Information Protocol (RIP)

- Is a Distance Vector Protocol
  - “New York” starts, announces itself with a RIP broadcast
  - “Chicago” learns that New York is one hop away
  - Passes this on in its broadcasts



Routing Information Protocol (RIP)

- Learning Routing Information
  - “Dallas” receives broadcast from Chicago
  - Already knows “Chicago” is one hop from Dallas
  - So New York must be two hops from Dallas
  - Places this information in its routing table



Advantages of RIP and Disadvantages of RIPv1

- Advantages of RIP:
  - RIP is very useful in a small network, where it has very little overhead in terms of bandwidth used and configuration and management time.
  - Easy to implement than newer IGP protocols.
  - Many implementations are available in the RIP field.

- Disadvantages of RIPv1:
  - minimal amount of information for router to route the packet and also very large amount of unused space.
  - Subnet support: Supports subnet routes only within the subnet network.
  - Not secure; anyone can act as a router just by sending RIPv1 messages.
  - RIPv1 was developed for an AS that originally included less than a 100 routers.

RIPv2

- Advantages:
  - An AS can include several hundred routers with RIP-2 protocol.
  - Compatible upgrade of RIPv1 including subnet routing, authentication, CIDR aggregation, route tags and multicast transmission.
  - Subnet Support: uses more convenient partitioning using variable-length subnets.
  - An end system can run RIP in passive mode to listen for routing information without supplying any.
  - Low requirement in memory and processing at the node
- RIP and RIP2 are for the IPv4 network, while the RIPng is designed for the IPv6 network.

Router RIP Configuration Mode

- Use the **`router rip`** command to enable RIP v1
- Use the **`no router rip`** command to disable RIP

```
R1# conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)# router rip
R1(config-router)#
```

RIP Configuration Options

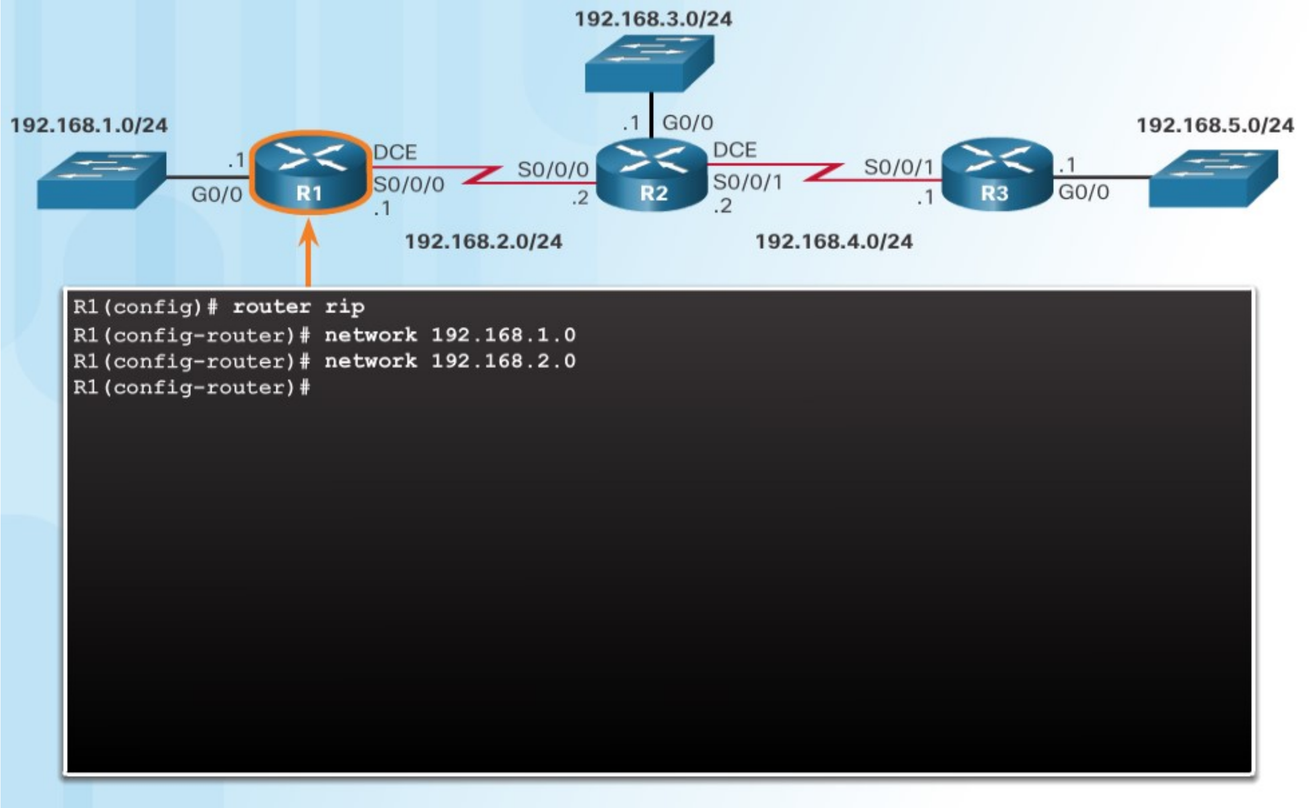
```
R1(config-router)# ?

Router configuration commands:
  address-family          Enter Address Family command mode
  auto-summary            Enable automatic network number summarization
  default                 Set a command to its defaults
  default-information     Control distribution of default information
  default-metric          Set metric of redistributed routes
  distance                Define an administrative distance
  distribute-list         Filter networks in routing updates
  exit                    Exit from routing protocol configuration mode
  flash-update-threshold  Specify flash update threshold insecond
  help                    Description of the interactive help system
  input-queue             Specify input queue depth
  maximum-paths           Forward packets over multiple paths
  neighbor                Specify a neighbor router
  network                 Enable routing on an IP network
  no                      Negate a command or set its defaults
  offset-list             Add or subtract offset from RIP metrics
  output-delay            Interpacket delay for RIP updates
  passive-interface       Suppress routing updates on an interface
  redistribute            Redistribute information from another routing protocol
  timers                  Adjust routing timers
  traffic-share           How to compute traffic share over alternate paths
  validate-update-source  Perform sanity checks against source address of routing updates
  version                 Set routing protocol version

R1(config-router)#
```

Advertise Networks

- The **`network`** *`network-address`* router configuration mode command:
  - Enables RIP on all interfaces that belong to a specific network
  - Advertises the network in RIP routing updates sent to other routers every 30 seconds.
  - *Note: RIPv1 is a classful routing protocol for IPv4.*



Verify RIP Routing

```
R1# show ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "rip"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Sending updates every 30 seconds, next due in 16 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Redistributing: rip

  Default version control: send version 1, receive any version
    Interface             Send  Recv  Triggered RIP  Key-chain
    GigabitEthernet0/0    1     1 2
    Serial0/0/0           1     1 2

  Automatic network summarization is in effect
  Maximum path: 4
  Routing for Networks:
    192.168.1.0
    192.168.2.0

  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.2.2          120      00:00:15
  Distance: (default is 120)
```

`show ip protocols` – displays IPv4 routing protocols configured on the router.

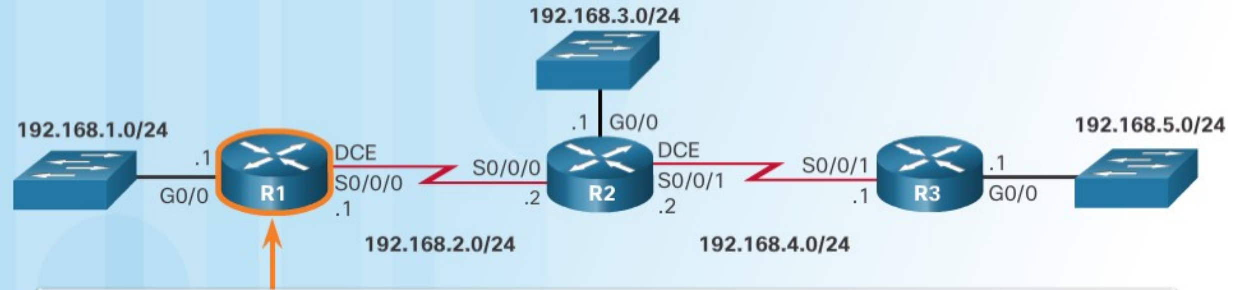
```
R1# show ip route | begin Gateway
Gateway of last resort is not set

      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected,
GigabitEthernet0/0
L        192.168.1.1/32 is directly connected,
GigabitEthernet0/0
      192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.2.0/24 is directly connected, Serial0/0/0
L        192.168.2.1/32 is directly connected, Serial0/0/0
R     192.168.3.0/24 [120/1] via 192.168.2.2, 00:00:24,
Serial0/0/0
R     192.168.4.0/24 [120/1] via 192.168.2.2, 00:00:24,
Serial0/0/0
R     192.168.5.0/24 [120/2] via 192.168.2.2, 00:00:24,
Serial0/0/0
R1#
```

`show ip route` – displays RIP routes installed in the routing table.

Enable and Verify RIPv2

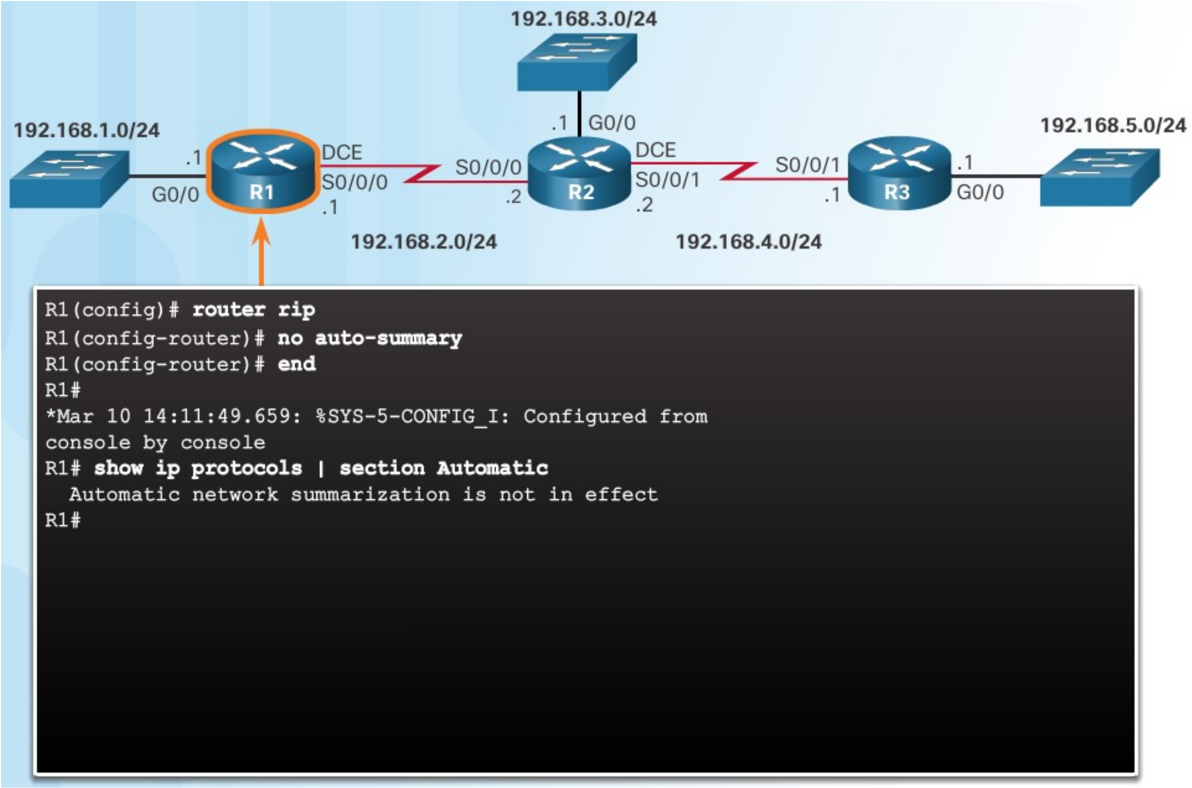
- Use the **`version 2`** router configuration mode command to enable RIPv2
- Use the **`show ip protocols`** command to verify that RIPv2 is configured.
- Use the **`show ip route command`** to verify the RIPv2 routes in the routing table.




```
R1(config)# router rip
R1(config-router)# version 2
R1(config-router)# ^Z
R1#
R1# show ip protocols | section Default
  Default version control: send version 2, receive version 2
    Interface             Send  Recv  Triggered RIP  Key-chain
    GigabitEthernet0/0      2     2
    Serial0/0/0             2     2
R1#
```

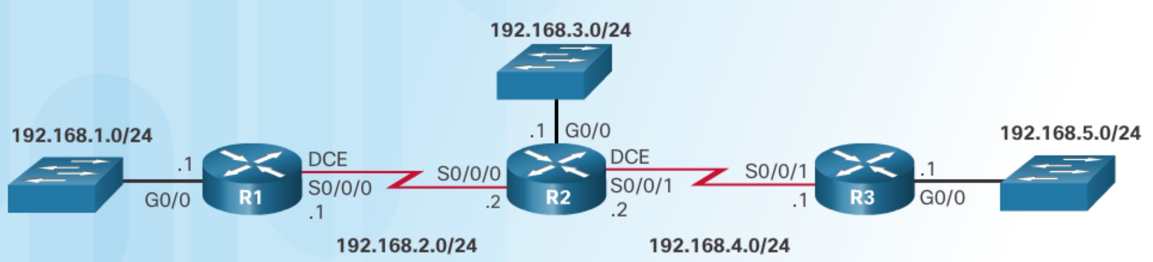
Disable Auto Summarization

- RIPv2 automatically summarizes networks at major network boundaries.
- Use the **`no auto-summary`** router configuration mode command to disable auto summarization.
- Use the **`show ip protocols`** command to verify that auto summarization is off.



Configure Passive Interfaces

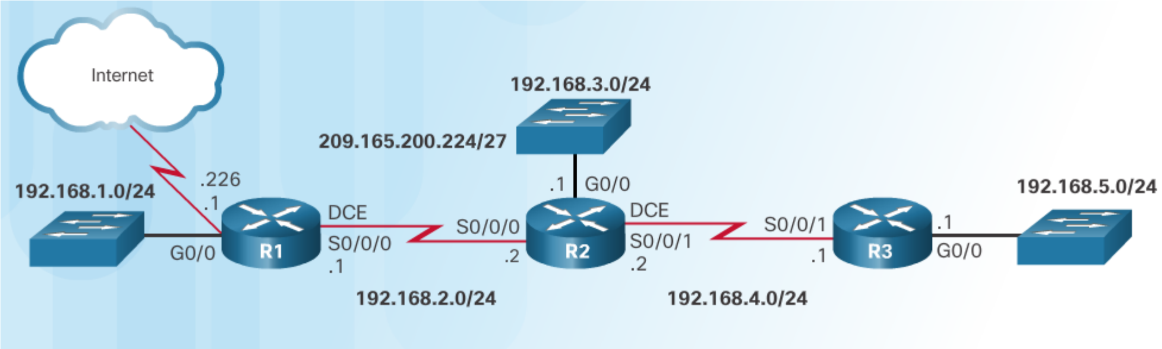
- RIP updates:
  - Are forwarded out all RIP-enabled interfaces by default.
  - Only need to be sent out interfaces that are connected to other RIP-enabled routers.
- Sending RIP updates to LANs wastes bandwidth, wastes resources, and is a security risk.
- Use the **`passive-interface`** router configuration command to stop routing updates out the interface.
- Still allows that network to be advertised to other routers.




```
R1(config)# router rip
R1(config-router)# passive-interface g0/0
R1(config-router)# end
R1#
R1# show ip protocols | begin Default
  Default version control: send version 2, receive version 2
    Interface             Send  Recv  Triggered RIP  Key-
chain
    Serial0/0/0           2     2
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
    192.168.1.0
    192.168.2.0
  Passive Interface(s):
    GigabitEthernet0/0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.2.2          120      00:00:06
  Distance: (default is 120)
```

Propagate a Default Route

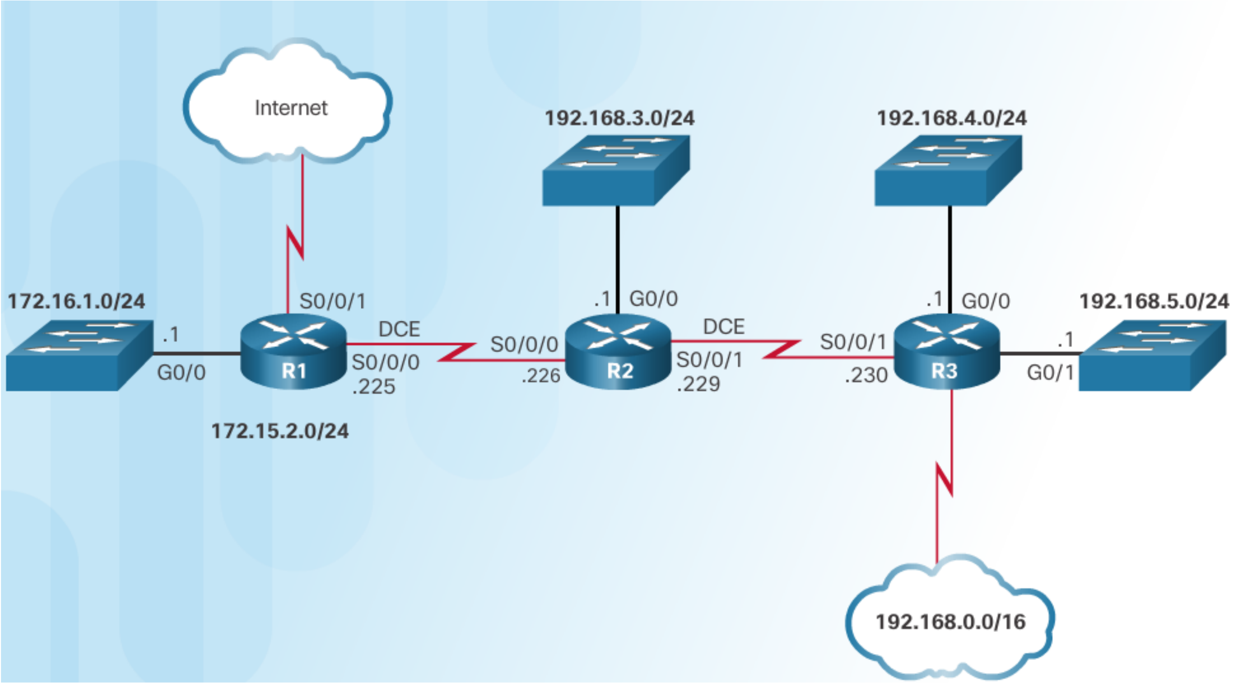
- In the diagram a default static route to the Internet is configured on R1.
- The **`default-information originate`** router configuration command instructs R1 to send the default static route information in the RIP updates.




```
R1(config)# ip route 0.0.0.0 0.0.0.0 S0/0/1 209.165.200.226
R1(config)# router rip
R1(config-router)# default-information originate
R1(config-router)# ^Z
R1#
*Mar 10 23:33:51.801: %SYS-5-CONFIG_I: Configured from console by console
R1# show ip route | begin Gateway
Gateway of last resort is 209.165.200.226 to network 0.0.0.0

S*    0.0.0.0/0 [1/0] via 209.165.200.226, Serial0/0/1
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, GigabitEthernet0/0
L        192.168.1.1/32 is directly connected, GigabitEthernet0/0
      192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.2.0/24 is directly connected, Serial0/0/0
L        192.168.2.1/32 is directly connected, Serial0/0/0
R     192.168.3.0/24 [120/1] via 192.168.2.2, 00:00:08, Serial0/0/0
R     192.168.4.0/24 [120/1] via 192.168.2.2, 00:00:08, Serial0/0/0
R     192.168.5.0/24 [120/2] via 192.168.2.2, 00:00:08, Serial0/0/0
      209.165.200.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.200.0/24 is directly connected, Serial0/0/1
L        209.165.200.225/27 is directly connected, Serial0/0/1
R1#
```

Routing Table Entries



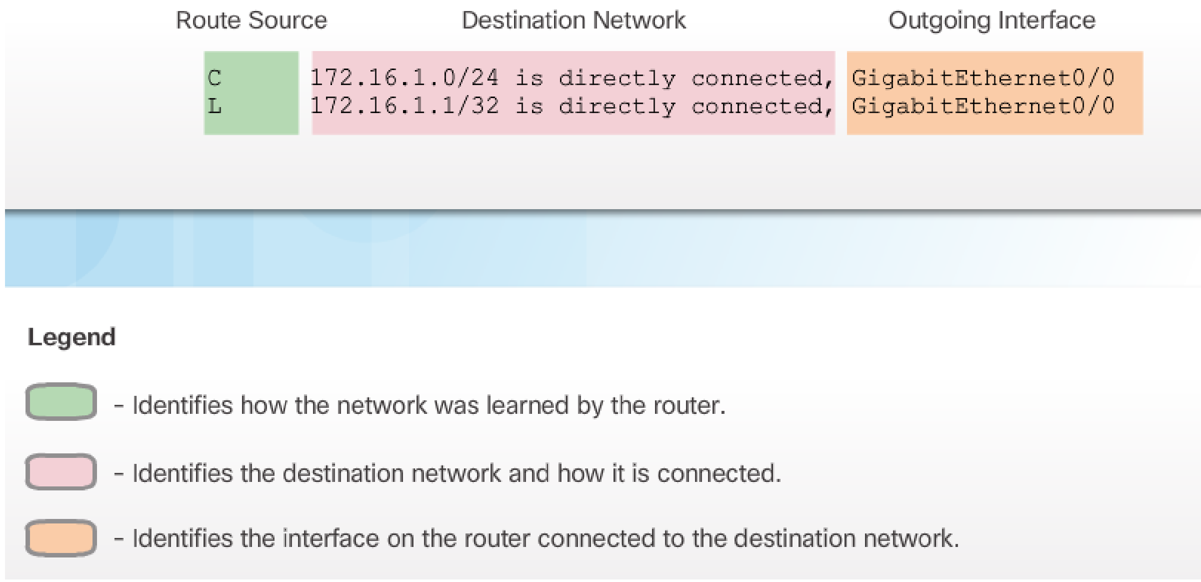

```
R1# show ip route | begin Gateway
Gateway of last resort is 209.165.200.234 to network 0.0.0.0

S* 0.0.0.0/0 [1/0] via 209.165.200.234, Serial0/0/1
                    is directly connected, Serial0/0/1
    172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
C   172.16.1.0/24 is directly connected, GigabitEthernet0/0
L   172.16.1.1/32 is directly connected, GigabitEthernet0/0
R   172.16.2.0/24 [120/1] via 209.165.200.226, 00:00:12, Serial0/0/0
R   172.16.3.0/24 [120/2] via 209.165.200.226, 00:00:12, Serial0/0/0
R   172.16.4.0/28 [120/2] via 209.165.200.226, 00:00:12, Serial0/0/0
R   192.168.0.0/16 [120/2] via 209.165.200.226, 00:00:03, Serial0/0/0
    209.165.200.0/24 is variably subnetted, 5 subnets, 2 masks
C   209.165.200.224/30 is directly connected, Serial0/0/0
L   209.165.200.225/32 is directly connected, Serial0/0/0
R   209.165.200.228/30 [120/1] via 209.165.200.226, 00:00:12, Serial0/0/0
C   209.165.200.232/30 is directly connected, Serial0/0/1
L   209.165.200.233/30 is directly connected, Serial0/0/1
R1#
```

Routing Table for R1

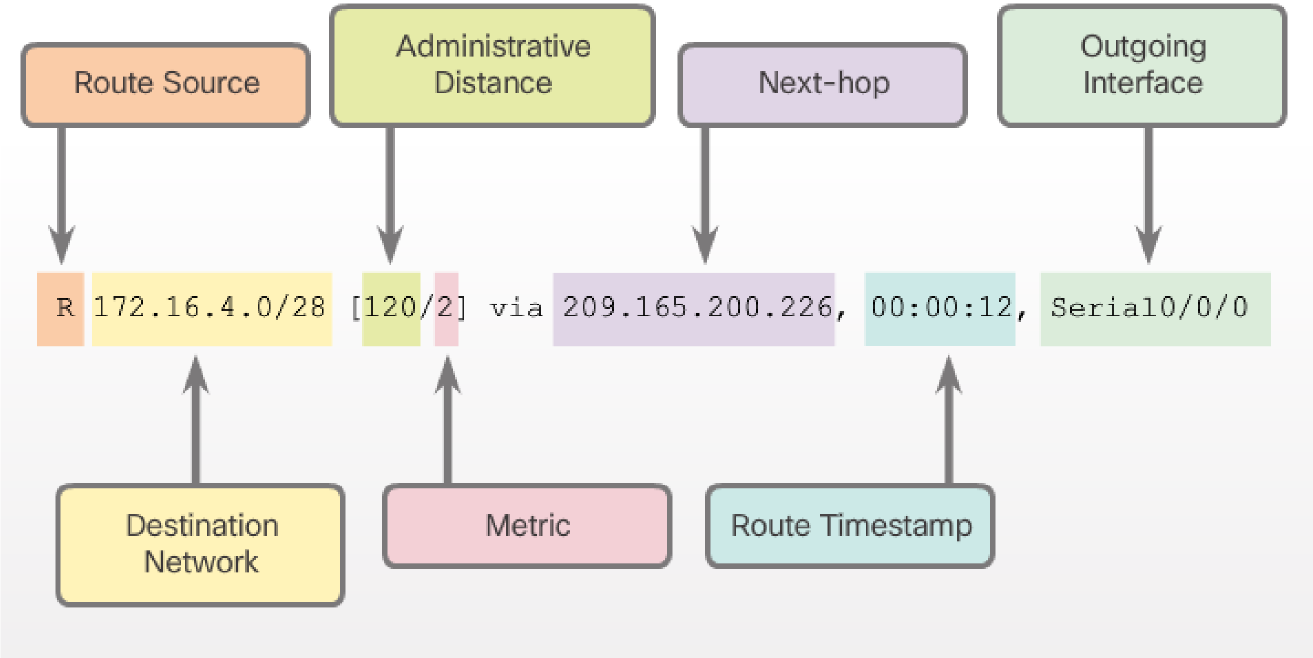
Directly Connected Entries

- Directly Connected Networks (C) are automatically added to the routing table when the interface is configured and activated.
- Entries contain the following information:
  - Route source - how the route was learned.
  - Destination network – remote network.
  - Outgoing Interface – exit interface used to forward packets to destination.
- Other route source entries include:
  - S –Static Route
  - D – EIGRP routing protocol
  - O – OSPF routing protocol
  - R - RIP routing protocol



Remote Network Entries

- Routes to remote networks contain the following information:
  - Route source – how route was learned
  - Destination network
  - Administrative distance (AD) - trustworthiness of the route.
  - Metric – value assigned to reach the remote network. Lower is better.
  - Next hop – IPv4 address of the next router that the packet should be forwarded to.
  - Route timestamp – time since the route was updated.
  - Outgoing interface - the exit interface to use to forward the packet



Dynamically Learned IPv4 Routes

- The routing table is a hierarchical structure that is used to speed up the lookup process when locating routes and forwarding packets.
- The hierarchy includes:
  - Ultimate Routes
  - Level 1 routes
  - Level 1 parent routes
  - Level 2 child routes

```
R1# show ip route | begin Gateway
Gateway of last resort is 209.165.200.234 to network 0.0.0.0

S*    0.0.0.0/0 [1/0] via 209.165.200.234, Serial0/0/1
                is directly connected, Serial0/0/1
      172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
C     172.16.1.0/24 is directly connected, GigabitEthernet0/0
L     172.16.1.1/32 is directly connected, GigabitEthernet0/0
R     172.16.2.0/24 [120/1] via 209.165.200.226, 00:00:12, Serial0/0/0
R     172.16.3.0/24 [120/2] via 209.165.200.226, 00:00:12, Serial0/0/0
R     172.16.4.0/28 [120/2] via 209.165.200.226, 00:00:12, Serial0/0/0
R     192.168.0.0/16 [120/2] via 209.165.200.226, 00:00:03,Serial0/0/0
      209.165.200.0/24 is variably subnetted, 5 subnets, 2 masks
C     209.165.200.224/30 is directly connected, Serial0/0/0
L     209.165.200.225/32 is directly connected, Serial0/0/0
R     209.165.200.228/30 [120/1] via 209.165.200.226, 00:00:12, Serial0/0/0
C     209.165.200.232/30 is directly connected, Serial0/0/1
L     209.165.200.233/32 is directly connected, Serial0/0/1
R1#
```

Ultimate Route

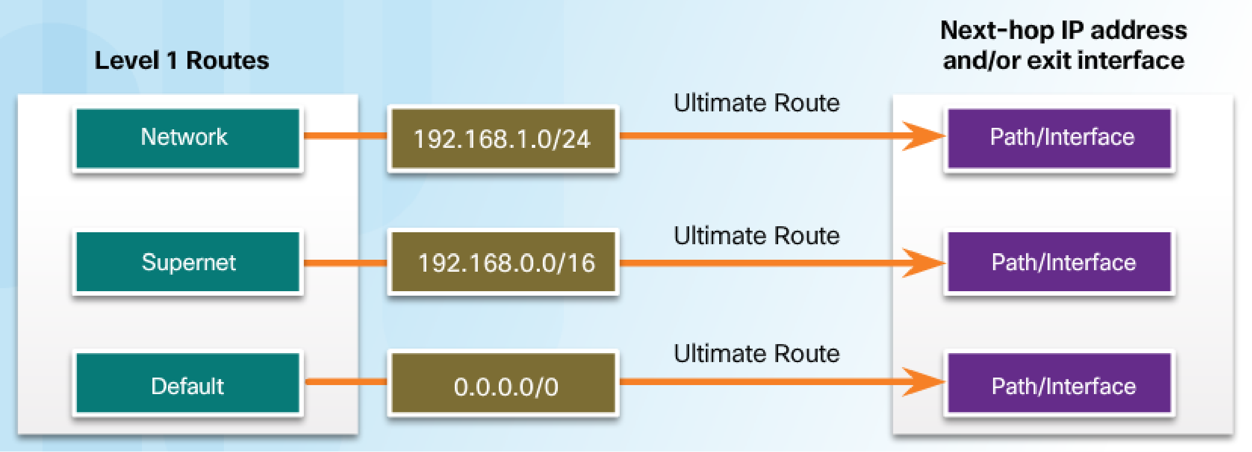
- An ultimate route is a routing table entry that contains either a next-hop IPv4 address or an exit interface.
- Directly connected, dynamically learned, and local routes are ultimate routes.

```
R1# show ip route | begin Gateway
Gateway of last resort is 209.165.200.234 to network 0.0.0.0

S*    0.0.0.0/0 [1/0] via 209.165.200.234, Serial0/0/1
                is directly connected, Serial0/0/1
      172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
C     172.16.1.0/24 is directly connected, GigabitEthernet0/0
L     172.16.1.1/32 is directly connected, GigabitEthernet0/0
R     172.16.2.0/24 [120/1] via 209.165.200.226, 00:00:12, Serial0/0/0
R     172.16.3.0/24 [120/2] via 209.165.200.226, 00:00:12, Serial0/0/0
R     172.16.4.0/28 [120/2] via 209.165.200.226, 00:00:12,Serial0/0/0
R     192.168.0.0/16 [120/2] via 209.165.200.226, 00:00:03,Serial0/0/0
      209.165.200.0/24 is variably subnetted, 5 subnets, 2 masks
C     209.165.200.224/30 is directly connected, Serial0/0/0
L     209.165.200.225/32 is directly connected, Serial0/0/0
R     209.165.200.228/30 [120/1] via 209.165.200.226, 00:00:12, Serial0/0/0
C     209.165.200.232/30 is directly connected, Serial0/0/1
L     209.165.200.233/32 is directly connected, Serial0/0/1
R1#
```

Level 1 Route

- A level 1 route can be a:
  - Network route - a network route that has a subnet mask equal to that of the classful mask.
  - Supernet route - a network address with a mask less than the classful mask, for example, a summary address.
  - Default route - a static route with the address 0.0.0.0/0




```
R1# show ip route | begin Gateway
Gateway of last resort is 209.165.200.234 to network 0.0.0.0

S*    0.0.0.0/0 [1/0] via 209.165.200.234, Serial0/0/1
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      172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
C     172.16.1.0/24 is directly connected, GigabitEthernet0/0
L     172.16.1.1/32 is directly connected, GigabitEthernet0/0
R     172.16.2.0/24 [120/1] via 209.165.200.226, 00:00:12, Serial0/0/0
R     172.16.3.0/24 [120/2] via 209.165.200.226, 00:00:12, Serial0/0/0
R     172.16.4.0/28 [120/2] via 209.165.200.226, 00:00:12, Serial0/0/0
R     192.168.0.0/16 [120/2] via 209.165.200.226, 00:00:03,Serial0/0/0
      209.165.200.0/24 is variably subnetted, 5 subnets, 2 masks
C     209.165.200.224/30 is directly connected, Serial0/0/0
L     209.165.200.225/32 is directly connected, Serial0/0/0
R     209.165.200.228/30 [120/1] via 209.165.200.226, 00:00:12, Serial0/0/0
C     209.165.200.232/30 is directly connected, Serial0/0/1
L     209.165.200.233/32 is directly connected, Serial0/0/1
R1#
```
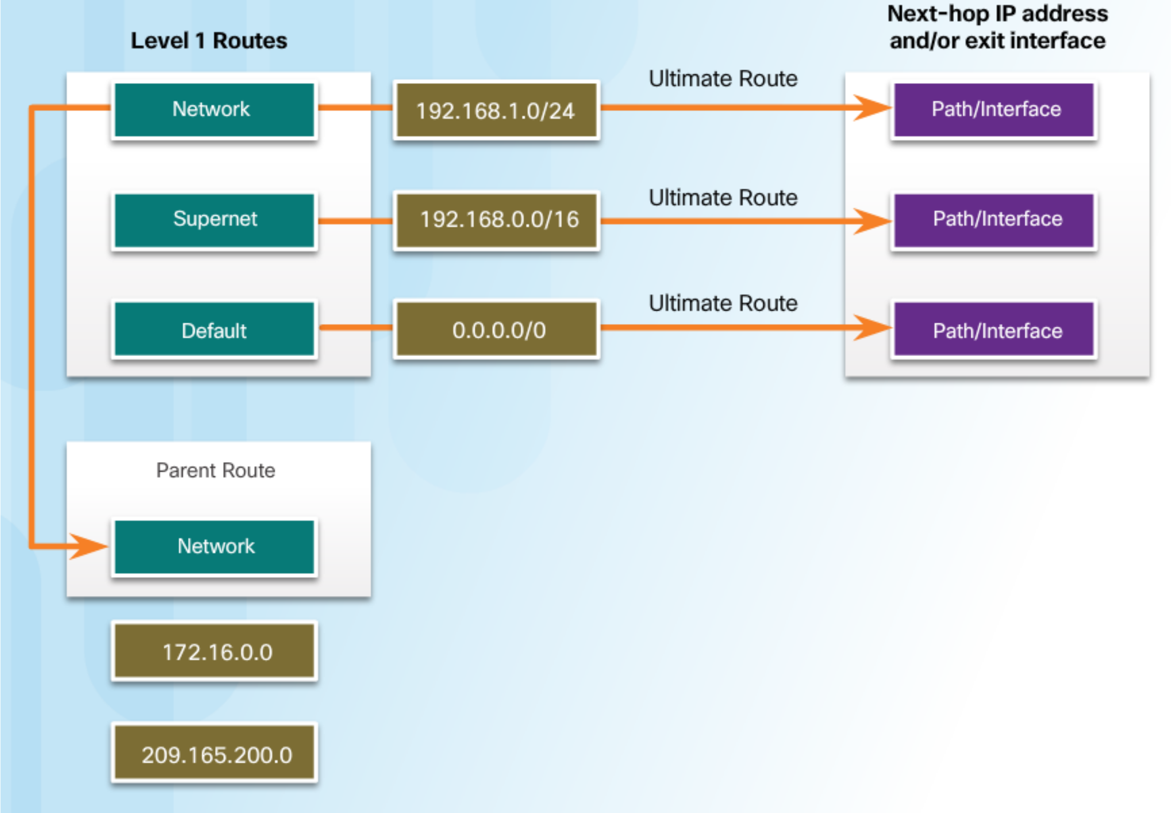

Level 1 Parent Route

- A parent route is a level 1 network route that is subnetted.
- In the routing table, it basically provides a heading for the specific subnets it contains.




```
R1# show ip route | begin Gateway
Gateway of last resort is 209.165.200.234 to network 0.0.0.0

S*     0.0.0.0/0 [1/0] via 209.165.200.234, Serial0/0/1
                 is directly connected, Serial0/0/1
       172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
C      172.16.1.0/24 is directly connected, GigabitEthernet0/0
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R      172.16.3.0/24 [120/2] via 209.165.200.226, 00:00:12, Serial0/0/0
R      172.16.4.0/28 [120/2] via 209.165.200.226, 00:00:12, Serial0/0/0
R      192.168.0.0/16 [120/2] via 209.165.200.226, 00:00:03,Serial0/0/0
       209.165.200.0/24 is variably subnetted, 5 subnets, 2 masks
C      209.165.200.224/30 is directly connected, Serial0/0/0
L      209.165.200.225/32 is directly connected, Serial0/0/0
R      209.165.200.228/30 [120/1] via 209.165.200.226, 00:00:12, Serial0/0/0
C      209.165.200.232/30 is directly connected, Serial0/0/1
L      209.165.200.233/32 is directly connected, Serial0/0/1
R1#
```
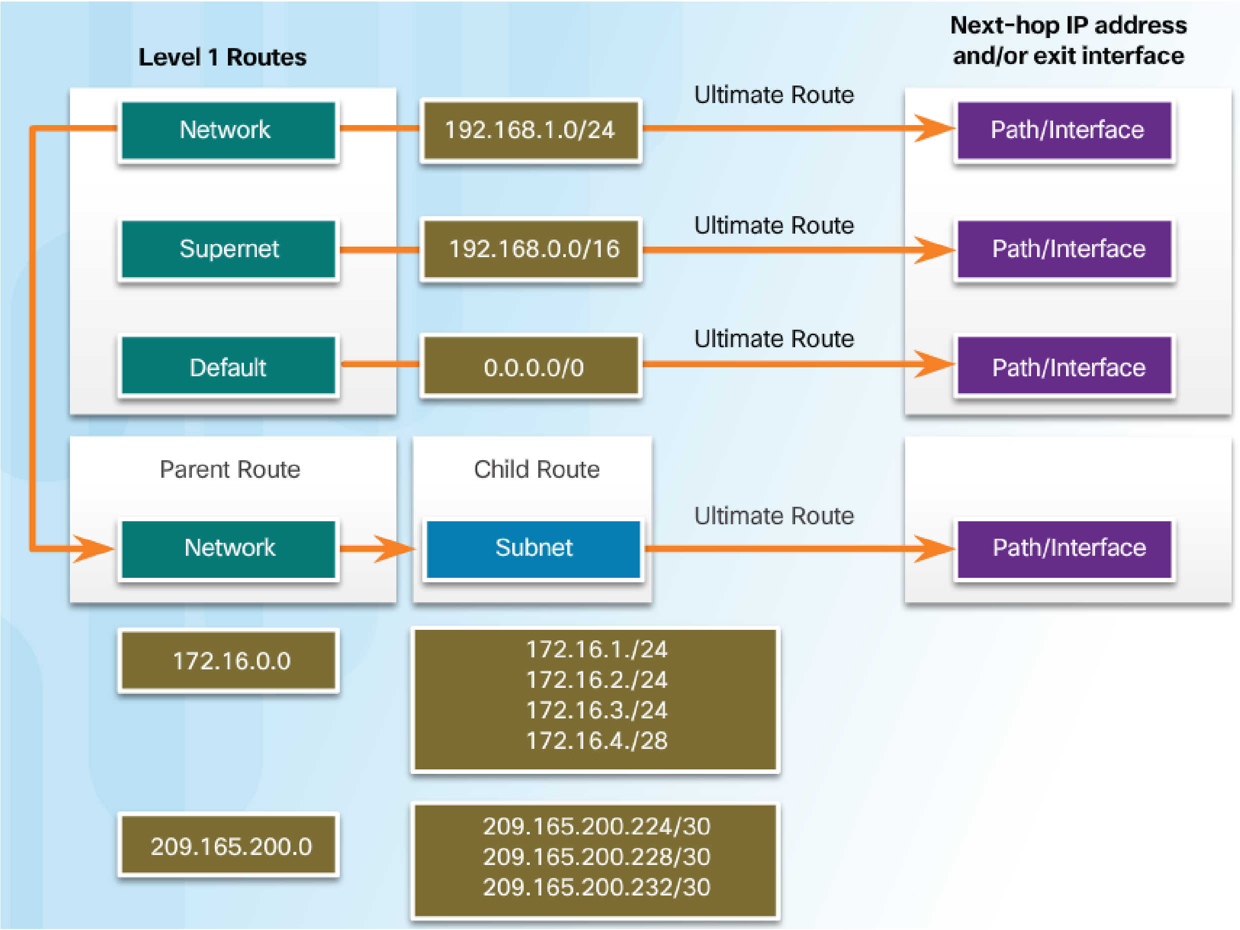

Level 2 Child Route

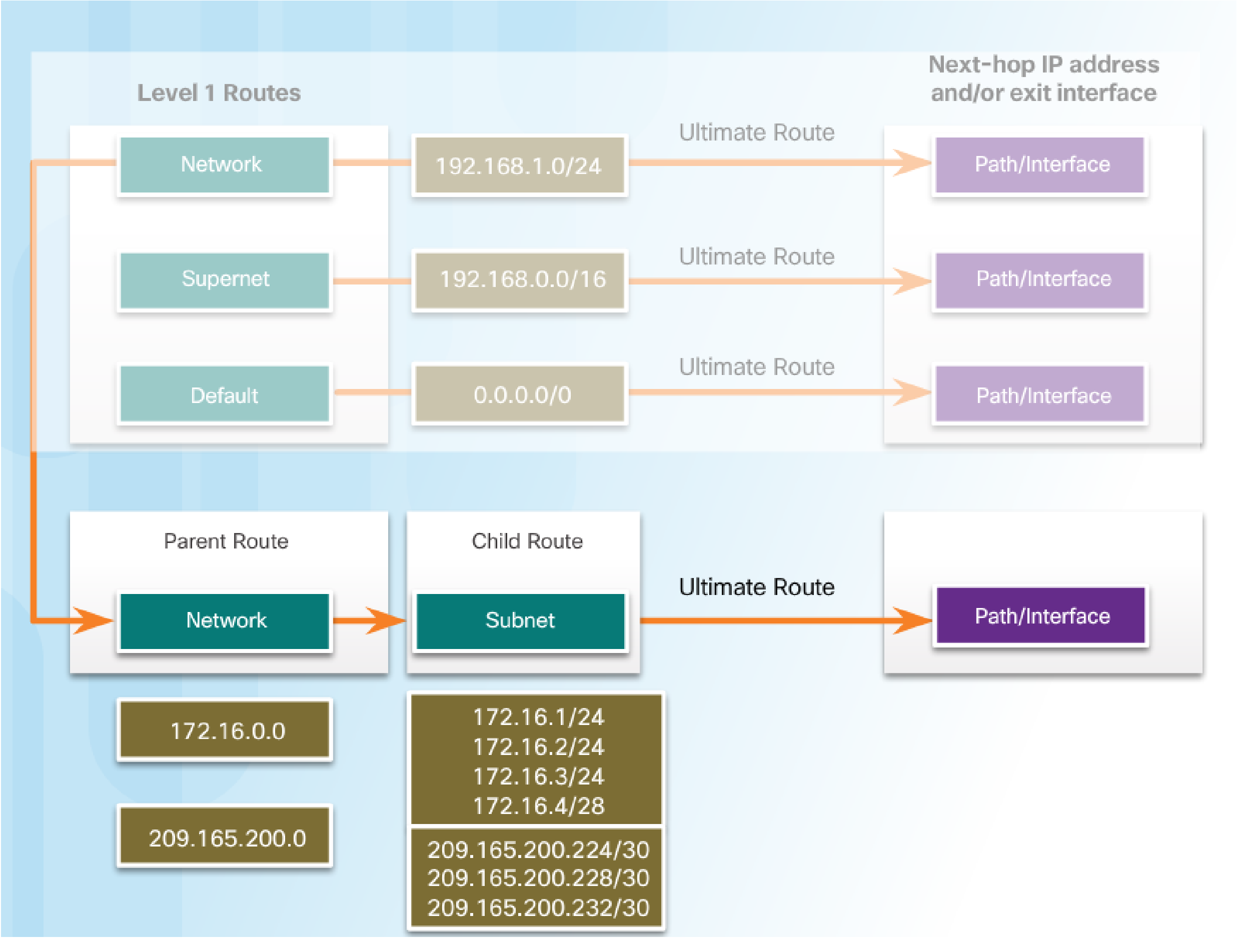
- A level 2 child route is a route that is a subnet of a classful network address.
- Level 1 parent routes contain level 2 child routes.
- Level 2 child routes are also ultimate routes.




```
R1# show ip route | begin Gateway
Gateway of last resort is 209.165.200.234 to network 0.0.0.0

S*    0.0.0.0/0 [1/0] via 209.165.200.234, Serial0/0/1
                is directly connected, Serial0/0/1
      172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
C     172.16.1.0/24 is directly connected, GigabitEthernet0/0
L     172.16.1.1/32 is directly connected, GigabitEthernet0/0
R     172.16.2.0/24 [120/1] via 209.165.200.226, 00:00:12, Serial0/0/0
R     172.16.3.0/24 [120/2] via 209.165.200.226, 00:00:12, Serial0/0/0
R     172.16.4.0/28 [120/2] via 209.165.200.226, 00:00:12, Serial0/0/0
R     192.168.0.0/16 [120/2] via 209.165.200.226, 00:00:03,Serial0/0/0
      209.165.200.0/24 is variably subnetted, 5 subnets, 2 masks
C     209.165.200.224/30 is directly connected, Serial0/0/0
L     209.165.200.225/32 is directly connected, Serial0/0/0
R     209.165.200.228/30 [120/1] via 209.165.200.226, 00:00:12, Serial0/0/0
C     209.165.200.232/30 is directly connected, Serial0/0/1
L     209.165.200.233/30 is directly connected, Serial0/0/1
R1#
```

Route Lookup Process

- Router lookup process:
  - If the best match is a level 1 ultimate route, then this route is used to forward the packet.
  - If the best match is a level 1 parent route, the router then examines child routes (the subnet routes).
  - If there is a match with a level 2 child route, that is used to forward the packet.
  - If there is no match with level 2 child routes, the router searches level 1 supernet or default routes. If there is a match, that route is used.
  - If there is no match found in the routing table the packet is dropped.



Best Route = Longest Match

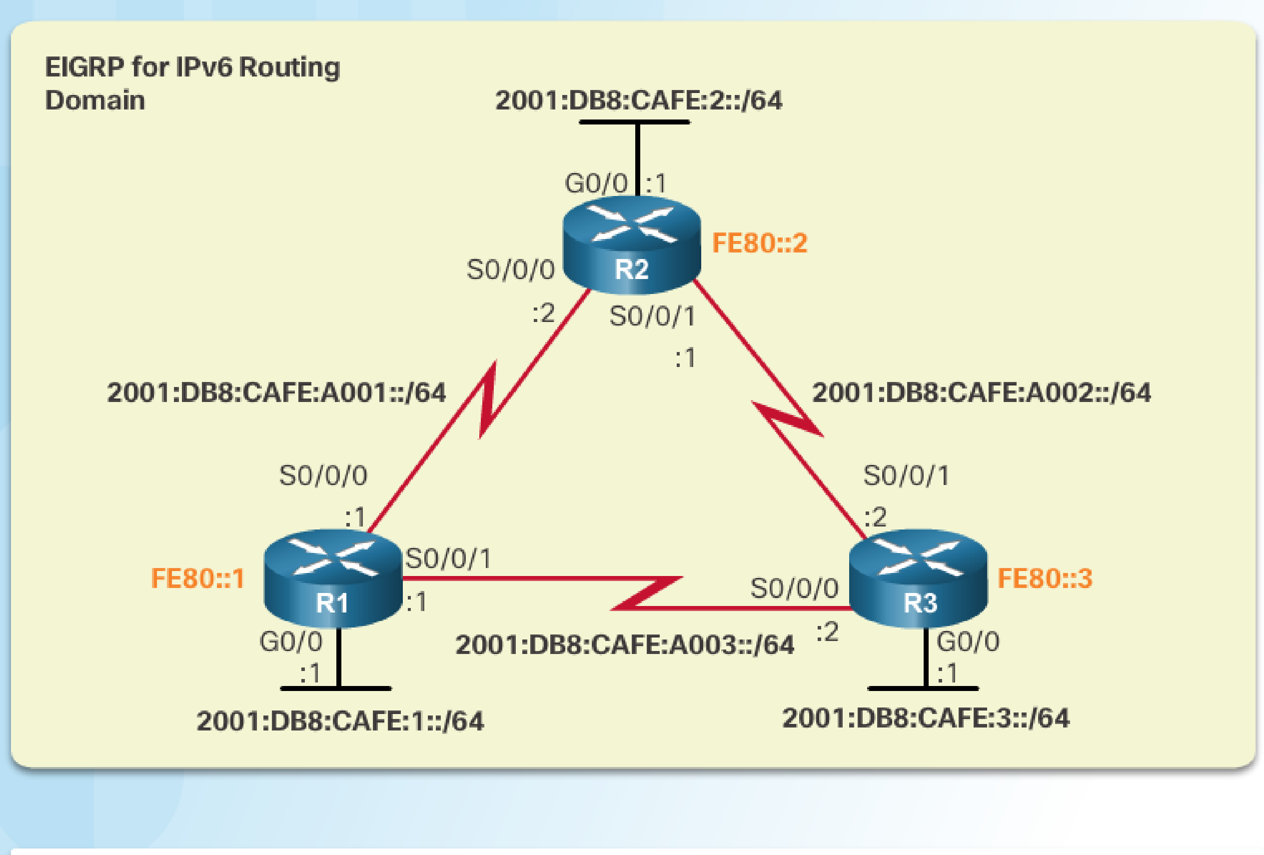
- The best match is the route in the routing table that has the most number of far left matching bits with the destination IPv4 address of the packet.
- The route with the greatest number of equivalent far left bits, or the longest match, is always the preferred route.

IP Packet Destination	172.16.0.10	10101100.00010000.00000000.00001010
Route 1	172.16.0.0/12	10101100.00010000.00000000.00000000
Route 2	172.16.0.0/18	10101100.00010000.00000000.00000000
Route 3	172.16.0.0/26	10101100.00010000.00000000.00000000

Longest Match to IP Packet Destination

IPv6 Routing Table Entries

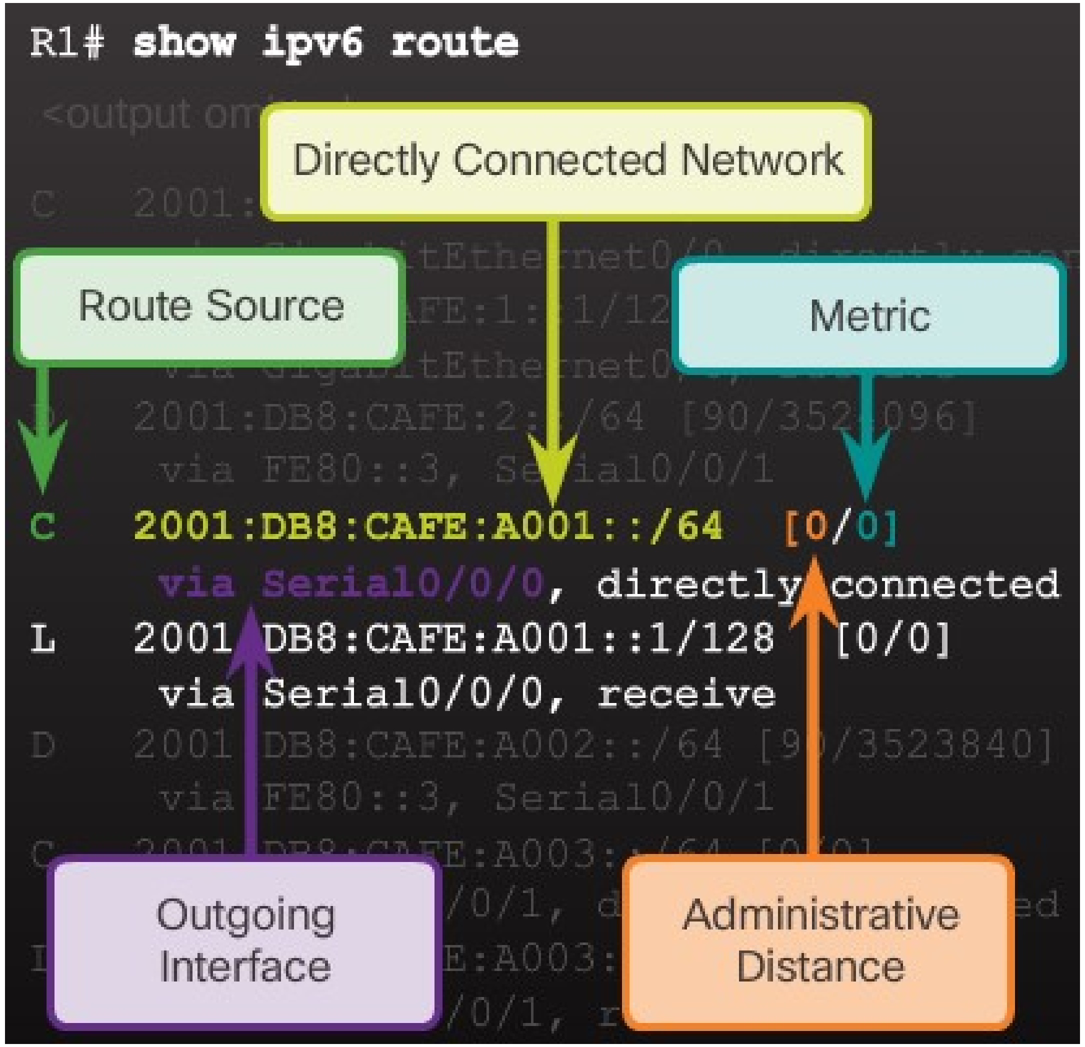
- An IPv6 routing table includes directly connected, static and dynamically learned routes.
- All IPv6 routes are level 1 ultimate routes.



The FE80 address represents the link-local address assigned to each router.

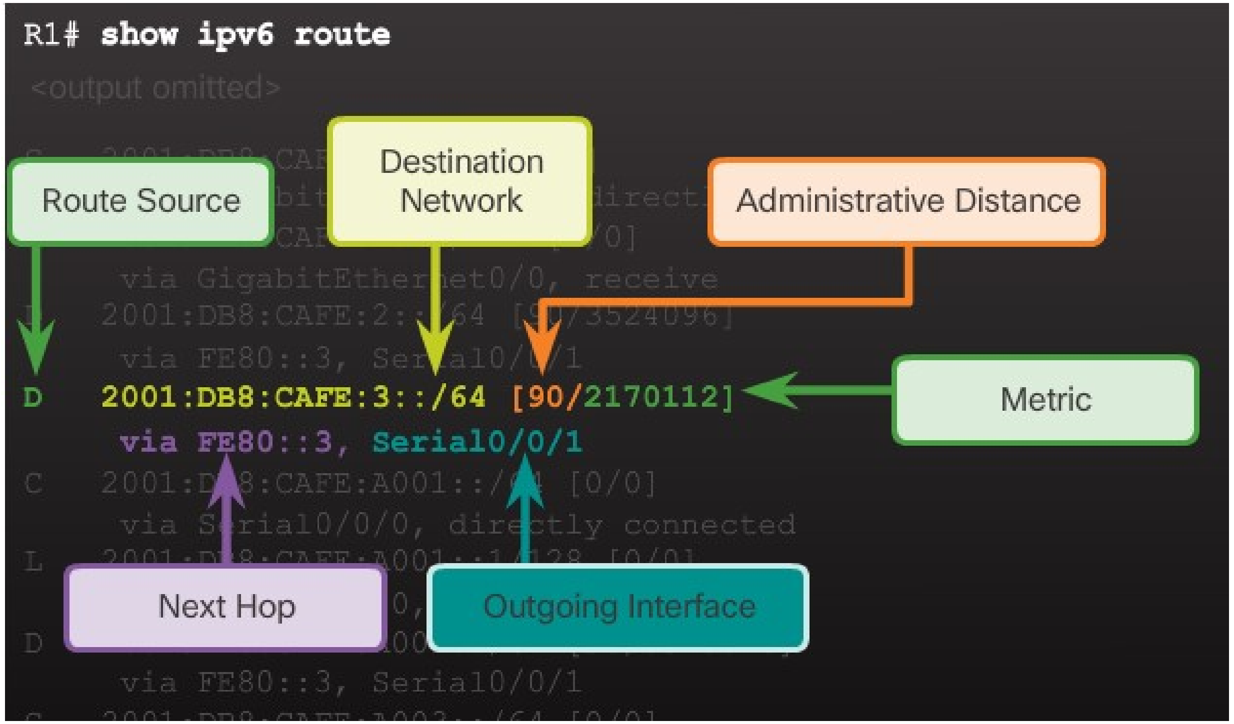
IPv6 Routing Table Directly Connected Entries

- Use the **`show ipv6 route`** command to display the IPv6 routing table.
- The directly connected route entries include the following:
    - Route source – How the route was learned. Directly connected indicated with a C and L for local route.
    - Directly connected network address.
    - Administrative distance – Trustworthiness of the route (lower more trustworthy).
    - Metric – Value assigned to reach the network (lower is preferred route).
    - Outgoing interface – Exit interface used to forward packet.



Remote IPv6 Network Entries

- The remote IPv6 route entries also include the following:
  - Route source – How the route was learned. Common codes include O (OSPF), D (EIGRP), R (RIP), and S (Static route).
  - Next hop - Identifies the IPv6 address of the next router to forward the packet to.
- The IPv6 router lookup process:
  - Examines level 1 network routes for the best match.
  - Longest match is the best match.

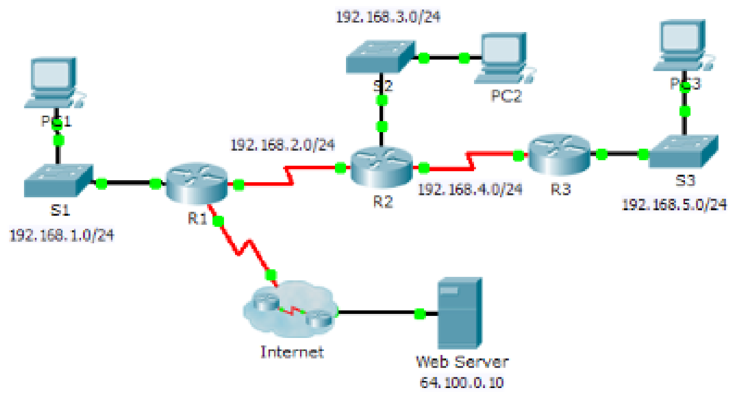


Packet Tracer – Configuring RIPv2

Cisco Networking Academy® Mind Wide Open®

Packet Tracer – Configuring RIPv2

Topology



Objectives

Part 1: Configure RIPv2

Part 2: Verify Configurations

Background

Although RIP is rarely used in modern networks, it is useful as a foundation for understanding basic network routing. In this activity, you will configure a default route, RIP version 2, with appropriate network statements and passive interfaces, and verify full connectivity.

Part 1: Configure RIPv2

Step 1: Configure RIPv2 on R1.

a. Use the appropriate command to create a default route on **R1** for all Internet traffic to exit the network through S0/0/1.

b. Enter RIP protocol configuration mode.

c. Use version 2 of the RIP protocol and disable the summarization of networks.

d. Configure RIP for the networks that connect to **R1**.

e. Configure the LAN port that contains no routers so that it does not send out any routing information.

f. Advertise the default route configured in step 1a with other RIP routers.

g. Save the configuration.

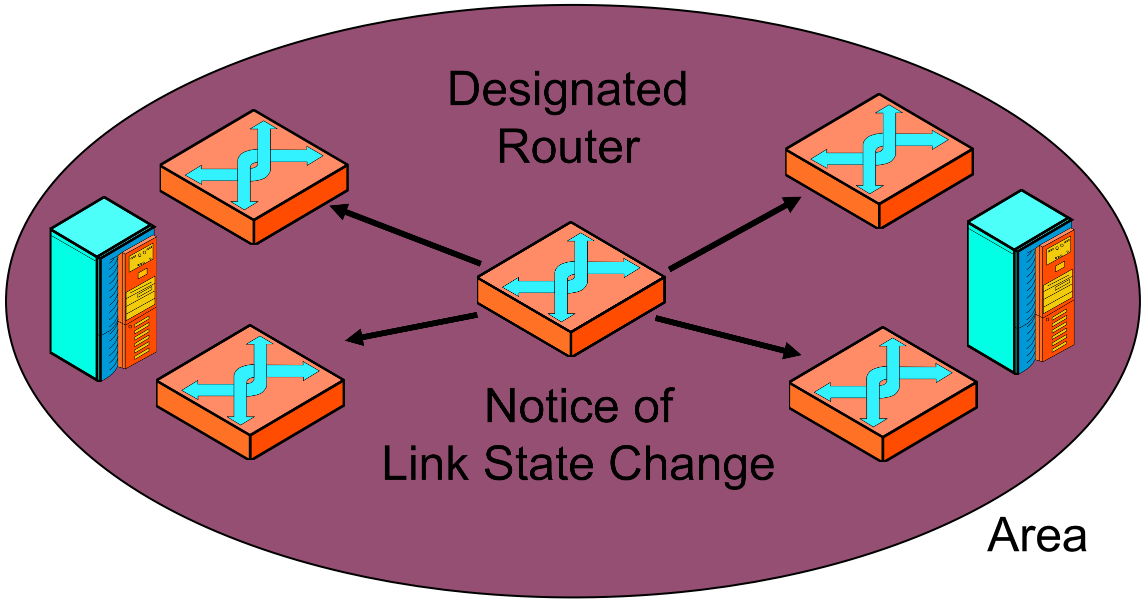
Other Dynamic Routing Protocols

- Routing Protocols developed to meet the need of larger networks include:
  - Open Shortest Path First (OSPF)
  - Intermediate System-to-Intermediate System (IS-IS).
  - Enhanced IGRP (EIGRP)
- Border Gateway Protocol (BGP) is used between Internet service providers (ISPs)

	Interior Gateway Protocols				Exterior Gateway Protocols
	Distance Vector		Link-State		Path Vector
IPv4	RIPv2	EIGRP	OSPFv2	IS-IS	BGP-4
IPv6	RIPng	EIGRP for IPv6	OSPFv3	IS-IS for IPv6	BGP-MP

OSPF Routing Protocol

- Network is Divided into Areas
  - Each area has a designated router
- When a router senses a link state change
  - Sends this information to the designated router
- Designated Router Notifies all Routers
  - Within its area



OSPF Routing Protocol

- Link State Protocol
  - Link is connection between two routers
  - OSPF routing table stores more information about each link than just its hop count: cost, reliability, etc.
  - Allows OSPF routers to optimize routing based on these variables
- Efficient
  - Only routers are informed (not hosts)
  - Usually only updates are transmitted, not whole tables
- Fast Convergence
  - When a failure occurs, a router transmits the notice to the designated router
  - Designated router send the information back out to other routers immediately

Selecting RIP or OSPF

- RIP is fine for small networks
  - Easy to implementing
  - 15 hops is not a problem
  - Broadcasting, interrupting hosts are not too important
- OSPF is Scalable
  - Works with networks of any size
  - Management complexities are worth the cost in large networks

Border Gateway Protocol (BGP)

- To connect different autonomous systems
  - Must standardize cross-system routing information exchanges
  - BGP is most popular today
  - Gateway is the old name for router
  - Exterior routing protocol
- Distance vector approach
  - Number of hops to a distant system is stored in the router forwarding table
- Normally only sends updates