RIP version 1

Routing Protocols and Concepts – Chapter 5

Cisco Networking Academy®
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Objectives

- Describe the functions, characteristics, and operation of the RIPv1 protocol.
- Configure a device for using RIPv1.
- Verify proper RIPv1 operation.
- Describe how RIPv1 performs automatic summarization.
- Configure, verify, and troubleshoot default routes propagated in a routed network implementing RIPv1.
- Use recommended techniques to solve problems related to RIPv1

Historical Development

Overview of RIP Historical Impact

	Networking Protocols Development		RIP Development
Early 1970s	TCP/IP Early Development		
Mid 1970s		Xerox PARC Universal Protocol (PUP)	Gateway Information Protocol (GWINFO)
Late 1970s		Xerox Network System (XNS)	Routing Information Protocol
Early 1980s	TCP/IP Standardized RFCs 791, 793	Berkeley Software Distribution (UNIX BSD 4.2)	routed daemon ("route-dee")
1988			RFC 1058: RIP
1994			RFC 1723: RIPv2
1997			RFC 2080: RIPng

RIPv1

- RIP Characteristics
  - -A classful, Distance Vector (DV) routing protocol
  - -Metric = hop count
  - -Routes with a hop count > 15 are unreachable
  - -Updates are broadcast every 30 seconds

RIPv1 Message Details

Encapsulated RIPv1 Message

Data Link Frame Header	IP Packet Header	UDP Segment Header	RIP Message (504 bytes; Up to 25 routes)

Data Link Frame
MAC Destination Address = Broadcast: FF-FF-FF-FF-FF-FF
MAC Source Address = Address of sending interface

IP Packet
IP Source Address = Address of sending interface
IP Destination Address = Broadcast: 255.255.255.255
Protocol field = 17 for UDP

UDP Segment
Source Port = 520
Destination Port = 520

RIP Message:
Command: Request (1); Response (2)
Version = 1
Address Family ID = 2 for IP
Routes: Network IP Address
Metric: Hop Count

RIPv1

- RIP Message Format
- RIP header - divided into 3 fields
  - -Command field
  - -Version field
  - -Must be zero (specified room for future expansion of this protocol)
- Route Entry - composed of 3 fields
  - -Address family identifier
  - -IP address
  - -Metric

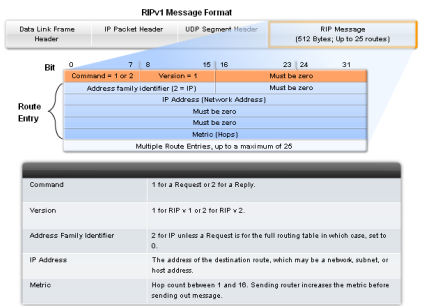
RIPv1 Message Format

Data Link Frame Header	IP Packet Header	UDP Segment Header	RIP Message (512 Bytes; Up to 25 routes)

Bit	0–7	8–15	16–23	24–31
	Command = 1 or 2	Version = 1	Must be zero	
Route Entry	Address family identifier (2 = IP)		Must be zero	
	IP Address (Network Address)			
	Must be zero			
	Must be zero			
	Metric (Hops)			
	Multiple Route Entries, up to a maximum of 25			

Command	1 for a Request or 2 for a Reply.
Version	1 for RIP v 1 or 2 for RIP v 2.
Address Family Identifier	2 for IP unless a Request is for the full routing table in which case, set to 0.
IP Address	The address of the destination route, which may be a network, subnet, or host address.
Metric	Hop count between 1 and 16. Sending router increases the metric before sending out message.

Why so many fields set to Zero?



- **Why are there so many fields set to zero?**
- RIP was developed before IP and was used for other network protocols (like XNS).
- BSD also had its influence. Initially, the extra space was added with the intention of supporting larger address spaces in the future.
- As we will see in Chapter 7, RIPv2 has now used most of these empty fields.

RIPv1

- RIP Operation
  - –RIP uses 2 message types:
    - Request message

      -This is sent out on startup by each RIP enabled interface

      -Requests all RIP enabled neighbors to send routing table
    - Response message

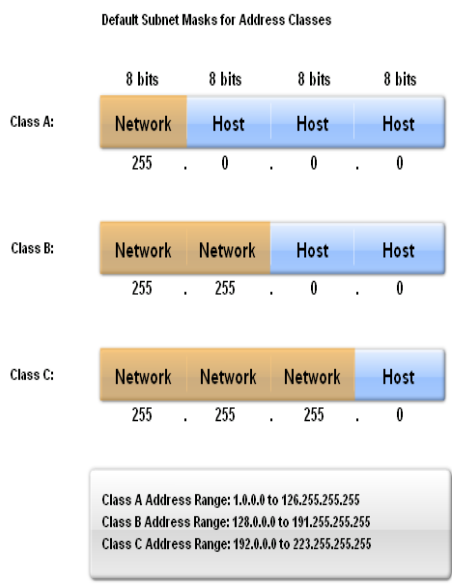
      -Message sent to requesting router containing routing table

RIP Messages

- Each RIP-configured interface sends out a request message on startup, requesting that all RIP neighbours send their complete routing tables.
- A response message is sent back by RIP-enabled neighbours.
- When the requesting router receives the responses, it evaluates each route entry. If a route entry is new, the receiving router installs the route in the routing table. If the route is already in the table, the existing entry is replaced if the new entry has a better hop count.
- The start-up router then sends a triggered update out all RIP-enabled interfaces containing its own routing table so that RIP neighbours can be informed of any new routes.

RIPv1

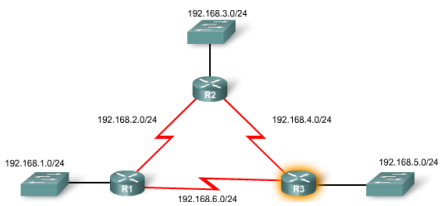
- IP addresses initially divided into classes
  - -Class A
  - -Class B
  - -Class C
- RIP is a classful routing protocol
  - -Does not send subnet masks in routing updates



RIPv1

- **Administrative Distance**
  - –RIP's default administrative distance is 120

Verifying Administrative Distance



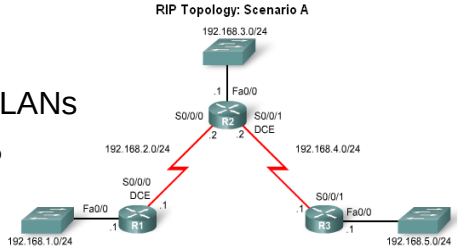

```
R3#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       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

R    192.168.1.0/24 [120/1] via 192.168.6.2, 00:00:05, Serial0/0/0
R    192.168.2.0/24 [120/1] via 192.168.6.2, 00:00:05, Serial0/0/0
                    [120/1] via 192.168.4.2, 00:00:05, Serial0/0/1
R    192.168.3.0/24 [120/1] via 192.168.4.2, 00:00:05, Serial0/0/1
C    192.168.4.0/24 is directly connected, Serial0/0/1
C    192.168.5.0/24 is directly connected, FastEthernet0/0
C    192.168.6.0/24 is directly connected, Serial0/0/0
```

```
R3#show ip protocols
Routing Protocol is "rip"
  <output omitted>
  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
  Routing for Networks:
    192.168.4.0
    192.168.5.0
    192.168.6.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.6.2          120      00:00:10
    192.168.4.2          120      00:00:18
  Distance: (default is 120)
```


Basic RIPv1 Configuration

- **A typical topology suitable for use by RIPv1 includes:**
  - -Three router set up
  - -No PCs attached to LANs
  - -Use of 5 different IP subnets

RIP Topology: Scenario A



Addressing Table: Scenario A

Device	Interface	IP Address	Subnet Mask
R1	Fa0/0	192.168.1.1	255.255.255.0
	S0/0/0	192.168.2.1	255.255.255.0
R2	Fa0/0	192.168.3.1	255.255.255.0
	S0/0/0	192.168.2.2	255.255.255.0
	S0/0/1	192.168.4.2	255.255.255.0
R3	Fa0/0	192.168.5.1	255.255.255.0
	S0/0/1	192.168.4.1	255.255.255.0

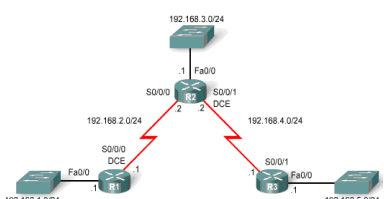
Basic RIPv1 Configuration

- Router RIP Command
  - –To enable RIP enter:
    - -*Router rip* at the global configuration prompt
    - -Prompt will look like ***R1(config-router)#***

```
R1#conf t
Enter configuration commands, one per line. End with CTRL/Z.
R1(config)#router ?
  bgp        Border Gateway Protocol (BGP)
  egp        Exterior Gateway Protocol (EGP)
  eigrp      Enhanced Interior Gateway Protocol (EIRGP)
  igrp       Interior Gateway Routing Protocol (IGRP)
  isis       ISO IS-IS
  iso-igrp   IGRP for OSI networks
  mobile     Mobile routes
  odr        On Demand stub Routes
  ospf       Open Shortest Path First (OSPF)
  rip        Routing Information Protocol (RIP)

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


Basic RIPv1 Configuration

- Specifying Networks
  - –Use the ***network*** command to:
    - -Enable RIP on all interfaces that belong to this network
    - -Advertise this network in RIP updates sent to other routers every 30 seconds




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

```
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
```

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

Verification and Troubleshooting

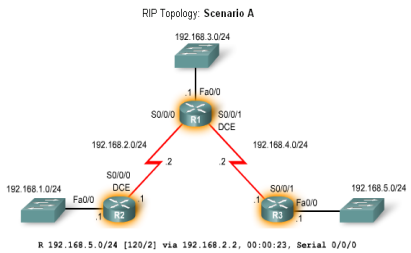
- Show ip Route
- To verify and troubleshoot routing

  -Use the following commands:

  -show ip route

  -show ip protocols

  -debug ip rip



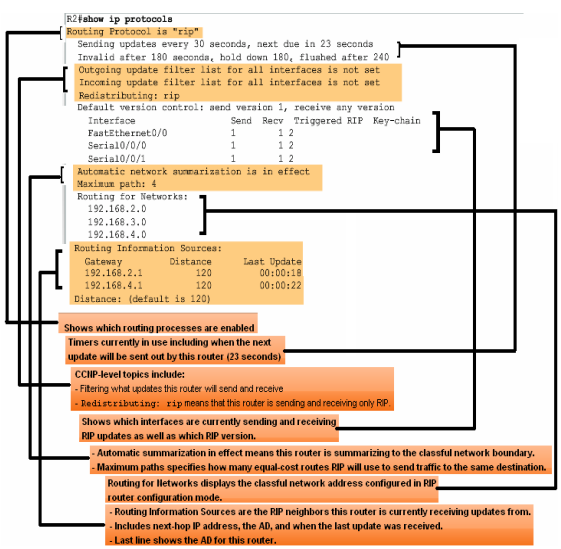
Interpreting a RIP Route in the Routing Table

R	Identifies the source of the route as RIP.
192.168.5.0	Indicates the address of the remote network.
/24	The subnet mask used for this network
[120/2]	The administrative distance (120) and the metric (2 hops)
via 192.168.2.2	Specifies the address of the next-hop router (R2) to send traffic to for the remote network.
00:00:23	Specifies the amount of time since the route was updated (here, 23 seconds). Another update is due in 7 seconds.
Serial0/0/0	192.168.4.2

Verification and Troubleshooting

- *show ip protocols* command

  -Displays routing protocol configured on router



Show IP Protocols

- If a network is missing from the routing table, check the routing configuration using show ip protocols. The show ip protocols command displays the routing protocol that is currently configured on the router. This output can be used to verify most RIP parameters to confirm that:

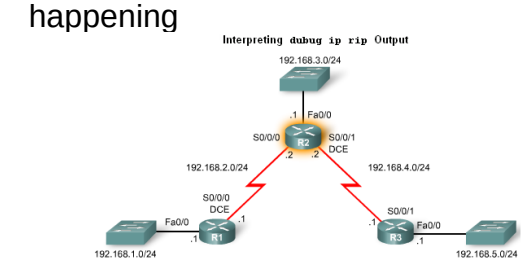
1. RIP routing is configured
2. The correct interfaces send and receive RIP updates
3. The router advertises the correct networks
4. RIP neighbors are sending updates

- This command is also very useful when verifying the operations of other routing protocols, as we will see later with EIGRP and OSPF.

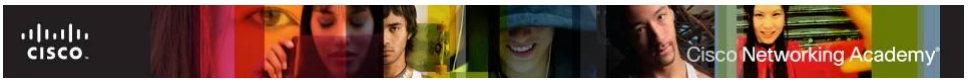
Verification and Troubleshooting

- **Debug ip rip** command

-Used to display RIP routing updates as they are happening




```
R2#debug ip rip
RIP protocol debugging is on
RIP: received v1 update from 192.168.2.1 on Serial0/0/0 - R2 receives an update from R1 advertising the R1's directly connected LAN.
     192.168.1.0 in 1 hops
RIP: received v1 update from 192.168.4.1 on Serial0/0/1 - R2 receives an update from R3 advertising the R3's directly connected LAN.
     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                  - R2 sends an update out Fa0/0 to all networks in the routing table except the network attached
     network 192.168.1.0 metric 2            to Fa0/0.
     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                  - R2 sends an update out S0/0/1 to R3. Included in the update are R1's LAN, the WAN between R1
     network 192.168.1.0 metric 2            and R2, and R2's LAN.
     network 192.168.2.0 metric 1          - Note that split horizon is in effect. R2 does not advertise the R3 LAN back to R3.
     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
```



Verification and Troubleshooting

- **Passive interface** command

  -Used to prevent a router from sending updates through an interface

  -Example:

  Router(config-router)#passive-interface interface-type interface-number

- **This command stops routing updates out the specified interface. However, the network that the specified interface belongs to will still be advertised in routing updates that are sent out other interfaces.**

Unnecessary Updates

- R2 is sending updates out FastEthernet0/0 even though no RIP device exists on that LAN. R2 has no way of knowing this and, as a result, sends an update every 30 seconds. Sending out unneeded updates on a LAN impacts the network in three ways:

1. Bandwidth is wasted transporting unnecessary updates. Because RIP updates are broadcast, switches will forward the updates out all ports.
2. All devices on the LAN must process the update up to the Transport layers, where the receiving device will discard the update.
3. Advertising updates on a broadcast network is a security risk. RIP updates can be intercepted with packet sniffing software. Routing updates can be modified and sent back to the router, corrupting the routing table with false metrics that misdirect traffic.

Verification and Troubleshooting

- **Passive interfaces**

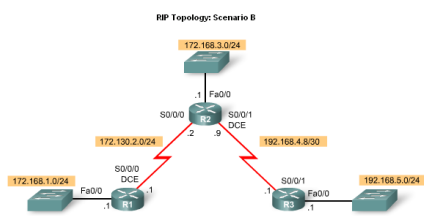
```
R2(config)#router rip
R2(config-router)#passive-interface FastEthernet 0/0
R2(config-router)#end
R2#show ip protocols
Routing Protocol is "rip"
    Sending updates every 30 seconds, next due in 14 seconds
    Invalid after 180 seconds, hold down 180, flushed after 240
    Outgoing update filter list for all interfaces is
    Incoming update filter list for all interfaces is
    Redistributing: rip
    Default version control: send version 1, receive any version
        Interface              Send  Recv  Triggered RIP  Key-chain
        Serial0/0/0            1     1 2
        Serial0/0/1            1     1 2
    Automatic network summarization is in effect
    Routing for Networks:
        192.168.2.0
        192.168.3.0
        192.168.3.0
        192.168.4.0
    Passive Interface(s):
        FastEthernet0/0
    Routing Information Sources:
    Gateway         Distance      Last Update
        192.168.2.1          120      00:00:27
        192.168.4.1          120      00:00:23
Distance: (default is 120)
```

Notice FastEthernet 0/0 is no longer listed under "Default version contol:"
However, R2 is still routing for 192.168.3.0 and now lists FastEthernet under "Passive Interfaces:"

Automatic Summarization

Modified Topology

- The original scenario has been modified such that:
  - Three classful networks are used:
    - 172.30.0.0/16
    - 192.168.4.0/24
    - 192.168.5.0/24
  - The 172.30.0.0/16 network is subnetted into three subnets:
    - 172.30.1.0/24
    - 172.30.2.0/24
    - 172.30.3.0/24
  - The following devices are part of the 172.30.0.0/16 classful network address:
    - All interfaces on R1
    - S0/0/0 and Fa0/0 on R2



RIP Topology: Scenario B

Subnet Mask	Subnet Mask	Subnet Mask	Subnet Mask
R1	Fa0/0	172.30.1.1	255.255.255.0
	S0/0/0	172.30.2.1	255.255.255.0
R2	Fa0/0	172.30.3.1	255.255.255.0
	S0/0/0	172.30.2.2	255.255.255.0
	S0/0/1	192.168.4.9	255.255.255.252
R3	Fa0/0	192.168.5.1	255.255.255.0
	S0/0/1	192.168.4.10	255.255.255.252

Automatic Summarization

- **Configuration Details**

-To remove the RIP routing process use the following command

No router rip

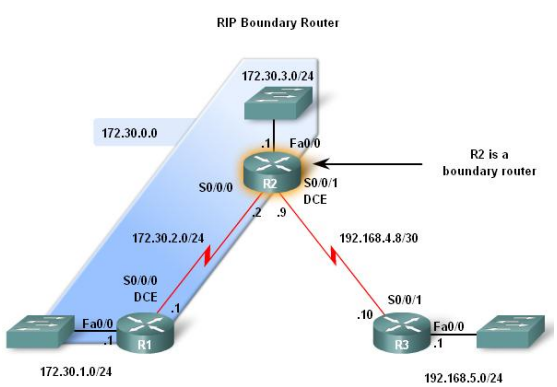
-To check the configuration use the following command

Show run

```
R2(config)#interface S0/0/0
R2(config-if)#ip address 172.30.2.2 255.255.255.0
R2(config-if)#interface fa0/0
R2(config-if)#ip address 172.30.3.1 255.255.255.0
R2(config-if)#interface S0/0/1
R2(config-if)#ip address 192.168.4.9 255.255.255.252
R2(config-if)#no router rip
R2(config)#router rip
R2(config-router)#network 172.30.0.0
R2(config-router)#netowrk 192.168.4.8
R2(config-router)#passive-interface FastEthernet 0/0
R2(config-router)#end
R2#show run
<output omitted>
!
router rip
 passive-interface FastEthernet0/0
```


Automatic Summarization

- **Boundary Routers**
  - –RIP automatically summarizes classful networks
  - –Boundary routers summarize RIP subnets from one major network to another.



Boundary Routers

- RIP is a classful routing protocol that automatically summarizes classful networks across major network boundaries.
- In the figure, you can see that R2 has interfaces in more than one major classful network. This makes R2 a boundary router in RIP. Serial 0/0/0 and FastEthernet 0/0 interfaces on R2 are both inside the 172.30.0.0 boundary.
- The Serial 0/0/1 interface is inside the 192.168.4.0 boundary.
- Because 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.

Automatic Summarization

Processing RIP Updates

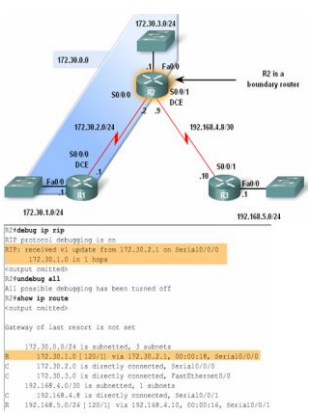
- 2 rules govern RIPv1 updates:

-If a routing update and the interface it's received on belong to the **same** network then

The subnet mask of the interface is applied to the network in the routing update

-If a routing update and the interface it's received on belong to a **different** network then

The classful subnet mask of the network is applied to the network in the routing update.



Example

```
R2#debug ip rip
RIP protocol debugging is on
RIP: received v1 update from 172.30.2.1 on Serial0/0/0
     172.30.1.0 in 1 hops
(**output omitted**)

R2#undebug all
All possible debugging has been turned off
R2#show ip route
<output omitted>

Gateway of last resort is not set

     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
R2#
```


Automatic Summarization

- **Sending RIP Updates**
  - –RIP uses automatic summarization to reduce the size of a routing table.

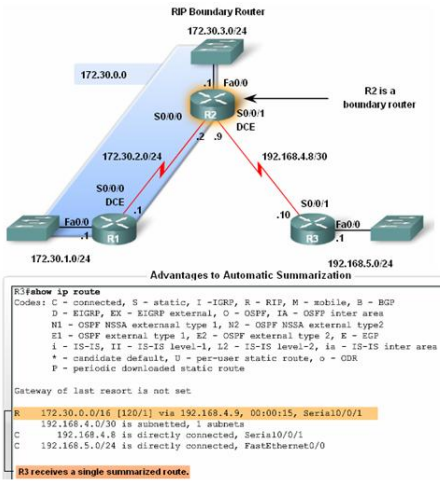
```
R1#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       <remaining codes omitted>

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, 00:00:17, Serial0/0/0
R    192.168.4.0/24 [120/1] via 172.30.2.2, 00:00:17, Serial0/0/0
R    192.168.5.0/24 [120/2] via 172.30.2.2, 00:00:17, Serial0/0/0
R2#debug ip rip
RIP protocol debugging is on
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
R2#undebug all
All possible debugging has been turned off
R2#
  Routes sent to R1.

R3#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       <remaining codes omitted>

Gateway of last resort is not set

R    172.30.0.0/16 [120/1] via 192.168.4.9, 00:00:15, 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
  Compare R1 and R3 Routes for Network 172.30.0.0
```

Automatic Summarization

- Advantages of automatic summarization:

  -The size of routing updates is reduced

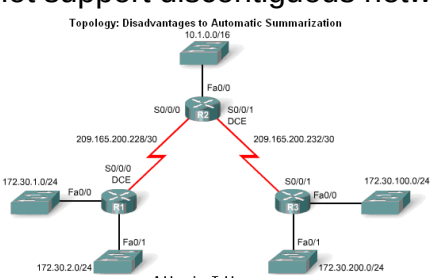
  -Single routes are used to represent multiple routes which results in faster lookup in the routing table.



Automatic Summarization

- Disadvantage of Automatic Summarization:

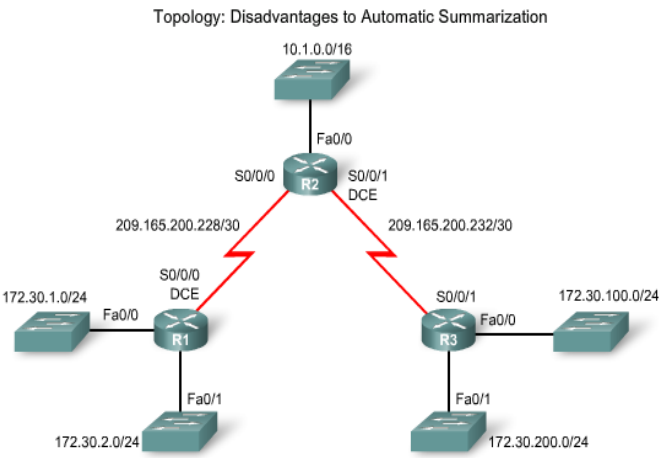
  -Does not support discontiguous networks



Addressing Table

Subnet Mask	Subnet Mask	Subnet Mask	Subnet Mask
R1	Fa0/0	172.30.1.1	255.255.255.0
	Fa0/1	172.30.2.1	255.255.255.0
	S0/0/0	209.165.200.229	255.255.255.252
R2	Fa0/0	10.1.0.1	255.255.255.0
	S0/0/0	209.165.200.230	255.255.255.252
	S0/0/1	209.165.200.233	255.255.255.252
R3	Fa0/0	172.30.100.1	255.255.255.0
	Fa0/0	172.30.200.1	255.255.255.0
	S0/0/1	209.165.200.234	255.255.255.252

Example

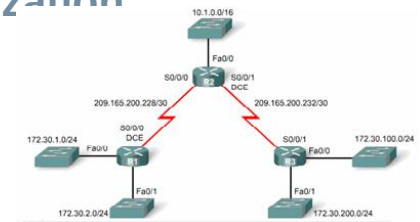


Discontiguous Networks

- Classful routing protocols do not include the subnet mask in routing updates.
- Networks are automatically summarized across major network boundaries since the receiving router in unable to determine the mask of the route.
- This is because the receiving interface may have a different mask than the subnetted routes.
- Notice that R1 and R3 both have subnets from the 172.30.0.0/16 major network, whereas R2 does not.
- Essentially, R1 and R3 are boundary routers for 172.30.0.0/16 because they are separated by another major network, 209.165.200.0/24.
- This separation creates a discontiguous network, as two groups of 172.30.0.0/24 subnets are separated by at least one other major network. 172.30.0.0/16 is a discontiguous network.

Automatic Summarization

- Discontiguous Topologies do not converge with RIPv1
- A router will only advertise major network addresses out interfaces that do not belong to the advertised route.




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

R    10.0.0.0/8 [120/1] via 209.165.200.230, 00:00:26, Serial0/0/0
     172.30.0.0/24 is subnetted, 3 subnets
R       172.30.0.0 [120/2] via 209.165.200.230, 00:00:26, Serial0/0/0
C       172.30.1.0 is directly connected, FastEthernet0/0
C       172.30.2.0 is directly connected, FastEthernet0/1
     209.165.200.0/30 is subnetted, 2 subnets
C       209.165.200.228 is directly connected, Serial0/0/0
R       209.165.200.232 [120/1] via 209.165.200.230, 00:00:26, Serial0/0/0
```

```
R2#show ip route
Gateway of last resort is not set

     10.0.0.0/16 is subnetted, 1 subnets
C       10.1.0.0 is directly connected, FastEthernet0/0
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
     209.165.200.0/30 is subnetted, 2 subnets
C       209.165.200.228 is directly connected, Serial0/0/0
C       209.165.200.232 is directly connected, Serial0/0/1
```

```
R3#show ip route
Gateway of last resort is not set

R    10.0.0.0/8 [120/1] via 209.165.200.233, 0:00:24, Serial0/0/1
     172.30.0.0/24 is subnetted, 3 subnets
R       172.30.0.0 [120/2] via 209.165.200.233, 00:00:23, Serial0/0/1
C       172.30.100.0 is directly connected, FastEthernet0/0
C       172.30.200.0 is directly connected, FastEthernet0/1
     209.165.200.0/30 is subnetted, 2 subnets
R       209.165.200.228 [120/1] via 209.165.200.233, 00:00:24, Serial0/0/1
C       209.165.200.232 is directly connected Serial0/0/1
```


Default Route and RIPv1

- Modified Topology: Scenario C
- Default routes

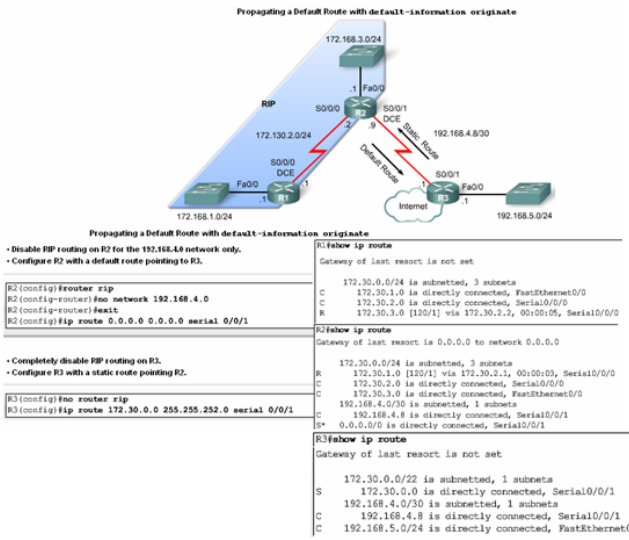
  Packets that are not defined specifically in a routing table will go to the specified interface for the default route

  Example: Customer routers use default routes to connect to an ISP router.

  Command used to configure a default route is

  ip route 0.0.0.0 0.0.0.0 s0/0/1

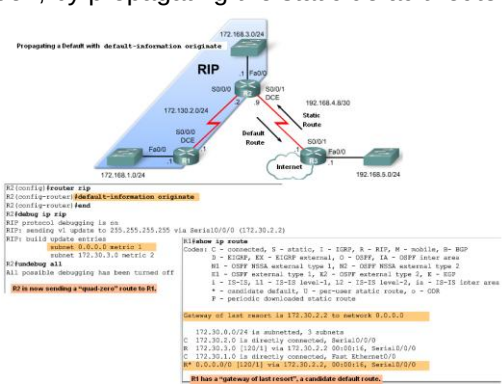
Default Route and RIPv1

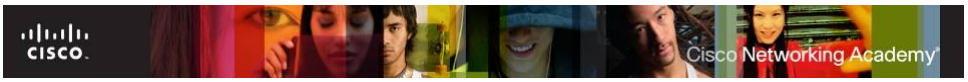


Default Route and RIPv1

- Propagating the Default Route in RIPv1
- *Default-information originate* command

-This command is used to specify that the router is to originate default information, by propagating the static default route in RIP update.





Summary

- RIP characteristics include:
  - Classful, distance vector routing protocol
  - Metric is Hop Count
  - Does not support VLSM or discontiguous subnets
  - Updates every 30 seconds
- Rip messages are encapsulated in a UDP segment with source and destination ports of 520

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