INFO 3605
Fundamentals of LAN Technologies
Lecture 19 - Learning IPv4 Routes with RIPv2

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Based on Chapter 19 of Odom, Wendell. *CCENT/CCNA ICND1 100-105 official cert guide*. Indianapolis, IN: Cisco Press, 2016.

Updating your routes dynamically

- In most cases your home network only have one router.
- Adding more than one router means you may have to setup routes.
- If there a lot of routes, and changes need to be made, you may have to change each route entry which can be time consuming.
- These changes can be done automatically using a dynamic routing protocol.

Objectives

- The student must be able to:
  - Interpret the components of routing table
    - Prefix
    - Network mask
    - Next hop
    - Routing protocol code
    - Administrative distance
    - Metric
    - Gateway of last resort

Objectives

- The student must be able to:
  - Describe how a routing table is populated by different routing information sources
    - Admin distance
  - Compare and contrast static routing and dynamic routing
  - Configure, verify, and troubleshoot RIPv2 for IPv4 (excluding authentication, filtering, manual summarization, redistribution)

Test Your Knowledge

- Which of the following are features of RIPv2 (Choose two answers.)
  a. Uses a hop-count metric
  b. Sends update messages to broadcast address 255.255.255.255
  c. After convergence, only sends updates if a change occurs
  d. Uses split horizon as a loop prevention mechanism

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  b. Sends update messages to broadcast address 255.255.255.255

  c. After convergence, only sends updates if a change occurs

  d. Uses split horizon as a loop prevention mechanism

Test Your Knowledge

- Which of the following best describes the concept of the RIP hop count metric?
  a. The number of satellite links in a route.
  b. The number of routers between a router and a subnet, not counting that router.
  c. The number of routers between a router and a subnet, counting that router.
  d. The number of links between a router and a subnet, not counting the link where the subnet resides.
  e. The number of links between a router and a subnet, counting the link where the subnet resides.

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Test Your Knowledge

- Router R2 has interfaces with addresses/masks of 10.1.1.2/24 and 11.1.1.2/24. Which of the following commands would be part of a RIP Version 2 configuration on R2 that enables RIPv2 on both interfaces? (Choose three answers.)

  a. router rip

  b. router rip 3

  c. network 10.0.0.0

  d. network 10.1.1.1

  e. network 11.0.0.0

  f. network 11.1.1.2

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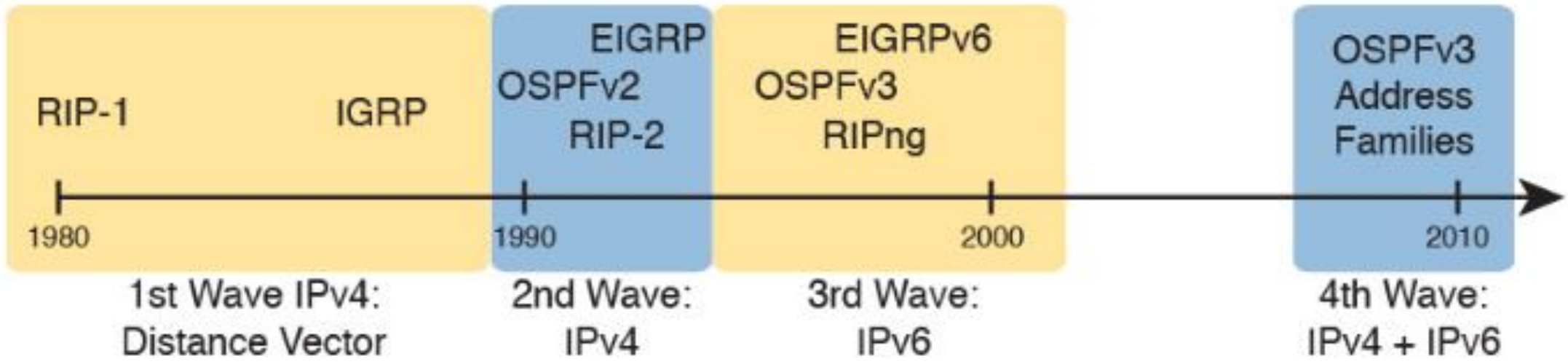
RIP and Routing Protocol Concepts

- Routing protocol essentially causes routers (and Layer 3 switches) to
  - **1.** Learn routing information about IP subnets from other neighboring routers
  - **2.** Advertise routing information about IP subnets to other neighboring routers
  - **3.** If a router learns of more than one route to reach one subnet, choose the best route based on that routing protocol's concept of a metric
  - **4.** React to changes when the network topology changes—for example, when a link fails, and converge to use a new choice of best route for each destination subnet

History of Interior Gateway Protocols

- Timeline for IP IGPs



Comparing IGPs

- Interior Gateway Protocols (IGP): Routing protocols intended the routing protocol for use inside one company or organization.
- Exterior Gateway Protocols (EGP): outing protocols intended for use between companies and between Internet service providers (ISP) in the Internet.

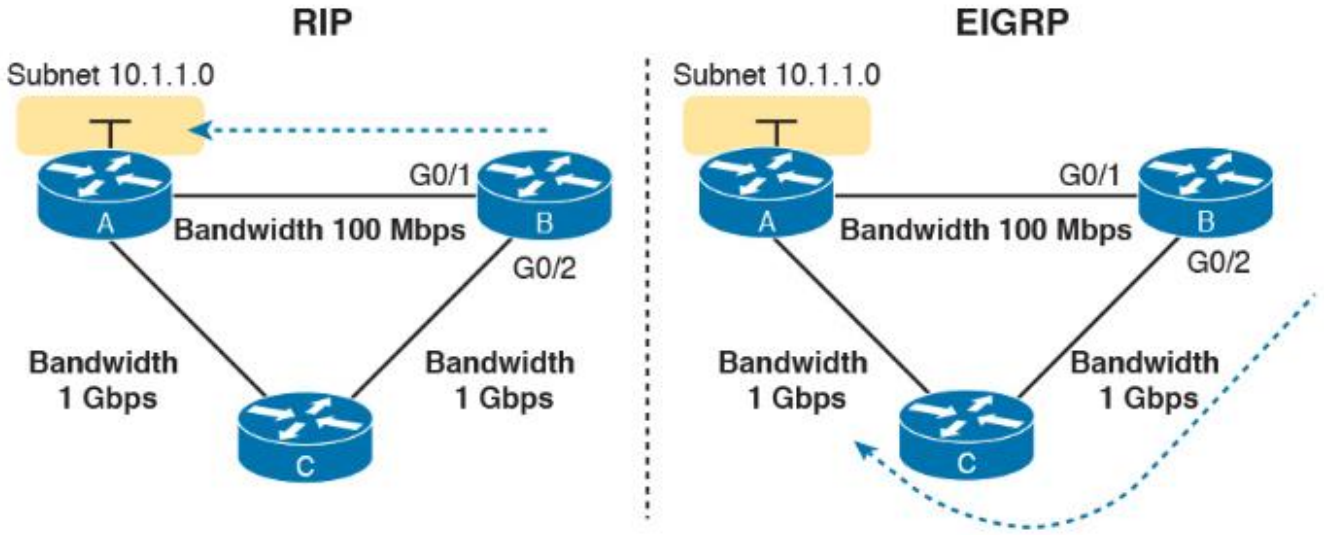
- ICND1 IGP: RIPv1, RIPV2.
- ICND2: EIGRP, OSPFv2, OSPFv3,

Comparing IGPs

- Four of the major comparison points when comparing these routing protocols:
- **1.** The underlying routing protocol algorithm: Specifically, whether the routing protocol uses logic referenced as distance vector (DV) or link state (LS).
- **2.** The usefulness of the metric: The routing protocol chooses which route is best based on its metric; so the better the metric, the better the choices made by that routing protocol.
- **3.** The speed of convergence: How long does it take all the routers to learn about a change in the network and update their IPv4 routing tables?
  - That concept, called convergence time, varies depending on the routing protocol.
- **4.** Whether the protocol is a public standard or a vendor-proprietary function: RIP and OSPF happen to be standards, defined by RFCs. EIGRP happens to be defined by Cisco, and until 2013, was kept private.

Comparing IGPs

- RIP's hop count metric treats each router as a hop, so the hop count is the number of other routers between a router and some remote subnet.
- EIGRP Choosing the Longer but Better Route to Subnet 10.1.1.0

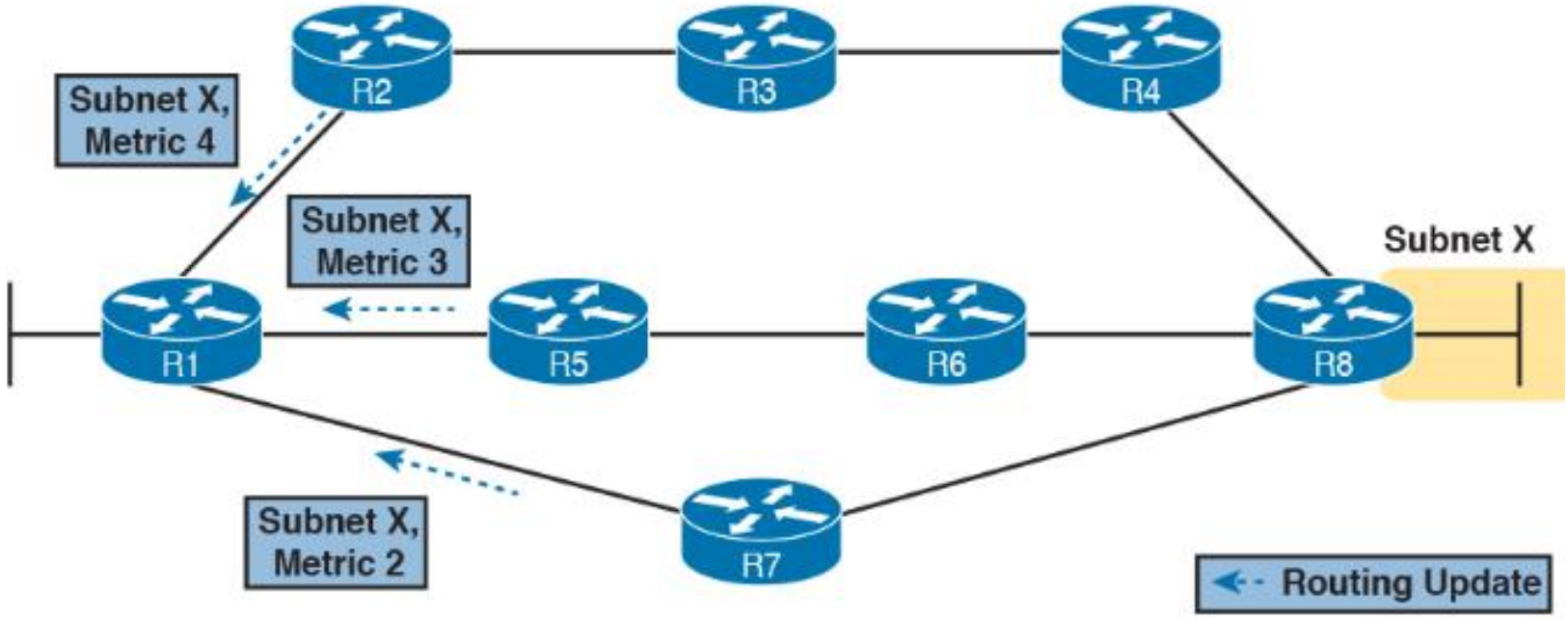


The Concept of a Distance and a Vector

- Each IGP can be categorized based on its internal logic, either distance vector (used by RIP) or link state.
- Distance vector describes what a router knows about each route.
- When a router learns about a route to a subnet, the routers learn three important facts related to each route:
  - the destination subnet,
  - the distance (that is, the routing protocol metric), and
  - the vector (that is, the link and next-hop router to use as part of that route).

The Concept of a Distance and a Vector

- Information Learned Using DV Protocols



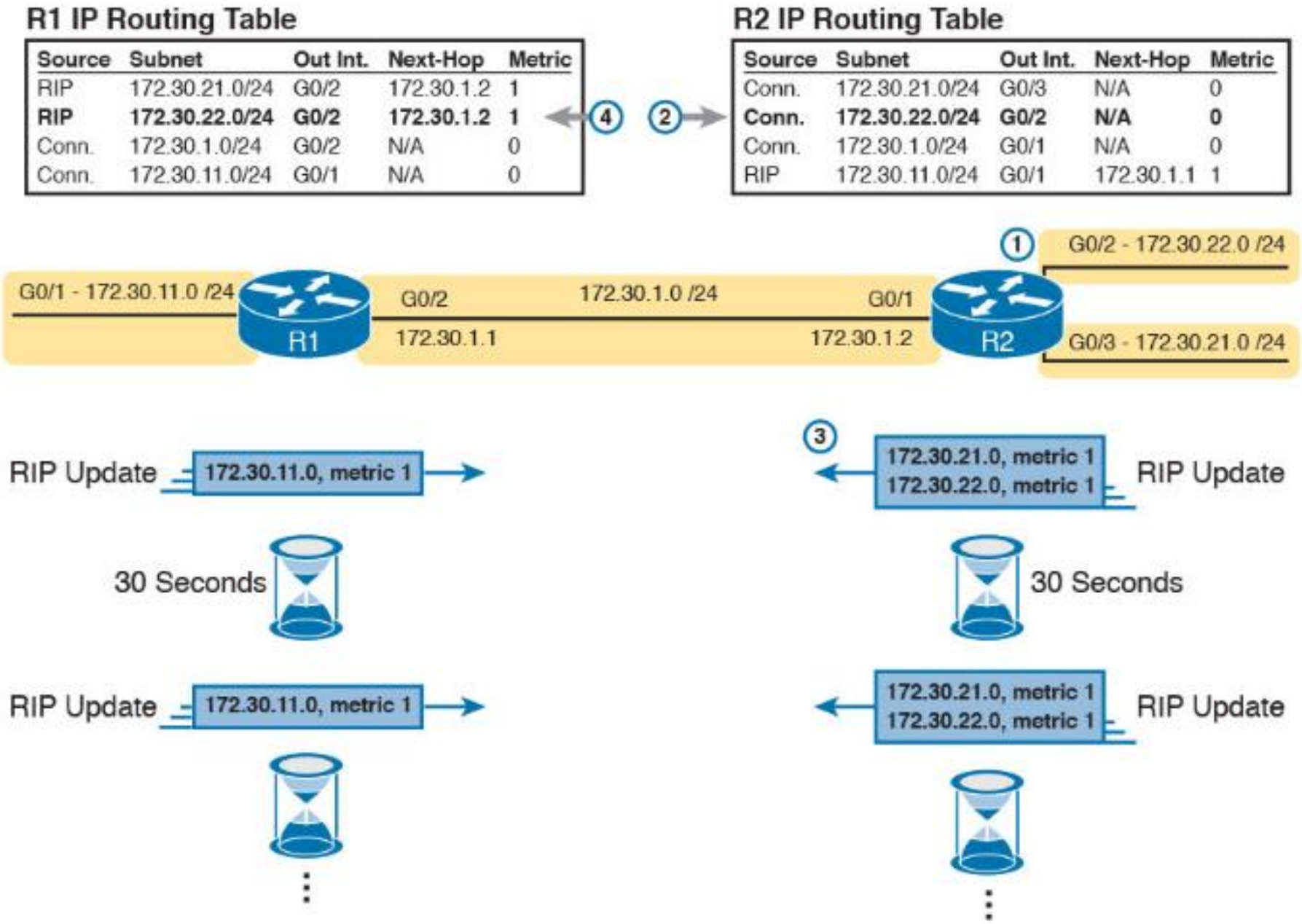
The Concept of a Distance and a Vector

- Three RIP updates advertise the following routes:
  - The four-hop route (distance) through R2 (vector) for subnet X
  - The three-hop route (distance) through R5 (vector) for subnet X
  - The two-hop route (distance) through R7 (vector) for subnet X
- If R1 had learned only one route to subnet X, say the route learned from R2
  - R1 would use that route because it is the only route R1 knows for subnet X.
  - Having learned three routes to subnet X, R1 picks the route with the best (lowest) metric, in this case the two-hop route through next-hop Router R7.

Full Update Messages and Split Horizon

- RIPv2 sends a periodic routing update based on a relatively short timer.
- RIP repeats the same update over and over on a timed basis even if nothing changes.

Full

- 
R1 IP Routing Table
Source Subnet Out Int. Next-Hop Metric
RIP 172.30.21.0/24 G0/2 172.30.1.2 1
RIP 172.30.22.0/24 G0/2 172.30.1.2 1
Conn. 172.30.1.0/24 G0/2 N/A 0
Conn. 172.30.11.0/24 G0/1 N/A 0
R2 IP Routing Table
Source Subnet Out Int. Next-Hop Metric
Conn. 172.30.21.0/24 G0/3 N/A 0
Conn. 172.30.22.0/24 G0/2 N/A 0
Conn. 172.30.1.0/24 G0/1 N/A 0
RIP 172.30.11.0/24 G0/1 172.30.1.1 1
4
2
1
G0/2 - 172.30.22.0 /24
G0/1 - 172.30.11.0 /24
G0/2
172.30.1.0 /24
G0/1
R1
172.30.1.1
172.30.1.2
R2
G0/3 - 172.30.21.0 /24
3
RIP Update
172.30.11.0, metric 1
172.30.21.0, metric 1
172.30.22.0, metric 1
RIP Update
30 Seconds
30 Seconds
RIP Update
172.30.11.0, metric 1
172.30.21.0, metric 1
172.30.22.0, metric 1
RIP Update

Full Update Messages and Split Horizon

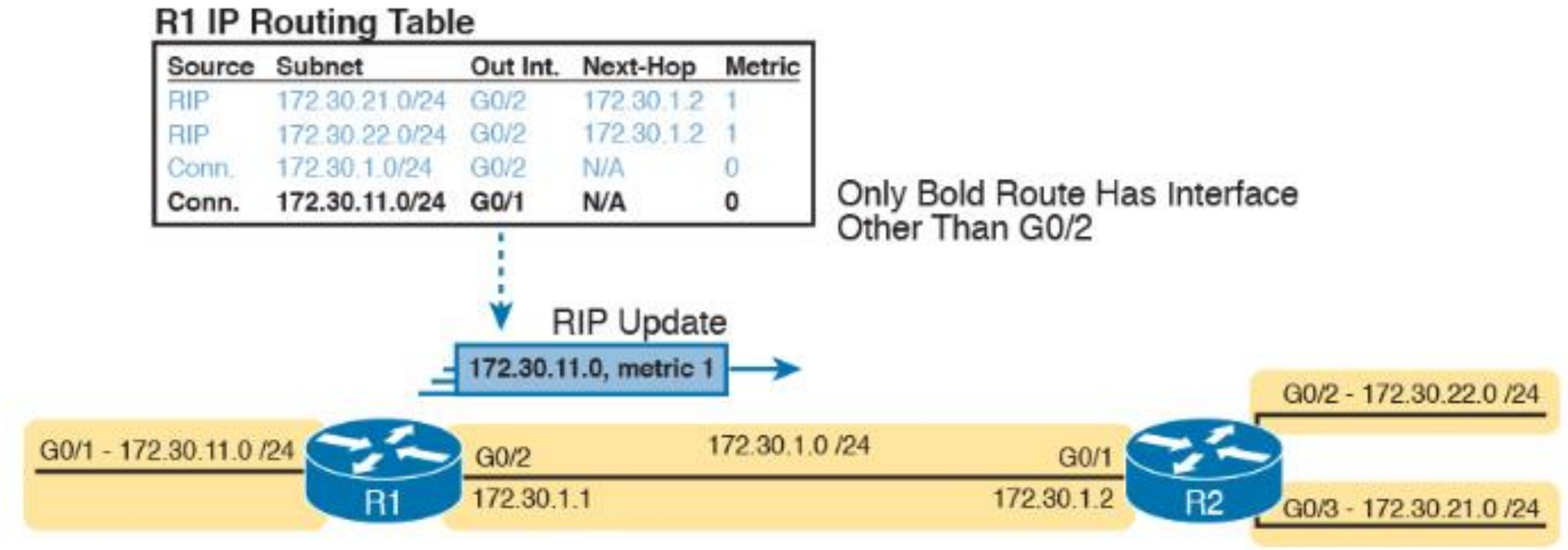
- Normal Steady-State RIP Operations: Full Update with Split Horizon
  - **1.** R2 interface G0/2 has an IP address and is in an up/up state.
  - **2.** R2 adds a connected route for 172.30.22.0/24, off interface G0/2, to R2's routing table.
  - **3.** R2 advertises its route for 172.30.22.0/24 to R1, with metric 1, in a RIP update sent to R1. The metric of 1 means that R1's metric to reach this subnet will be metric 1 (hop count 1).
  - **4.** R1 adds a route for subnet 172.30.22.0/24, listing it as a RIP learned route with metric 1.

Split Horizon

- We see a common DV feature called split horizon.
- Both routers list all four subnets in their IP routing tables. However, the RIP update messages do not list four subnets.
- Split horizon is a DV feature that tells a router to omit some routes from an update sent out an interface.
- Which routes are omitted from an update sent out interface X?
  - The routes that would use interface X as the outgoing interface.
  - Those routes that are not advertised on an interface usually include the routes learned in routing updates received on that interface.

Split Horizon

- R1 Does Not Advertise Three Routes Due to Split Horizon

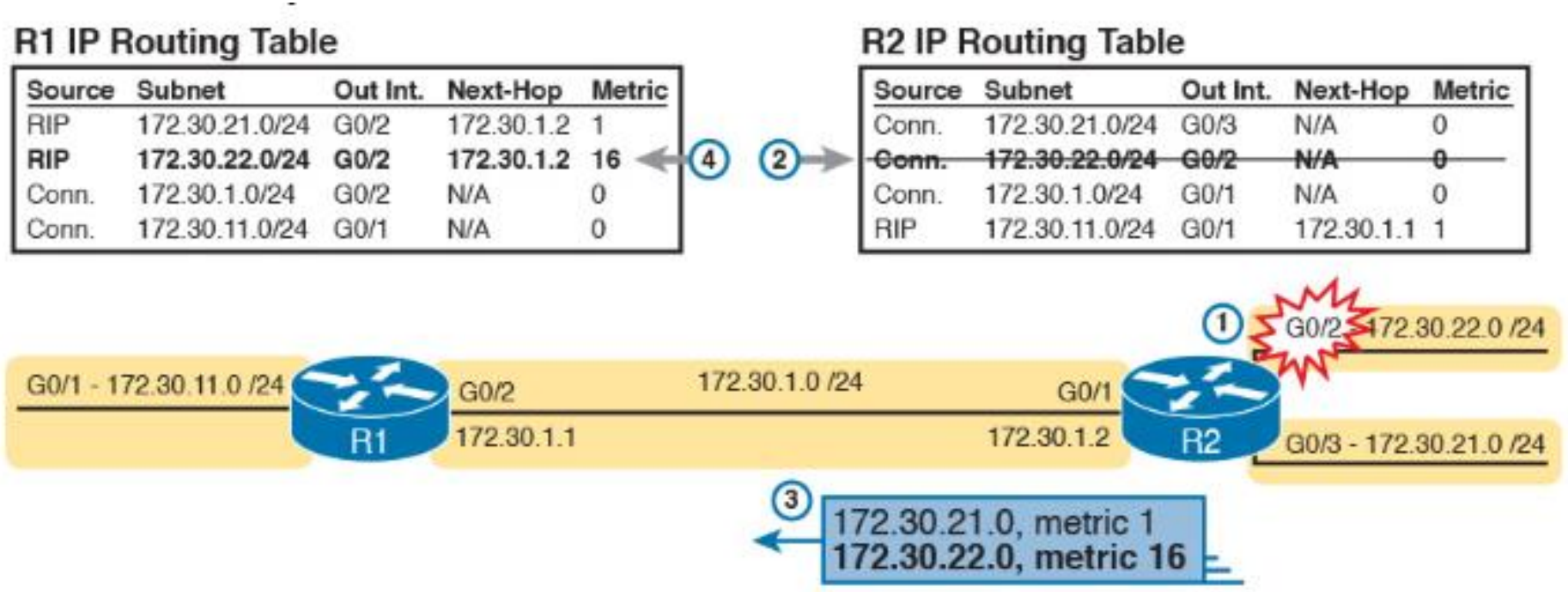


Route Poisoning

- A routing loop occurs when the routes for some destination, on a set of routers, would cause a packet sent to that destination to keep looping between those routers and never arrive at the destination.
- Routing protocols attempt to prevent any routing loop.
  - One of these features, route poisoning, helps all routers know for sure that a route has failed.
- Route poisoning refers to the practice of **advertising a failed route**, but with a special metric value called **infinity**.

Route Poisoning

- Route Poisoning



Route Poisoning

- Route Poisoning Process
  - **1.** R2's G0/2 interface fails.
  - **2.** R2 removes its connected route for 172.30.22.0/24 from its routing table.
  - **3.** R2 advertises 172.30.22.0 with an infinite metric (which for RIP is 16).
  - **4.** R1 realizes that the route to 172.30.22.0/24 no longer works.
    - R1 either removes the route from its routing table or marks the route as unusable (with an infinite metric) for a few minutes before removing the route.

Summarizing RIPv2 Features

- RIPv2 adds features beyond RIPv1.
  - RIPv2 supports authentication, which is a feature by which routers can use a password-like mechanism to make sure they exchange routes only with authentic other routers.
  - RIPv2 also supports manual route summarization, which allows an engineer to plan and reduce the size of routing tables.
  - RIPv2 adds support for variable-length subnet masks (VLSM).

Summarizing RIPv2 Features

- Key Features of RIPv1 and RIPv2

Feature	RIPv1	RIPv2
Hop-count metric	Yes	Yes
Sets 15 as the largest metric for a working route	Yes	Yes
Sends full routing updates	Yes	Yes
Uses split horizon	Yes	Yes
Uses route poisoning, with metric 16 to mean "infinite"	Yes	Yes
Sends mask in routing update, thereby supporting VLSM	No	Yes
Supports manual route summarization	No	Yes
Sends updates to 224.0.0.9 multicast address	No	Yes
Supports authentication	No	Yes

Configuring Core RIPv2 Features

- RIPv2 configuration is simple compared to the concepts related to routing protocols.
- Uses three commands:

  router rip
  version 2
  network *net-number*

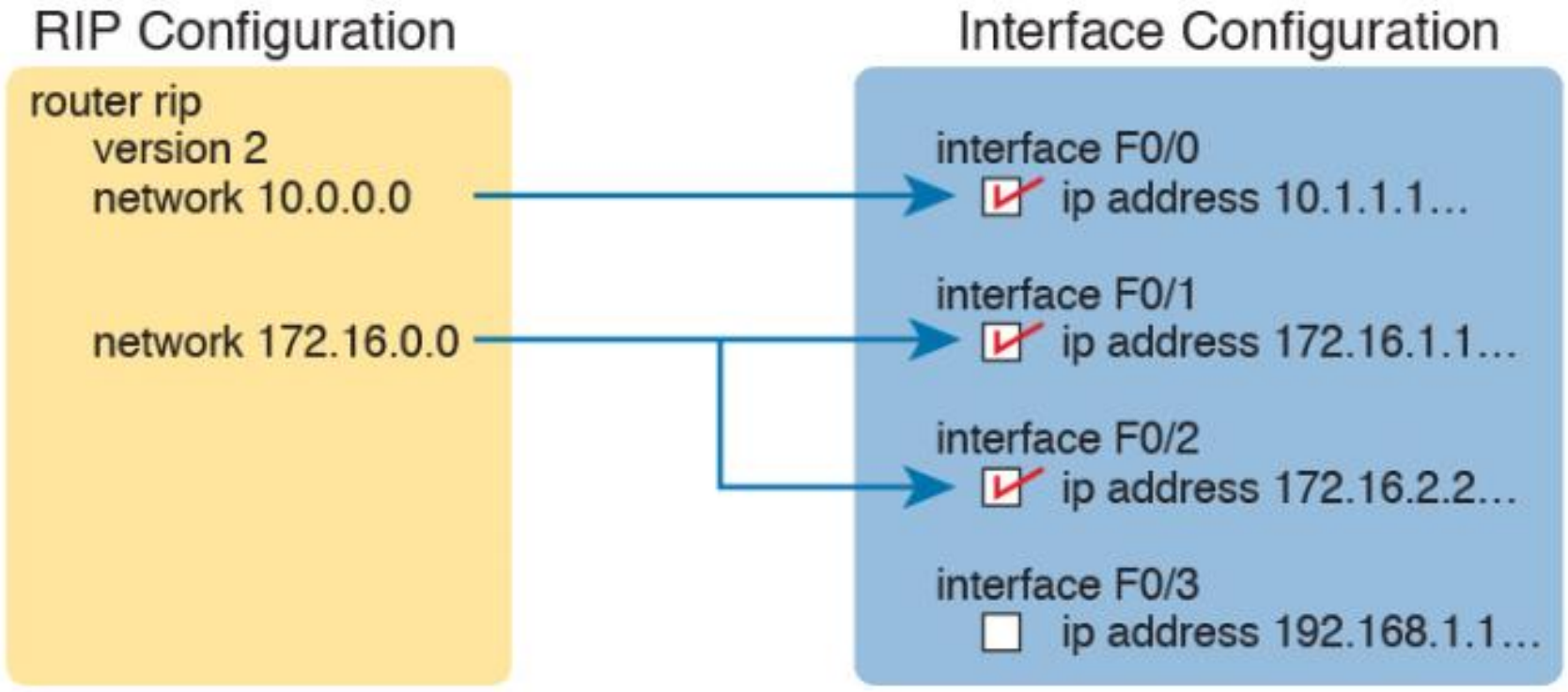
- **Step 1.** Use the router rip command in global configuration mode to move into RIP configuration mode.
- **Step 2.** Use the version 2 command in RIP configuration mode to tell the router to use RIP Version 2 exclusively.
- **Step 3.** Use one or more network net-number commands in RIP configuration mode to enable RIP on the correct interfaces.

Understanding the RIP network Command

- The RIP **network** indirectly identifies the interfaces on which RIP is then enabled.
  - The command has one parameter: some classful IP network number.
  - IOS then compares each interface IP address of each interface on the local router with the IP network in the network command.
  - IOS enables RIP on each interface whose IP address is in that same classful network.

Understanding the RIP network Command

- RIP Network Command Enabling RIP Per-Interface Logic

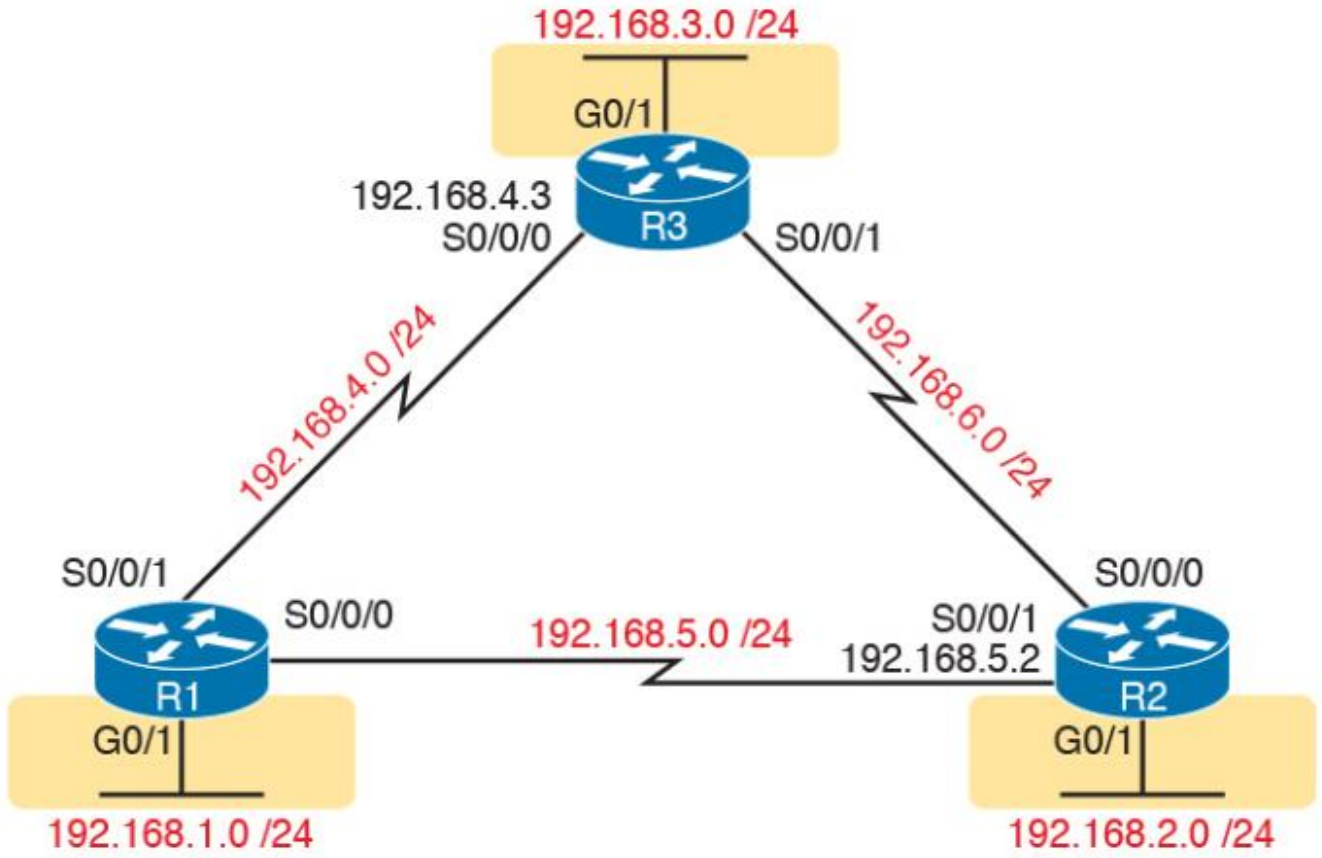


Understanding the RIP network Command

- RIP takes three separate actions once enabled on an interface.
  - **1.** The router sends routing updates out the interface.
  - **2.** The router listens for and processes incoming updates on that same interface.
  - **3.** The router advertises about the subnet connected to the interface.

RIP Configuration Example, with Many IP Networks

- RIPv2 Configuration:
  - Three Routers, Each Connected to Three Networks
- Different Class C networks on each link.



RIP Configuration Example, with Many IP Networks

```
! Router R1 configuration
router rip
 version 2
 network 192.168.1.0
 network 192.168.4.0
 network 192.168.5.0
```

```
! Router R2 configuration
router rip
 version 2
 network 192.168.2.0
 network 192.168.5.0
 network 192.168.6.0
```

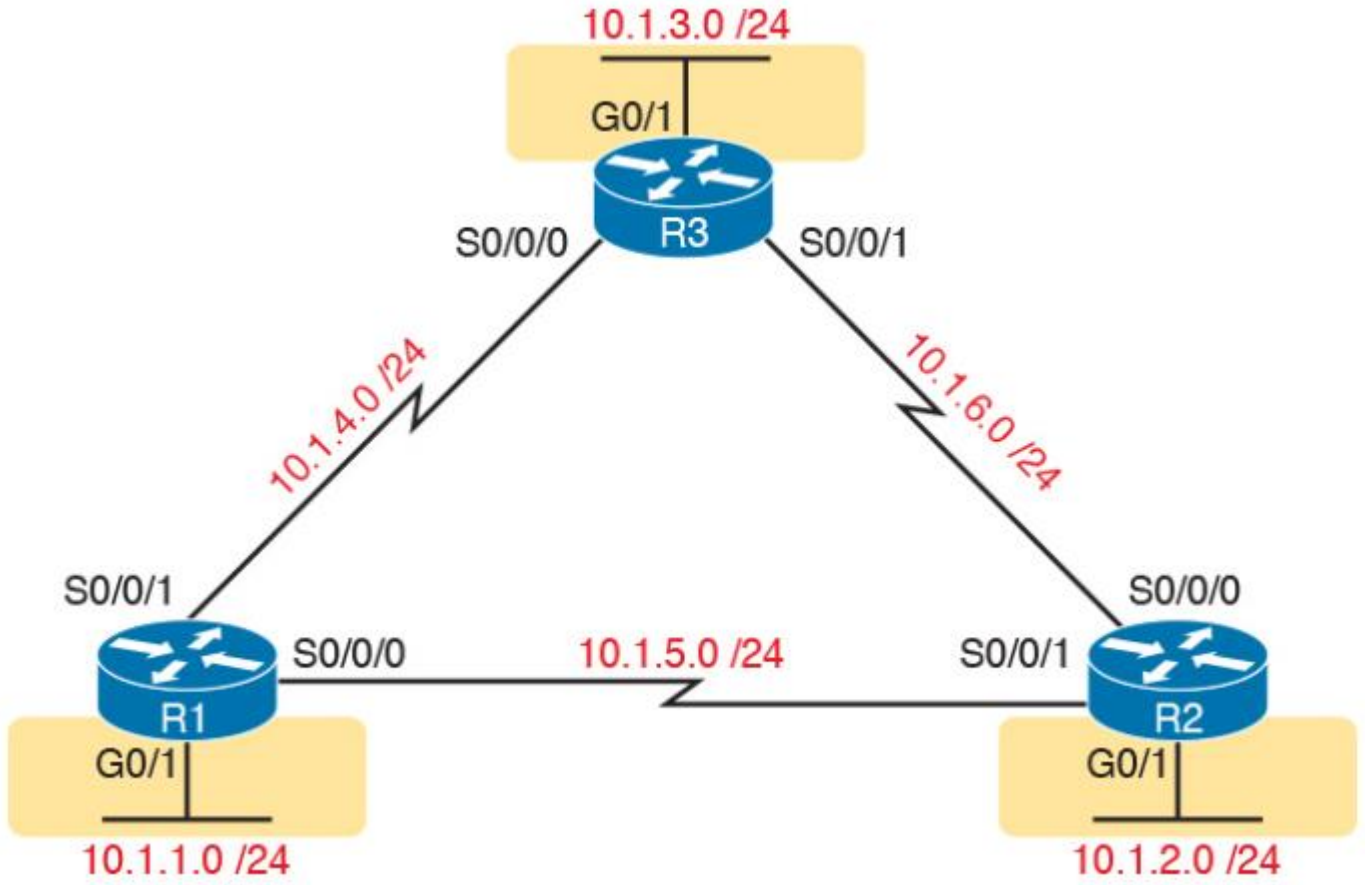
```
! Router R3 configuration
router rip
 version 2
 network 192.168.3.0
 network 192.168.4.0
 network 192.168.6.0
```

- RIPv2 Uses classful network values.
- IOS will actually accept a parameter besides a classful network number.
  - But changes it to the corresponding classful network number.

RIP Configuration Example, with One IP Network

- Three Routers, Each Connected to Subnets of Class A Network 10.0.0.0
- To enable RIPv2 on all interfaces, each router needs only one network command: the **network 10.0.0.0** command.

router rip
version 2
network 10.0.0.0



RIP Configuration Example, with One IP Network

- To enable RIPv2 on all interfaces, each router needs only one network command: the **network 10.0.0.0** command.

```
router rip
 version 2
 network 10.0.0.0
```

- How does RIPv2 support VLSM if only one network command is used?
  - Sends the classful mask in the routing updates.
  - Classful mask comes from the IP address of the directly connected interfaces.

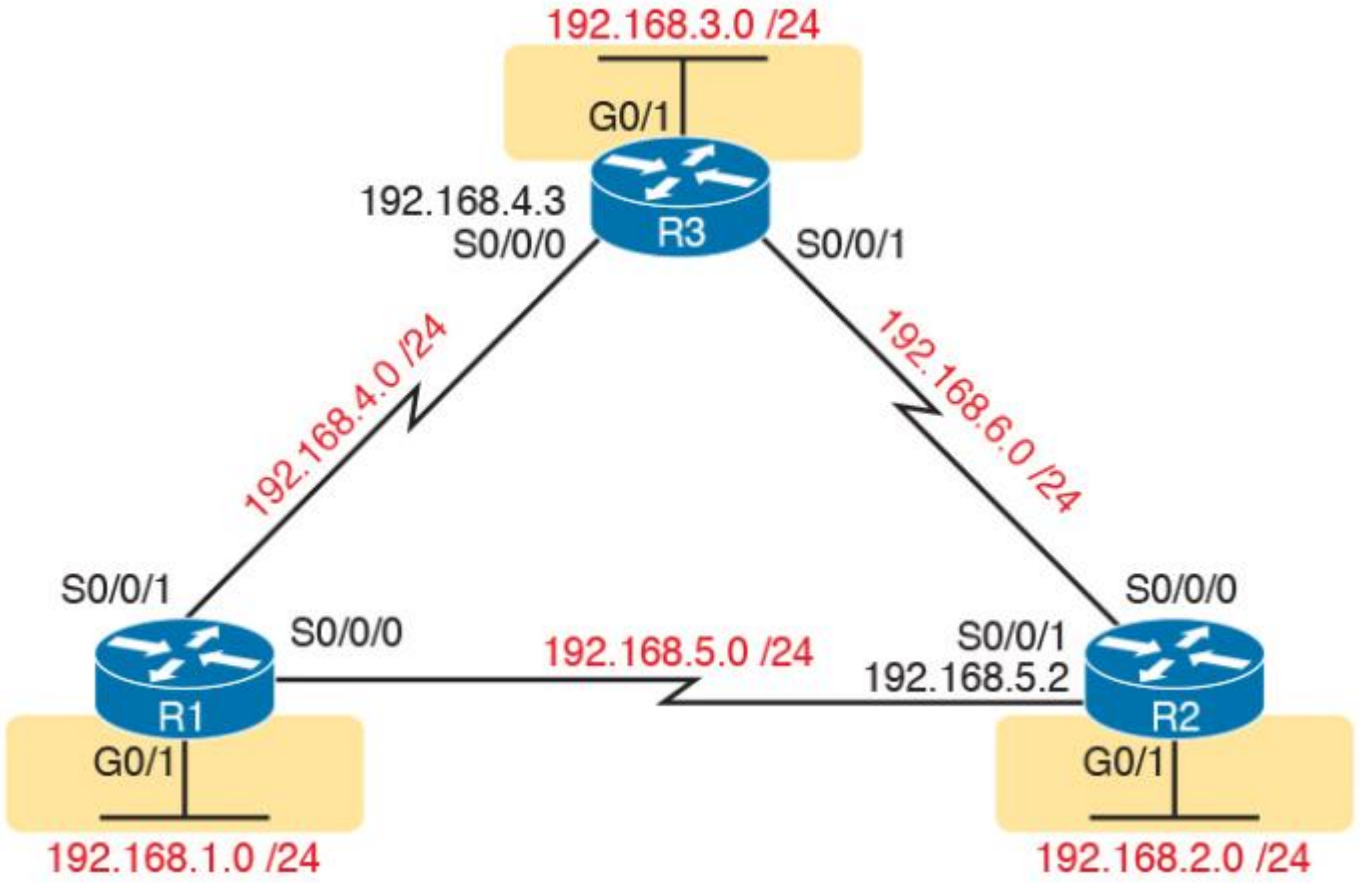
RIPv2 Verification

- IOS includes three primary show commands that are helpful to confirm how well RIPv2 is working.

Command	Purpose
show ip route [rip]	Routes: This command lists IPv4 routes as learned by RIP. The show ip route command lists all IPv4 routes, and the show ip route rip command lists RIP-learned routes only.
show ip protocols	Configuration: This command lists information about the RIP configuration, plus the IP addresses of neighboring RIP routers from which the local router has learned routes.
show ip rip database	Best routes: This command lists the prefix/length of all best routes known to RIP on this router, including routes learned from neighbors and connected routes for interfaces on which RIP has been enabled.

Examining RIP Routes in the IP Routing Table

- The show ip route Command



Examining RIP Routes in the IP Routing Table

- The show ip route Command

```
R1# show ip route
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

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, GigabitEthernet0/1
L        192.168.1.1/32 is directly connected, GigabitEthernet0/1
R     192.168.2.0/24 [120/1] via 192.168.5.2, 00:00:21, Serial0/0/0
R     192.168.3.0/24 [120/1] via 192.168.4.3, 00:00:05, Serial0/0/1
      192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.4.0/24 is directly connected, Serial0/0/1
L        192.168.4.1/32 is directly connected, Serial0/0/1
```

Examining RIP Routes in the IP Routing Table

- The show ip route Command

```
      192.168.5.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.5.0/24 is directly connected, Serial0/0/0
L        192.168.5.1/32 is directly connected, Serial0/0/0
R     192.168.6.0/24 [120/1] via 192.168.5.2, 00:00:21, Serial0/0/0
                     [120/1] via 192.168.4.3, 00:00:05, Serial0/0/1
R1# show ip route rip
! The same lines of legend show up here - removed for brevity

R     192.168.2.0/24 [120/1] via 192.168.5.2, 00:00:21, Serial0/0/0
R     192.168.3.0/24 [120/1] via 192.168.4.3, 00:00:05, Serial0/0/1
R     192.168.6.0/24 [120/1] via 192.168.5.2, 00:00:21, Serial0/0/0
                     [120/1] via 192.168.4.3, 00:00:05, Serial0/0/1
```

Examining RIP Routes in the IP Routing Table

- Using R1's route to 192.168.2.0/24 as an example, the details are as follows:
  - The network number and mask are listed, 192.168.2.0 and /24 in this case. (In some cases, the mask is on a heading line just above the route.)
  - The next-hop router's IP address is 192.168.5.2 in this case.
  - The outgoing interface is Serial0/0/0 in this case.
  - The update RIP timer that measures how long it has been since R1 has last heard about this route in a periodic RIP update is 21 seconds ago in this case.
  - The RIP metric for this route (1 in this case), is listed as the second number in the square brackets. For example, between R1 and subnet 192.168.2.0/24, one other router (R2) exists, so it is a one-hop route.
  - The administrative distance of the route is 120 in this case; the first number in brackets.

Examining RIP Routes in the IP Routing Table

```
R1# show ip route rip
! The same lines of legend show up here - removed for brevity

R     192.168.2.0/24 [120/1] via 192.168.5.2, 00:00:21, Serial0/0/0
R     192.168.3.0/24 [120/1] via 192.168.4.3, 00:00:05, Serial0/0/1
R     192.168.6.0/24 [120/1] via 192.168.5.2, 00:00:21, Serial0/0/0
                     [120/1] via 192.168.4.3, 00:00:05, Serial0/0/1
```

- If R1's S0/0/0 interface failed (can use shutdown command).
  - R1 would converge to use the two-hop route that runs through R3 next.
- The show ip route Command with New Metric 2 for Subnet 192.168.2.0

```
R1# show ip route rip
! The same lines of legend show up here - removed for brevity

R     192.168.2.0/24 [120/2] via 192.168.4.3, 00:00:01, Serial0/0/1
R     192.168.3.0/24 [120/1] via 192.168.4.3, 00:00:01, Serial0/0/1
R     192.168.6.0/24 [120/1] via 192.168.4.3, 00:00:01, Serial0/0/1
```

Comparing Routing Sources with Administrative Distance

- When an internetwork has redundant links and uses a single routing protocol, each router may learn multiple routes to reach a particular subnet.
- Some enterprises use multiple IP routing protocols.
  - One router might learn of multiple routes to a particular subnet using different routing protocols.
- Which routing protocol to use?
  - Metric?
- IOS solves this problem by assigning a numeric value to each routing protocol, called the administrative distance (AD).

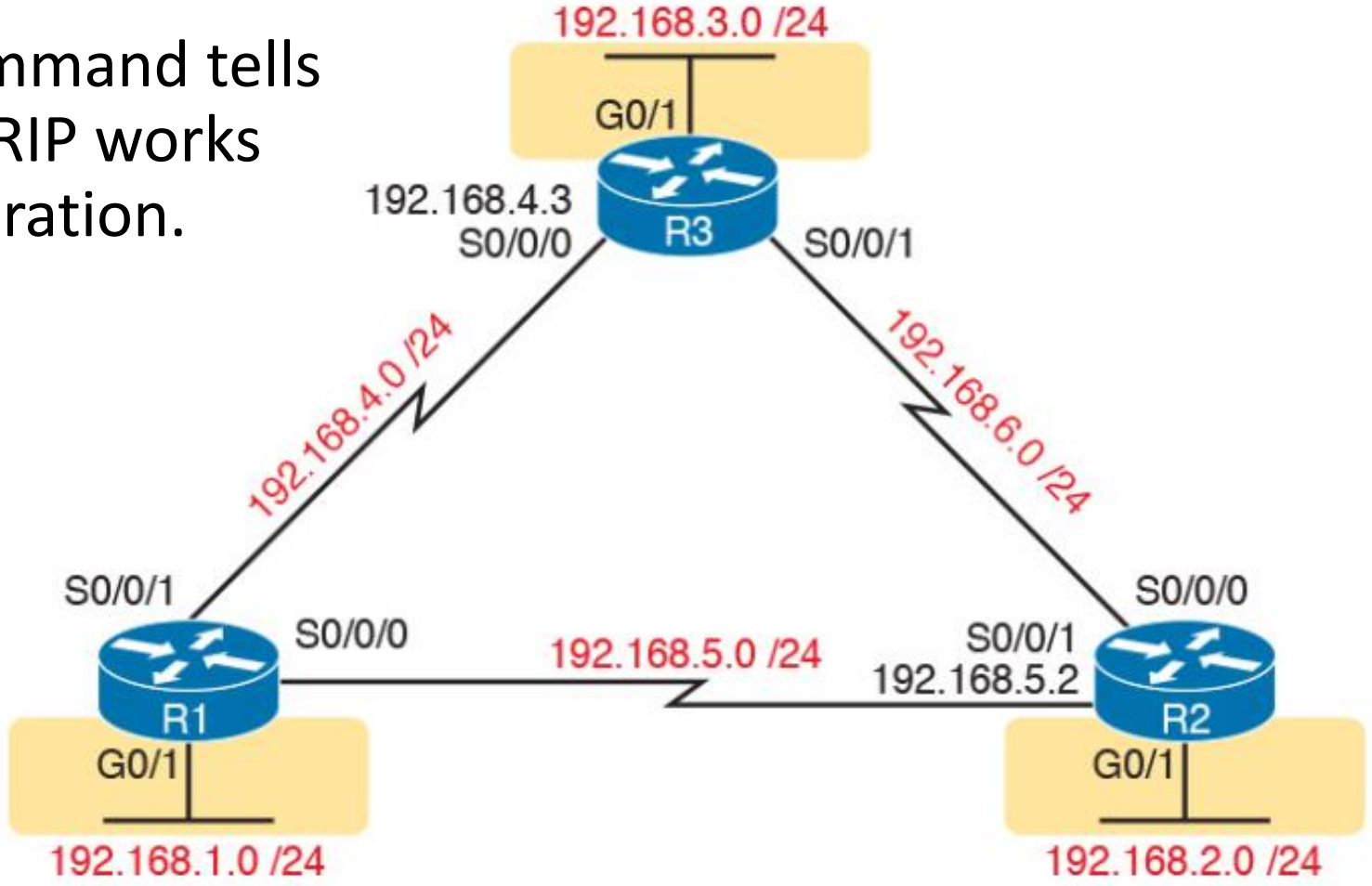
Comparing Routing Sources with Administrative Distance

- The smaller the Administrative Distance the better the route.
- IOS Defaults for Administrative Distance

Route Source	Administrative Distance
Connected routes	0
Static routes	1
EIGRP	90
OSPF	110
RIP (v1 and v2)	120
DHCP default route	254
Unknown or unbelievable	255

Revealing RIP Configuration with the show ip protocols Command

- The show ip protocols command tells us something about how RIP works and about the RIP configuration.



Revealing RIP Configuration with the show ip protocols Command

- The show ip protocols command tells us something about how RIP works and about the RIP configuration.

```
R1# show ip protocols
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 23 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Redistributing: rip
  Default version control: send version 2, receive version 2
    Interface             Send  Recv  Triggered RIP  Key-chain
    GigabitEthernet0/1    2     2
    Serial0/0/0           2     2
    Serial0/0/1           2     2
```

Revealing RIP Configuration with the show ip protocols Command

- The show ip protocols command tells us something about how RIP works and about the RIP configuration.

```
    Serial0/0/0            2     2
    Serial0/0/1            2     2
  Automatic network summarization is in effect
  Maximum path: 4
  Routing for Networks:
    192.168.1.0
    192.168.4.0
    192.168.5.0
Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.4.3          120      00:00:18
    192.168.5.2          120      00:00:05
  Distance: (default is 120)
```

Revealing RIP Configuration with the show ip protocols Command

- The show ip protocols command tells us something about how RIP works and about the RIP configuration.
  - The version 2 RIP subcommand configured R1 to send version 2 updates only and to process received version 2 updates only as well.
  - Automatic summarization (per the default auto-summary command) is enabled.
  - The maximum-paths command is set to 4 (also the default).
  - The “Routing for Networks” section re-lists the configuration of network commands, listing the network numbers in those commands. In this case, it implies three RIP subcommands: network 192.168.1.0, network 192.168.4.0, and network 192.168.5.0.

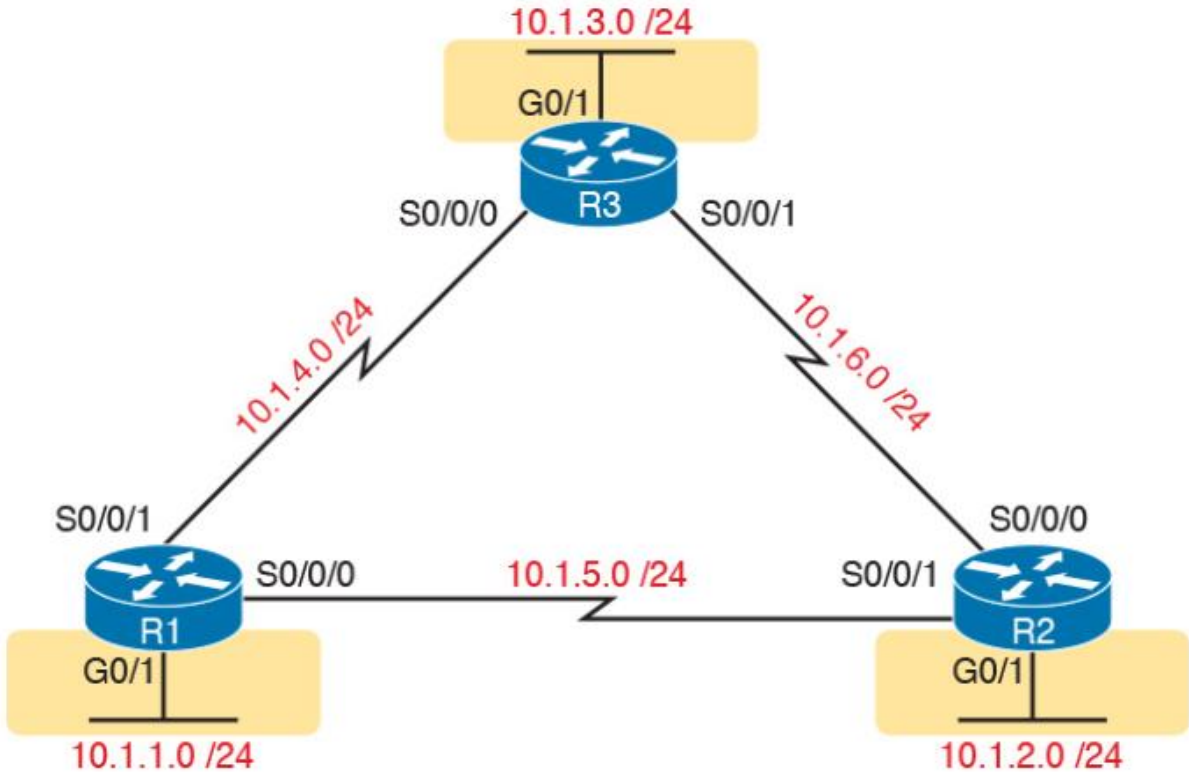
Examining the Best RIP Routes Using RIP Database

- The show ip rip database command lists the prefix/length of each subnet known to the local router's RIP process.
- This command lists:
  - Routes for subnets learned from other RIP routers.
  - Routes for connected subnets for which RIP is enabled on interfaces due to the RIP network command(s).

Examining the Best RIP Routes Using RIP Database

show ip rip database

```
R1# show ip rip database
10.0.0.0/8    auto-summary
10.1.1.0/24    directly connected, GigabitEthernet0/1
10.1.2.0/24
    [1] via 10.1.5.2, 00:00:00, Serial0/0/0
10.1.3.0/24
    [1] via 10.1.4.3, 00:00:08, Serial0/0/1
10.1.4.0/24    directly connected, Serial0/0/1
10.1.5.0/24    directly connected, Serial0/0/0
10.1.6.0/24
    [1] via 10.1.5.2, 00:00:00, Serial0/0/0
    [1] via 10.1.4.3, 00:00:08, Serial0/0/1
```



Examining the Best RIP Routes Using RIP Database

```
R1# show ip rip database
10.0.0.0/8    auto-summary
10.1.1.0/24    directly connected, GigabitEthernet0/1
10.1.2.0/24
    [1] via 10.1.5.2, 00:00:00, Serial0/0/0
10.1.3.0/24
    [1] via 10.1.4.3, 00:00:08, Serial0/0/1
10.1.4.0/24    directly connected, Serial0/0/1
10.1.5.0/24    directly connected, Serial0/0/0
10.1.6.0/24
    [1] via 10.1.5.2, 00:00:00, Serial0/0/0
    [1] via 10.1.4.3, 00:00:08, Serial0/0/1
```

show ip rip database

- Shows three RIP-learned routes.
- Hop-count metrics in brackets.
- Next-hop router IP addresses listed (R2, address 10.1.5.2, and R3, 10.1.4.3).
- Lists the connected subnets.
- Identifies the interfaces on which RIP has been enabled

Controlling RIP Updates with the passive-interface Command

- If there is no router on a specific network you do not need to advertise the routing updates.
- Why?
  - Less traffic on that network.
  - More secure.
    - No one can packet sniff the routing update to find out the other networks.
    - Unauthorised routers will not receive these updates.
- The RIPv2 passive-interface command can be used to stop all RIPv2 updates from being sent out the interface that is matched by a network command.
- The network will still be advertised.

Controlling RIP Updates with the passive-interface Command

- Directing RIPv2 to Not Send Advertisements with passive-interface

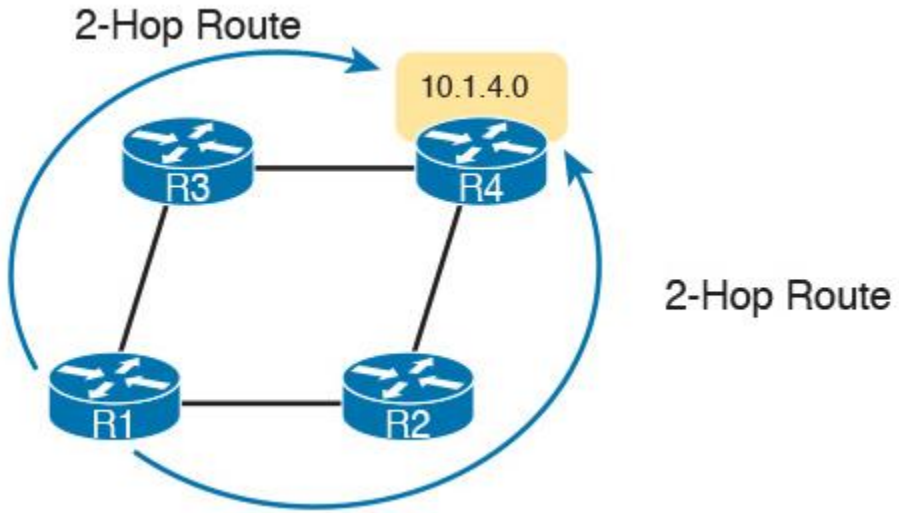
```
router rip
 version 2
 network 10.0.0.0
 passive-interface G0/1
```

- Using the passive-interface default Command Option
  - Good for cases with a lot of interfaces are to be made passive.

```
router rip
 version 2
 network 10.0.0.0
 passive-interface default
 no passive-interface s0/0/0
 no passive-interface s0/0/1
```

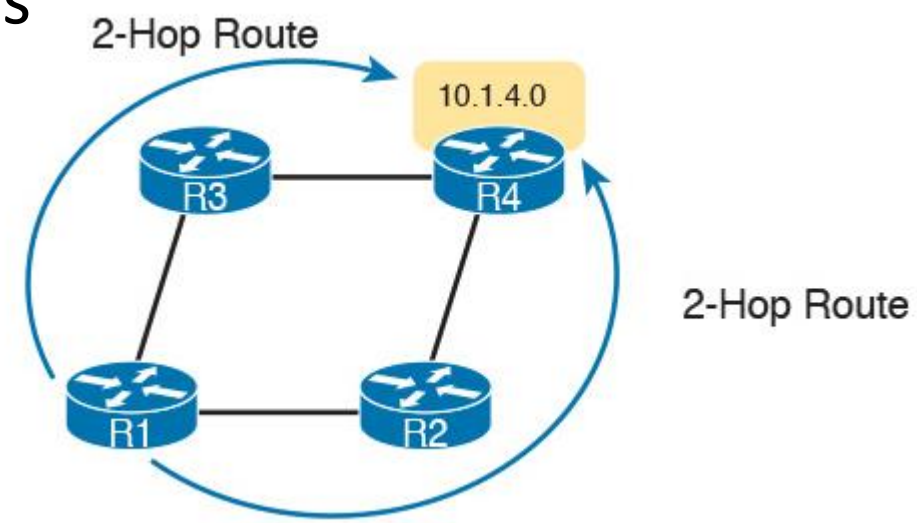
Supporting Multiple Equal-Cost Routes with Maximum Paths

- What should a router do when it learns multiple routes for the same subnet but the metrics tie?
- RIP's default behavior when it learns more than one route that ties is to put multiple routes into the routing table and use them all.



Supporting Multiple Equal-Cost Routes with Maximum Paths

- Cisco refers to this feature of using multiple equal-metric routes to the same destination as equal-cost load balancing.
- RIP controls this behavior with the maximum-paths number-of-paths RIP subcommand (default is 4).
- Setting the value to 1 disables the feature, so that RIP places the first-learned equal-metric route into the routing table.

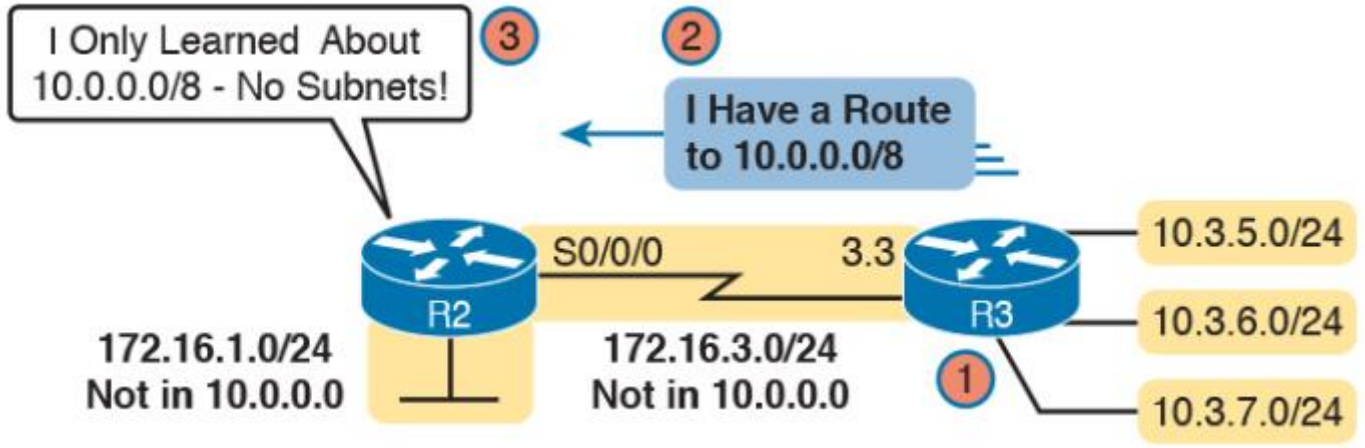


Understanding Autosummarization and Discontiguous Classful Networks

- Older routing protocols, namely RIPv1 and IGRP, were classified as classful routing protocols.
- These older classful routing protocols had to use a more careful and cautious subnet design plan to avoid a problem called a discontiguous classful network.
- Today, most enterprises use OSPF or EIGRP, or in a few cases, RIPv2.
  - All these protocols are classless routing protocols.
- When using RIPv2, if you configure the no auto-summary RIP subcommand on every router, you can avoid the problem altogether.

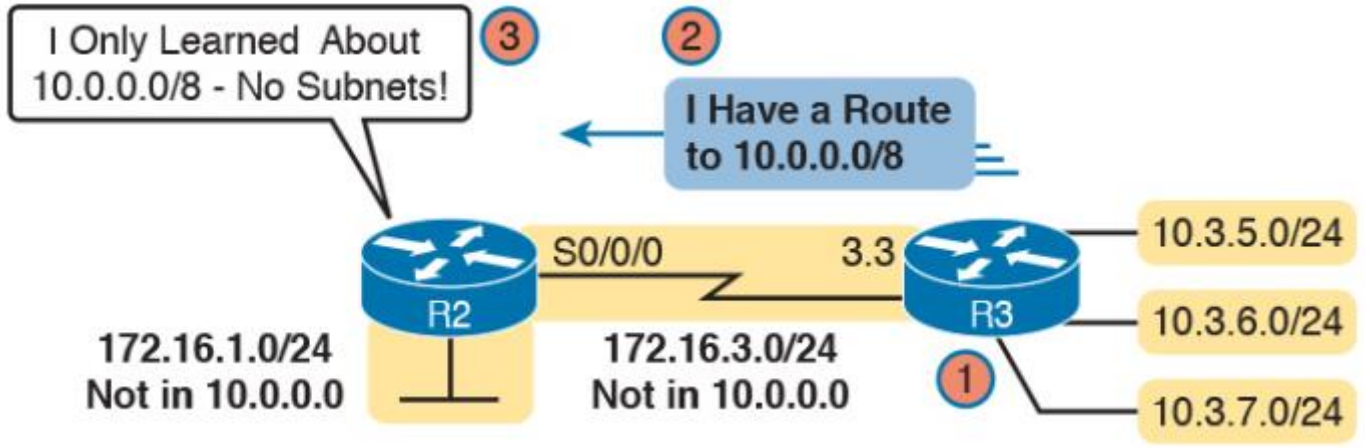
Understanding Autosummarization and Discontiguous Classful Networks

- A routing protocol that uses autosummarization automatically creates a summary route under certain conditions.
  - That one router connects to subnets of multiple different classful networks.
  - That router uses a routing protocol that uses the autosummary feature. (Note that classful routing protocols had to use this feature and could not disable it.)



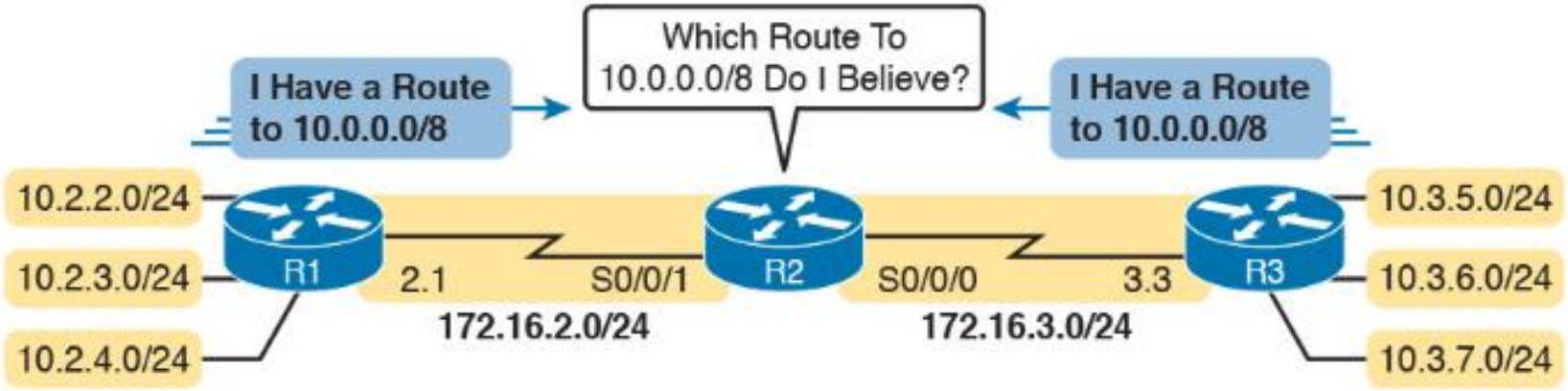
Understanding Autosummarization and Discontiguous Classful Networks

- **1.** R3 has autosummary enabled, with the RIPv2 auto-summary router subcommand.
- **2.** R3 advertises a route for all of Class A network 10.0.0.0, instead of advertising routes for each subnet inside network 10.0.0.0, because the link to R2 is a link in another network (172.16.0.0).
- **3.** R2 learns one route in network 10.0.0.0: a route to 10.0.0.0/8, which represents all of network 10.0.0.0, with R3 as the next-hop router.



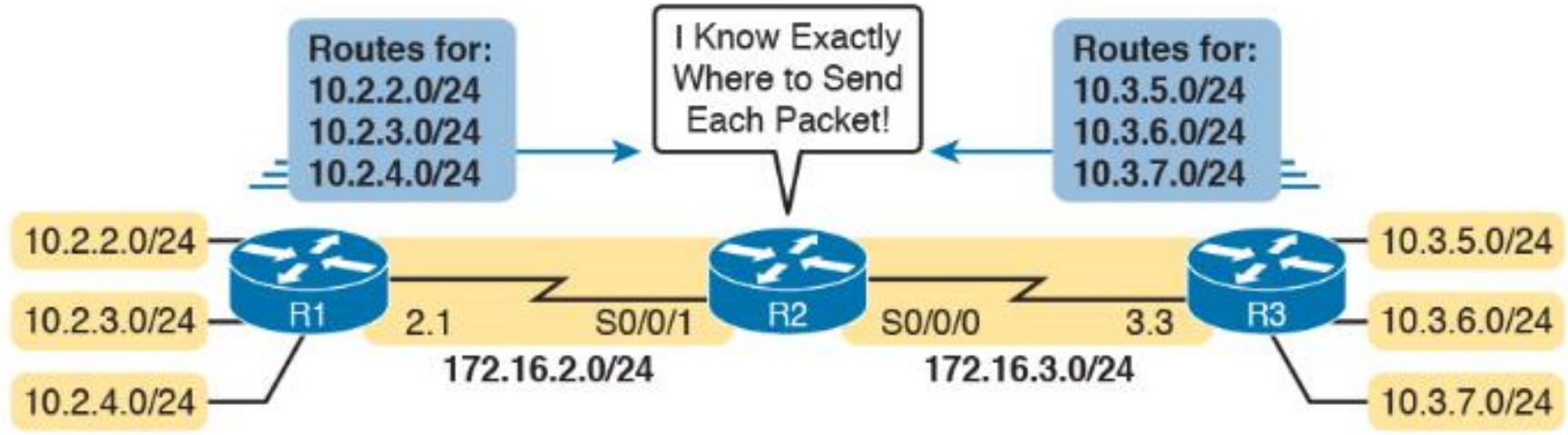
Understanding Autosummarization and Discontiguous Classful Networks

- Autosummarization when combined with a design that creates a discontiguous classful network, is not a good implementation.
- **Contiguous network:** A network topology in which subnets of network X are not separated by subnets of any other classful network.
- **Discontiguous network:** A network topology in which subnets of network X are separated by subnets of some other classful network.



Understanding Autosummarization and Discontiguous Classful Networks

- Solution 1: Keep all subnets of each classful network together in a design
- Solution 2: Disabling autosummarization with the no auto-summary RIPv2 subcommand.



Verifying Optional RIP Features

- Verifying RIPv2 Optional Configuration in show ip protocols Output

```
R2# show running-config
! Lines other than the RIP configuration are omitted
router rip
 version 2
 network 192.168.1.0
 network 192.168.4.0
 network 192.168.5.0
 no auto-summary
 maximum-paths 3
 passive-interface gigabitethernet0/1
```

Verifying Optional RIP Features

- Verifying RIPv2 Optional Configuration in show ip protocols Output

```
R1# show ip protocols
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 23 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Redistributing: rip
  Default version control: send version 2, receive version 2
    Interface             Send  Recv  Triggered RIP  Key-chain
    Serial0/0/0           2     2
    Serial0/0/1           2     2
  Automatic network summarization is not in effect
  Maximum path: 3
  Routing for Networks:
```

Verifying Optional RIP Features

- Verifying RIPv2 Optional Configuration in show ip protocols Output
- The show ip protocols output lists an interface either in the primary list of interfaces (those that are not passive) or in the list of passive interfaces, but not both.

```
    192.168.1.0
    192.168.4.0
    192.168.5.0
  Passive Interface(s):
    GigabitEthernet0/1
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.4.3           120      00:00:03
    192.168.5.2           120      00:00:09
  Distance: (default is 120)
```

Verifying Optional RIP Features

- Evidence of Equal-Cost Load Balancing

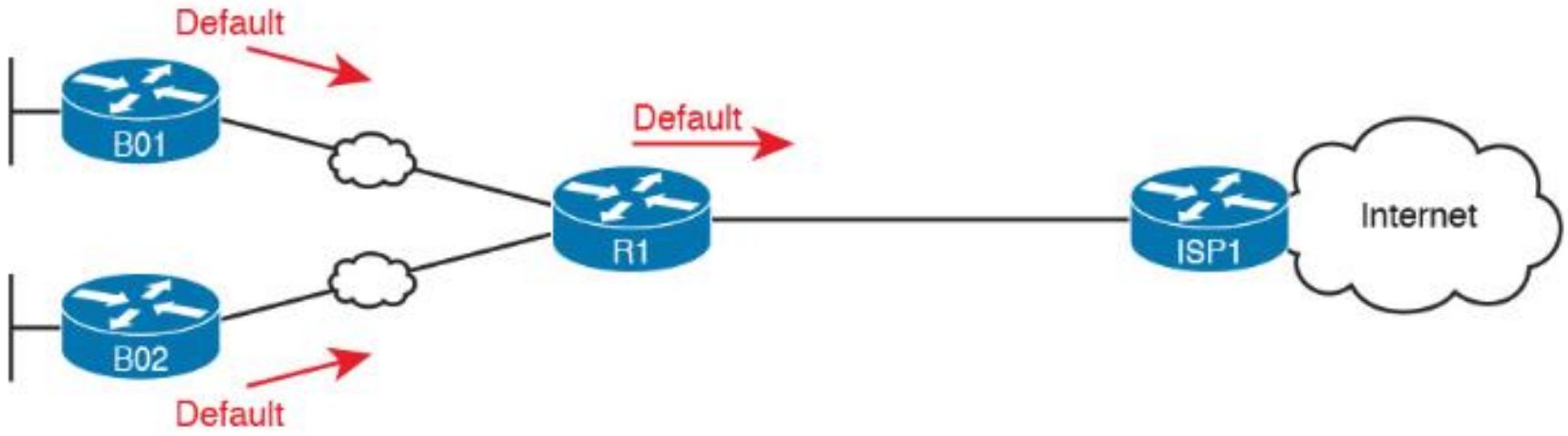
```
R1# show ip route rip
! Legend omitted for brevity

      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, GigabitEthernet0/1
L        192.168.1.1/32 is directly connected, GigabitEthernet0/1
R     192.168.2.0/24 [120/1] via 192.168.5.2, 00:00:21, Serial0/0/0
R     192.168.3.0/24 [120/1] via 192.168.4.3, 00:00:05, Serial0/0/1
      192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.4.0/24 is directly connected, Serial0/0/1
L        192.168.4.1/32 is directly connected, Serial0/0/1
      192.168.5.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.5.0/24 is directly connected, Serial0/0/0
L        192.168.5.1/32 is directly connected, Serial0/0/0
R     192.168.6.0/24 [120/1] via 192.168.5.2, 00:00:21, Serial0/0/0
                     [120/1] via 192.168.4.3, 00:00:05, Serial0/0/1
```

Verifying Optional RIP Features

- Summary of Optional RIPv2 features:
- **Step 1.** Disable RIP sent updates on some interfaces as follows:
  - **A.** Use the **passive-interface** *type number* command in RIP configuration mode to make RIP not send RIP updates out that RIP-enabled interface.
  - **B.** Use the passive-interface default command in RIP configuration mode to make RIP not send RIP updates out all interfaces by default, and then selectively use the no passive-interface type number command in RIP configuration mode to enable RIP sent updates on some interfaces.
- **Step 2**. Use the **no auto-summary** command in RIP configuration mode to disable automatic summarization on routers that connect to multiple classful networks, as needed.
- **Step 3.** Use the **maximum-paths** *number* command in RIP configuration mode to set the number of equal-metric routes for a single destination subnet to add to the IP routing table.

RIPv2 Default Routes

- In some designs, may want to use the default route concept.
  - May be a static default route.
- Branch Routers with Default Route to R1; R1 with Default Route to Internet



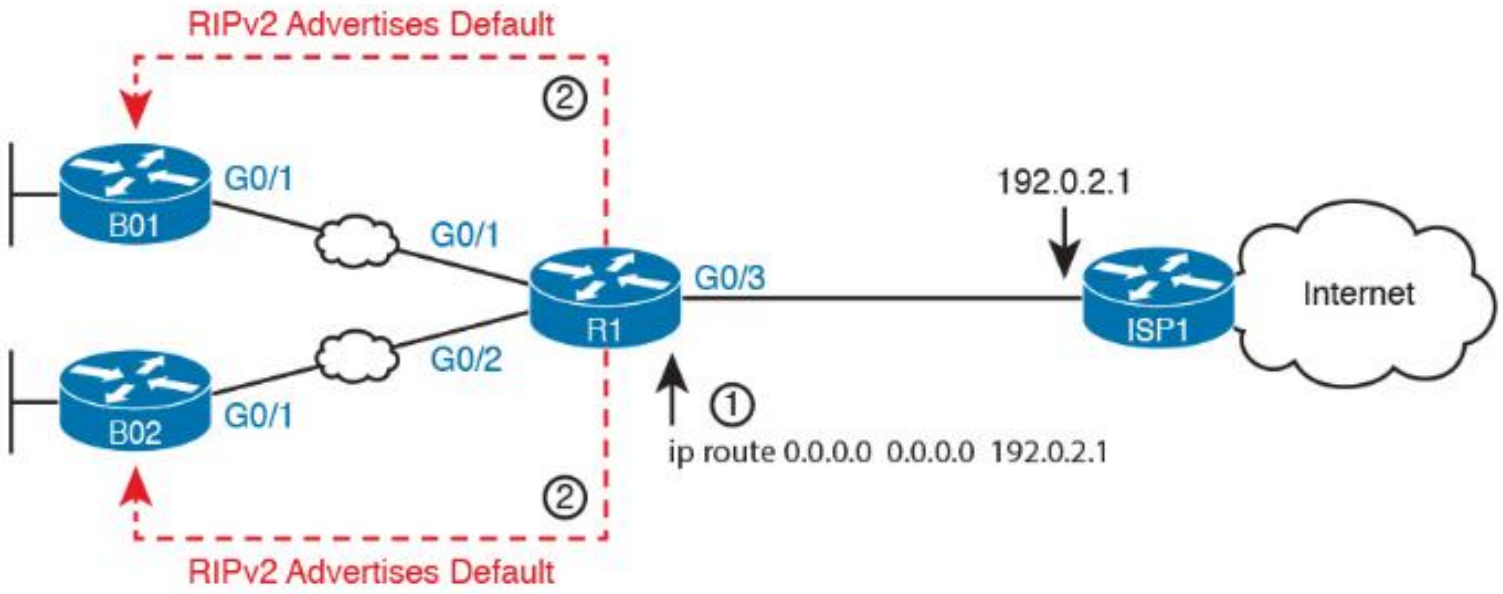
Learning Default Routes Using Static Routes and RIPv2

- Enterprise routers in this design could each use a static default route, but RIPv2 provides an alternative that uses a static default route on only one router.
- One router, directly connected to the link of the true default route, configures a static default route as normal.
  - That router then uses RIPv2 to advertise a default route—a route to 0.0.0.0, mask /0—to the other routers.

Learning Default Routes Using Static Routes and RIPv2

- A Scenario for RIPv2 to Advertise Default Routes
- Using the command (on R1 only in this case):

  default-information originate



Learning Default Routes Using Static Routes and RIPv2

- A Scenario for RIPv2 to Advertise Default Routes
- Using the command (on R1 only in this case):

  default-information originate

```
R1# configure terminal
R1(config)# ip route 0.0.0.0 0.0.0.0 192.0.2.1
R1(config)# router rip
R1(config-router)# default-information originate
R1(config-router)# end
R1#
```

Learning Default Routes Using Static Routes and RIPv2

- Displaying the Static Default Route Configured on Router R1

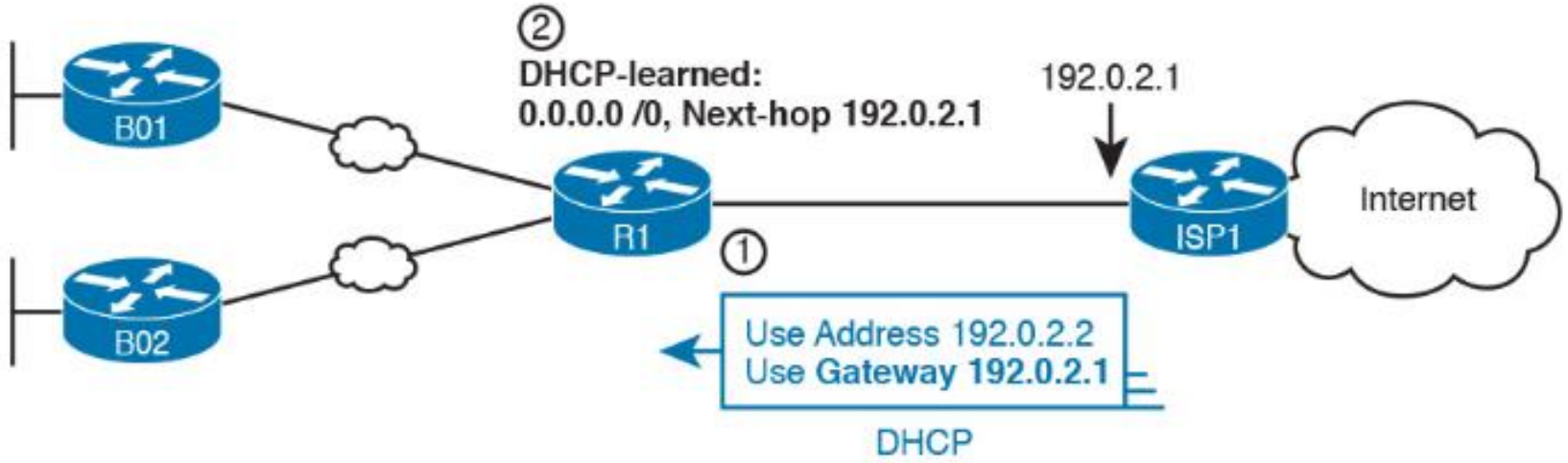
```
R1# show ip route static
! Legend omitted
Gateway of last resort is 192.0.2.1 to network 0.0.0.0

S*    0.0.0.0/0 [1/0] via 192.0.2.1
```

- Router B01 with Default Route Learned Using RIPv2

```
R1# show ip route rip
! Legend omitted
Gateway of last resort is 10.1.12.1 to network 0.0.0.0

R*    0.0.0.0/0 [120/1] via 10.1.12.1, 00:00:06, GigabitEthernet0/1
```

Learning a Default Route Using DHCP

- Enterprise Router Building and Advertising Default Routes with DHCP Client.
- Router R1 uses DHCP to learn its IP address (192.0.2.2).
- The DHCP process also lists a default gateway, 192.0.2.1, which in this case identifies the ISP router's IP address on the link.



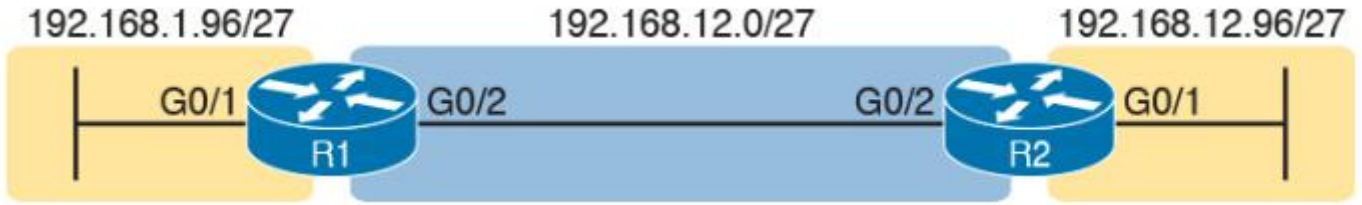
Learning a Default Route Using DHCP

- R1 has a default route, it can then use the same RIPv2 methods and the **default-information originate** RIP subcommand configured to advertise this default route.
- When adding a route to the default gateway, as learned with DHCP, IOS uses a default administrative distance of 254

```
R1# configure terminal
R1(config)# interface gigabitethernet0/1
R1(config-if)# ip address dhcp
R1(config-if)# end
R1#
R1# show ip route static
! Legend omitted
Gateway of last resort is 192.0.2.1 to network 0.0.0.0

S*    0.0.0.0/0 [254/0] via 192.0.2.1
```

Troubleshooting RIPv2

- Sample Network for Troubleshooting Examples




```
! Configuration on router R1
interface G0/1
 ip address 192.168.1.101 255.255.255.224
interface G0/2
 ip address 192.168.12.1 255.255.255.224
!
router rip
 version 2
 no auto-summary
 network 192.168.1.0
 network 192.168.12.0
```

```
! Configuration on router R2
interface G0/1
 ip address 192.168.12.102 255.255.255.224
interface G0/2
 ip address 192.168.12.2 255.255.255.224
!
router rip
 version 2
 network 192.168.12.0
```

Symptoms with Missing and Incorrect network Commands

- Router missing a network command
- Basically, two things happen:
  - The router does not advertise about the subnets on those interfaces.
  - The router does not exchange routing information with other routers on those interfaces.
- Use the command:

  show ip protocols

Symptoms with Missing and Incorrect network Commands

- show ip protocols on R1 with Missing network 192.168.12.0 Command
- R1 list only one interface and no information source.

```
R1# show ip protocols
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 4 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Redistributing: rip
  Default version control: send version 2, receive version 2
    Interface             Send  Recv  Triggered RIP  Key-chain
    GigabitEthernet0/1    2     2
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
    192.168.1.0
  Routing Information Sources:
    Gateway         Distance      Last Update
  Distance: (default is 120)
```

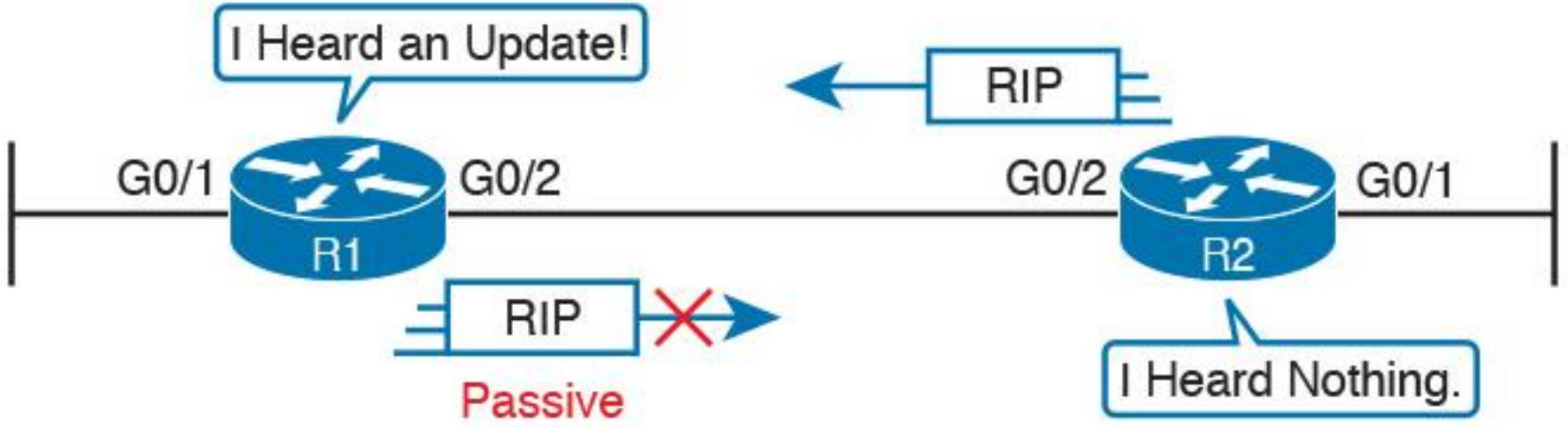
Symptoms with Missing and Incorrect network Commands

- show ip protocols on R1 with Missing network 192.168.1.0 Command

```
R1# show ip protocols
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 4 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Redistributing: rip
  Default version control: send version 2, receive version 2
    Interface             Send  Recv  Triggered RIP  Key-chain
    GigabitEthernet0/2    2     2
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
    192.168.12.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.12.2         120      00:00:12
  Distance: (default is 120)
```

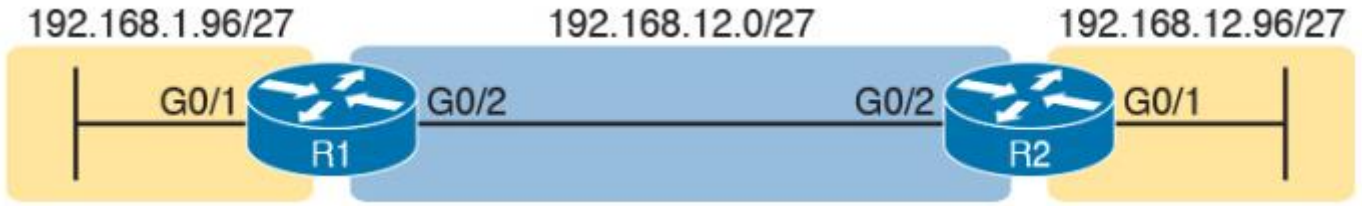
Issues Related to Passive Interfaces

- One-Way Exchange of Routes with Incorrect Passive Interface
- Used command **passive-interface g0/2** command to R1, instead of a **passive-interface g0/1** command.



Issues Related to auto-summary

- R1 does not perform automatic summarization, instead advertising a route for 192.168.1.96/27 to R2.

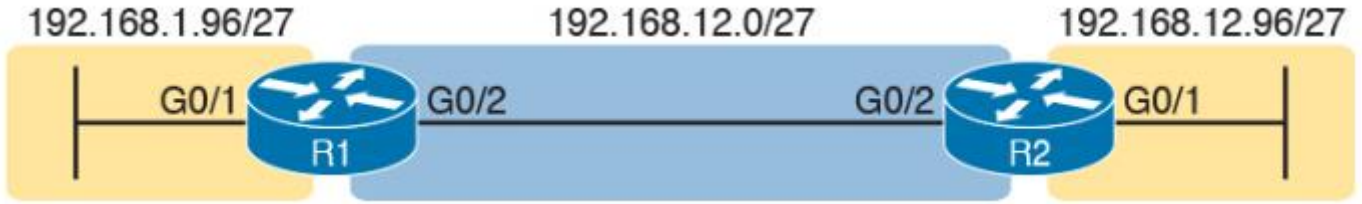



```
! Configuration on router R1
interface G0/1
 ip address 192.168.1.101 255.255.255.224
interface G0/2
 ip address 192.168.12.1 255.255.255.224
!
router rip
 version 2
 no auto-summary
 network 192.168.1.0
 network 192.168.12.0
```

```
! Configuration on router R2
interface G0/1
 ip address 192.168.12.102 255.255.255.224
interface G0/2
 ip address 192.168.12.2 255.255.255.224
!
router rip
 version 2
 network 192.168.12.0
```

Issues Related to auto-summary

- show ip route rip on R2 with Different auto-summary Settings on R1




```
! R2's RIP route with no auto-summary configured on R1 (per Example 19-12)
R2# show ip route | section 192.168.1.0
! lines omitted for brevity
      192.168.1.0/27 is subnetted, 1 subnets
R        192.168.1.96 [120/1] via 192.168.12.1, 00:00:16, Serial0/0/1
```

```
! R2's RIP route with auto-summary configured on R1
R2# show ip route rip
! lines omitted for brevity
R     192.168.1.0/24 [120/1] via 192.168.12.1, 00:00:03, Serial0/0/1
```

RIP Issues Caused by Other Router Features

- Even though RIP may be configured correctly, there may be other issues.
- RIP operates only on working interfaces; that is, interfaces that are in an up and up status per the show interfaces and show ip interfaces commands.
- RIP requires that all neighbors on a link be in the same subnet.
- The ACL configuration could inadvertently match and discard RIP messages.
  - RIP uses UDP as a transport protocol, with well-known UDP port 520.
  - ACLs can match and discard these packets.

Summary of RIP Troubleshooting Issues

- **Step 1.** The RIP network command controls where RIP operates. If a missing network command fails to enable RIP on an interface:
  - **A.** RIP will not advertise about that connected subnet.
  - **B.** RIP will not send advertisements out that interface or process received advertisements in that interface.
- **Step 2.** The passive-interface command should not be used for interfaces that connect to other routers.
  - If configured, the passive router does not advertise routes to neighboring routers, even though the passive router can still learn RIP routes from RIP messages entering that interface.

Summary of RIP Troubleshooting Issues

- Step 3. The no auto-summary command has an impact only on routers that directly connect to more than one classful network.
  - However, the command is needed only if a discontiguous classful network exists.
- Step 4. Some non-RIP features impact RIP operation, namely
  - A. Interfaces must be working for RIPv2 to use the interfaces.
  - B. Two routers on the same link must have IP addresses in the same subnet for RIPv2 to exchange routing information.
  - C. Note that ACLs can filter RIP update messages and therefore break RIP.

Configuration Command Reference

Command	Description
router rip	Global command that moves the user into RIP configuration mode
network *network-number*	RIP subcommand that lists a classful network number, enabling RIP on all of that router's interfaces in that classful network
version 2	RIP subcommand that sets the RIP version
passive-interface {*interface-type interface-number*}	RIP subcommand that tells RIP to no longer advertise RIP updates on the listed interface
passive-interface default	RIP subcommand that changes the default setting on RIP-enabled interfaces to be passive instead of not passive
no passive-interface {*interface-type interface-number*}	RIP subcommand that overrides a default passive setting per the passive-interface default command for the listed interface
[no] auto-sunmmary	RIP subcommand that toggles on (auto-summary) and off (no auto-summary) the autosummarization feature of RIP
maximum-paths *number*	RIP subcommand that sets the number of equal-metric routes for the same subnet that RIP will add to the IP routing table
default-information originate	RIP subcommand that causes RIP to advertise a default route—a route for prefix 0.0.0.0, mask 0.0.0.0—if the local router has a default route in its routing table already
ip address dhcp	Interface subcommand that causes a router to act as a DHCP client, learning the IPv4 address to use on the interface and dynamically learning a default route that uses the DHCP-announced default gateway address as the next-hop IP address in a static route

EXEC Command Reference

Command	Purpose
show ip interface brief	Lists one line per router interface, including the IP address and interface status; an interface must have an IP address and be in an "up and up" status before RIP begins to work on the interface
show ip route [rip]	Lists the routing table, including RIP-learned routes, and optionally just RIP-learned routes
show ip route *ip-address*	Lists details about the route the router would match for a packet sent to the listed IP address
show ip protocols	Lists information about the RIP configuration, plus the IP addresses of neighboring RIP routers from which the local router has learned routes
show ip rip database	Lists one line per router interface, including the IP address and interface status; an interface must have an IP address and be in an "up and up" status before RIP begins to work on the interface

What do you know now?

- Which of the following network commands, following a router rip command, would cause RIP to send updates out two interfaces whose IP addresses are 10.1.2.1 and 10.1.1.1, mask 255.255.255.0?
  a. network 10.0.0.0
  b. network 10.1.1.0 10.1.2.0
  c. network 10.1.1.1. 10.1.2.1
  d. network 10.1.0.0 255.255.0.0
  e. network 10

What do you know now?

- Which of the following network commands, following a router rip command, would cause RIP to send updates out two interfaces whose IP addresses are 10.1.2.1 and 10.1.1.1, mask 255.255.255.0?

  a. network 10.0.0.0

  b. network 10.1.1.0 10.1.2.0

  c. network 10.1.1.1. 10.1.2.1

  d. network 10.1.0.0 255.255.0.0

  e. network 10

What do you know now?

- Review the snippet from a show ip route command on a router:

  10.1.2.0 [120/1] via 10.1.128.252, 00:00:13, Serial0/0/1

- Which of the following statements must be true regarding this output? (Choose two answers.)
  a. The administrative distance is 1.
  b. The administrative distance is 120.
  c. The metric is 1.
  d. The metric is not listed.
  e. The router added this route to the routing table 13 seconds ago.
  f. The router must wait 13 seconds before advertising this route again.

What do you know now?

- Review the snippet from a show ip route command on a router:

  10.1.2.0 [120/1] via 10.1.128.252, 00:00:13, Serial0/0/1

- Which of the following statements must be true regarding this output? (Choose two answers.)

  a. The administrative distance is 1.

  b. The administrative distance is 120.

  c. The metric is 1.

  d. The metric is not listed.

  e. The router added this route to the routing table 13 seconds ago.

  f. The router must wait 13 seconds before advertising this route again.

What do you know now?

- Routers R1 and R2 use RIPv2, and should exchange routes with each other. R1 and R2 connect on an Ethernet link, with both routers using their G0/0 interfaces. R2 learns routes from R1, but R1 does not learn routes from R2. Which of the following mistakes could result in this symptom?

  a. R2 has configured a passive-interface gigabitethernet0/0 command.

  b. R1's and R2's IP address/mask values are 10.1.1.1/25 and 10.1.1.201/25, respectively.

  c. R1's has no RIP network command that matches R1's G0/0 interface IP address.

  d. R2 is missing a no auto-summary command.

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Summary

- Comparisons of IGPs.
- A list of RIPV2 features in comparison to RIPv1.
- Matching router logic on one route with the RIP network command.
- The three actions RIP takes when enabled on an interface.
- RIP Verification.
- Analysis of the contents of a single IP route in the output of the show ip route command.
- List of administrative distance values.
- Common troubleshooting issues.

End of Lecture 19, Further Reading, References

- Odom, Wendell. *CCENT/CCNA ICND1 100-105 official cert guide*. Indianapolis, IN: Cisco Press, 2016.