Chapter 5

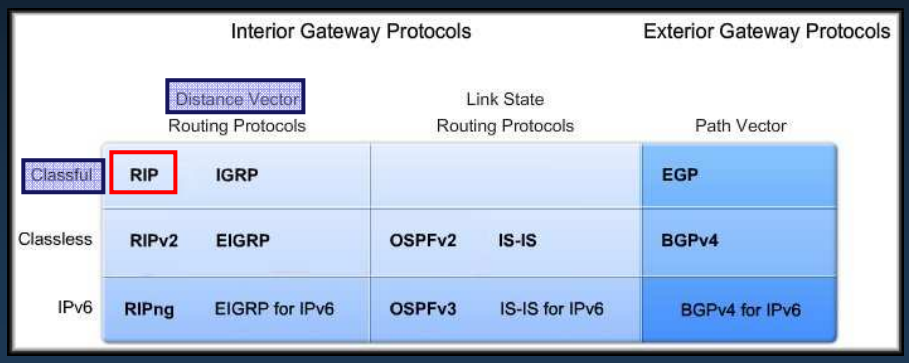
RIP Version 1 (RIPv1)

Note for Instructors

- These presentations are the result of a collaboration among the instructors at St. Clair College in Windsor, Ontario.
- Thanks must go out to Rick Graziani of Cabrillo College. His material and additional information was used as a reference in their creation.
- If anyone finds any errors or omissions, please let me know at:
  - tdame@stclaircollege.ca.

RIP Version 1

RIPv1: Distance Vector, Classful Routing Protocol



Background and Perspective

- RIP evolved from the Xerox Network System (NS) in the late 1970's.
- Various vendors included their own, slightly different, version of the protocol in their networking software.
- In 1988, it was standardized under RFC 1058.
- Why learn RIP?
  - Still in use today.
  - Help understand fundamental concepts and comparisons of protocols such as classful (RIPv1) and classless (RIPv2).
  - RIP is not a protocol "on the way out."
  - An IPv6 form of RIP called RIPng (next generation) is now available..

RIPv1 Characteristics and Message Format

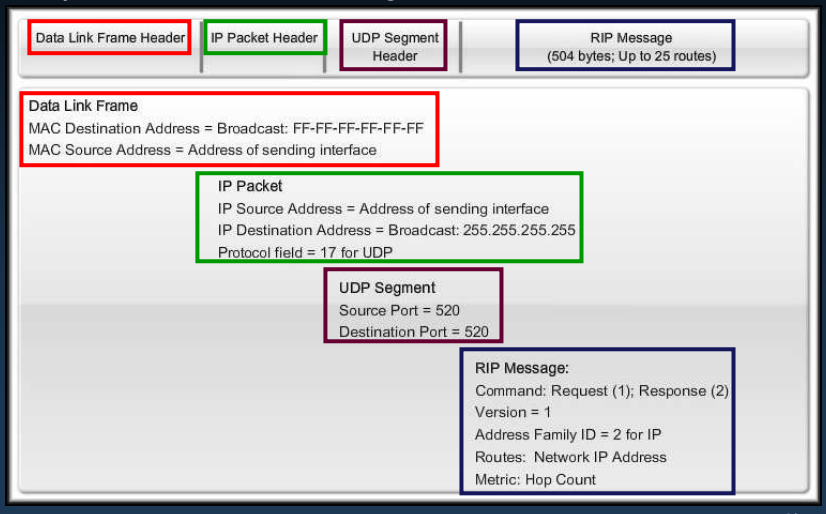
- NOTE:
  - The first version of RIP is often called RIPv1 to distinguish it from RIP version 2 (RIPv2).
  - Both versions share many of the same features.
  - When discussing features common to both versions, we will refer to RIP.
  - When discussing features unique to each version, we will use RIPv1 and RIPv2.

RIPv1 Characteristics and Message Format

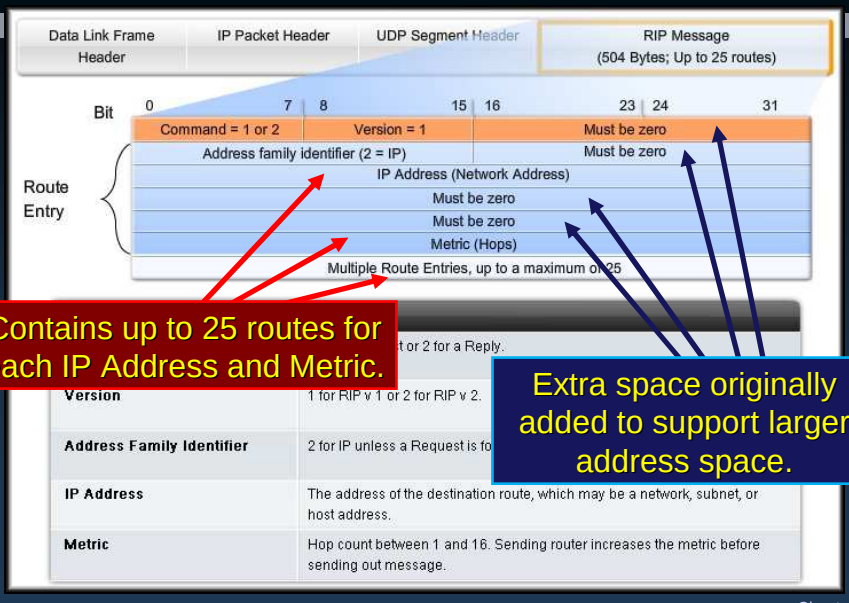
- RIP Characteristics:
  - Distance vector routing protocol.
  - Uses hop count as its only metric for path selection.
  - Advertised routes with hop counts greater than 15 are considered unreachable.
  - Routing Table Updates:
    - RIPv1: Broadcast every 30 seconds.
    - RIPv2: Multicast every 30 seconds.

RIPv1 Characteristics and Message Format

- Encapsulated RIPv1 Message:



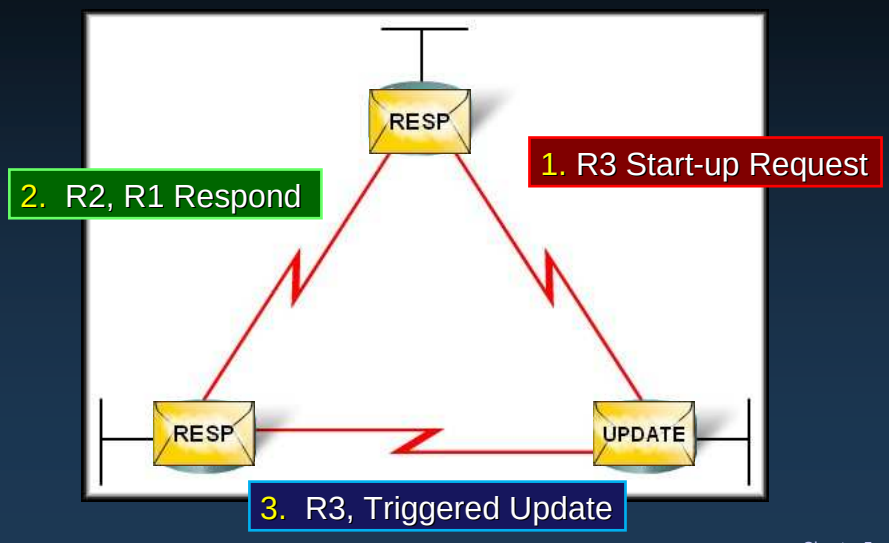
RIPv1 Characteristics and Message Format



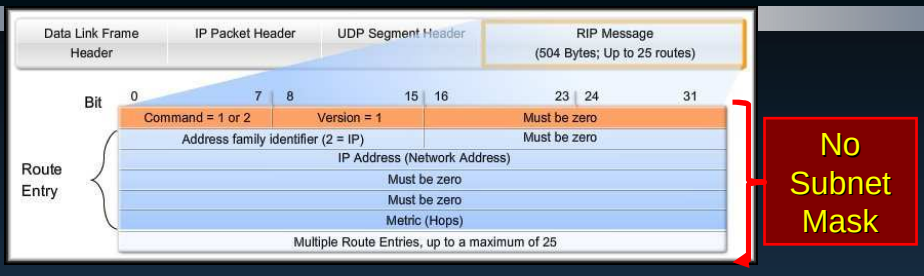
RIP Operation

- On Start-up:
  - Each RIP-configured interface broadcasts a request message, asking any RIP neighbours to send their complete routing table.
  - Each RIP neighbour responds with the information.
  - The requesting router evaluates each route:
    - If it's a new route, it gets added to the routing table.
    - If it's already in the routing table and has a better hop count (lower), the routing table is updated.
    - If there are no changes, it is ignored.
  - The requesting router then sends a triggered update out all interfaces that contains its routing table.

RIP Operation



IP Address Classes and Classful Routing



- RIPv1 is a classful routing protocol.
- RIPv1 does not send subnet mask information in the update.
- The router determines the subnet mask.
  - Uses the subnet mask configured on a local interface.
  - OR applies the default, classful subnet mask.
- Because of this limitation, RIPv1 networks cannot be discontiguous, nor can they implement VLSM.

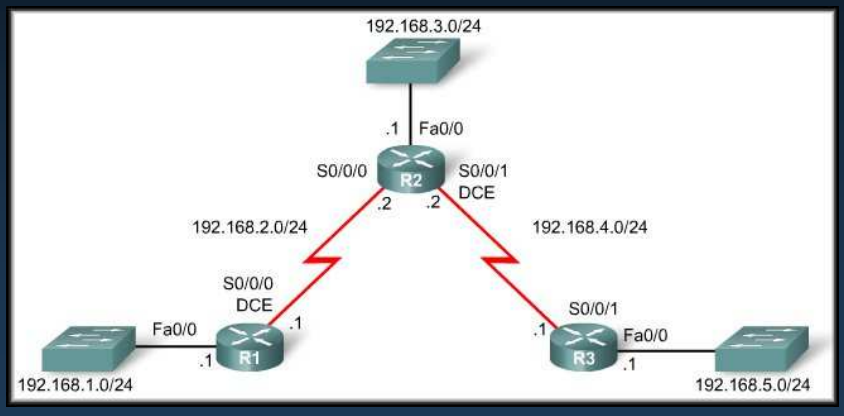
Administrative Distance (AD)

```
R3# show ip route
<output omitted>
R       192.168.1.0/24 [120/1] via 192.168.6.2, 00:00:05, Serial0/0/0
<output omitted>

R3# show ip protocols
<output omitted>
Routing Protocol is "rip"
  Routing Information Sources:
  Gateway         Distance      Last Update
    192.168.6.2   120           00:00:10
Distance: (default is 120)
```

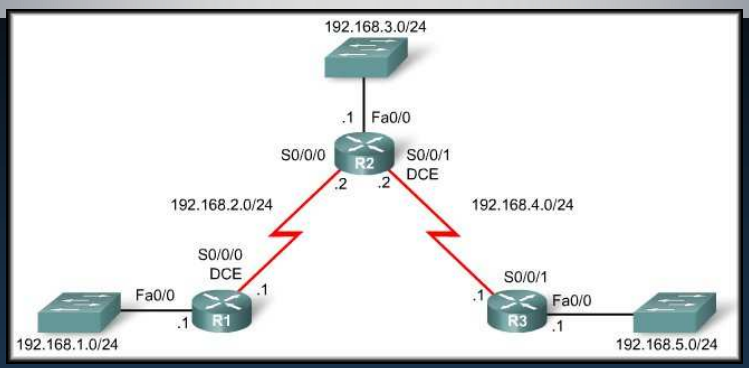
- Administrative Distance (AD) is the trustworthiness (or preference) of the route source.
  - RIP has a default administrative distance of 120.
  - When compared to other interior gateway protocols, RIP is the least-preferred routing protocol.

RIP Version 1

Basic RIPv1 Configuration



RIPv1 Scenario A



- Notice that this topology uses five Class C networks.
- Remember, RIPv1 is a classful routing protocol and all networks MUST have the same subnet mask.
- We will see that the class of the network is used by RIPv1 to determine the subnet mask.

Enabling RIP: `router rip` command

```
R1# conf t
R1(config)# router rip
R1(config-router)#
```

Global Configuration Mode

Issue command

Prompt changes

- The **`router rip`** command:
  - Does not directly start the RIP process.
  - Provides access to configure routing protocol settings.
- No routing updates are sent until you configure the networks that are participating in RIP.

Enabling RIP: `router rip` command

```
R1# conf t
R1(config)# router rip
R1(config-router)#
```

Global Configuration Mode

Issue command

Prompt changes

- To remove the RIP routing process from a device:

  `no router rip`
  - Stops the RIP process.
  - Erases all existing RIP configuration commands.

Specifying Networks

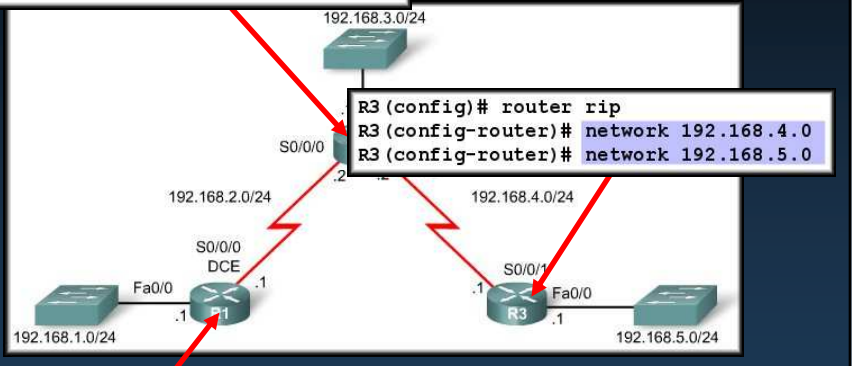
```
Router(config-router)# network
                    [directly-connected-classful-network-address]
```

- The **network** command:
  - Enter the classful network address for each directly connected network.
  - Functions:
    - Enables RIP on all interfaces that belong to a specific network. Associated interfaces will now both send and receive RIP updates.
    - Advertises the specified network in RIP routing updates sent to other routers every 30 seconds.

Specifying Networks

```
R2(config)# router rip
R2(config-router)# network 192.168.2.0
R2(config-router)# network 192.168.3.0
R2(config-router)# network 192.168.4.0
```

ONLY directly connected classful addresses!

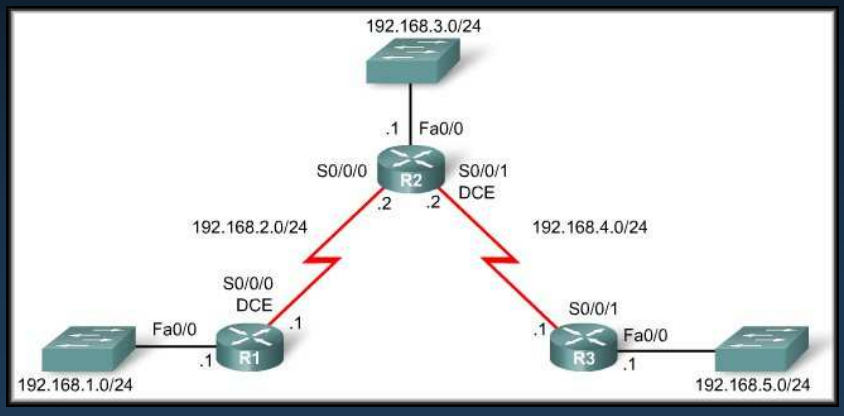



```
R3(config)# router rip
R3(config-router)# network 192.168.4.0
R3(config-router)# network 192.168.5.0
```

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

RIP Version 1

Verification and Troubleshooting

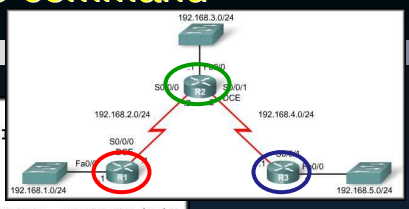


show ip route command

```
R1# show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile,
<output omitted>
Gateway of last resort is not set

R    192.168.4.0/24 [120/1] via 192.168.2.2, 00:00:02, Serial0/0/0
R    192.168.5.0/24 [120/2] via 192.168.2.2, 00:00:02, Serial0/0/0
C    192.168.1.0/24 is directly connected, FastEthernet0/0
C    192.168.2.0/24 is directly connected, Serial0/0/0
R    192.168.3.0/24 [120/1] via 192.168.2.2, 00:00:02, Serial0/0/0
```

- **C** in the output indicates directly connected networks.
- **R** in the output indicates RIP routes.
- Because this command displays the entire routing table, it is normally the first command used to check for convergence.
- Routes might not immediately appear when you execute the command because networks take some time to converge.

show ip route command




```
R1# show ip route
Codes: C - connected, S - static, I - IGRP, R - RI
<output omitted>
Gateway of last resort is not set

R    192.168.4.0/24 [120/1] via 192.168.2.2, 00:00:02, Serial0/0/0
R    192.168.5.0/24 [120/2] via 192.168.2.2, 00:00:02, Serial0/0/0
C    192.168.1.0/24 is directly connected, FastEthernet0/0
C    192.168.2.0/24
R    192.168.3.0/24
```

```
R2# show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile,
<output omitted>
Gateway of last resort is not set

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, 00:00:12, Serial0/0/1
R    192.168.1.0/24 [120/1] 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
```

```
R3# show ip route
Codes: C - connecte
<output omitted>
Gateway of last res

C    192.168.4.0/24 is directly connected, Serial0/0/1
C    192.168.5.0/24 is directly connected, FastEthernet0/0
R    192.168.1.0/24 [120/2] via 192.168.4.2, 00:00:08, Serial0/0/1
R    192.168.2.0/24 [120/1] via 192.168.4.2, 00:00:08, Serial0/0/1
R    192.168.3.0/24 [120/1] via 192.168.4.2, 00:00:08, Serial0/0/1
```


show ip route command

Identifies RIP as the source of the route.

Remote network address and subnet mask.

```
R1# show ip route

<output omitted>

R    192.168.5.0/24    [120/2]    via 192.168.2.2    00:00:23    Serial0/0/0
```

AD of 120 / Metric of 2 hops.

Address of the next-hop router.

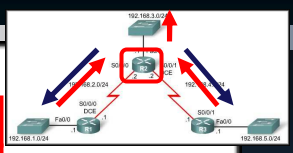
Elapsed time since last update.

The local, exit interface

show ip protocols command

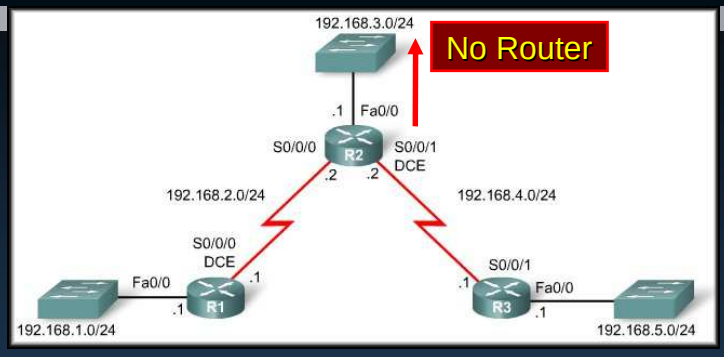
```
R2#show ip protocols
Routing Protocol is "rip"
  Sending updates every 30 seconds, next due in 23 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Redistributing: rip
  Default version control: send version 1, receive any version
    Interface                Send  Recv  Triggered RIP  Key-chain
    FastEthernet0/0          1     1 2
    Serial0/0/0              1     1 2
    Serial0/0/1              1     1 2
  Automatic network summarization is in effect
  Maximum path: 4
  Routing for Networks:
    192.168.2.0
    192.168.3.0
    192.168.4.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.2.1           120      00:00:18
    192.168.4.1           120      00:00:22
  Distance: (default is 120)
```


debug ip rip command



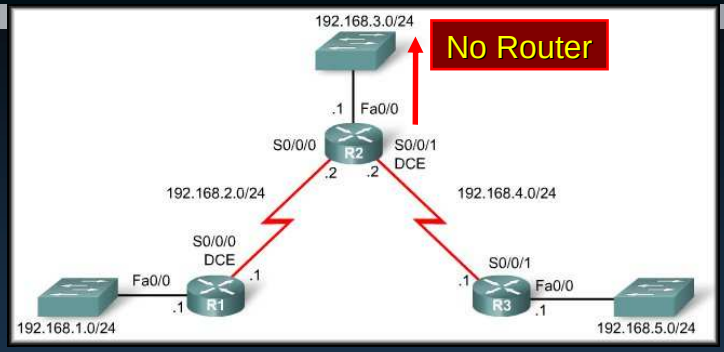
```
R2#debug ip rip
RIP protocol debugging is on
RIP: received v1 update from 192.168.2.1 on Serial0/0/0
     192.168.1.0 in 1 hops
RIP: received v1 update from 192.168.4.1 on Serial0/0/1
     192.168.5.0 in 1 hops
RIP: sending  v1 update to 255.255.255.255 via FastEthernet0/0 (192.168.3.1)
RIP: build update entries
     network 192.168.1.0 metric 2
     network 192.168.2.0 metric 1
     network 192.168.4.0 metric 1
     network 192.168.5.0 metric 2
RIP: sending  v1 update to 255.255.255.255 via Serial0/0/1 (192.168.4.2)
RIP: build update entries
     network 192.168.1.0 metric 2
     network 192.168.2.0 metric 1
     network 192.168.3.0 metric 1
RIP: sending  v1 update to 255.255.255.255 via Serial0/0/0 (192.168.2.2)
RIP: build update entries
     network 192.168.3.0 metric 1
     network 192.168.4.0 metric 1
     network 192.168.5.0 metric 2
R2#undebug all
All possible debugging has been turned off
```

Passive Interfaces



- Some routers can have interfaces **that do not connect to another router**.
- There is no reason to send routing updates out that interface.
- You can use the **`passive-interface`** command with RIP to configure an interface to NOT send those updates.

Passive Interfaces



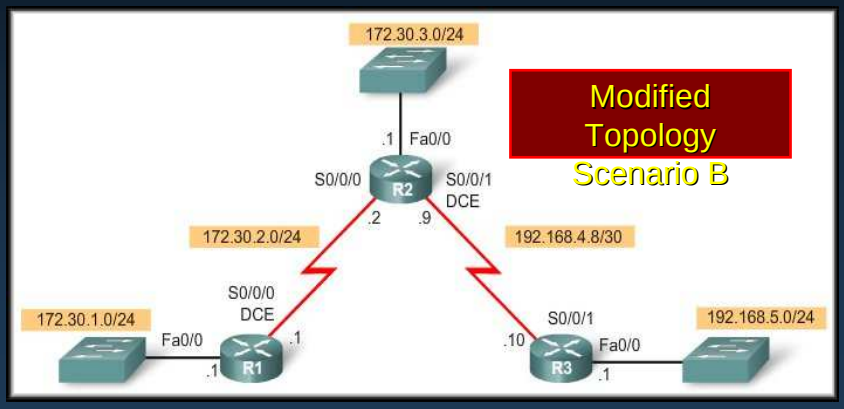

```
passive-interface [interface-type interface-number]
```

```
R2(config)# router rip
R2(config-router)# passive-interface FastEthernet 0/0
```

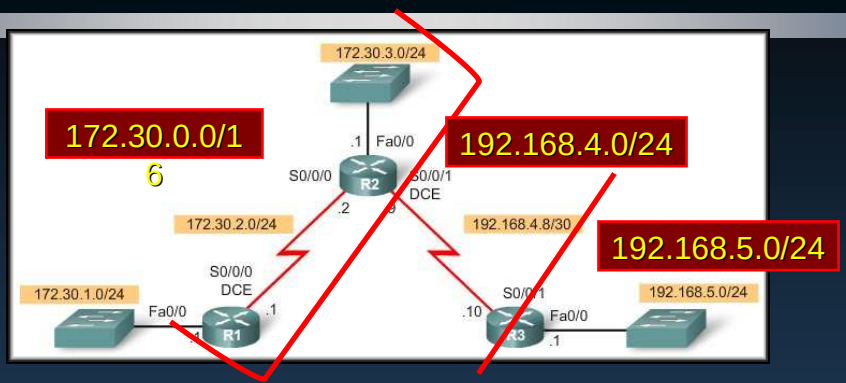
NO updates sent out interface fa0/0.

RIP Version 1

Automatic Summarization

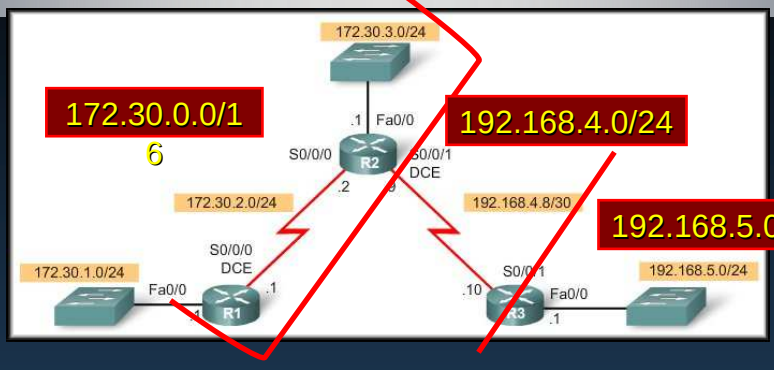


Modified Topology: Scenario B



- Three classful networks:
  - 172.30.0.0/16
  - 192.168.4.0/24
  - 192.168.5.0/24
- 172.30.0.0/16 subnetted to:
  - 172.30.1.0/24
  - 172.30.2.0/24
  - 172.30.3.0/24
- 192.168.4.0/24 subnetted to:
  - 192.168.4.8/30

Modified Topology: Scenario B



- Fewer routes in a routing table means that the routing table process can more quickly locate the route needed to forward the packet.
- Summarizing several routes into a single route is known as route summarization or route aggregation.

Modified Topology: Scenario B

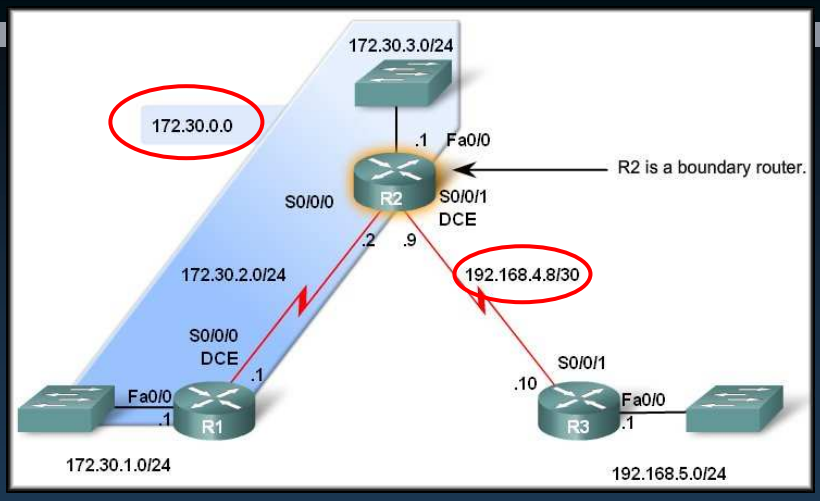
Configuration Changes – R1

```
R1(config)# interface fa0/0
R1(config-if)# ip address 172.30.1.1 255.255.255.0
R1(config-if)# interface S0/0/0
R1(config-if)# ip address 172.30.2.1 255.255.255.0
R1(config-if)# no router rip
R1(config)# router rip
R1(config-router)# network 172.30.1.0
R1(config-router)# network 172.30.2.0
R1(config-router)# passive-interface Fa
R1(config-router)# end
R1# show run
<output omitted>
!
router rip
passive-interface FastEthernet0/0
network 172.30.0.0
!
<output omitted>
```

IOS automatically corrects subnet entries to a classful network address.

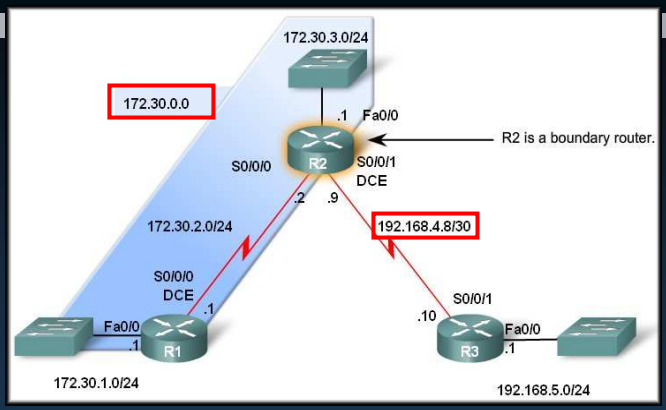
The same thing will happen when R2 and R3 are changed.

Boundary Routers and Auto-Summarization



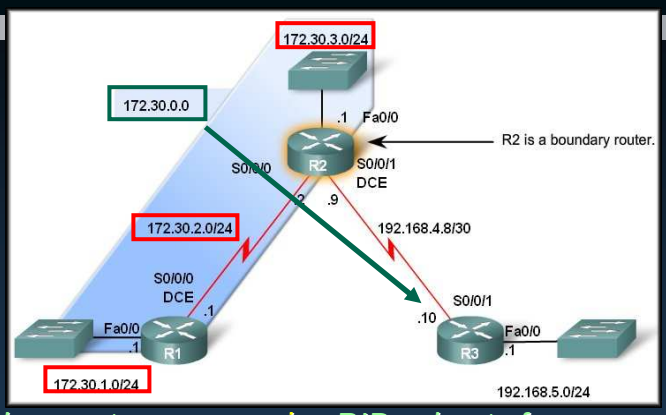
- RIP is a classful routing protocol that automatically summarizes classful networks across major network boundaries.

Boundary Routers and Auto-Summarization



- R2 has interfaces in more than one major classful network.
- This makes R2 a boundary router in RIP.

Boundary Routers and Auto-Summarization



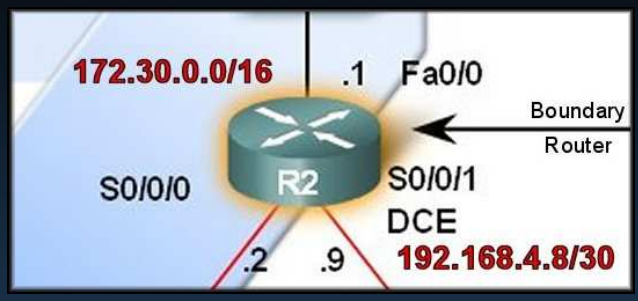
- *Boundary routers summarize RIP subnets from one major network to the other.*
- Updates for the 172.30.1.0, 172.30.2.0, and 172.30.3.0 networks will automatically be summarized into 172.30.0.0 when sent out R2's Serial 0/0/1 interface.

Processing RIP Updates

```
R2# show ip route
     172.30.0.0/24 is subnetted, 3 subnets
R       172.30.1.0 [120/1] via 172.30.2.1, 00:00:18, Serial0/0/0
C       172.30.2.0 is directly connected, Serial0/0/0
C       172.30.3.0 is directly connected, FastEthernet0/0
     192.168.4.0/30 is subnetted, 1 subnets
C       192.168.4.8 is directly connected, Serial0/0/1
R    192.168.5.0/24 [120/1] via 192.168.4.10, 00:00:16, Serial0/0/1
```

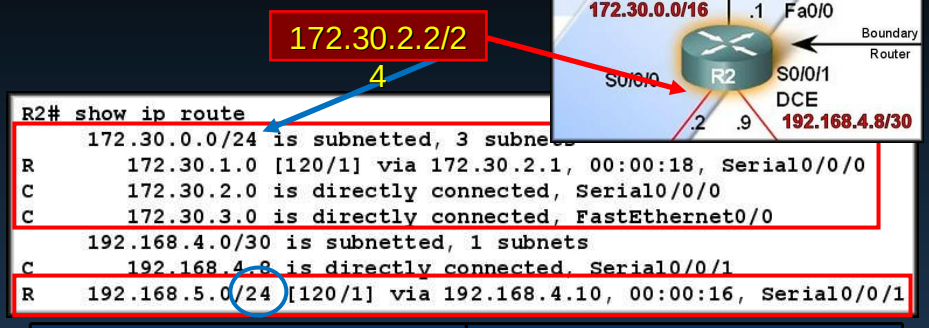
- Classful routing protocols such as RIPv1 do not include the subnet mask in the routing update.
- However, the routing table includes RIPv1 routes with both the network address and the subnet mask.
- So…..*How does a router running RIPv1 determine what subnet mask it should apply to a route when adding it to the routing table?*

Rules for Processing RIP Updates



Routing Update and Interface	Routing Update Subnet Mask
Same classful Major Network	Use the Interface Subnet Mask
Different classful Major Network	Use the Classful Subnet Mask

Rules for Processing RIP Updates

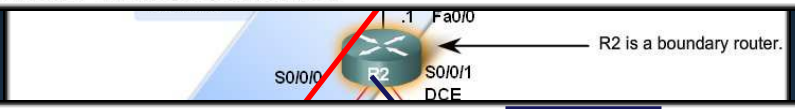


Routing Update and Interface	Routing Update Subnet Mask
Same classful Major Network	Use the Interface Subnet Mask
Different classful Major Network	Use the Classful Subnet Mask

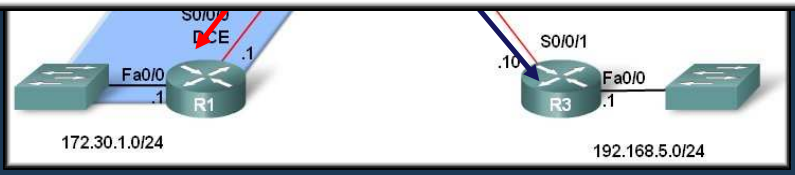
Sending RIP Updates

- Using debug to view Automatic Summarization

```
RIP: sending v1 update to 255.255.255.255 via Serial0/0/0 (172.30.2.2)
RIP: build update entries
      network 172.30.3.0 metric 1
      network 192.168.4.0 metric 1
      network 192.168.5.0 metric 2
```

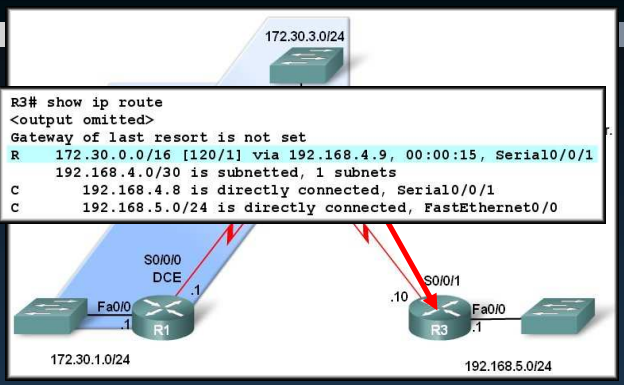



```
RIP: sending v1 update to 255.255.255.255 via Serial0/0/1 (192.168.4.9)
RIP: build update entries
      network 172.30.0.0 metric 1
```



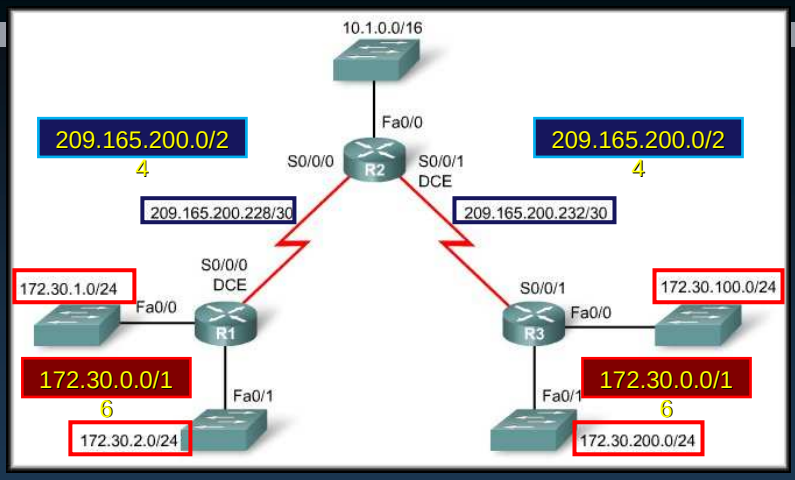
Advantages of Auto-Summarization

- Smaller routing updates are sent and received, which uses less bandwidth for routing updates between R2 and R3.



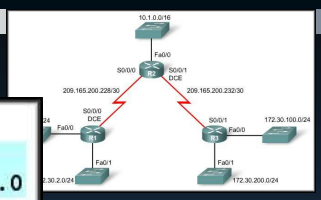
- *R3 has a single route for the 172.30.0.0/16 network, regardless of how many subnets there are or how it is subnetted.*
  - Using a single route results in a faster lookup process in the routing table for R3.

Disadvantages of Auto-Summarization



- **Discontiguous network**, two or more subnets separated by at least one other major network.
- **172.30.0.0/16** is a discontiguous network.

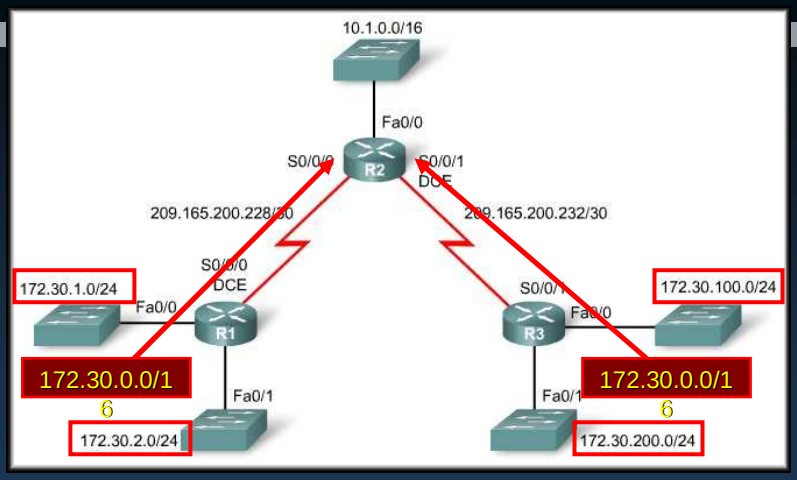
Discontiguous Networks Do Not Converge



```
R1(config)# router rip
R1(config-router)# network 172.30.0.0
R1(config-router)# network 209.165.200.0

R2(config)# router rip
R2(config-router)# network 10.0.0.0
R2(config-router)# network 209.165.200.0

R3(config)# router rip
R3(config-router)# network 172.30.0.0
R3(config-router)# network 209.165.200.0
```

- RIPv1 configuration is correct, but it is **unable to determine all the networks** in this discontiguous topology.

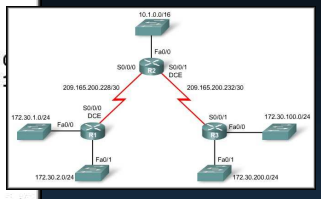
Discontiguous Networks Do Not Converge



- Routers **R1 and R3** will **both** advertise the 172.30.0.0/16 major network address **(a summary route)** to R2.

Discontiguous Networks Do Not Converge

```
R1# show ip route

     172.30.0.0/24 is subnetted, 3 subnets
C       172.30.1.0 is directly connected, FastEthernet0/0
C       172.30.2.0 is directly connected, FastEthernet0/1

R3# show ip route

     172.30.0.0/24 is subnetted, 3 subnets
C       172.30.100.0 is directly connected, FastEthernet0/0
C       172.30.200.0 is directly connected, FastEthernet0/1
```



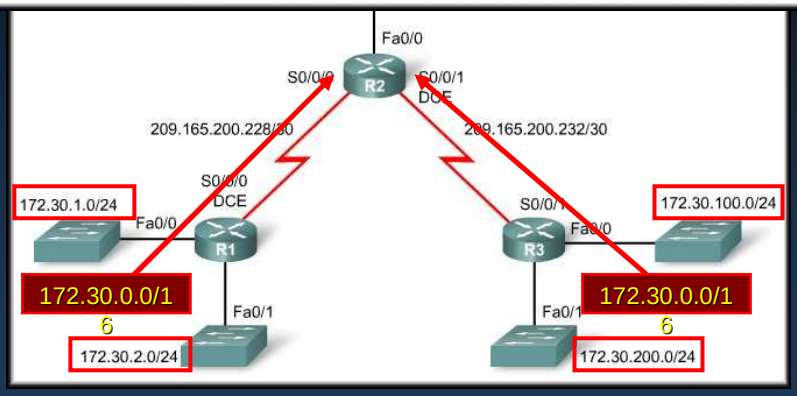
- **R1 does not have** routes to the LANs attached to R3.
- **R3 does not have** routes to the LANs attached to R1.
- **Note:** The text/curriculum has the following routes for R1 and R3 (Text: Figure 5-15 and 5-17). These routes are **NOT** in the routing tables.

```
R1: R 172.30.0.0 [120/2] via 209.165.200.230, 00:00:26, Serial0/0/0
R3: R 172.30.0.0 [120/2] via 209.165.200.233, 00:00:22, Serial0/0/1
```

Discontiguous Networks Do Not Converge

```
R2# show ip route

R    172.30.0.0/16 [120/1] via 209.165.200.234, 00:00:14, Serial0/0/1
                   [120/1] via 209.165.200.229, 00:00:19, Serial0/0/0
```

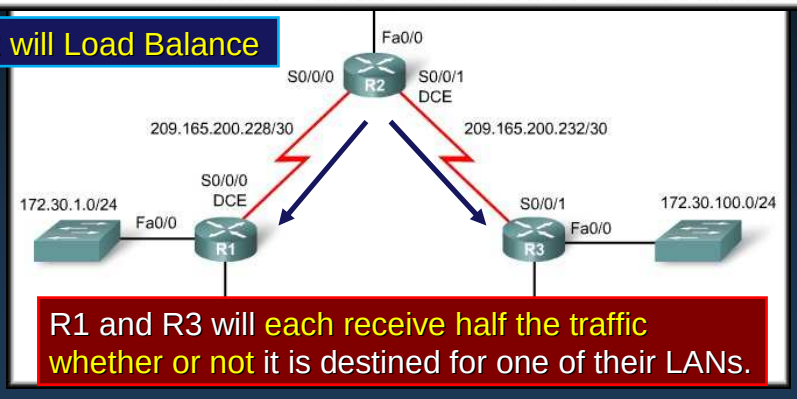
Two equal cost paths to 172.30.0.0/16



Discontiguous Networks Do Not Converge

```
R2# show ip route

R    172.30.0.0/16 [120/1] via 209.165.200.234, 00:00:14, Serial0/0/1
                   [120/1] via 209.165.200.229, 00:00:19, Serial0/0/0
```

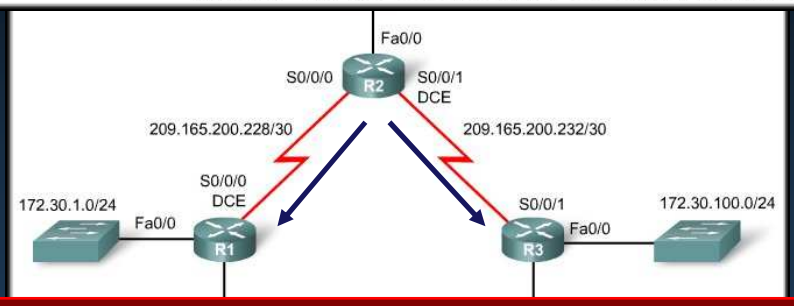
R2 will Load Balance



R1 and R3 will each receive half the traffic whether or not it is destined for one of their LANs.

Discontiguous Networks Do Not Converge

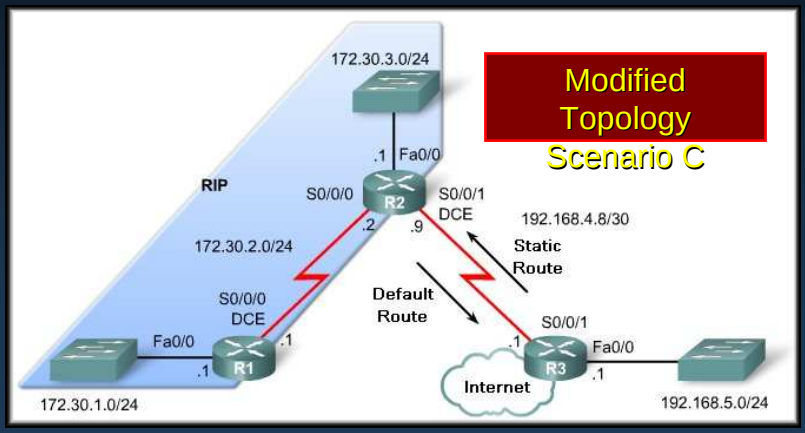
```
R2# show ip route

R    172.30.0.0/16 [120/1] via 209.165.200.234, 00:00:14, Serial0/0/1
                   [120/1] via 209.165.200.229, 00:00:19, Serial0/0/0
```



Classful routing protocols do not support discontiguous networks because the subnet mask is not included in the routing table update.

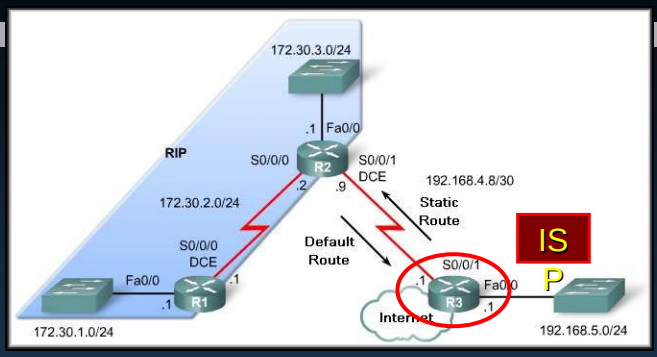
RIP Version 1

Default Route and RIPv1



Modified Topology
Scenario C

Default Routes



- In today's networks, customers do not necessarily have to exchange routing updates with their ISP.
- Customer routers have a **default route** that sends **all traffic** to the ISP router.
- The ISP configures a **static route pointing to the customer router** for addresses inside the customer's network.

Default Routes

- **Default Route:**
  - A special **static route** that is used to route packets with a **destination IP address that does not match** any of the other routes in the routing table.
  - It tells the router…..

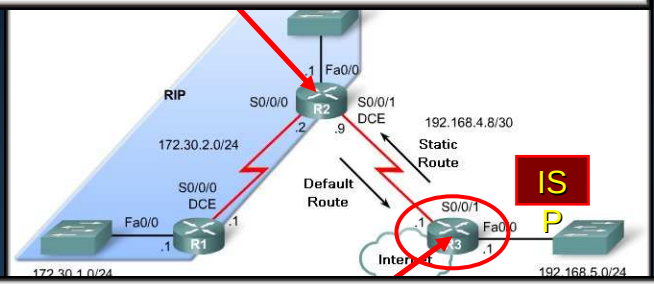
"If you don't know where to forward the frame, send it here."

  - Uses a **quad-zero** definition for the route.

```
ip route 0.0.0.0 0.0.0.0
                [next-hop-address/exit-interface]
```

RIPv1 Configuration R2 and R3

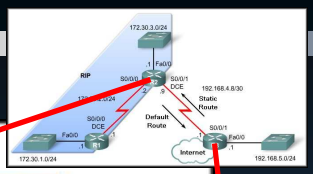
```
R2(config)# router rip
R2(config-router)# network 172.30.2.0
R2(config-router)# network 172.30.3.0
R2(config-router)# exit

R2(config)# ip route 0.0.0.0 0.0.0.0 serial 0/0/1
```




```
R3(config)# no router rip

R3(config)# ip route 172.30.0.0 255.255.252.0 serial 0/0/1
```


RIPv1 Configuration R2 and R3

Routing Tables

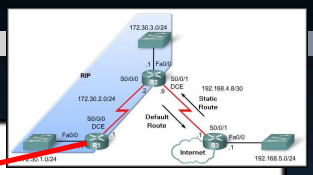


```
R2# show ip route
<output omitted>
Gateway of last resort is 0.0.0.0 to network 0.0.0.0
     172.30.0.0/24 is subnetted, 3 subnets
R       172.30.1.0 [120/1] via 172.30.2.1, 00:00:03, Serial0/0/0
C       172.30.2.0 is directly connected, Serial0/0/0
C       172.30.3.0 is directly connected, FastEthernet0/0
     192.168.4.0/30 is subnetted, 1 subnets
C       192.168.4.8 is directly connected, Serial0/0/1
S*   0.0.0.0/0 is directly connected, Serial0/0/1
```

```
R3# show ip route
<output omitted>
Gateway of last resort is not set
     172.30.0.0/22 is subnetted, 1 subnets
S       172.30.0.0 is directly connected, Serial0/0/1
     192.168.4.0/30 is subnetted, 1 subnets
C       192.168.4.8 is directly connected, Serial0/0/1
C    192.168.5.0/24 is directly connected, FastEthernet0/0
```

Propagating the Default Route

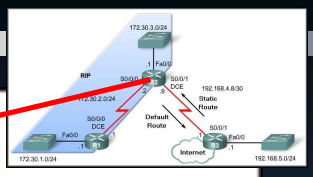
Routing Table



```
R1# show ip route
<output omitted>
Gateway of last resort is not set
     172.30.0.0/24 is subnetted, 3 subnets
C       172.30.1.0 is directly connected, FastEthernet0/0
C       172.30.2.0 is directly connected, Serial0/0/0
R       172.30.3.0 [120/1] via 172.30.2.2, 00:00:05, Serial0/0/0
```

- What about R1?
  - Knows the 172.30.0.0/24 subnets but nothing else.
  - How does it forward traffic destined for the internet?
    - It also needs a default route.
  - Could configure a static default route on every router but this is inefficient and does not react to topology changes.

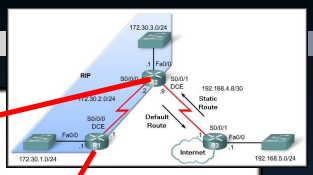
Propagating the Default Route



```
R2(config)# router rip
R2(config-router)# default-information originate
R2(config-router)# end

R2# debug ip rip
RIP: sending v1 update to 255.255.255.255 via Serial0/0/0 (172.30.2.2)
RIP: build update entries
       subnet 0.0.0.0 metric 1
       subnet 172.30.3.0 metric 1
```

- Instead, in R2, you can use the **`default-information originate`** command.
- This command specifies that R2 (already has a default route) is to originate default information.
  - R2 is to include the static default route in RIP updates.

Propagating the Default Route




```
R2(config)# router rip
R2(config-router)# default-information originate
R2(config-router)# end

R2# debug ip rip
RIP: sending v1 update to 255.255.255.255 via Serial0/0/0 (172.30.2.2)
RIP: build update entries
       subnet 0.0.0.0 metric 1
       subnet 172.30.3.0 metric 1
```

```
R1# show ip route
<output omitted>
Gateway of last resort is not set
     172.30.0.0/24 is subnetted, 3 subnets
C       172.30.1.0 is directly connected, FastEthernet0/0
C       172.30.2.0 is directly connected, Serial0/0/0
R       172.30.3.0 [120/1] via 172.30.2.2, 00:00:05, Serial0/0/0
```

```
C       172.30.1.0 is directly connected, FastEthernet0/0
R*   0.0.0.0/0 [120/1] via 172.30.2.2, 00:00:16, Serial0/0/0
```