# Dynamic Routing

NETWORK ADMINISTRATION

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# Objectives

- design a simple networks

- configure a routing table

- static & dynamic

# Dynamic Routing Protocols

Dynamic Routing Protocol Overview
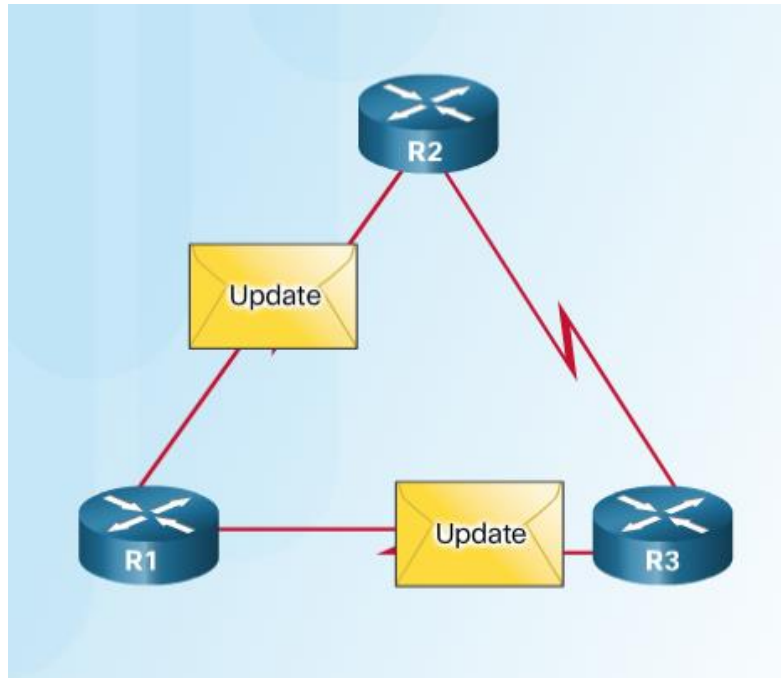## Dynamic Routing Protocol Overview

| | 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 |

- RIP protocol was updated to RIPv2 to accommodate growth in the network environment

    RIPv2 does not scale to current larger network implementations

- 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)

# Dynamic Routing Protocols

Dynamic Routing Protocol Overview
## 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.
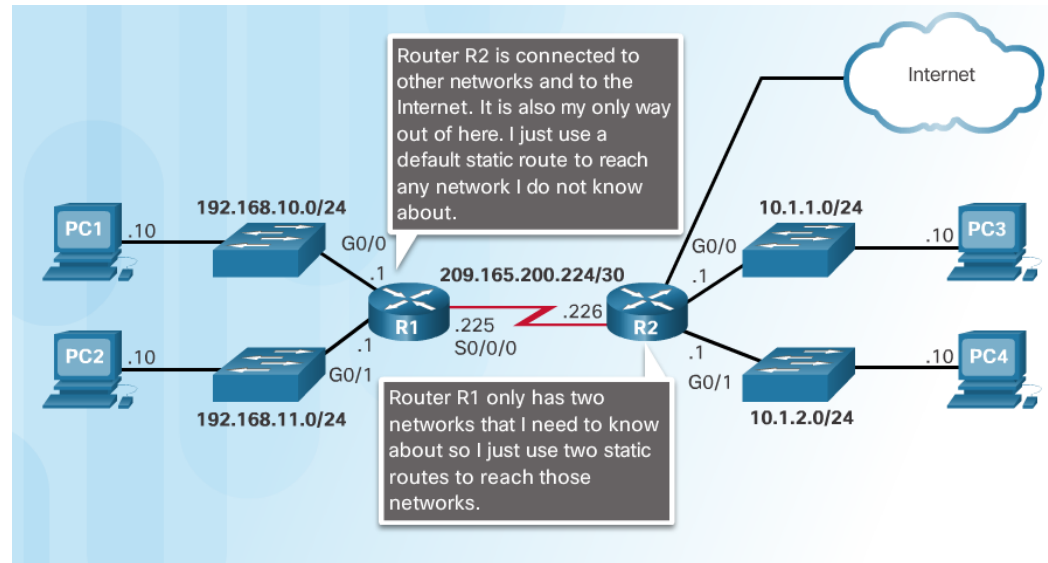
# Dynamic Routing Protocols

Dynamic versus Static Routing
Static Routing Uses

- 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 route**
ip route x.x.x.x y.y.y.y interface
ip route x.x.x.x y.y.y.y nexthop-address

**gateway of last resort to the default gateway default route**
ip route 0.0.0.0 0.0.0.0 nexthop-address / ip route 0.0.0.0 0.0.0.0 interface
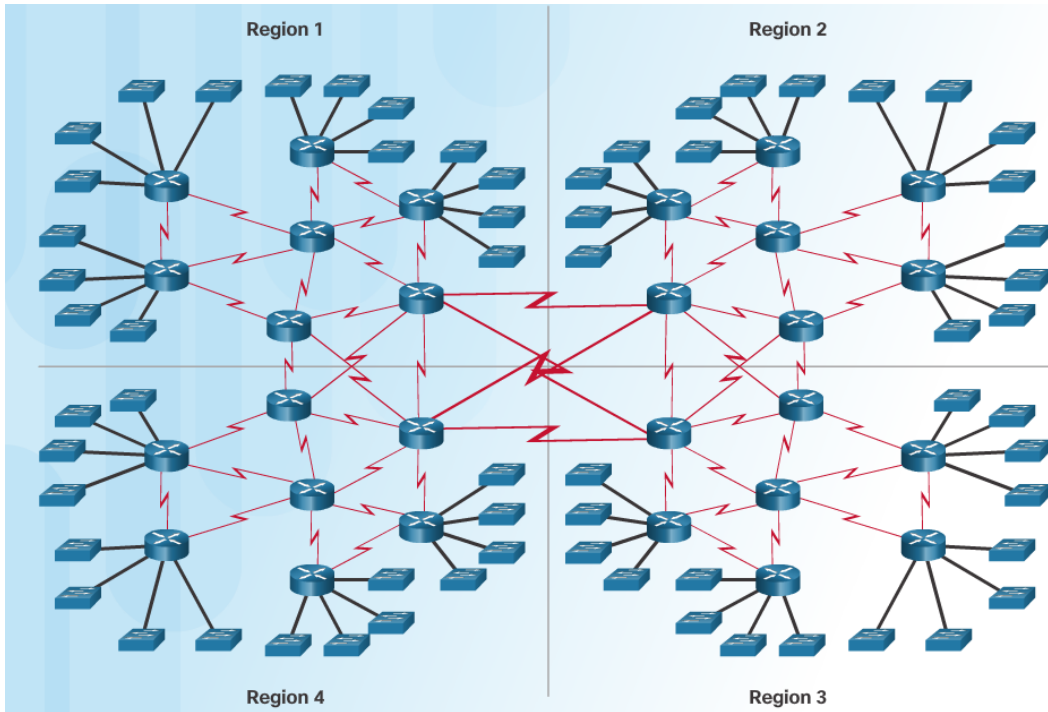
# Dynamic Routing Protocols

Dynamic versus Static Routing
## 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

Dynamic versus Static Routing
## 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 Protocols

Dynamic versus Static Routing
## 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. |

# RIPv2

## Router RIP Configuration Mode

- Use the **router rip** command to enable RIP v1

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

- Use the **no router rip command** to disable RIP

**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)#
```
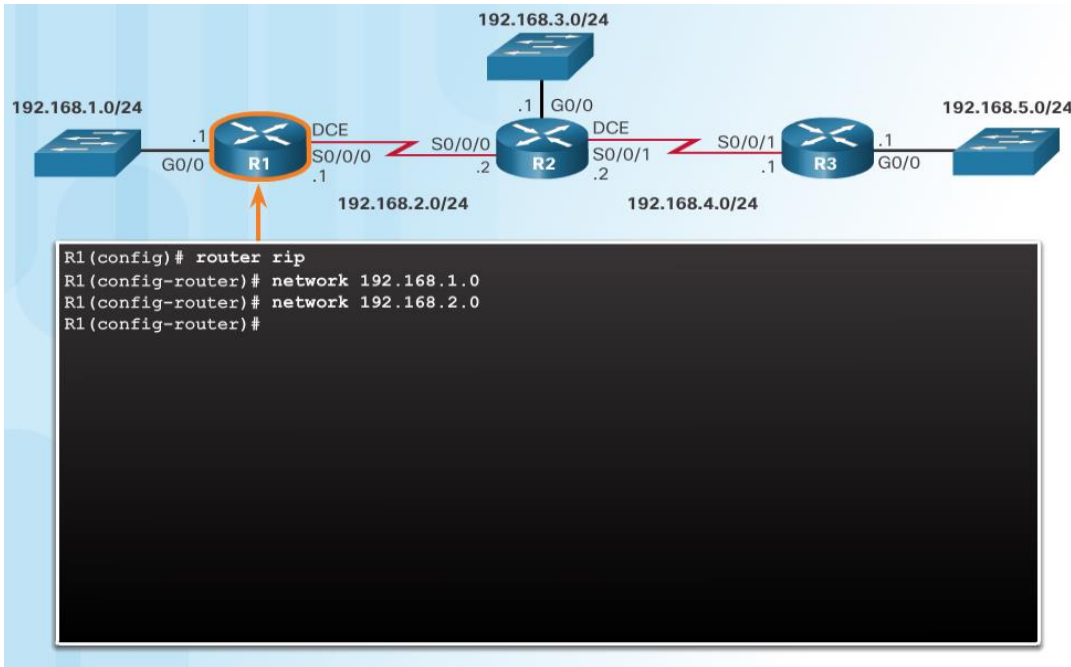
# RIPv2

## Advertise Networks



```
R1(config)# router rip
R1(config-router)# network 192.168.1.0
R1(config-router)# network 192.168.2.0
R1(config-router)#
```

- 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.

# RIPv2

## 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)

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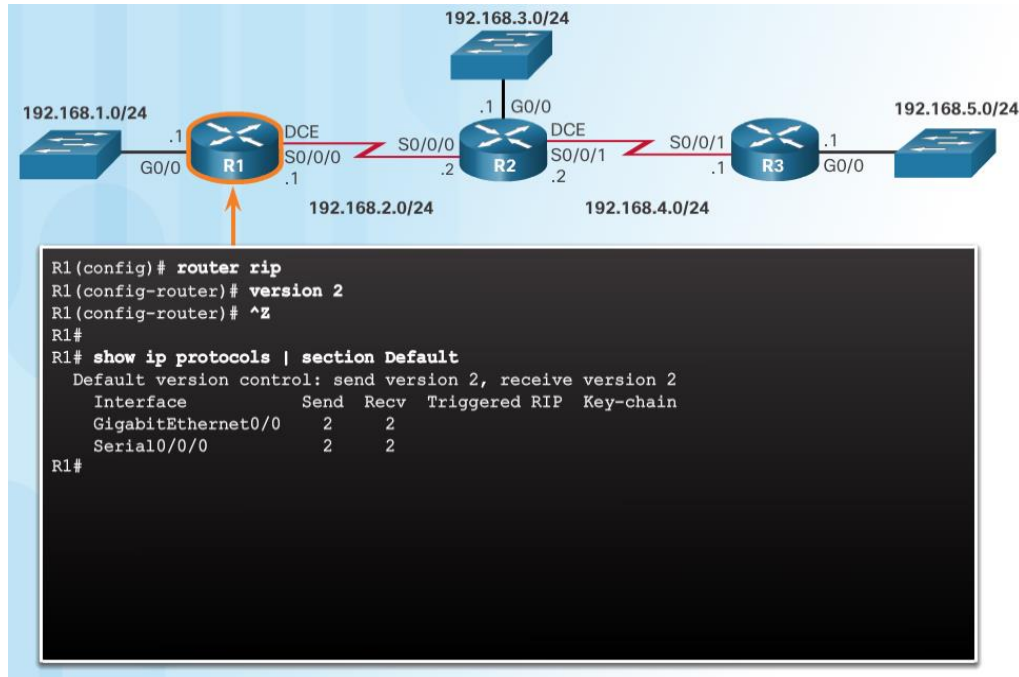
```
R1# show ip route | begin Gateway
Gateway of last resort is not set

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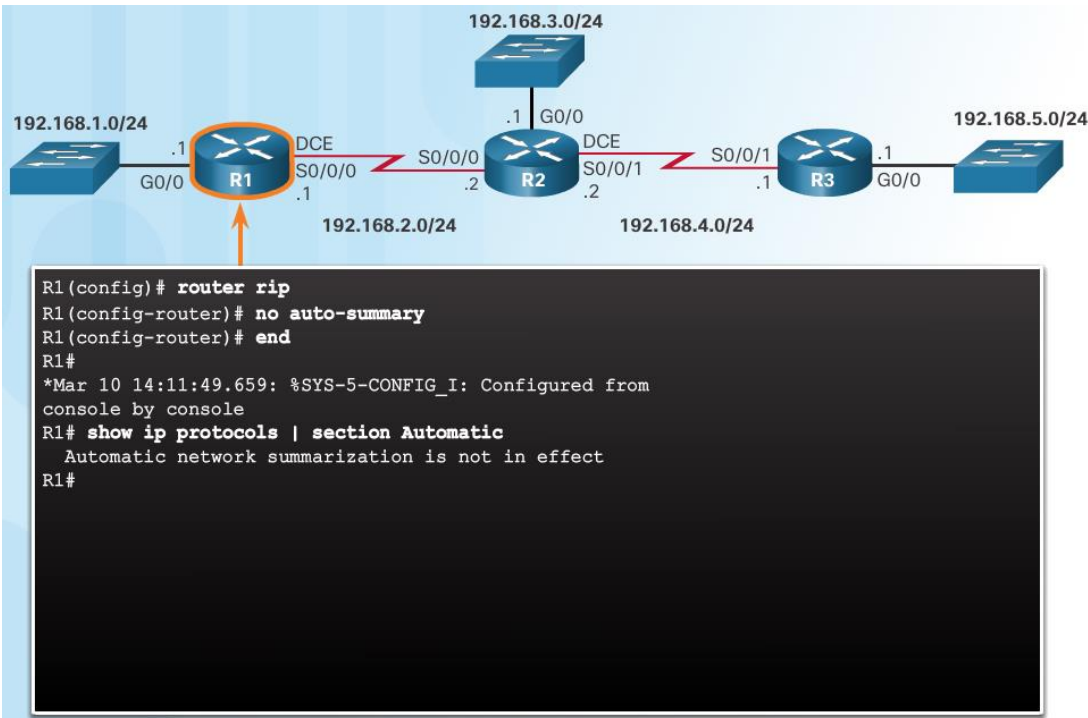
**show ip protocols –** displays IPv4 routing protocols configured on the router.

# RIPv2

## Enable and Verify RIPv2



```
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#
```

- 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.

# RIPv2

## Disable Auto Summarization



```
R1(config)# router rip
R1(config-router)# no auto-summary
R1(config-router)# end
R1#
*Mar 10 14:11:49.659: %SYS-5-CONFIG_I: Configured from
console by console
R1# show ip protocols | section Automatic
   Automatic network summarization is not in effect
R1#
```

- 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.
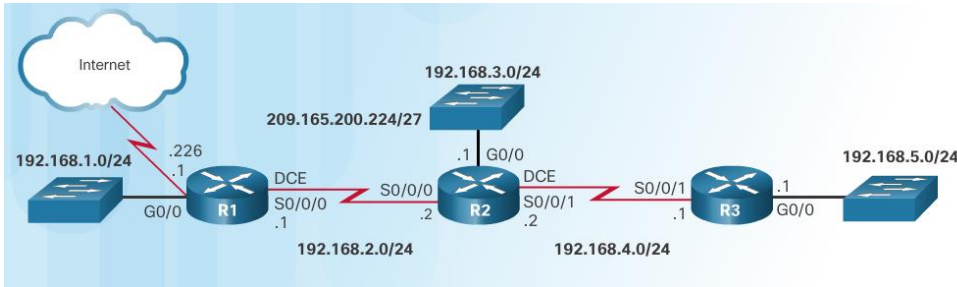
# RIPv2

## 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.
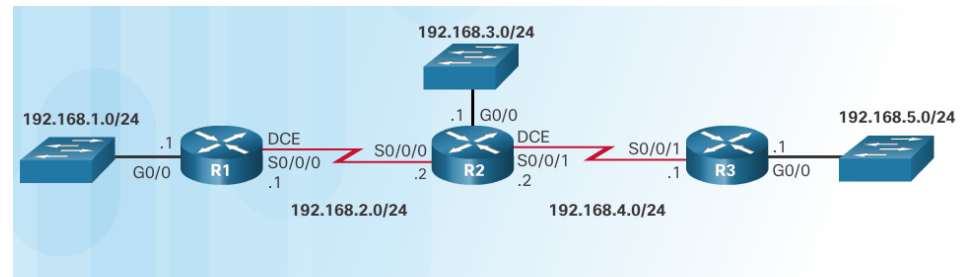


```
R1(config)# router rip
R1(config-router)# passive-interface g0/0
R1(config-router)# end
R1#
R1# show ip protocols | begin Default
  Default version control: send version 2, receive version 2
    Interface            Send  Recv  Triggered RIP  Key-
chain
    Serial0/0/0            2     2
  Automatic 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)

R1#
```
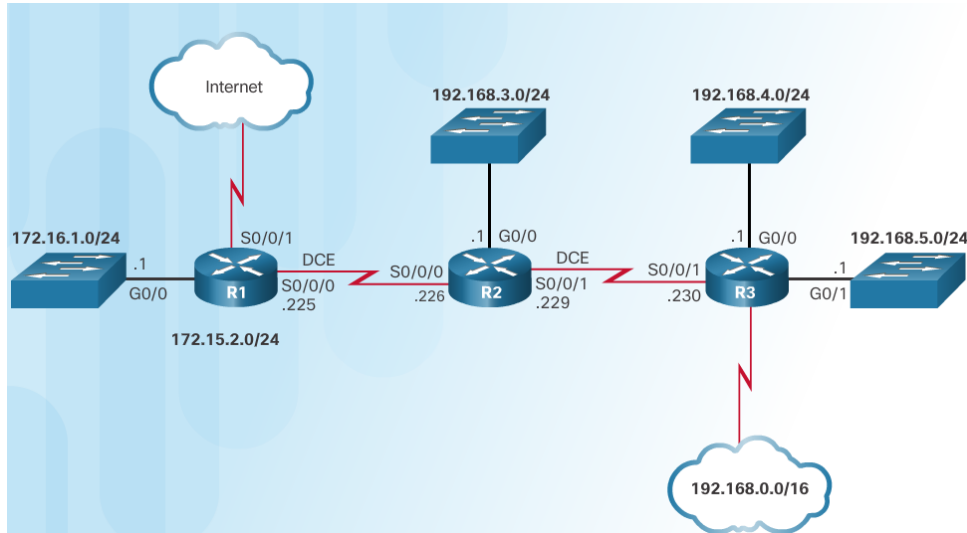
# RIPv2

## Propagate a Default Route



```
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#
```

- 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.

# The Routing Table

## 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

# The Routing Table

## Parts of an IPv4 Route Entry
### Directly Connected Entries

| Route Source | Destination Network | Outgoing Interface |
|---|---|---|
| C | 172.16.1.0/24 is directly connected, | GigabitEthernet0/0 |
| L | 172.16.1.1/32 is directly connected, | GigabitEthernet0/0 |

**Legend**

- Identifies how the network was learned by the router.

- Identifies the destination network and how it is connected.

- Identifies the interface on the router connected to the destination network.

- 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

# The Routing Table

Parts of an IPv4 Route Entry
## Remote Network Entries
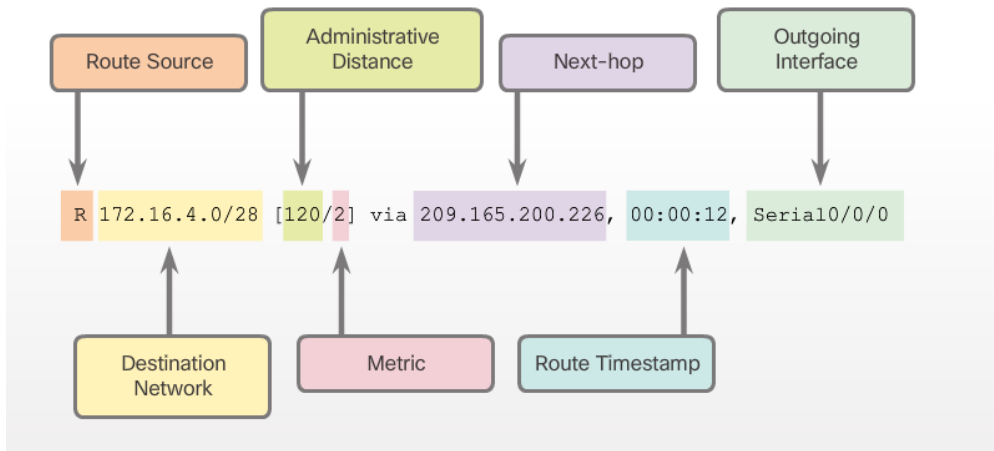


- Routes to remote networks contain the following information:

  - 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

# RIPv2

The IPv4 Route Lookup Process
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

# Thank you.

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