Distance Vector Routing Protocols
RIP version 1

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Dynamic Routing Protocols

- Classifying Routing Protocols
- Routing Protocols Metrics
- Administrative Distance of a Route

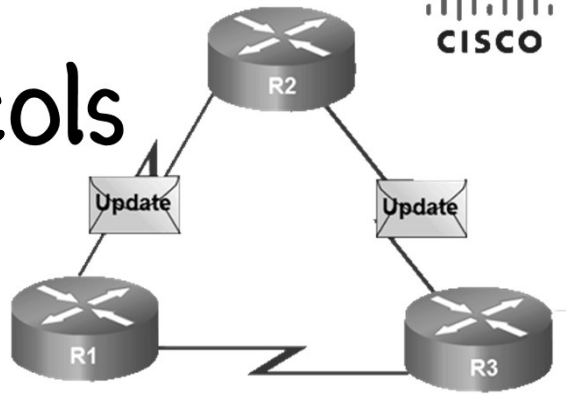
Distance Vector Routing Protocols

- Network Discovery
- Routing Table Maintenance
- Routing Loops

RIP version 1

- Basic RIPv1 Configuration
- Verification and Troubleshooting
- Automatic Summarization
- Default Route and RIPv1

Dynamic Routing Protocols



- Function(s) of Dynamic Routing Protocols:
  - Dynamically share information between routers.
  - Automatically update routing table when topology changes.
  - Determine best path to a destination.
- The purpose of a dynamic routing protocol is to:
  - Discover remote networks
  - Maintaining up-to-date routing information
  - Choosing the best path to destination networks
  - Ability to find a new best path if the current path is no longer available

Dynamic Routing Protocols

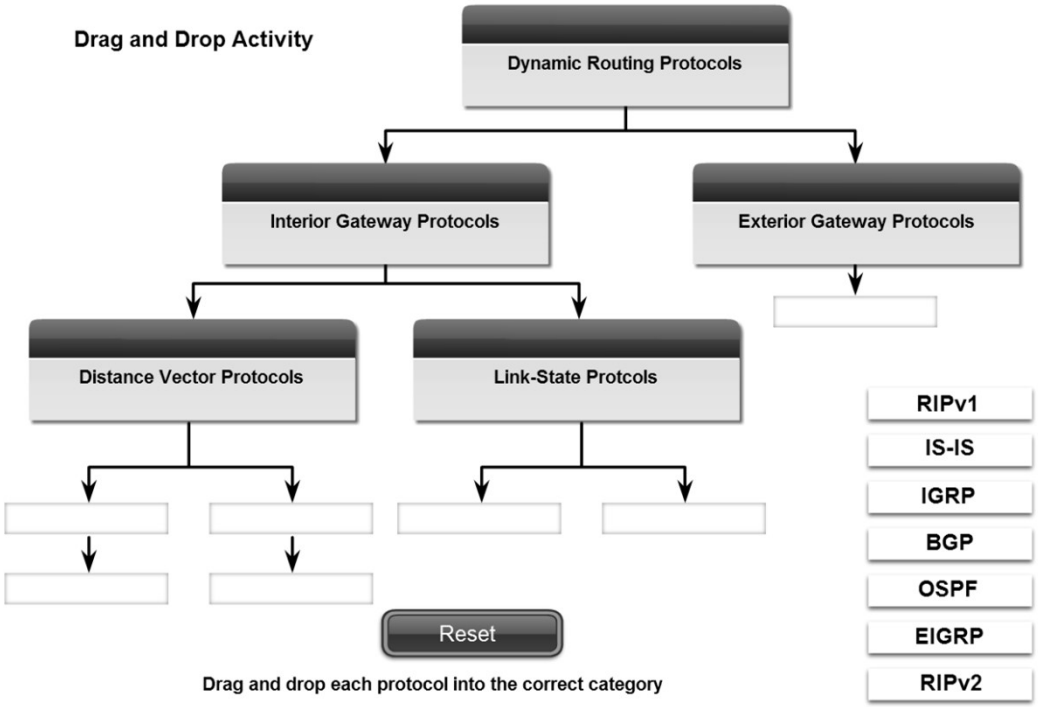
- Components of a routing protocol
  - Algorithm
    - In the case of a routing protocol algorithms are used for facilitating routing information and best path determination
  - Routing protocol messages
    - These are messages for discovering neighbors and exchange of routing information

Dynamic Routing Protocols

	Dynamic routing	Static routing
Configuration Complexity	Generally independent of the network size	Increases with network size
Required administrator knowledge	Advanced knowledge required	No extra knowledge required
Topology changes	Automatically adapts to topology changes	Administrator intervention required
Scaling	Suitable for simple and complex topologies	Suitable for simple topologies
Security	Less secure	More secure
Resource usage	Uses CPU, memory, link bandwith	No extra resources needed
Predictability	Route depends on the current topology	Route to destination is always the same

Classifying Routing Protocols

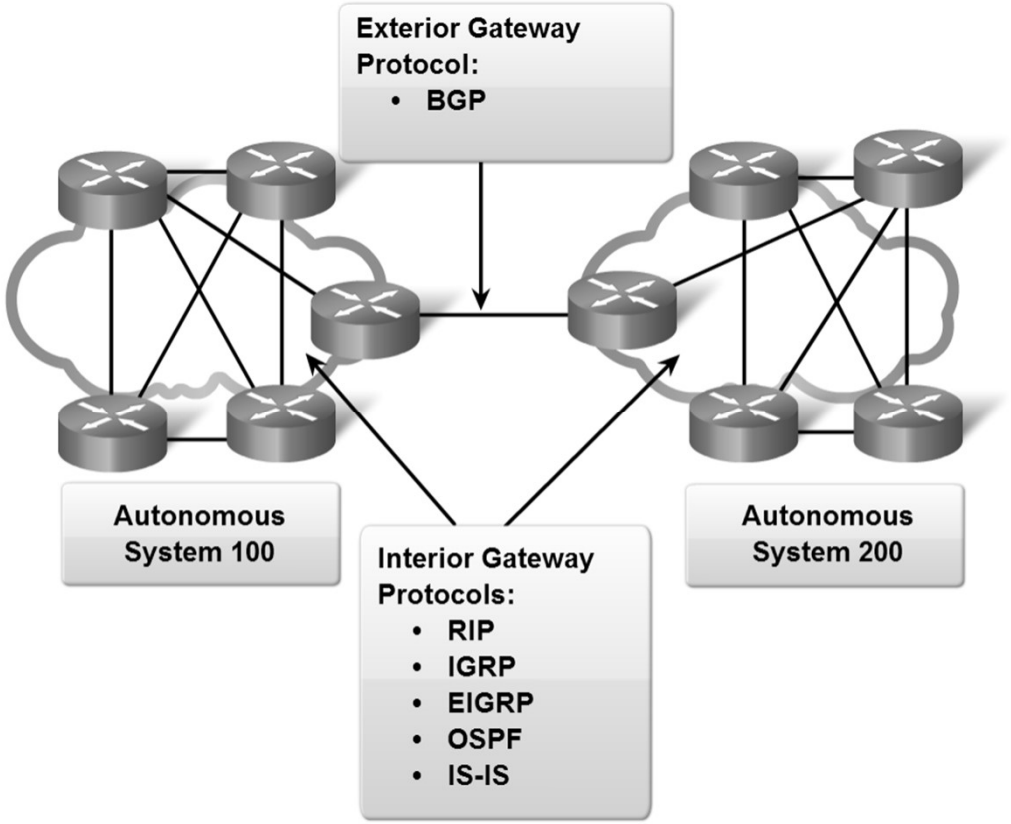
- Dynamic routing protocols are grouped according to characteristics. Examples include:
  - RIP
  - IGRP
  - EIGRP
  - OSPF
  - IS-IS
  - BGP



- Autonomous System is a group of routers under the control of a single authority.

Classifying Routing Protocols

- Types of routing protocols:
  - Interior Gateway Protocols (IGP)
  - Exterior Gateway Protocols (EGP)

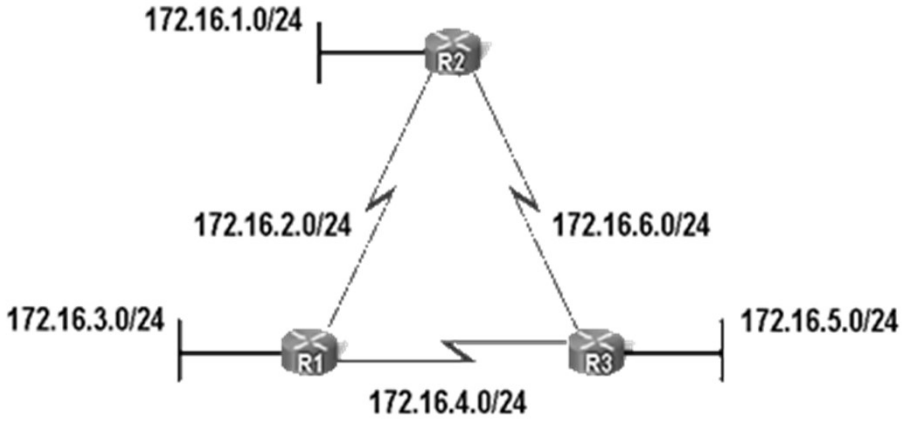


Classifying Routing Protocols

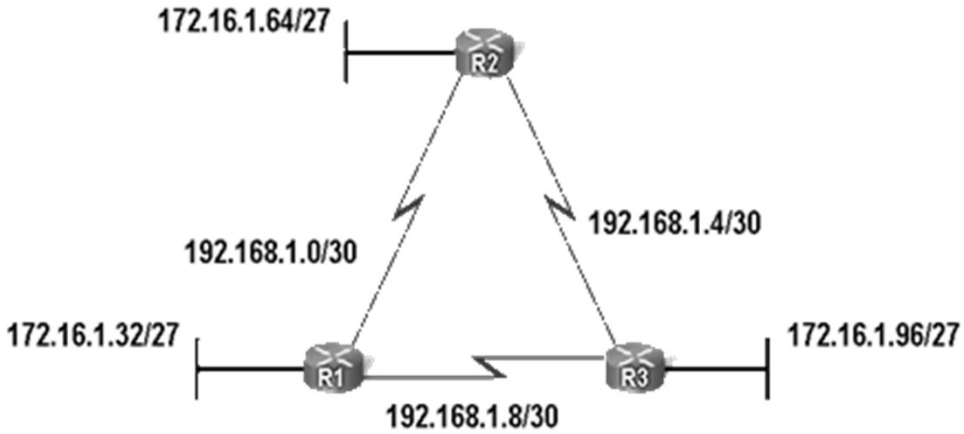
- Interior Gateway Protocols (IGP)
  - Distance vector
    - routes are advertised as vectors of distance & direction.
    - incomplete view of network topology.
    - Generally, periodic updates.
  - Link state
    - complete view of network topology is created.
    - updates are not periodic.

Classifying Routing Protocols

- Classifying Routing Protocols
  - Classful routing protocols
    - Do NOT send subnet mask in routing updates
  - Classless routing protocols
    - Do send subnet mask in routing updates.



Classful: Subnet mask is the same throughout the topology

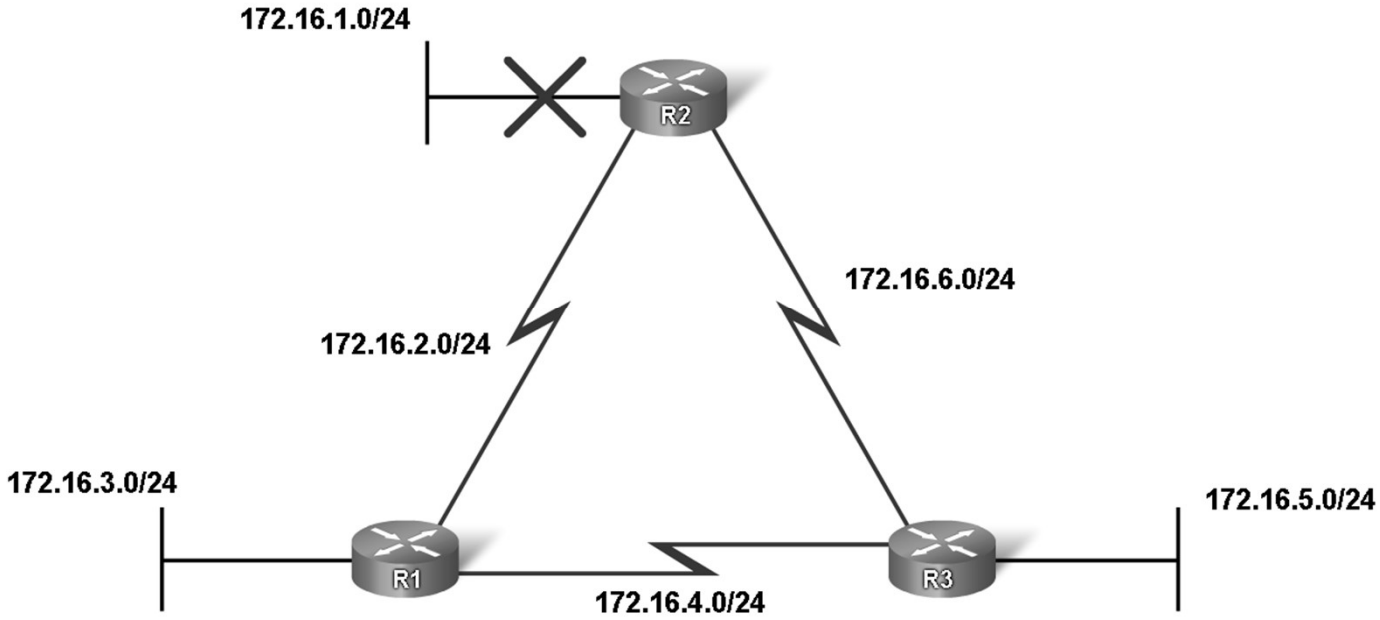


Classless: Subnet mask can vary in the topology

Classifying Routing Protocols

- **Convergence** is defined as when all routers' routing tables are at a state of consistency

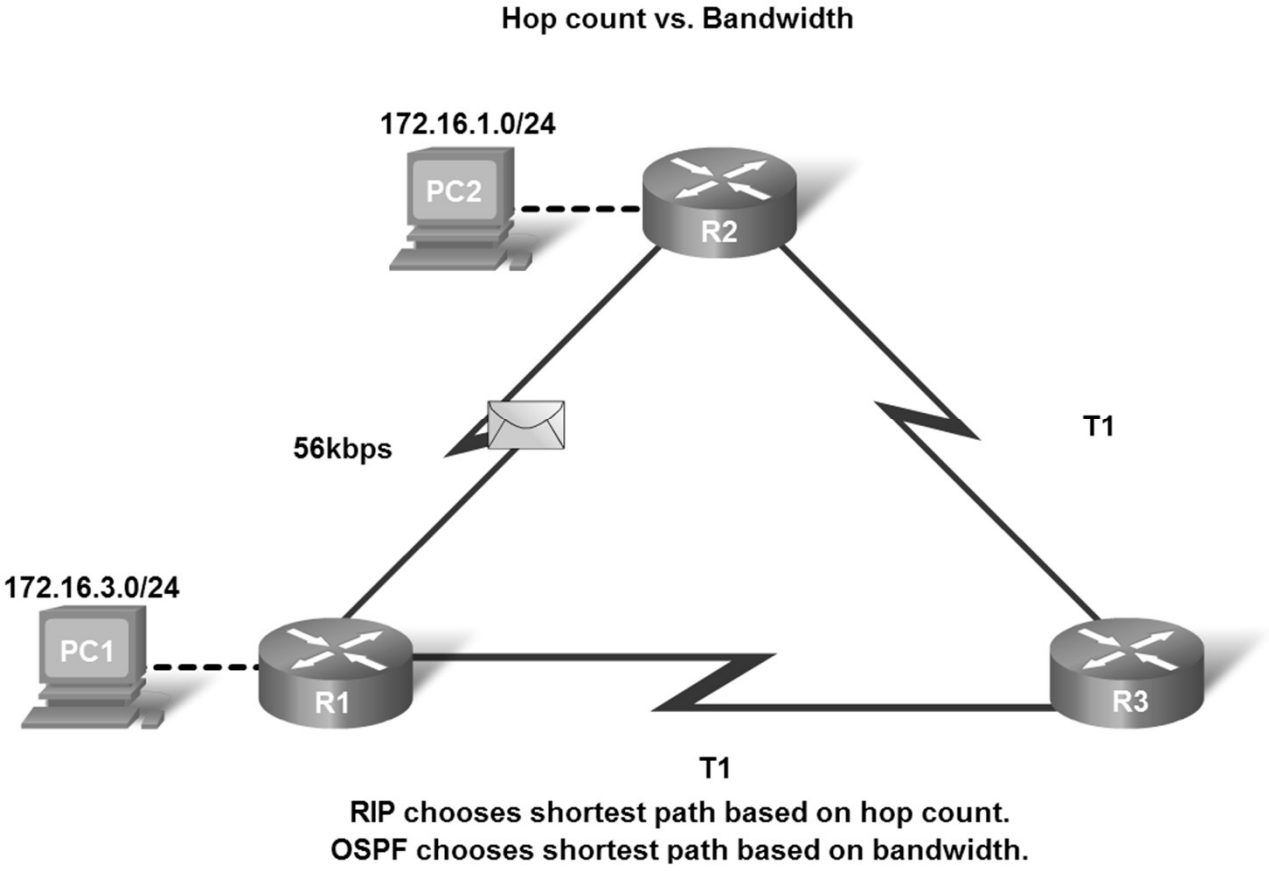
Comparing Convergence



Slower Convergence: RIP and IGRP
Faster Convergence : EIGRP and OSPF

Routing Protocols Metrics

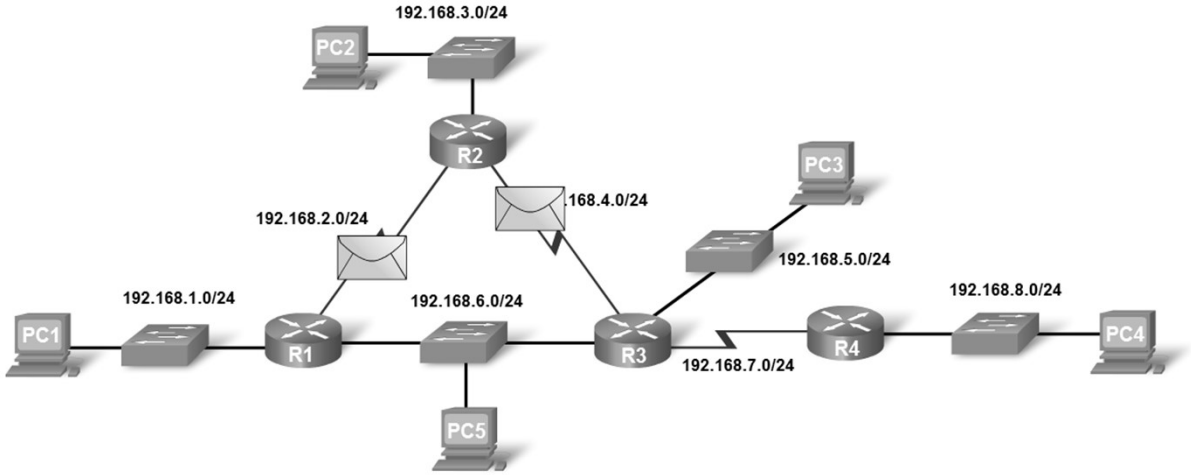
- Metric : A value used by a routing protocol to determine which routes are better than others.
  - Hop count
  - Bandwidth
  - Cost
  - Delay
  - Load
  - Reliability



Routing Protocols Metrics

- Load balancing
  - This is the ability of a router to distribute packets among multiple same cost paths

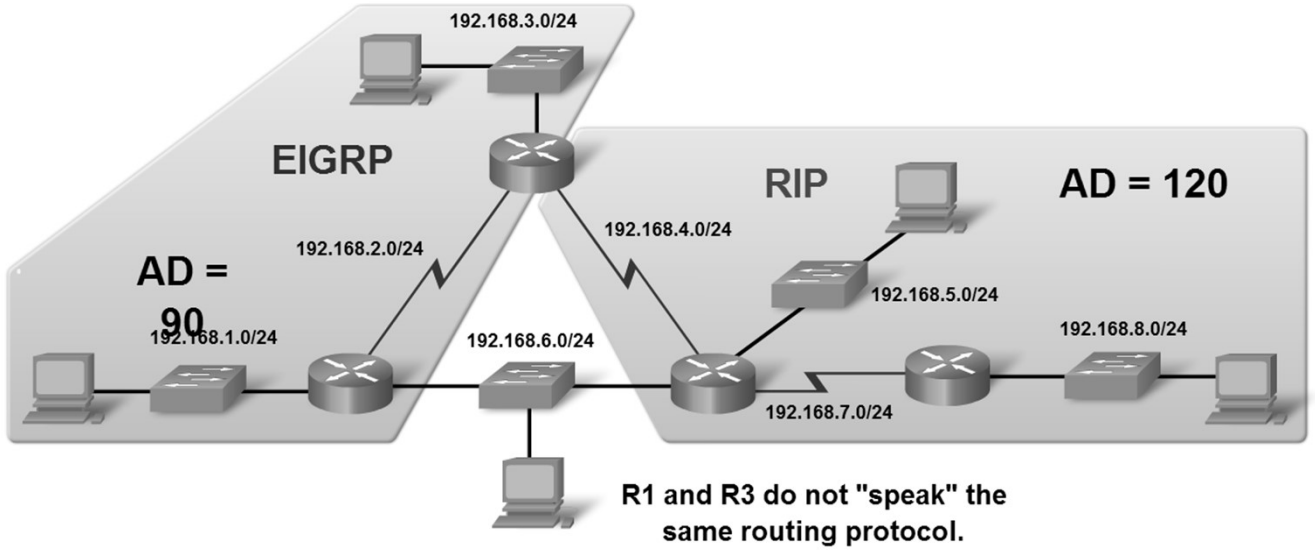
Load Balancing Across Equal Cost Paths




```
R2#show ip route
<output omitted>

R    192.168.6.0/24 [120/1] via 192.168.2.1, 00:00:24, Serial0/0/0
                    [120/1] via 192.168.4.1, 00:00:26, Serial0/0/1
```

Administrative Distance of a Route

- Purpose of a metric
  - It's a calculated value used to determine the best path to a destination
- Purpose of Administrative Distance
  - It's a numeric value that specifies the preference of a particular route



Administrative Distance of a Route

Default Administrative Distances

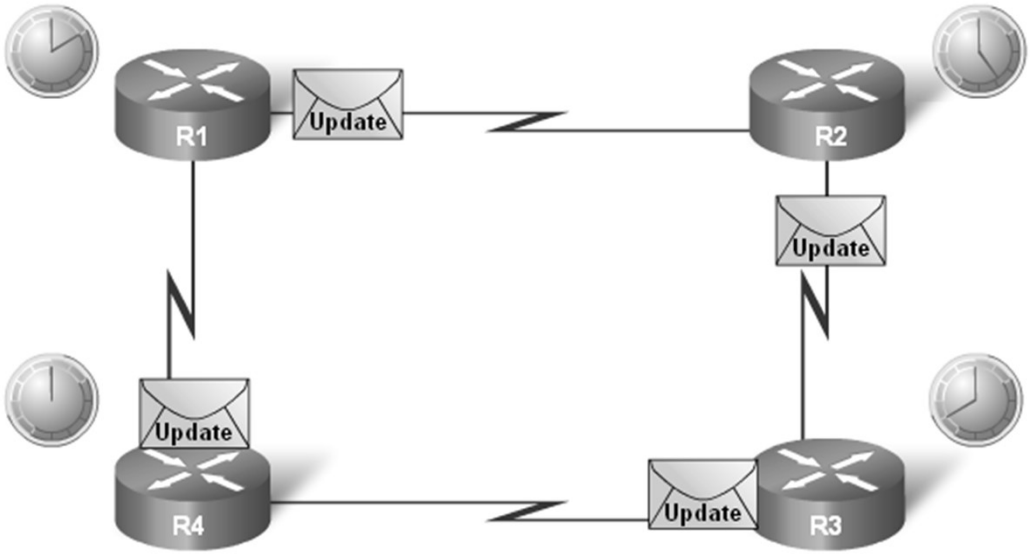
Route Source	Administrative Distance
Connected	0
Static	1
EIGRP summary route	5
External BGP	20
Internal EIGRP	90
IGRP	100
OSPF	110
IS-IS	115
External EIGRP	170
Internal BGP	200

Distance Vector Routing Protocols

- Examples of Distance Vector routing protocols:
  - Routing Information Protocol (RIP)
  - Interior Gateway Routing Protocol (IGRP)
  - Enhanced Interior Gateway Routing Protocol (EIGRP)
- Distance Vector Technology
  - The Meaning of Distance Vector:
    - A router using distance vector routing protocols knows 2 things:
      - Distance to final destination
      - Vector, or direction, traffic should be directed

Distance Vector Routing Protocols

- Characteristics of Distance Vector routing protocols:
  - Periodic updates
  - Neighbors
  - Broadcast updates
  - Entire routing table is included with routing update



Distance Vector Routing Protocols

- Routing Protocol Characteristics
  - Criteria used to compare routing protocols includes
    - Time to convergence
    - Scalability
    - Resource usage
    - Implementation & maintenance

Network Discovery

- Cold Starts : Router Initial Start Up
- Initial Exchange of Routing Information
- Exchange of Routing Information

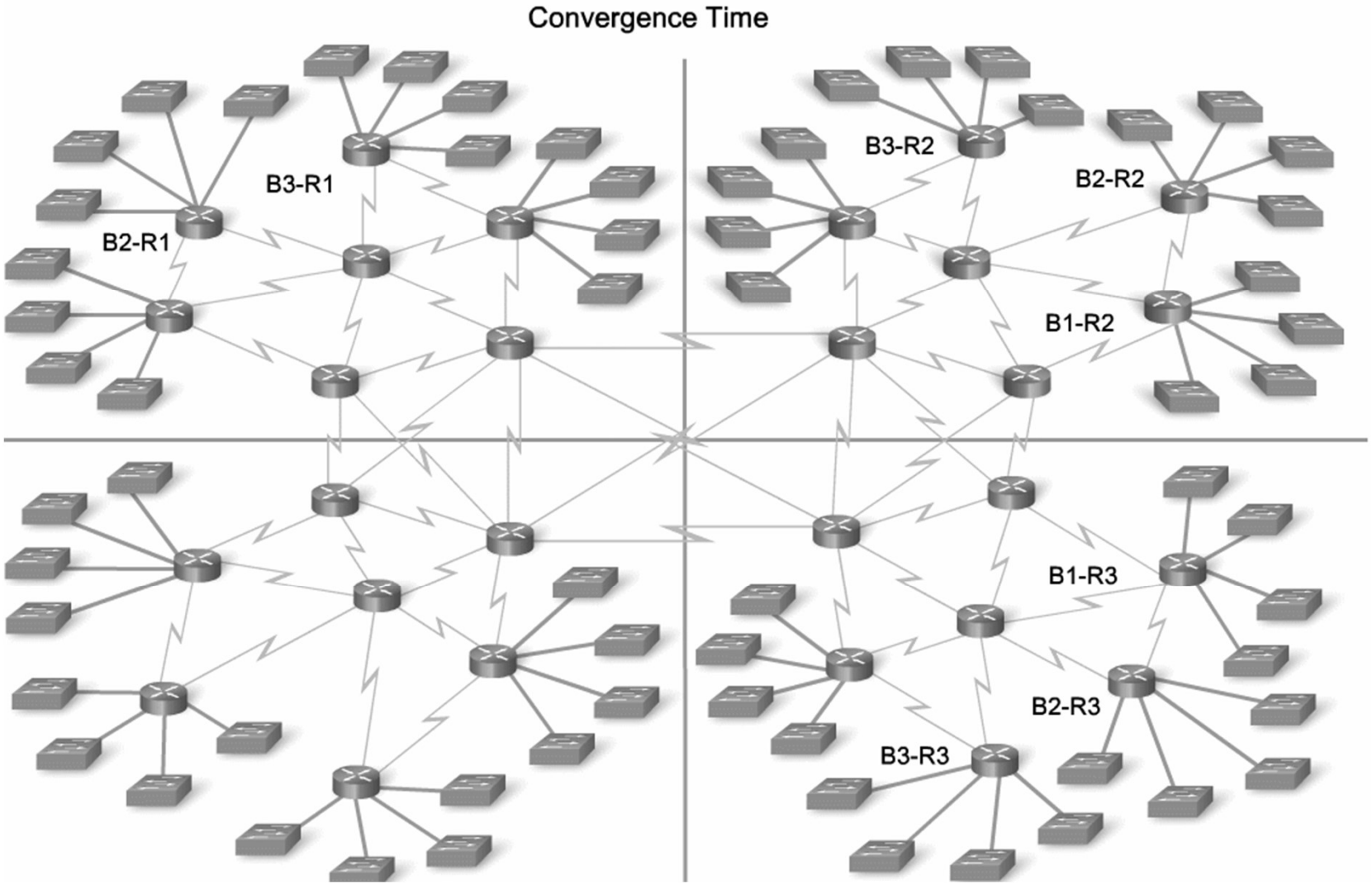
Network	Interface	Hop

Network	Interface	Hop

Network	Interface	Hop

Network Discovery

- Convergence



Routing Table Maintenance

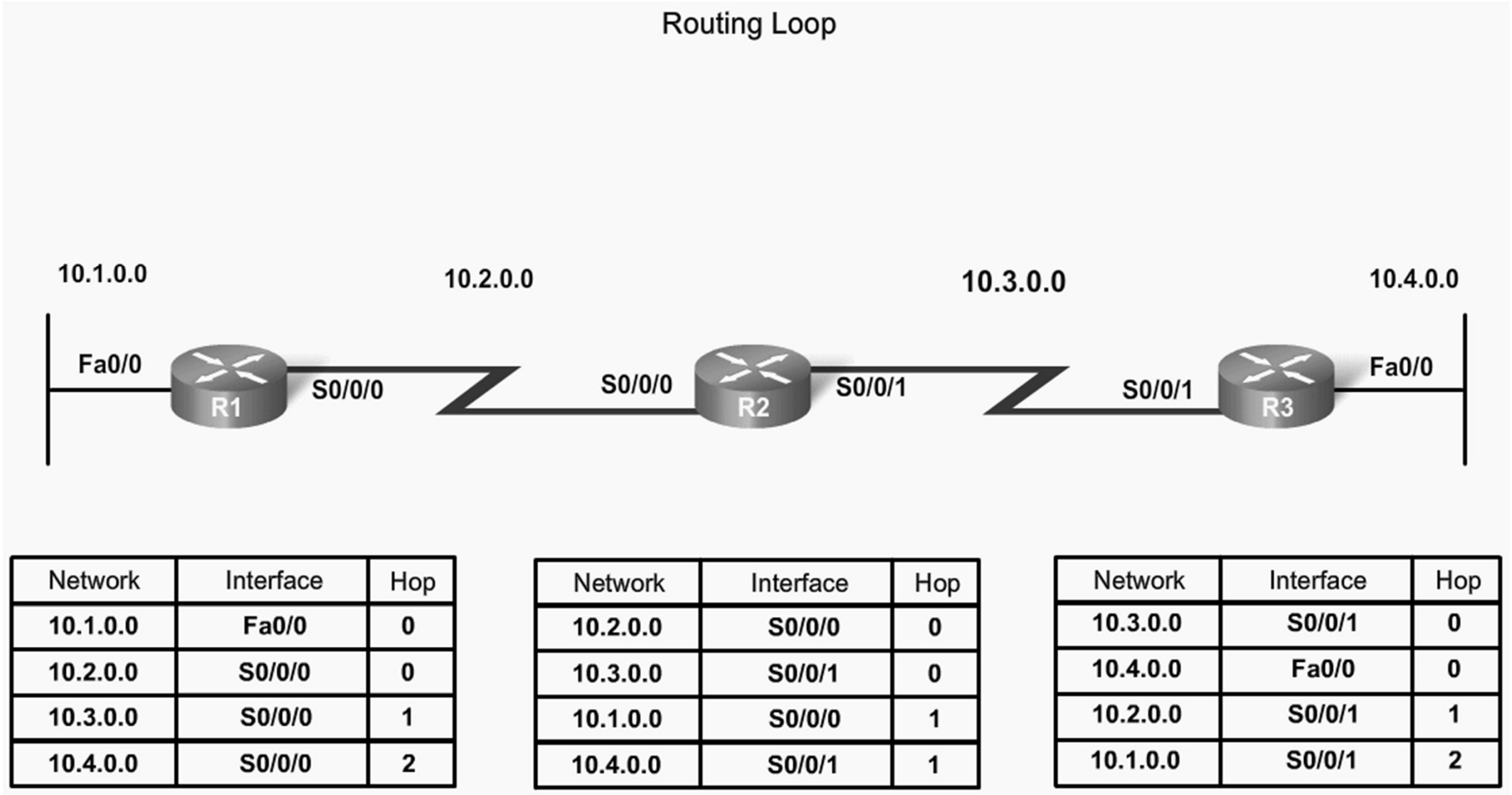
- Periodic Updates : RIP Update timer (default 30)
  - RIP Timers : In addition to the update timer, the IOS implements three additional timers for RIP:
    - Invalid timer (default 180)
    - Holddown timer (default 180)
    - Flush timer (default 240)

```
R1#show ip protocols
Routing Protocol is "rip"
  Sending updates every 30 seconds, next due in 13 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  <output omitted>
  Routing for Networks:
    10.0.0.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.3.0.1              120      00:00:27
  Distance: (default is 120)
```

- Bounded Update : EIGRP
- Triggered Update
- Random Jitter

Routing Loops

- Definition and Implications



Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	2

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	1

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	Fa0/0	0
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

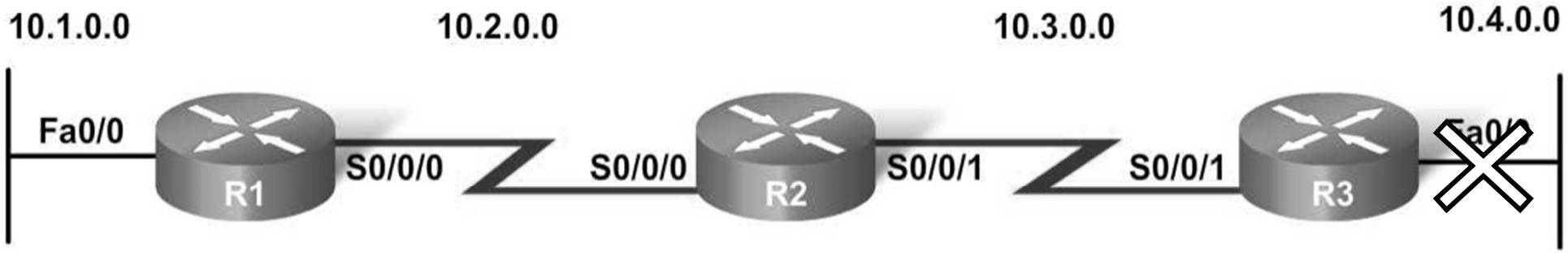
Routing Loops

- The loop may be a result of:

- A routing loop can create the following conditions:

Routing Loops

- Problem : Count to Infinity



Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	2

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	1

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	Fa/0/1	0
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Routing Loops

- Setting a Maximum
  - RIP defines infinity as 16 hops - an "unreachable" metric. Once the routers "count to infinity," they mark the route as unreachable.

Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	16

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	16

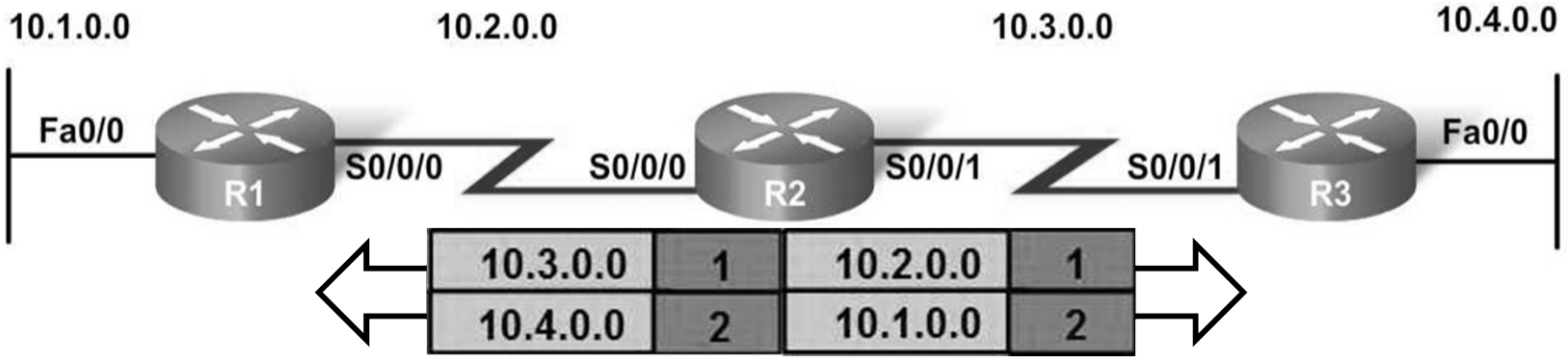
Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	S0/0/1	16
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Routing Loops

- Preventing Routing Loop with Holddown Timers
  - Holddown timers instruct routers to hold any changes that might affect routes for a specified period of time. If a route is identified as down or possibly down, any other information for that route containing the same status, or worse, is ignored for a predetermined amount of time (the holddown period).

Routing Loops

- Split Horizon Rule
  - The split horizon rule says that a router should not advertise a network through the interface from which the update came.



Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	2

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	1

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	Fa/0/1	0
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Routing Loops

- Route Poisoning
  - Route poisoning is used to mark the route as unreachable in a routing update that is sent to other routers.

Network is converged on "poisoned" route.

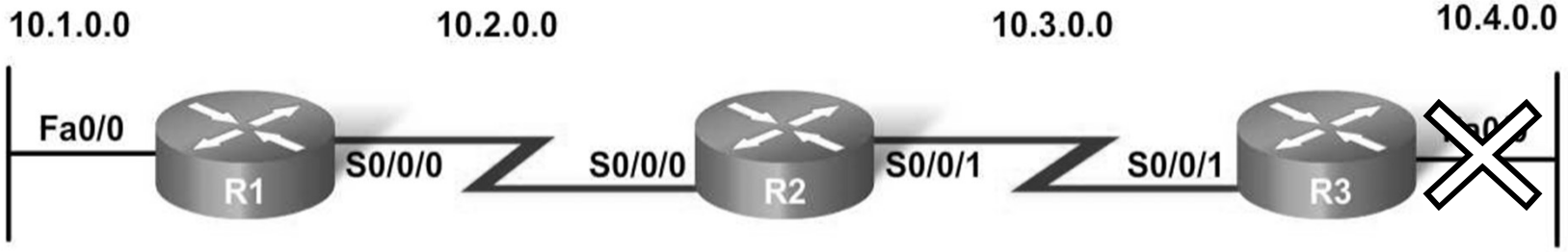
Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	16

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	16

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	Fa0/0	16
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Routing Loops

- Split horizon with poison reverse
  - The rule for split horizon with poison reverse states when sending updates out a specific interface, designate any networks that were learned on that interface as unreachable.



Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	2

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	1

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	Fa/0/1	0
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Routing Loops

- IP & TTL
  - Time to Live (TTL) is an 8-bit field in the IP header that limits the number of hops a packet can traverse through the network before it is discarded.

Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	4

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.4.0.0	S0/0/0	1
10.1.0.0	S0/0/1	3

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	S0/0/1	2
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

RIP & IGRP & EIGRP

Distance Vector Routing Protocols Compared

	RIPv1	RIPv2	IGRP	EIGRP
Speed of Convergance				
Scalability - size of network				
Use of VLSM				
Resource usage				
Implementation and maintenance				

Slow | Fast | Low | Medium | High

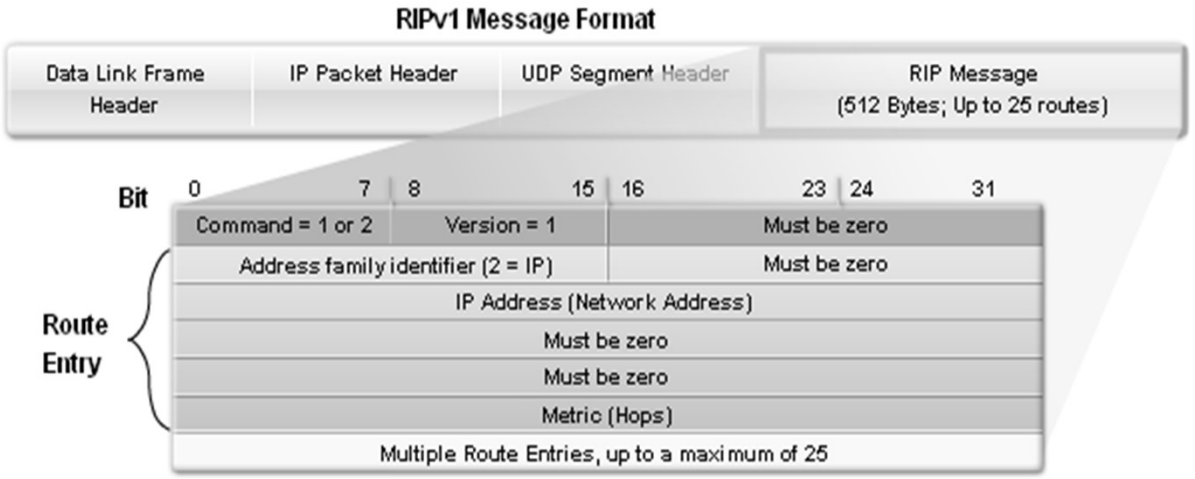
Small | Large | Simple | Complex | Yes | No

RIP version 1

- 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

RIP version 1

- RIP Message Format
- RIP header - divided into 3 fields
  - Command field
  - Version field
  - Must be zero
- Route Entry - composed of 3 fields
  - Address family identifier
  - IP address
  - Metric



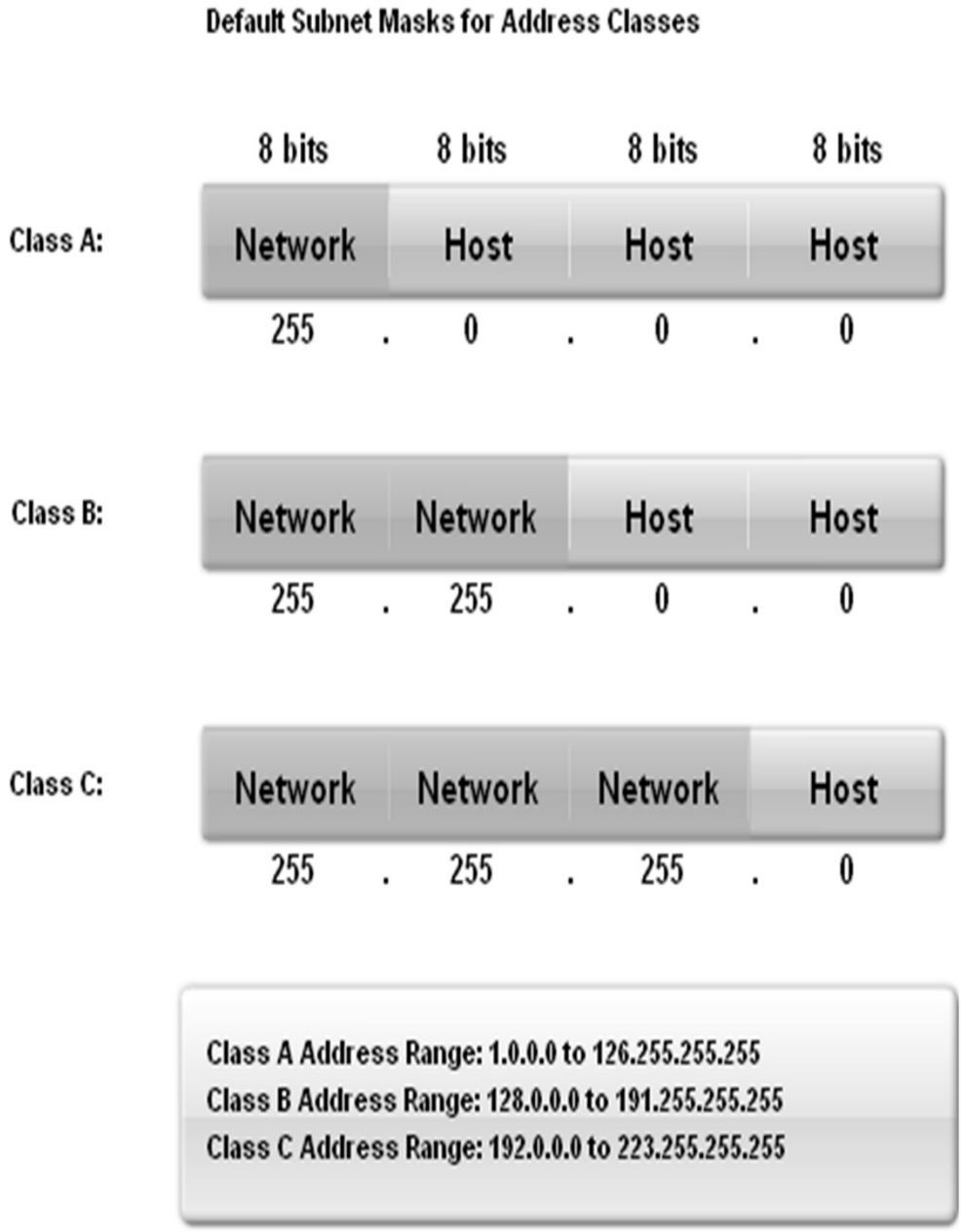
Command	1 for a Request or 2 for a Reply.
Version	1 for RIP v 1 or 2 for RIP v 2.
Address Family Identifier	2 for IP unless a Request is for the full routing table in which case, set to 0.
IP Address	The address of the destination route, which may be a network, subnet, or host address.
Metric	Hop count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

RIP version 1

- 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

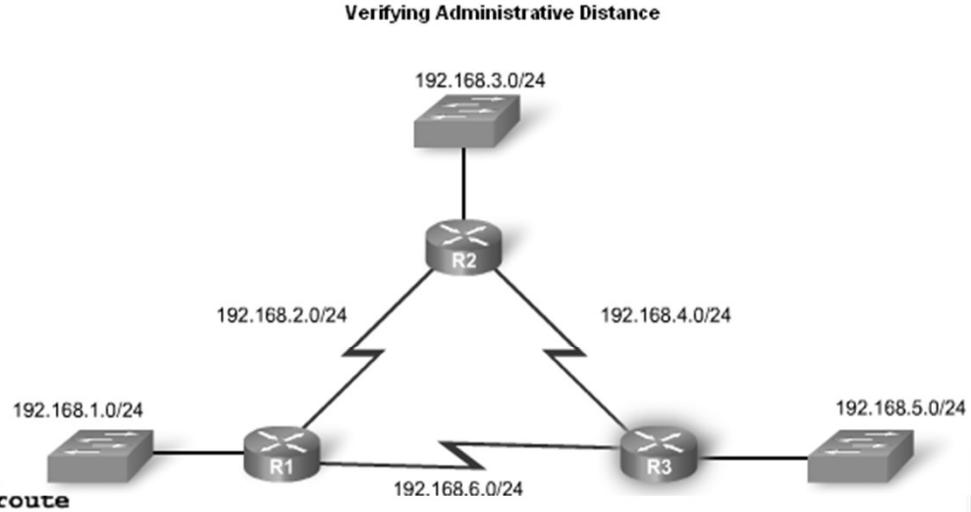
RIP version 1

- 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



RIP version 1

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

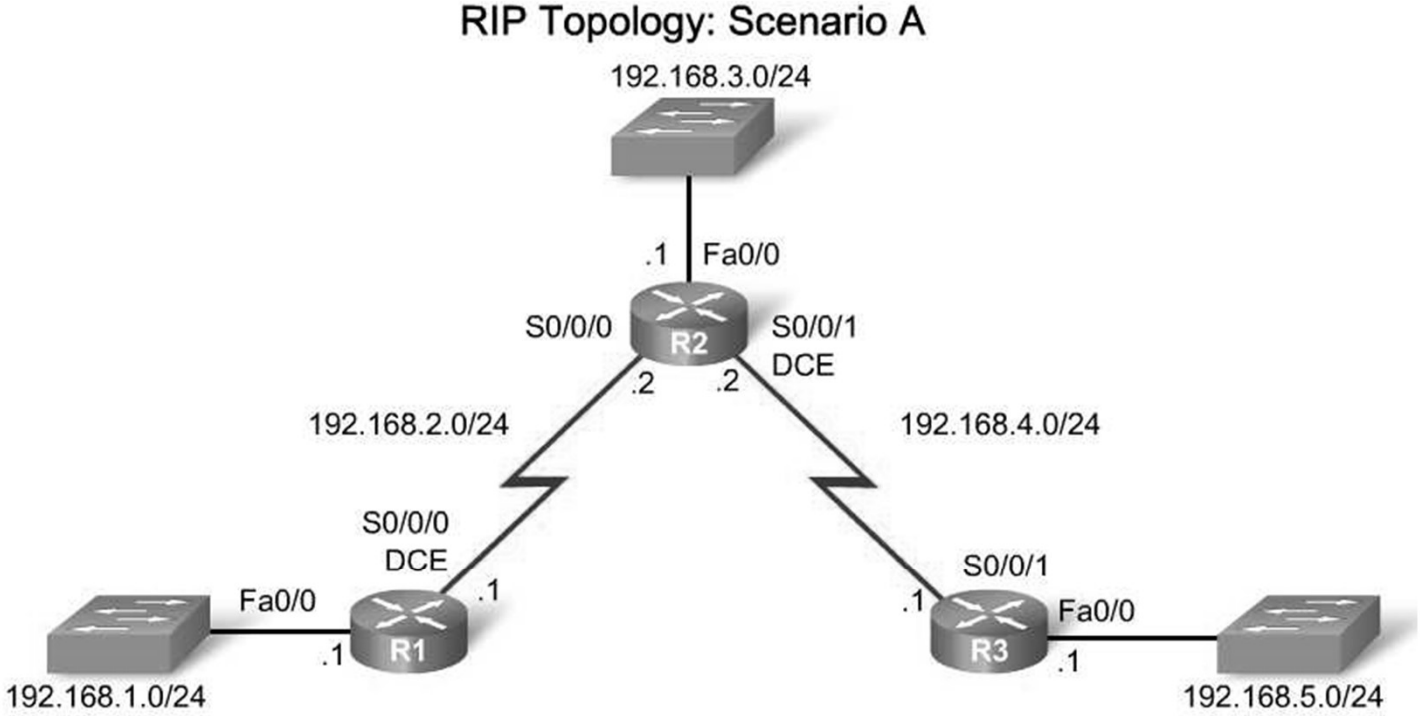



```
R3#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter
       * - 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 :



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

- Basic Settings on a Router
- Router RIP Command
  - Specifying Networks

```
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
```

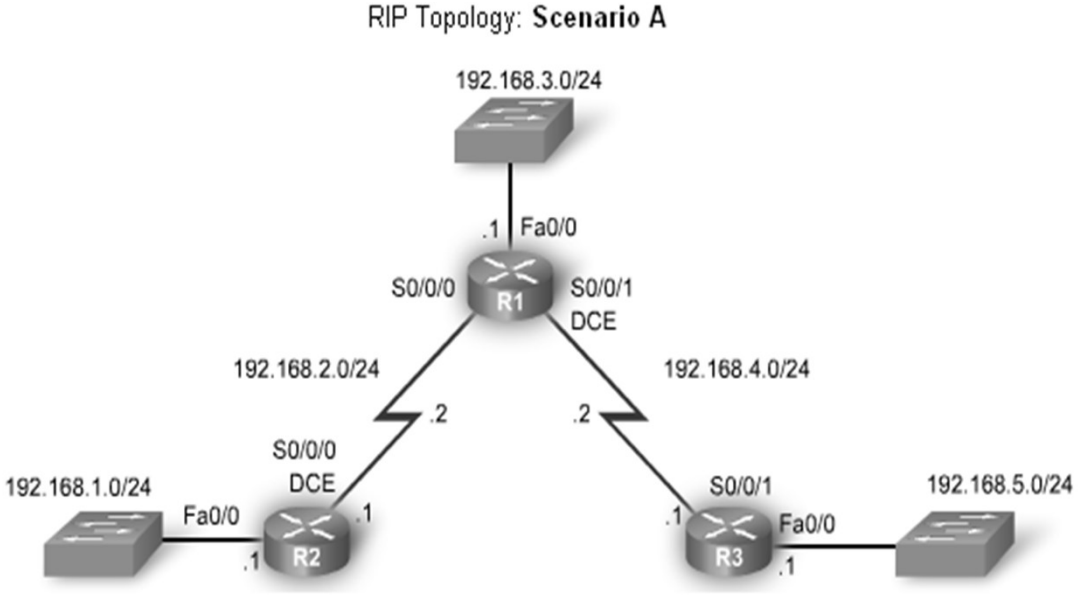
```
R3(config)#router rip
R3(config-router)#network 192.168.4.0
R3(config-router)#network 192.168.5.0
```

```
R1#conf t
Enter configuration commands, one per line. End with CTRI
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)#
```

Verification and Troubleshooting

- Use the following commands:

```
show running-config
show ip route
show ip protocols
debug ip rip
```



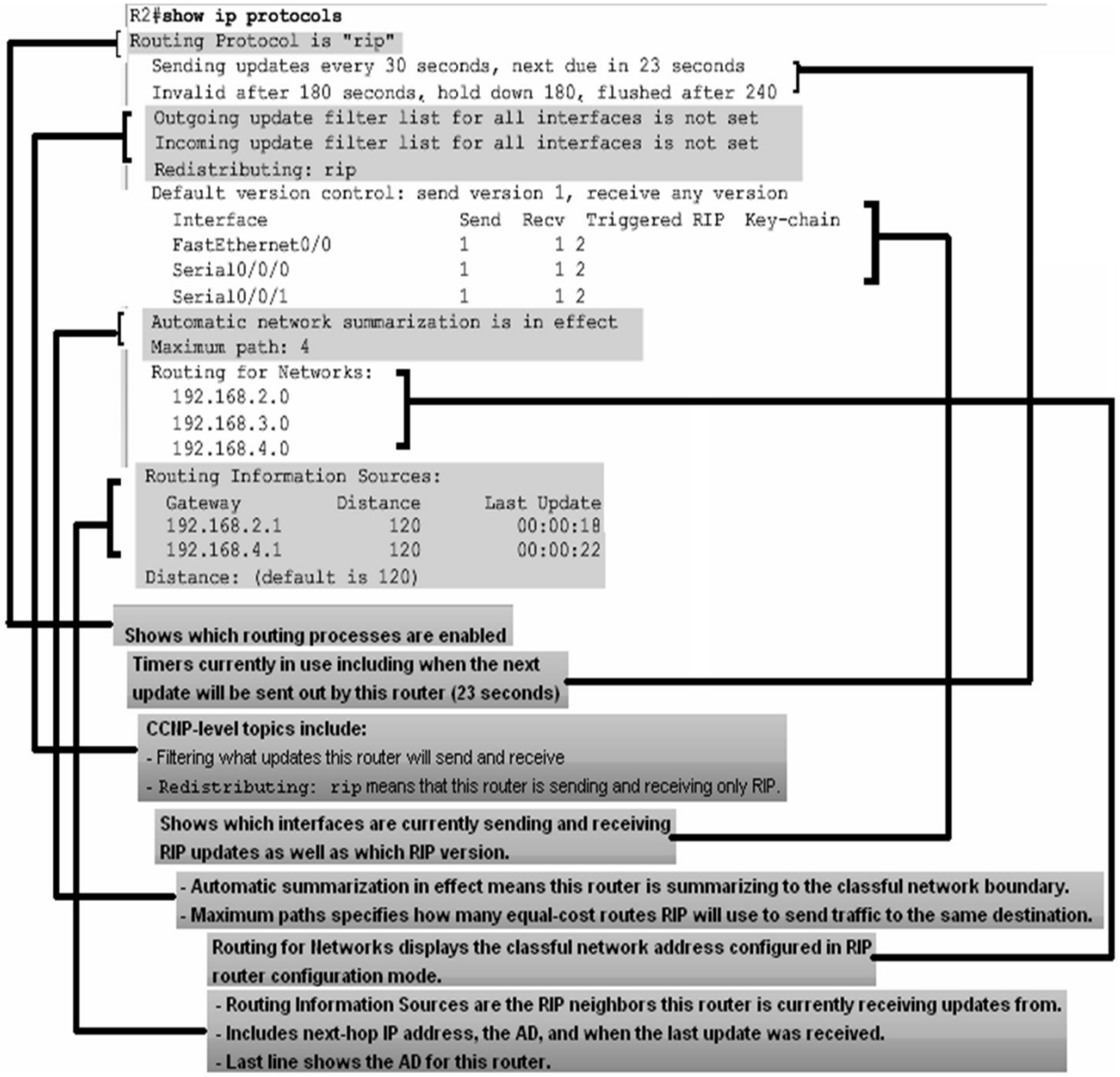
Interpreting a RIP Route in the Routing Table

`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

- Use the following commands:

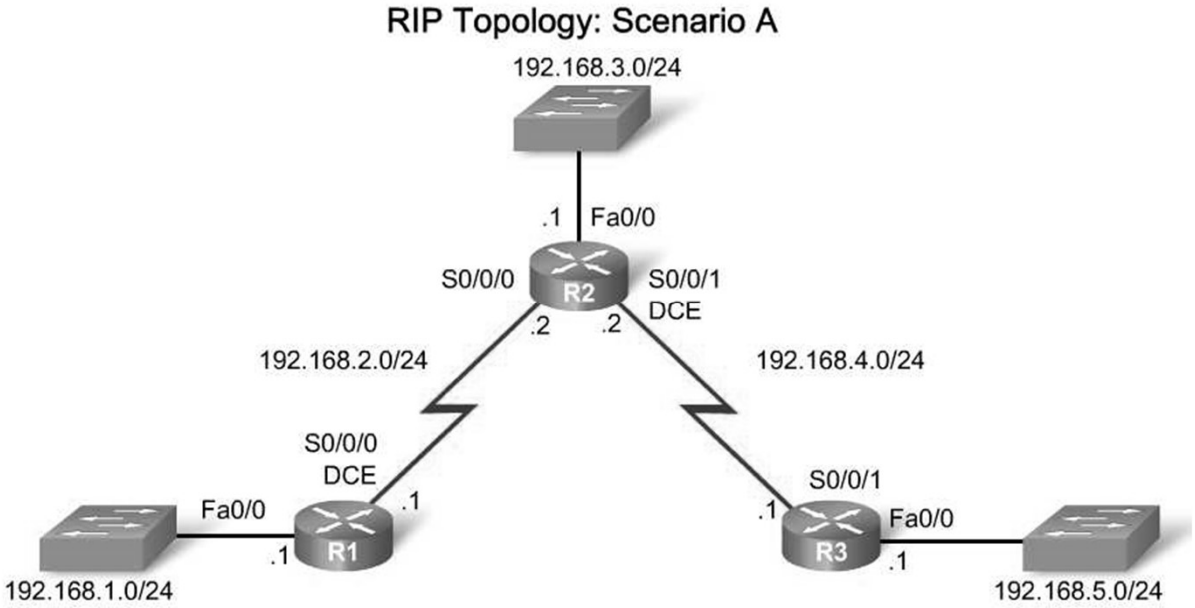
```
show running-config
show ip route
show ip protocols
debug ip rip
```



Verification and Troubleshooting

- Use the following commands:

```
show running-config
show ip route
show ip protocols
debug ip rip
```




```
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
```

- R2 receives an update from R1 advertising the R1's directly connected LAN.
- R2 receives an update from R3 advertising the R3's directly connected LAN.
- R2 sends an update out Fa0/0 to all networks in the routing table except the network attached to Fa0/0.
- R2 sends an update out S0/0/1 to R3. Included in the update are R1's LAN, the WAN between R1 and R2, and R2's LAN.
- Note that split horizon is in effect. R2 does not advertise the R3 LAN back to R3.

Verification and Troubleshooting

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

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

Verification and Troubleshooting

- Passive interface command

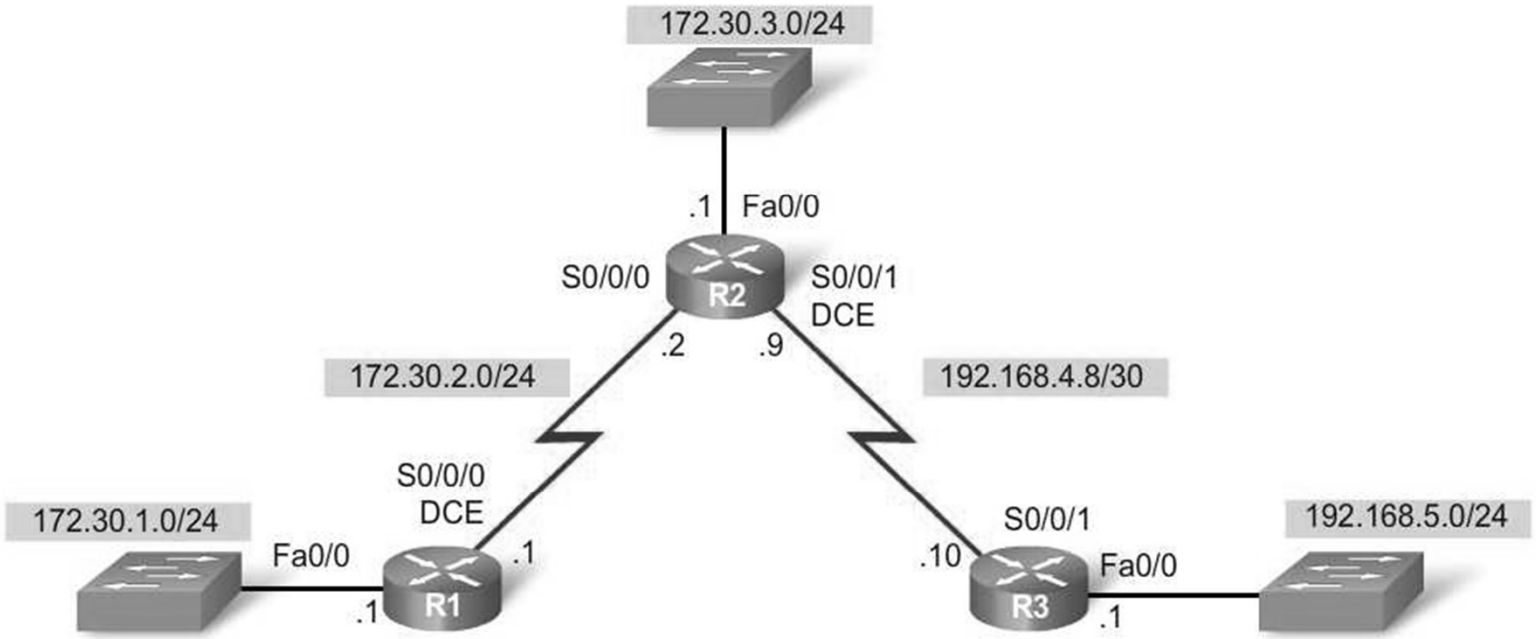
```
R2(config)#router rip
R2(config-router)#passive-interface FastEthernet 0/0
R2(config-router)#end
R2#show ip protocols
Routing Protocol is "rip"
    Sending updates every 30 seconds, next due in 14 seconds
    Invalid after 180 seconds, hold down 180, flushed after 240
    Outgoing update filter list 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 : Scenario B

RIP Topology: Scenario B

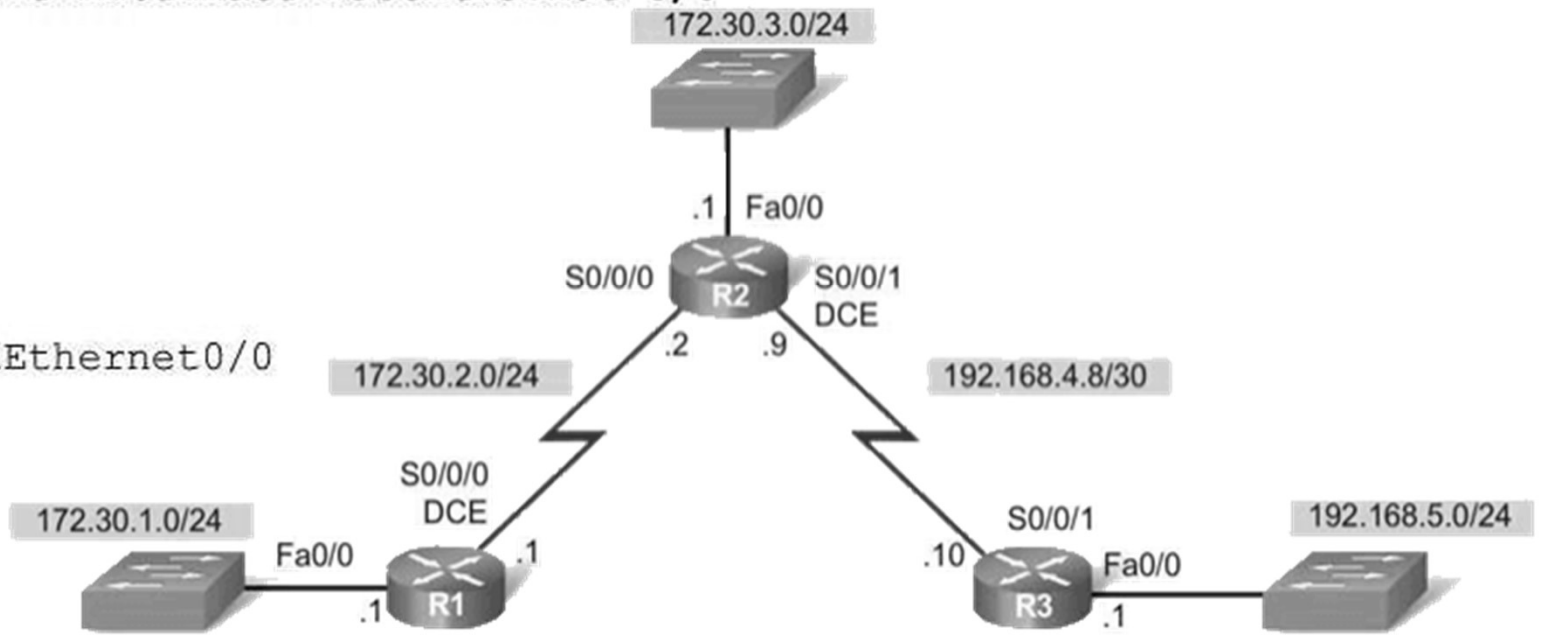


RIP Topology: Scenario B

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

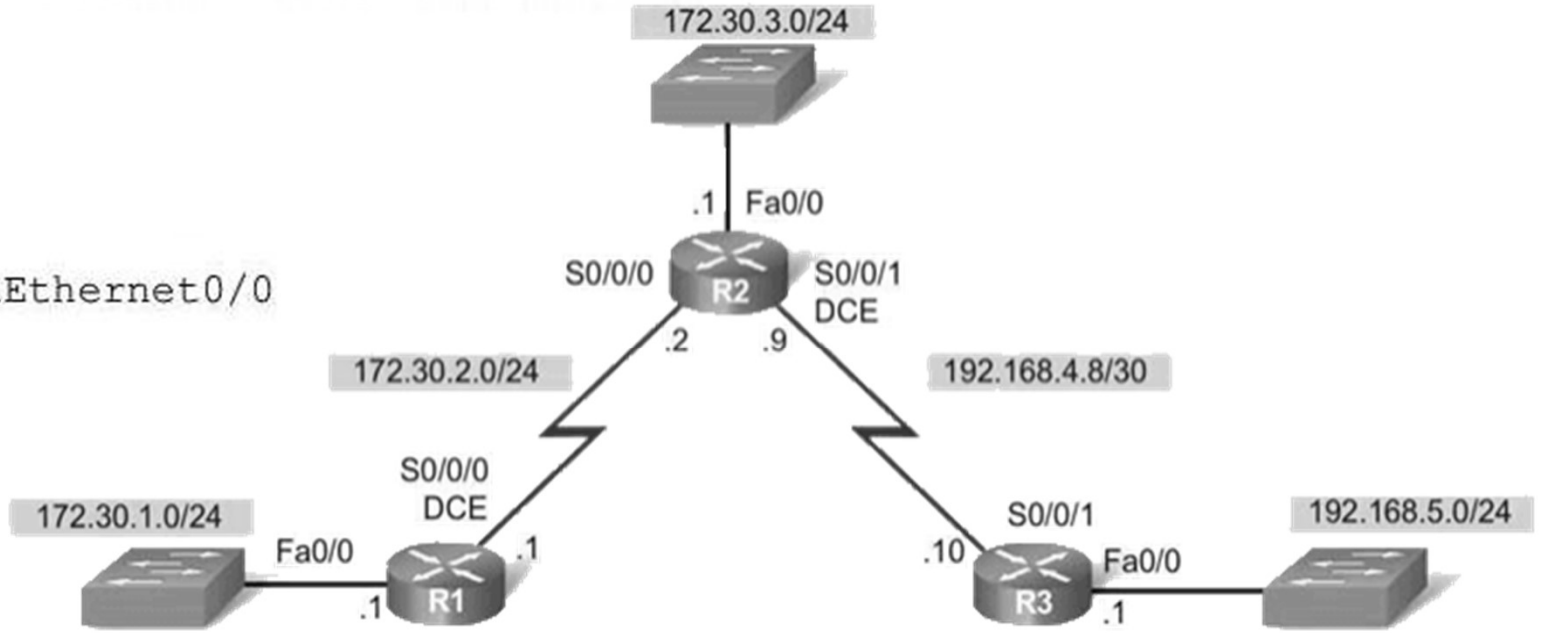
Automatic Summarization

```
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 FastEthernet 0/0
R1(config-router)#end
R1#show run
 (**output omitted**)

!
router rip
 passive-interface FastEthernet0/0
 network 172.30.0.0
!
 (**output omitted**)

R1#
```



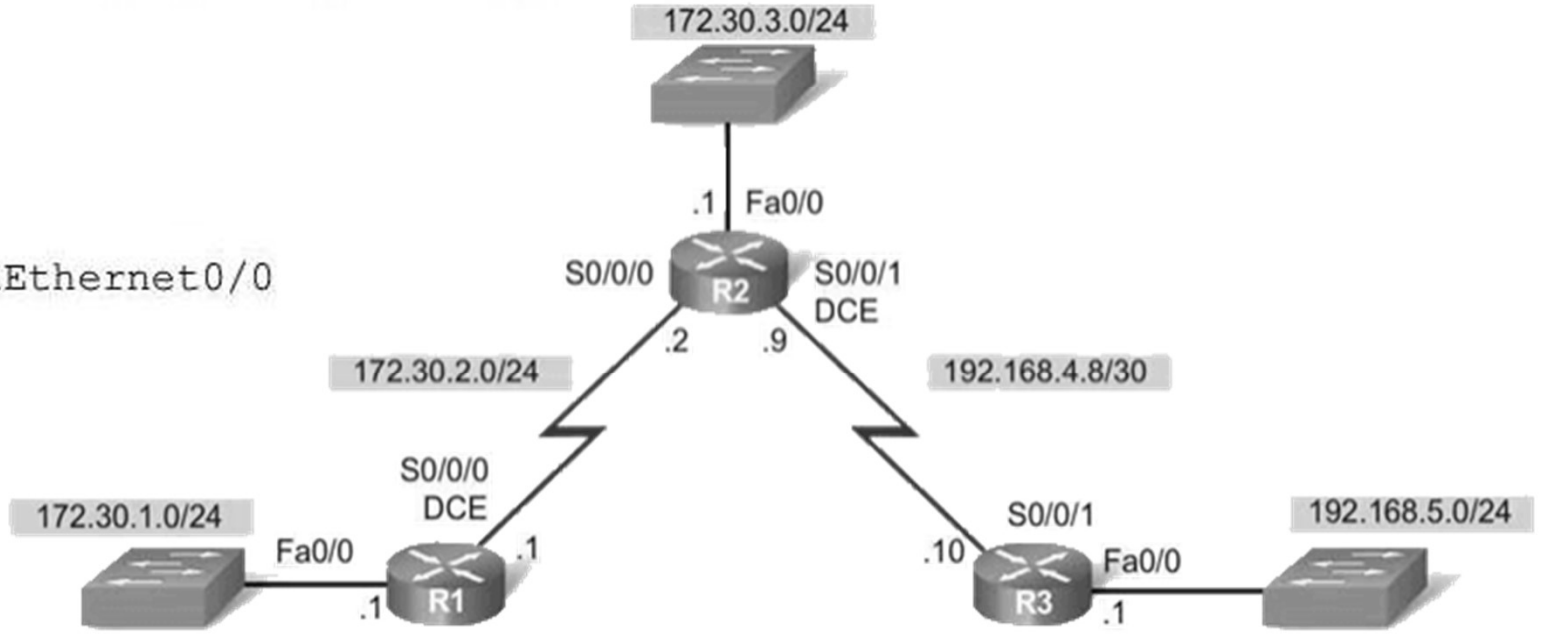
Automatic Summarization

```
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)#network 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
 network 172.30.0.0
 network 192.168.4.0
!
 (**output omitted**)
R2#
```



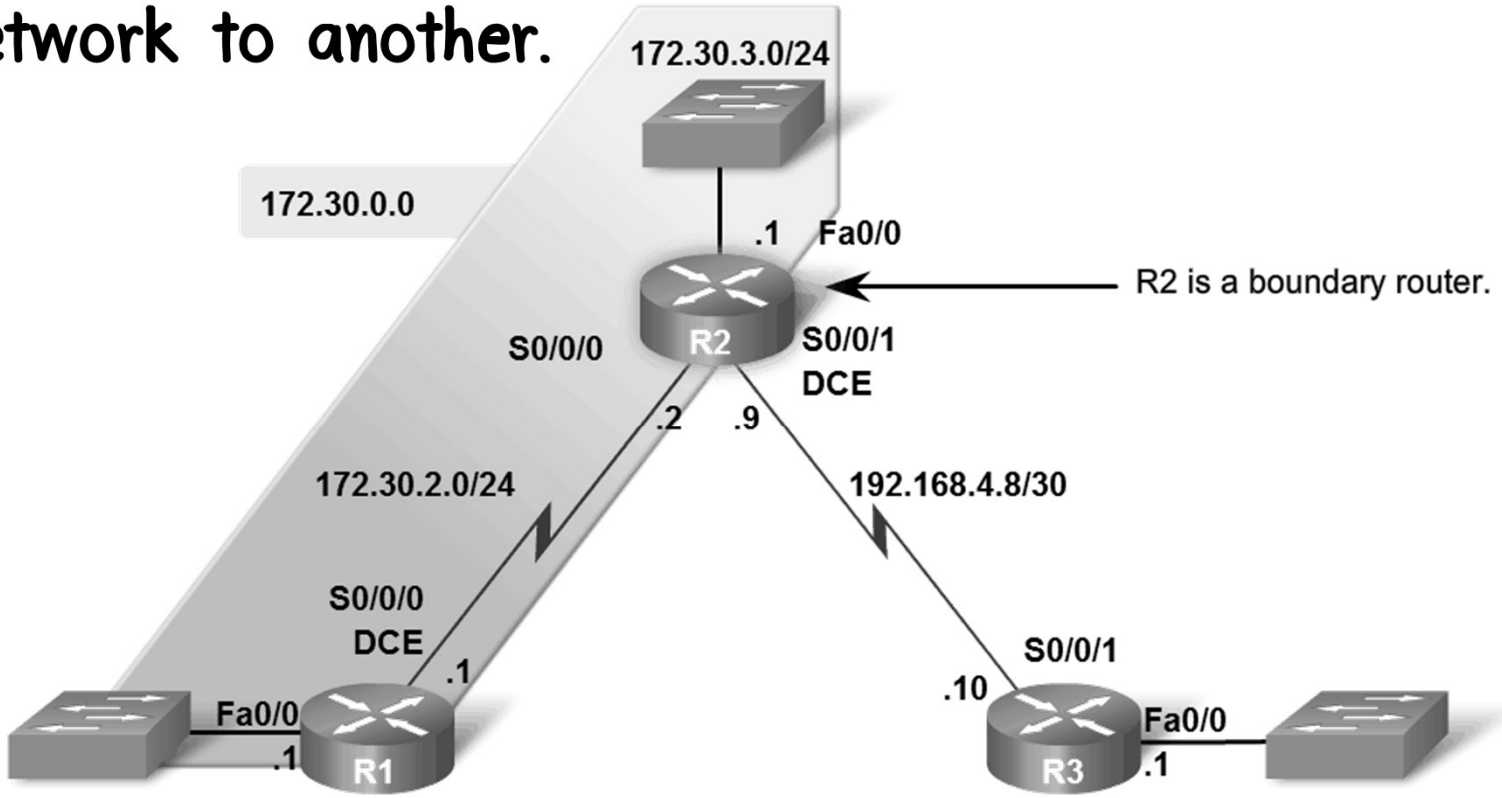
Automatic Summarization

```
R3(config)#interface fa0/0
R3(config-if)#ip address 192.168.5.1 255.255.255.0
R3(config-if)#interface S0/0/1
R3(config-if)#ip address 192.168.4.10 255.255.255.252
R3(config-if)#no router rip
R3(config)#router rip
R3(config-router)#network 192.168.4.0
R3(config-router)#network 192.168.5.0
R3(config-router)#passive-interface FastEthernet 0/0
R3(config-router)#end
R3#show run
 (**output omitted**)
!
router rip
 passive-interface FastEthernet0/0
 network 192.168.4.0
 network 192.168.5.0
!
 (**output omitted**)
R3#
```



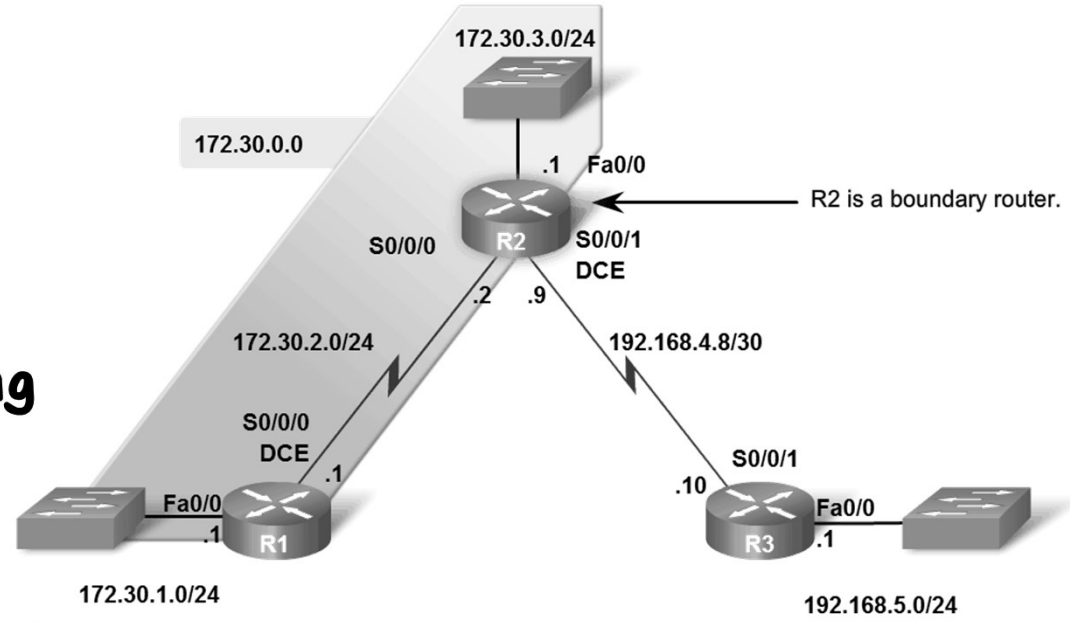
Automatic Summarization

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



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.




```
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.

```
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#
```

```
R1#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
     (**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, 00:00:17, 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
```

```
R3#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - B
     (**output 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
```

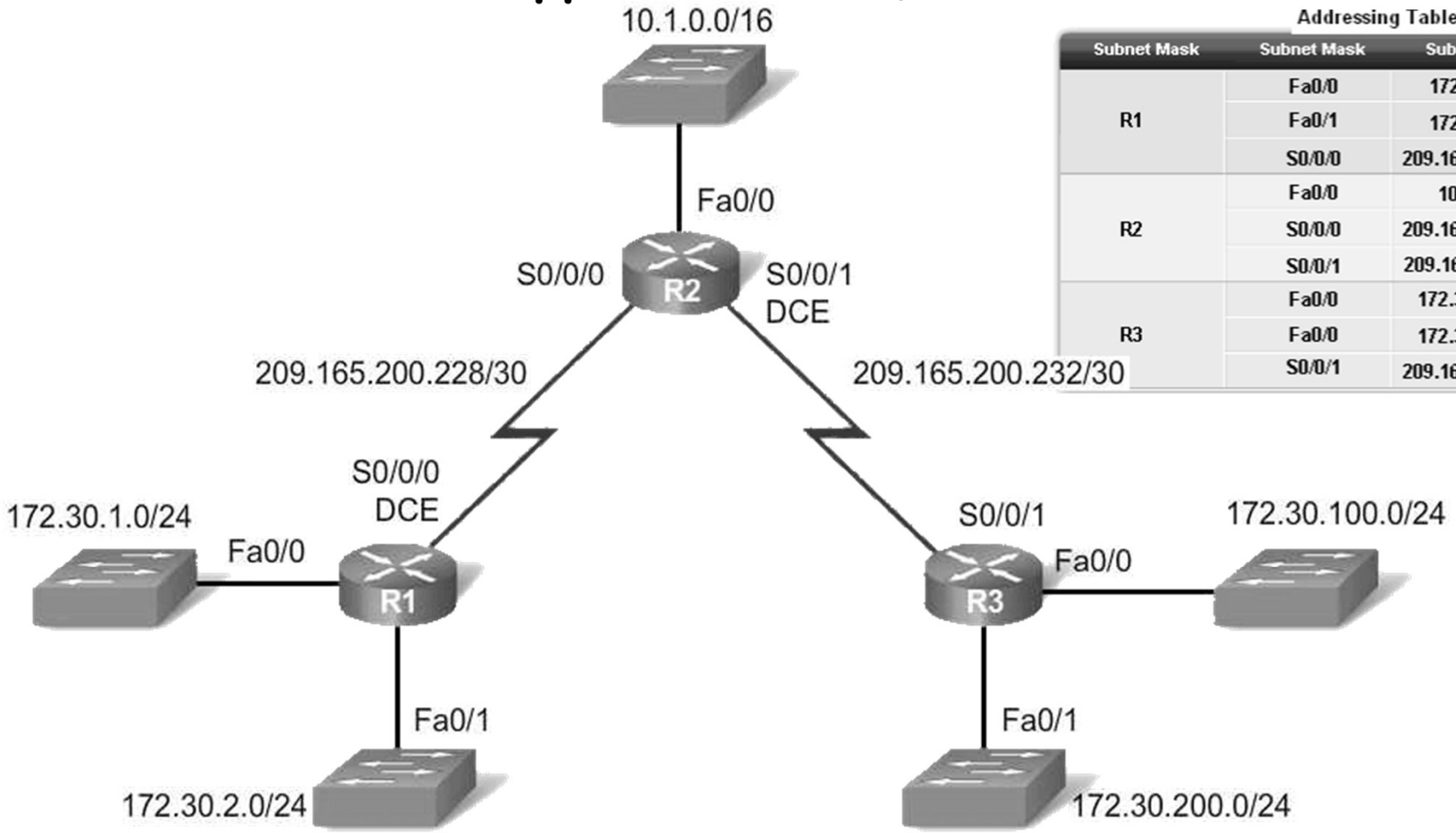
Automatic Summarization

- 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.

```
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 - OSFP inter area
       N1 - OSPF NSSA externasl type 1, N2 - OSPF NSSA external type2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, II - 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    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
```

Automatic Summarization

- Disadvantage of Automatic Summarization:
  - Does not support discontiguous networks

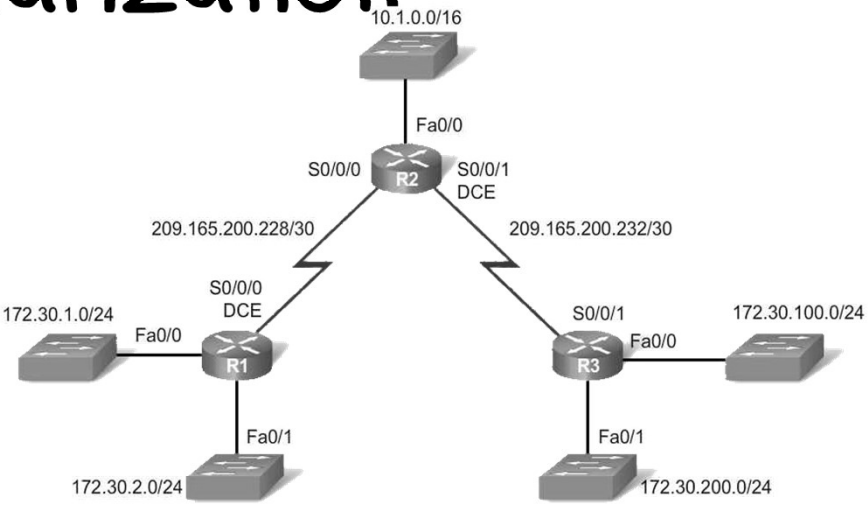


Addressing Table

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

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.



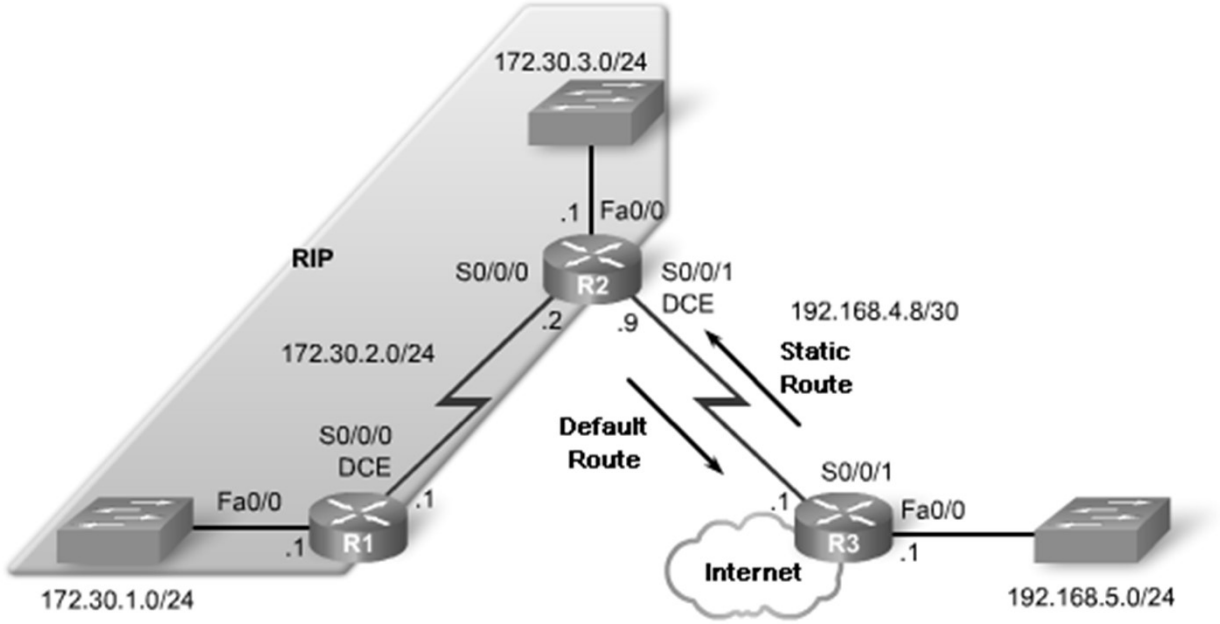

```
R1#sh ip route
Gateway of last resort is not set
R    10.0.0.0/8 [120/1] via 209.165.200.230, 00:00:03, Serial0/0
     172.30.0.0/24 is subnetted, 2 subnets
C       172.30.1.0 is directly connected, FastEthernet0/0
C       172.30.2.0 is directly connected, FastEthernet0/1
     209.165.200.0/30 is subnetted, 2 subnets
C       209.165.200.228 is directly connected, Serial0/0
R       209.165.200.232 [120/1] via 209.165.200.230, 00:00:03, Serial0/0
R2#sh 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 209.165.200.229, 00:00:26, Serial0/0
                   [120/1] via 209.165.200.234, 00:00:16, Serial0/1
     209.165.200.0/30 is subnetted, 2 subnets
C       209.165.200.228 is directly connected, Serial0/0
C       209.165.200.232 is directly connected, Serial0/1
R3#show ip route
Gateway of last resort is not set
R    10.0.0.0/8 [120/1] via 209.165.200.233, 00:00:10, Serial0/1
     172.30.0.0/24 is subnetted, 2 subnets
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, 00:00:10, Serial0/1
C       209.165.200.232 is directly connected, Serial0/1
```

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



- **Disable RIP routing on R2 for the 192.168.4.0 network only.**
- **Configure R2 with a default route pointing to R3.**

```
R2(config)#router rip
R2(config-router)#no network 192.168.4.0
R2(config-router)#exit
R2(config)#ip route 0.0.0.0 0.0.0.0 serial 0/0/1
```

- **Completely disable RIP routing on R3.**
- **Configure R3 with a static route pointing R2.**

```
R3(config)#no router rip
R3(config)#ip route 172.30.0.0 255.255.252.0 serial 0/0/1
```

Router R1

```
     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
```

Router R2

```
     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
```

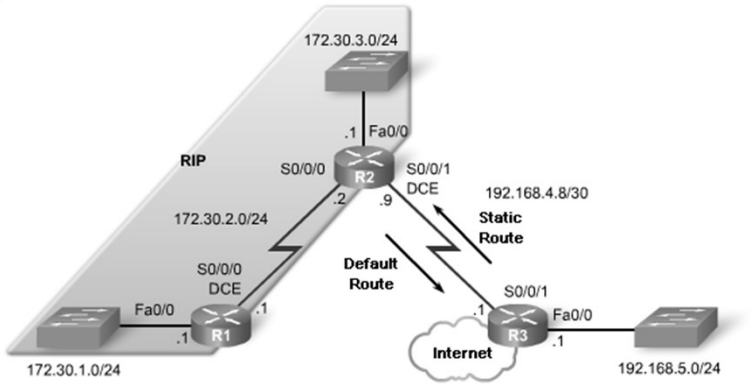
Router R3

```
     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
```

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.

```
R2(config)#router rip
R2(config-router)#default-information originate
R2(config-router)#end
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
           subnet 0.0.0.0 metric 1
           subnet 172.30.3.0 metric 2
R2#undebug all
All possible debugging has been turned off
```




```
R1#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 172.30.2.2 to network 0.0.0.0

   172.30.0.0/24 is subnetted, 3 subnets
C  172.30.2.0 is directly connected, Serial0/0/0
R  172.30.3.0 [120/1] via 172.30.2.2 00:00:16, Serial0/0/0
C  172.30.1.0 is directly connected, Fast Ethernet0/0
R* 0.0.0.0/0 [120/1] via 172.30.2.2, 00:00:16, Serial0/0/0
```

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

Questions and Answers