Lecture 8

IGP Protocols

(RIP & IGRP)

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OBJECTIVES

- Routing Information Protocol (RIP)
  - RIP
  - RIPv2
- RIP Routing Configuration
- RIP Timers
- Passive Interface
- Interior Gateway Routing Protocol (IGRP)
- Verifying the Configuration

Routing Information Protocol (RIP)

- Routing Information Protocol (RIP) is a true **distance-vector** routing protocol.

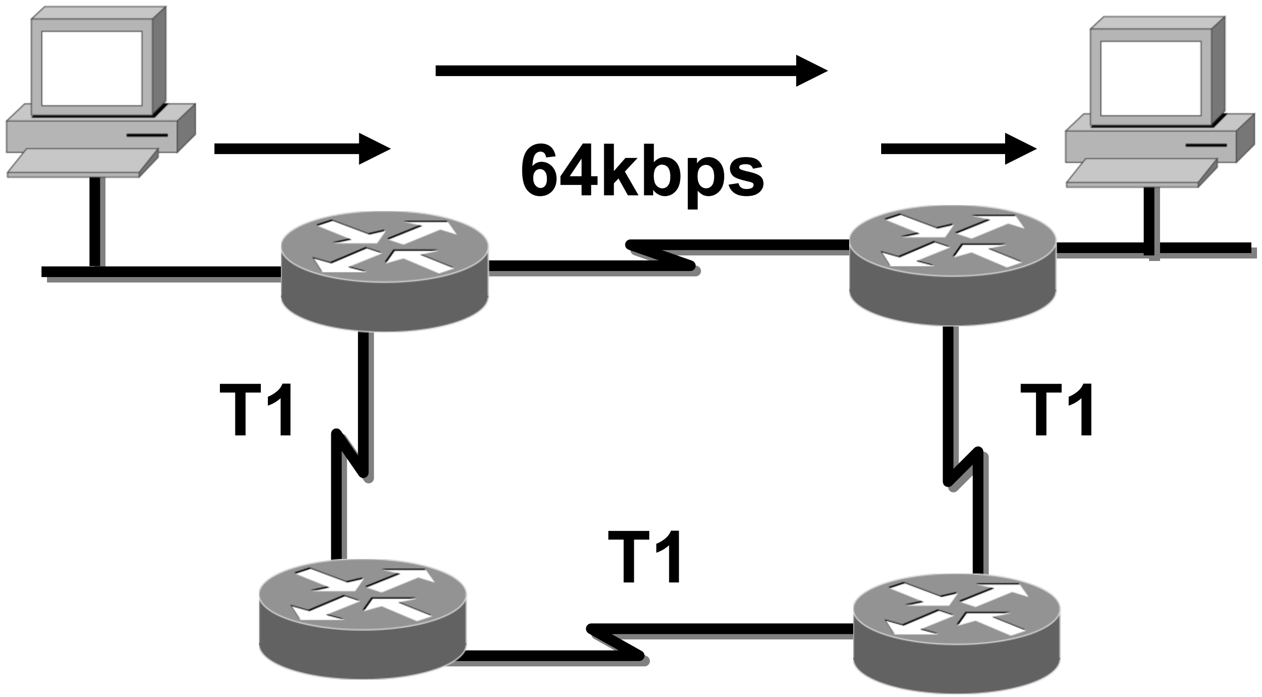
- It sends the complete routing table out to all active interfaces every 30 seconds.

- RIP only uses **hop count** to determine the best way to a remote network, but it has a maximum allowable hop count of 15 by default, meaning that 16 is deemed unreachable.

- RIP works well in small networks, but it's inefficient on large networks with slow WAN links or on networks with a large number of routers installed.

- RIP version 1 uses only classful routing, which means that all devices in the network must use the same subnet mask.

RIP Overview



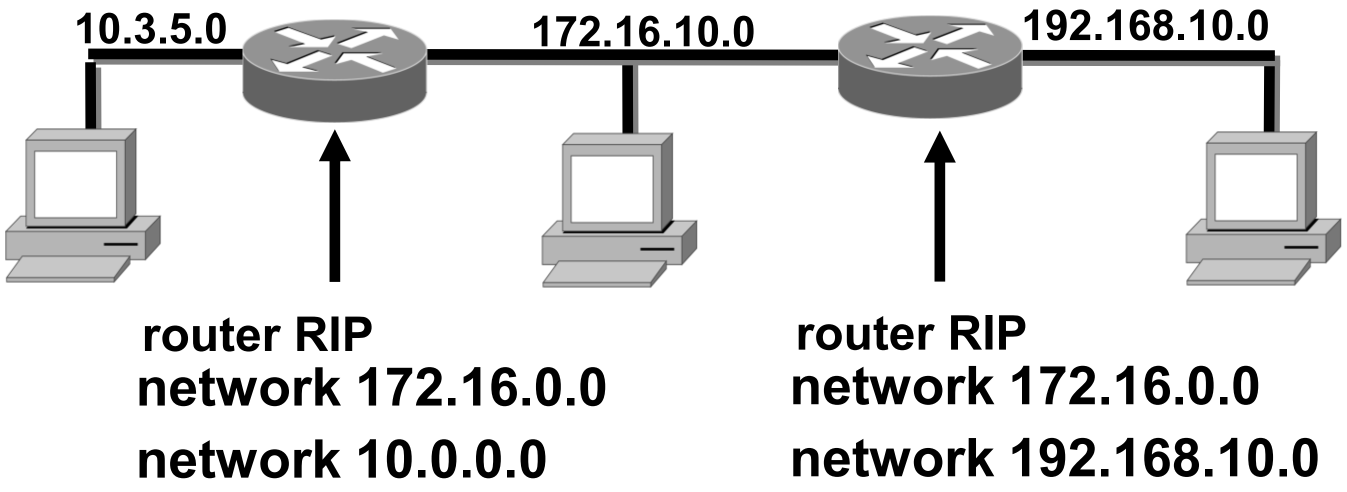
- Hop count metric selects the path, 16 is unreachable
- Full route table broadcast every 30 seconds
- Load balance maximum of 6 equal cost paths (default = 4)
- RIPv2 supports VLSM and Discontiguous networks

RIP Routing Configuration

To configure RIP routing, just **turn on** the protocol with the router rip command and tell the RIP routing protocol which networks to advertise.

Router(config)#**router rip**

Router(config-router)#**network** ***network-number****



*Network is a classful network address.

Every device on network uses the same subnet mask

FIGURE 10.4 Typical classful network

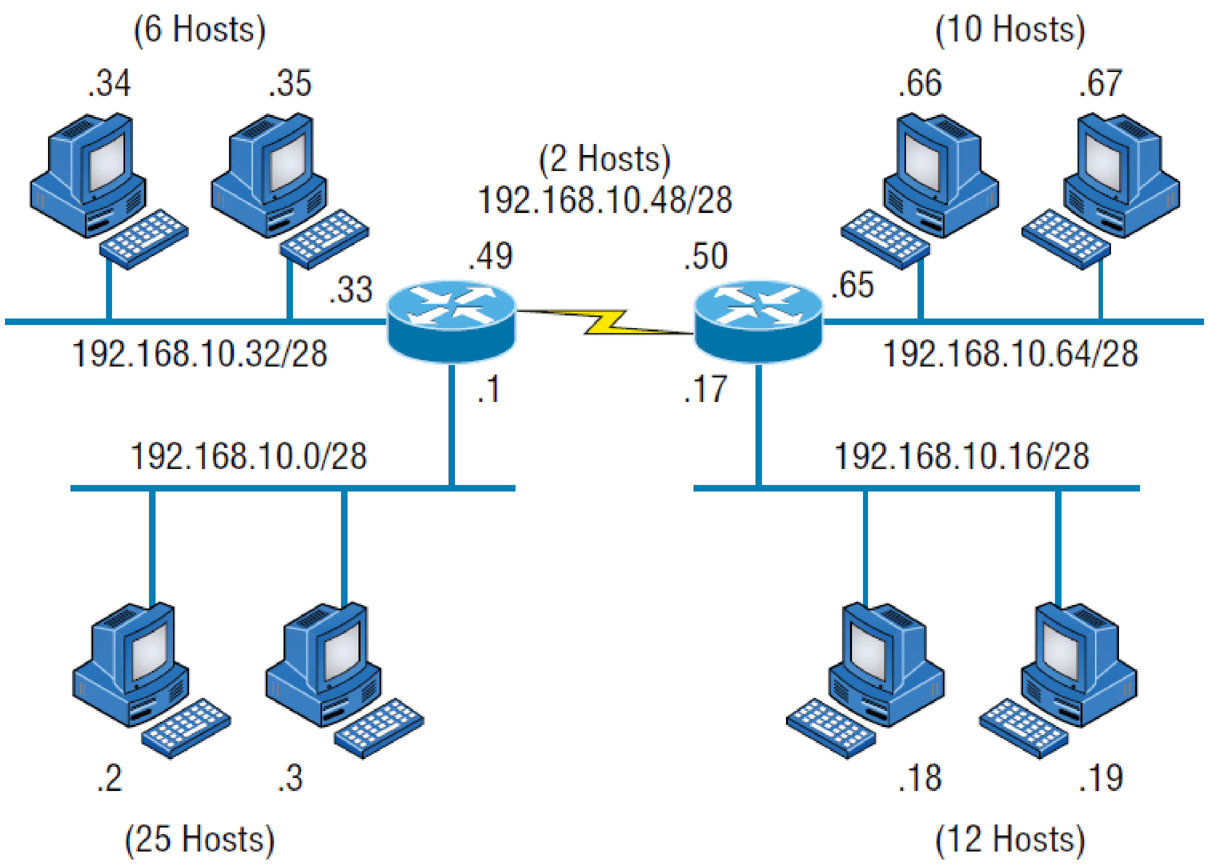
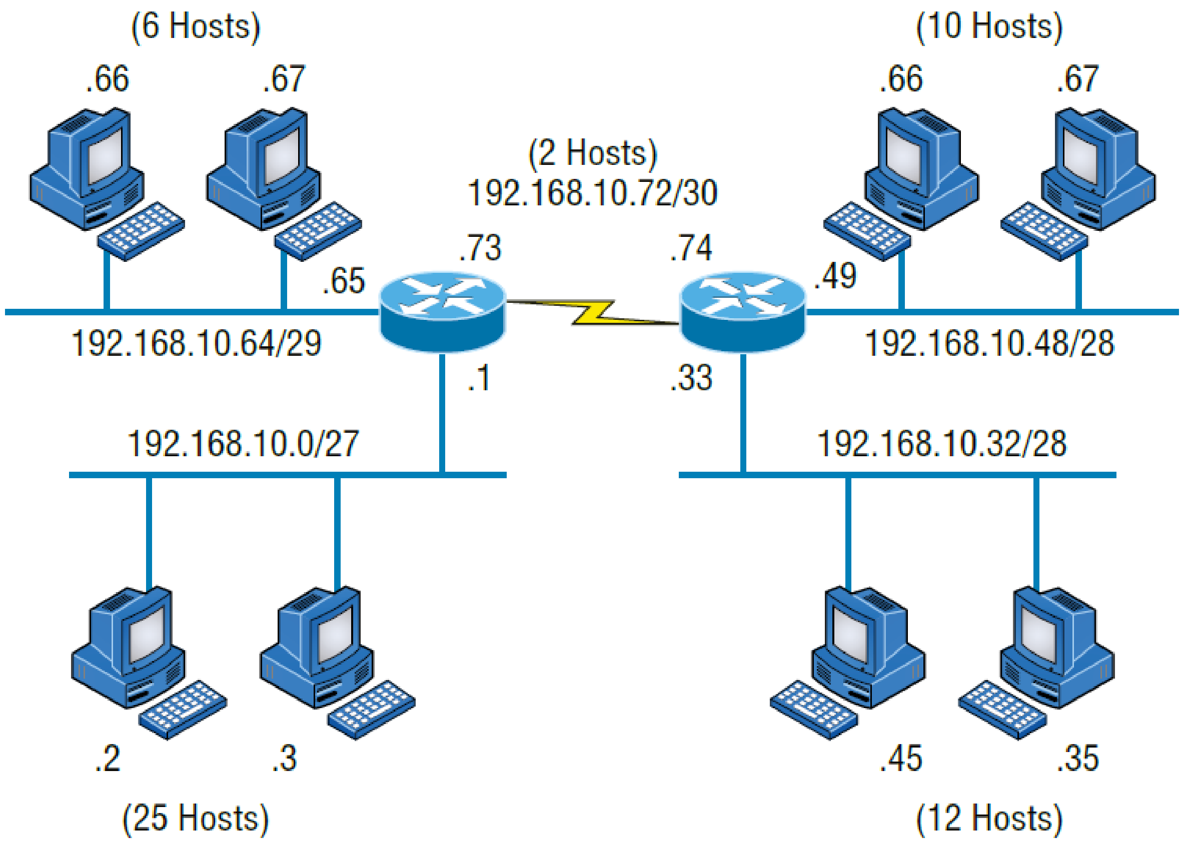
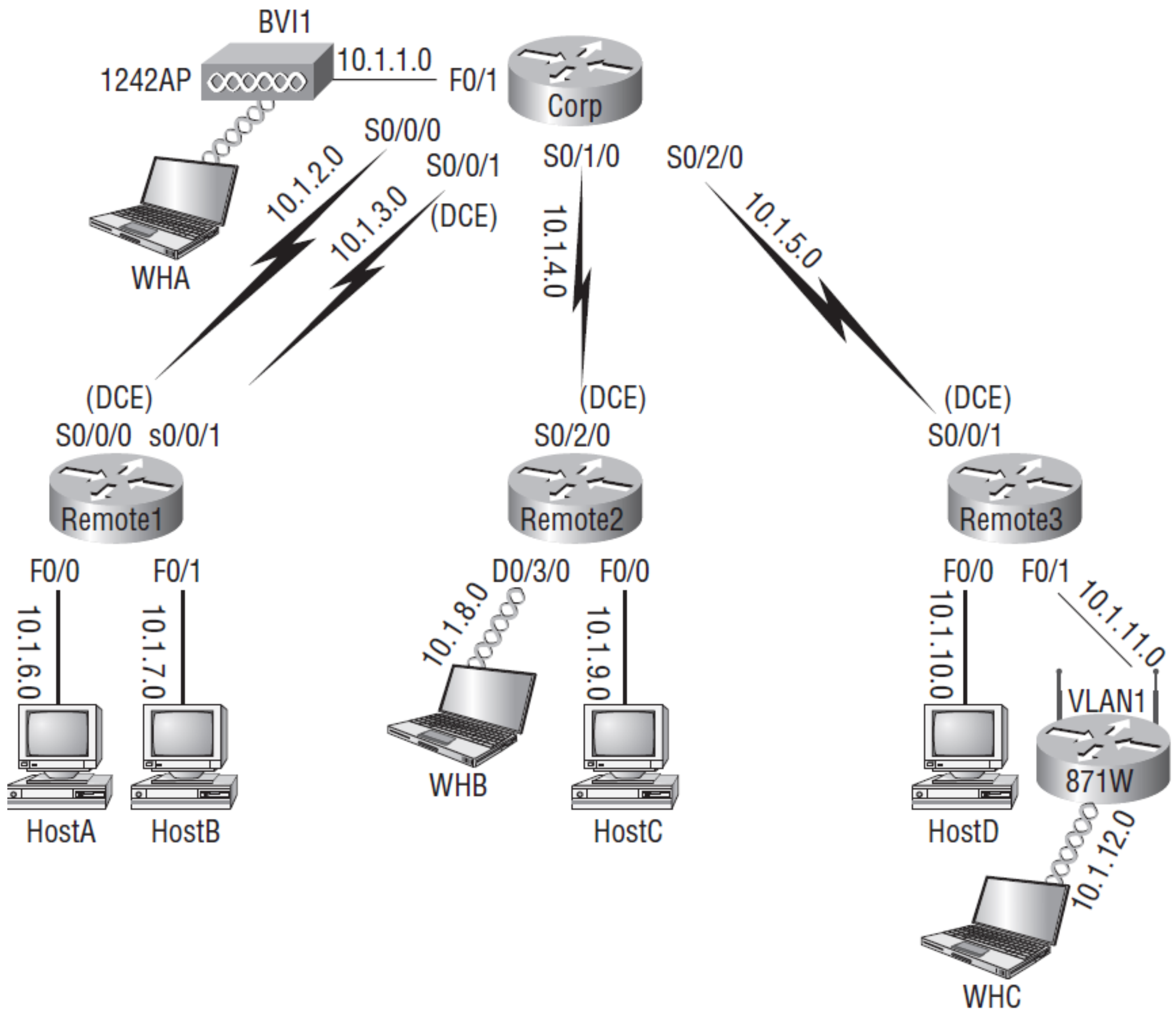


FIGURE 10.5 Classless network design



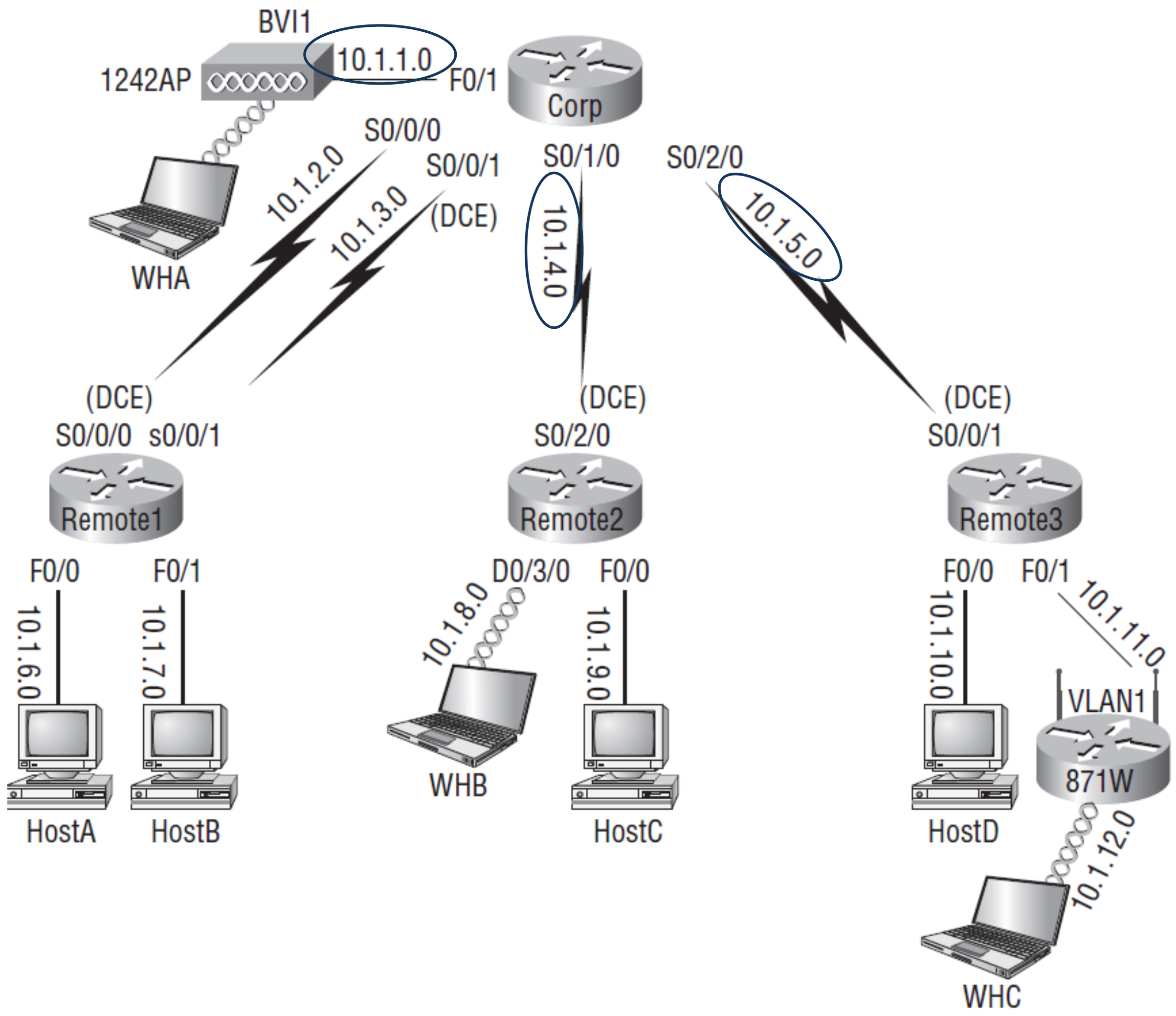
Configuring RIP Routing

```
R1(config-router)#do show ip route
     10.0.0.0/24 is subnetted, 12 subnets
S       10.1.11.0 [150/0] via 10.1.3.1
S       10.1.10.0 [150/0] via 10.1.3.1
S       10.1.9.0 [150/0] via 10.1.3.1
S       10.1.8.0 [150/0] via 10.1.3.1
S       10.1.12.0 [150/0] via 10.1.3.1
C       10.1.3.0 is directly connected, Serial0/0/1
C       10.1.2.0 is directly connected, Serial0/0/0
R       10.1.1.0 [120/1] via 10.1.3.1, 00:00:04, Serial0/0/1
                 [120/1] via 10.1.2.1, 00:00:04, Serial0/0/0
C       10.1.7.0 is directly connected, FastEthernet0/1
C       10.1.6.0 is directly connected, FastEthernet0/0
R       10.1.5.0 [120/1] via 10.1.3.1, 00:00:04, Serial0/0/1
                 [120/1] via 10.1.2.1, 00:00:04, Serial0/0/0
R       10.1.4.0 [120/1] via 10.1.3.1, 00:00:09, Serial0/0/1
                 [120/1] via 10.1.2.1, 00:00:09, Serial0/0/0
```



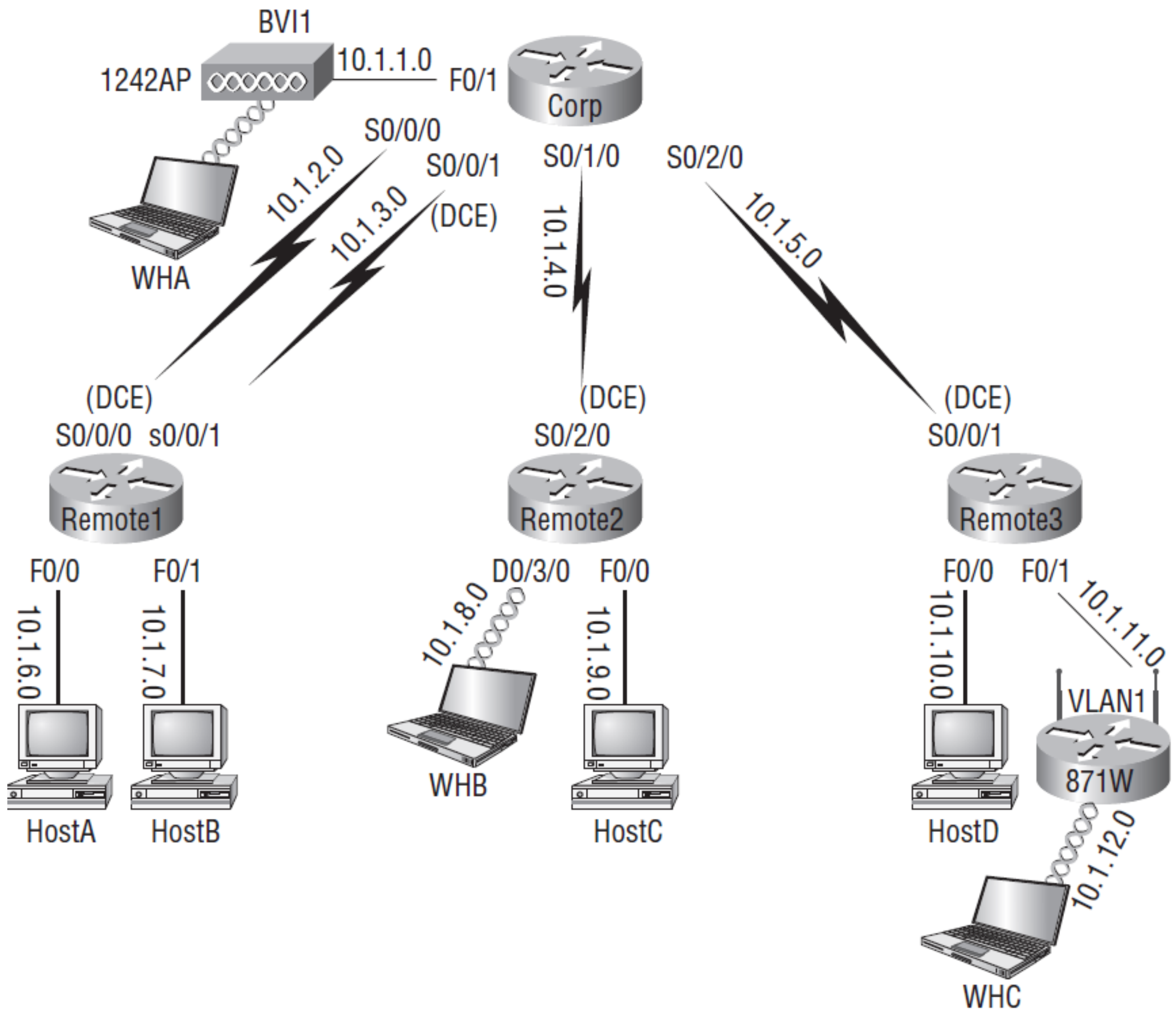
Configuring RIP Routing

```
R1(config-router)#do show ip route
     10.0.0.0/24 is subnetted, 12 subnets
S       10.1.11.0 [150/0] via 10.1.3.1
S       10.1.10.0 [150/0] via 10.1.3.1
S       10.1.9.0 [150/0] via 10.1.3.1
S       10.1.8.0 [150/0] via 10.1.3.1
S       10.1.12.0 [150/0] via 10.1.3.1
C       10.1.3.0 is directly connected, Serial0/0/1
C       10.1.2.0 is directly connected, Serial0/0/0
R       10.1.1.0 [120/1] via 10.1.3.1, 00:00:04, Serial0/0/1
                 [120/1] via 10.1.2.1, 00:00:04, Serial0/0/0
C       10.1.7.0 is directly connected, FastEthernet0/1
C       10.1.6.0 is directly connected, FastEthernet0/0
R       10.1.5.0 [120/1] via 10.1.3.1, 00:00:04, Serial0/0/1
                 [120/1] via 10.1.2.1, 00:00:04, Serial0/0/0
R       10.1.4.0 [120/1] via 10.1.3.1, 00:00:09, Serial0/0/1
                 [120/1] via 10.1.2.1, 00:00:09, Serial0/0/0
```



Configuring RIP Routing

```
R1(config-router)#do show ip route
     10.0.0.0/24 is subnetted, 12 subnets
S       10.1.11.0 [150/0] via 10.1.3.1
S       10.1.10.0 [150/0] via 10.1.3.1
S       10.1.9.0 [150/0] via 10.1.3.1
S       10.1.8.0 [150/0] via 10.1.3.1
S       10.1.12.0 [150/0] via 10.1.3.1
C       10.1.3.0 is directly connected, Serial0/0/1
C       10.1.2.0 is directly connected, Serial0/0/0
R       10.1.1.0 [120/1] via 10.1.3.1, 00:00:04, Serial0/0/1
                 [120/1] via 10.1.2.1, 00:00:04, Serial0/0/0
C       10.1.7.0 is directly connected, FastEthernet0/1
C       10.1.6.0 is directly connected, FastEthernet0/0
R       10.1.5.0 [120/1] via 10.1.3.1, 00:00:04, Serial0/0/1
                 [120/1] via 10.1.2.1, 00:00:04, Serial0/0/0
R       10.1.4.0 [120/1] via 10.1.3.1, 00:00:09, Serial0/0/1
                 [120/1] via 10.1.2.1, 00:00:09, Serial0/0/0
```



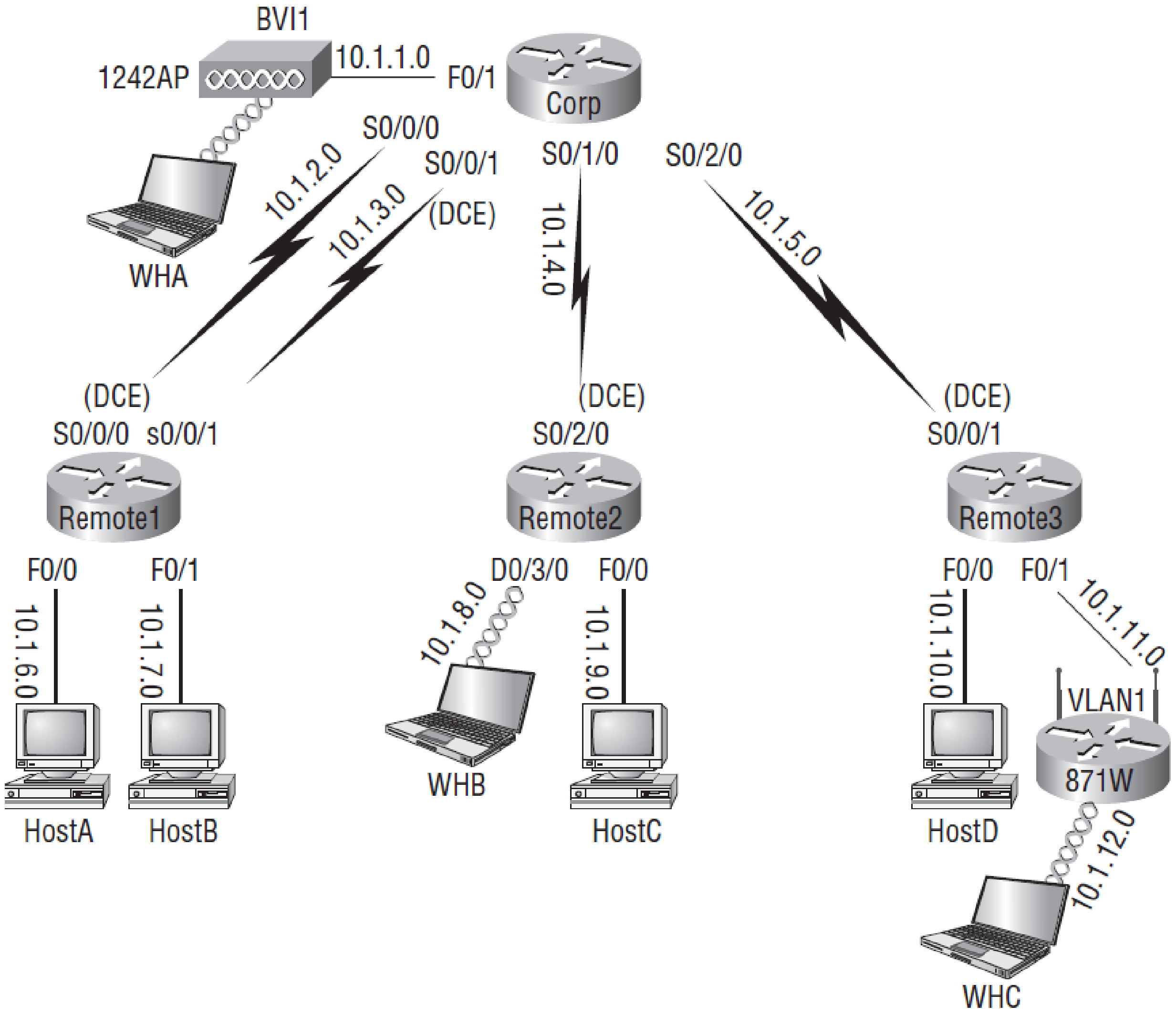
The number of hops to that remote network

Configuring RIP Routing

R2

```
R2#config t
R2(config)#router rip
R2(config-router)#network 10.0.0.0
```

```
R2(config-router)#do show ip route
     10.0.0.0/24 is subnetted, 12 subnets
S       10.1.11.0 [150/0] via 10.1.4.1
S       10.1.10.0 [150/0] via 10.1.4.1
C       10.1.9.0 is directly connected, FastEthernet0/0
C       10.1.8.0 is directly connected, Dot11Radio0/3/0
S       10.1.12.0 [150/0] via 10.1.4.1
R       10.1.3.0 [120/1] via 10.1.4.1, 00:00:03, Serial0/2/0
R       10.1.2.0 [120/1] via 10.1.4.1, 00:00:03, Serial0/2/0
R       10.1.1.0 [120/1] via 10.1.4.1, 00:00:03, Serial0/2/0
R       10.1.7.0 [120/2] via 10.1.4.1, 00:00:03, Serial0/2/0
R       10.1.6.0 [120/2] via 10.1.4.1, 00:00:03, Serial0/2/0
R       10.1.5.0 [120/1] via 10.1.4.1, 00:00:03, Serial0/2/0
```

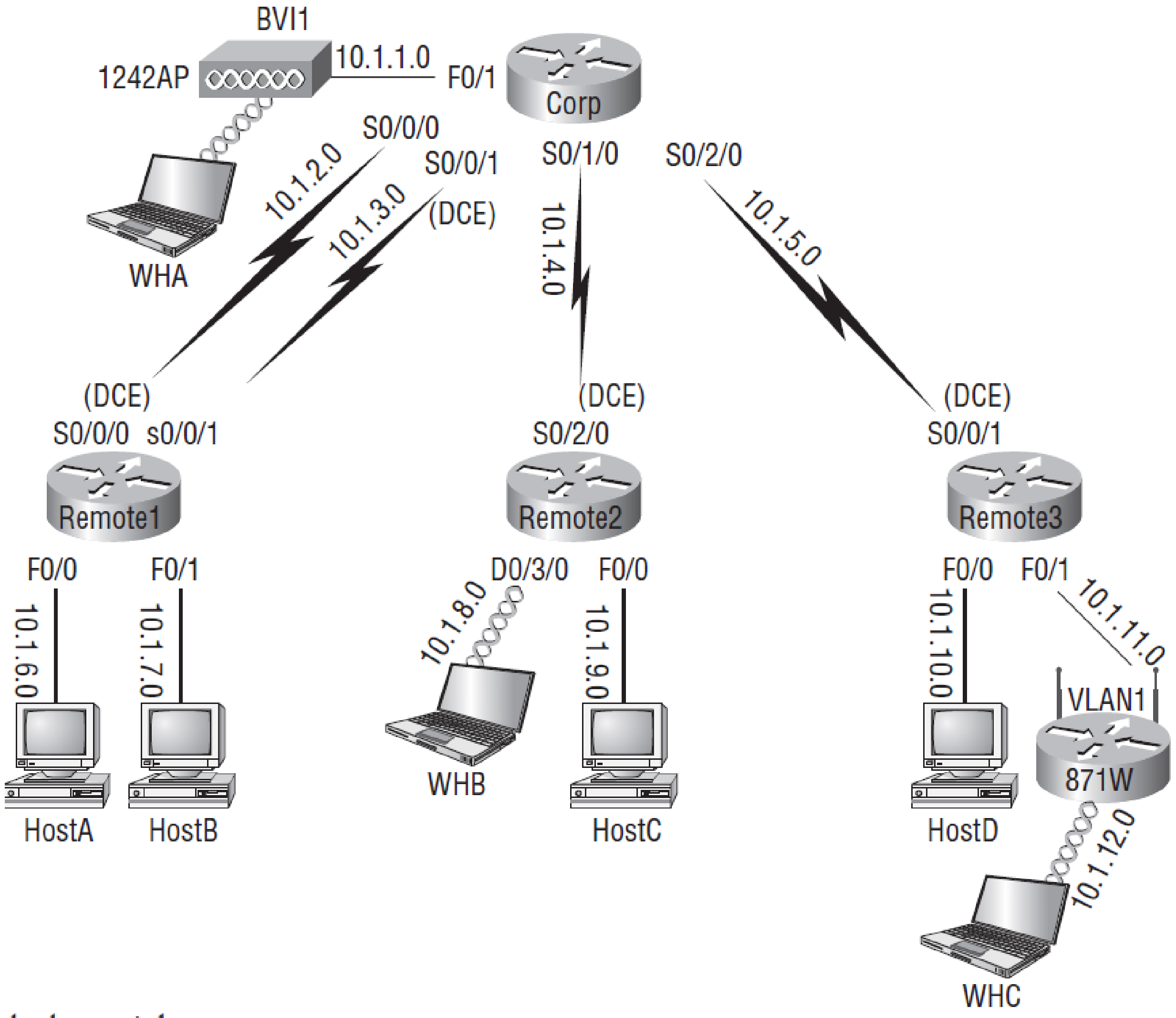


Configuring RIP Routing

871W

```
871W#config t
871W(config)#no ip route 0.0.0.0 0.0.0.0 10.1.11.1
871W(config)#router rip
871W(config-router)#network 10.0.0.0

871W(config-router)#do sh ip route
     10.0.0.0/24 is subnetted, 12 subnets
C       10.1.11.0 is directly connected, Vlan1
R       10.1.10.0 [120/1] via 10.1.11.1, 00:00:23, Vlan1
R       10.1.9.0 [120/3] via 10.1.11.1, 00:00:23, Vlan1
R       10.1.8.0 [120/3] via 10.1.11.1, 00:00:23, Vlan1
C       10.1.12.0 is directly connected, Dot11Radio0
R       10.1.3.0 [120/2] via 10.1.11.1, 00:00:23, Vlan1
R       10.1.2.0 [120/2] via 10.1.11.1, 00:00:23, Vlan1
R       10.1.1.0 [120/2] via 10.1.11.1, 00:00:23, Vlan1
R       10.1.7.0 [120/3] via 10.1.11.1, 00:00:24, Vlan1
R       10.1.6.0 [120/3] via 10.1.11.1, 00:00:24, Vlan1
R       10.1.5.0 [120/1] via 10.1.11.1, 00:00:24, Vlan1
R       10.1.4.0 [120/2] via 10.1.11.1, 00:00:24, Vlan1
```



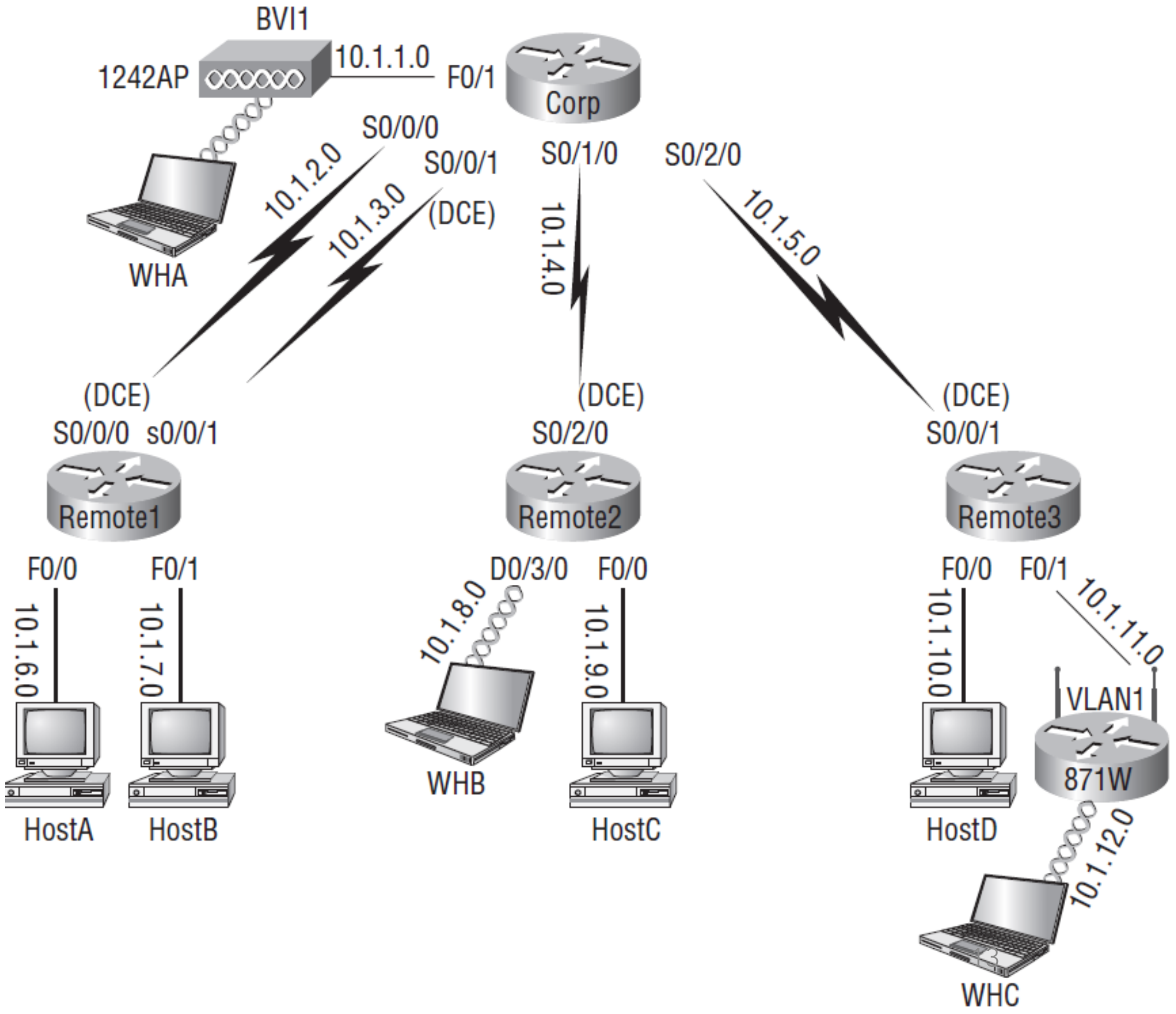
It's important to remember administrative distances and why we needed to either remove the static routes before we added RIP routing or set them higher than 120 as we did.

Verifying the RIP Routing Tables

Each routing table should now have all directly connected routes as well as RIP-injected routes received from neighboring routers.

This output shows us the contents of the Corp routing table:

```
     10.0.0.0/24 is subnetted, 12 subnets
R       10.1.11.0 [120/1] via 10.1.5.2, 00:00:28, Serial0/2/0
R       10.1.10.0 [120/1] via 10.1.5.2, 00:00:28, Serial0/2/0
R       10.1.9.0 [120/1] via 10.1.4.2, 00:00:26, Serial0/1/0
R       10.1.8.0 [120/1] via 10.1.4.2, 00:00:26, Serial0/1/0
R       10.1.12.0 [120/2] via 10.1.5.2, 00:00:28, Serial0/2/0
C       10.1.3.0 is directly connected, Serial0/0/1
C       10.1.2.0 is directly connected, Serial0/0/0
C       10.1.1.0 is directly connected, FastEthernet0/1
R       10.1.7.0 [120/1] via 10.1.3.2, 00:00:07, Serial0/0/1
                 [120/1] via 10.1.2.2, 00:00:10, Serial0/0/0
R       10.1.6.0 [120/1] via 10.1.3.2, 00:00:07, Serial0/0/1
                 [120/1] via 10.1.2.2, 00:00:10, Serial0/0/0
C       10.1.5.0 is directly connected, Serial0/2/0
C       10.1.4.0 is directly connected, Serial0/1/0
```



RIP Timers

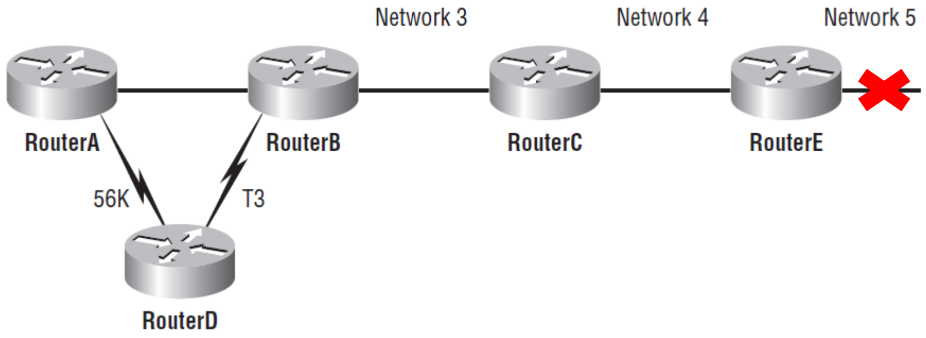
- **Route update timer** Sets the interval (typically 30 seconds) between periodic routing updates in which the router sends a complete copy of its routing table out to all neighbors.

- **Route invalid timer** Determines the length of time that must elapse (180 seconds) before a router determines that a route has become invalid.

- **Holddown timer** This sets the amount of time during which routing information is suppressed. Routes will enter into the holddown state when an update packet is received that indicated the route is unreachable. This continues either until an update packet is received with a better metric or until the holddown timer expires. The default is 180 seconds.

- **Route flush timer** Sets the time between a route becoming invalid and its removal from the routing table (240 seconds).

  This gives the router enough time to tell its neighbors about the invalid route before the local routing table is updated.



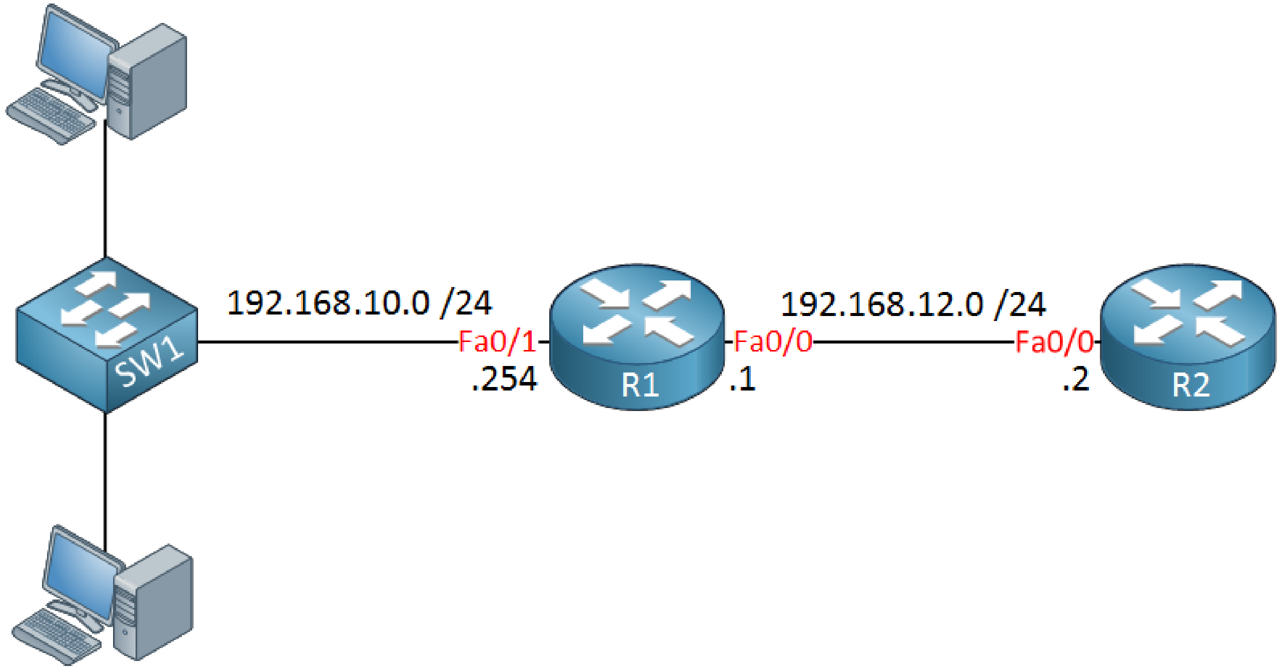
Remember

- RIP has a maximum hop count of only 15.
- It performs full routing-table updates every 30 seconds, which would bring a larger internetwork to a painful crawl.
- Each time a router sends out an update to a neighbor router, it increments the hop count by one for each router

```
R        10.1.3.0 [120/15] via 10.1.5.1, 00:00:15, Serial0/0/1
```

- The next router that receives the table from that router will just discard the route to network 10.1.3.0 since the hop count would then be 16, which is invalid

Holding Down RIP Propagation



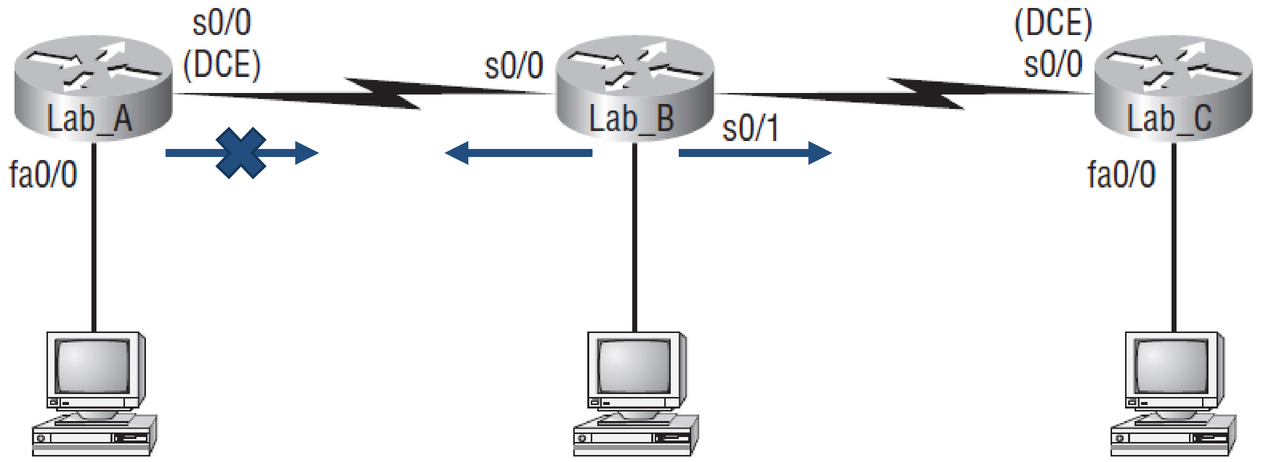
- Above we have two routers, R1 and R2. On the left side, there's the 192.168.10.0 /24 network with a switch and some computers.
- R1 wants to advertise this network to R2 but since there are no other RIP routers in the 192.168.10.0 /24 network, it's pointless to send RIP updates on the FastEthernet 0/1 interface.
- To prevent this from happening, we will use **the passive-interface command**. This will ensure that the network is advertised in RIP but it will not send RIP updates on the interface.

Passive Interface

- There's a few different ways to stop unwanted RIP updates from propagating across your LANs and WANs, and the easiest one is through the `passive-interface` command

```
Lab_A#config t
Lab_A(config)#router rip
Lab_A(config-router)#network 192.168.10.0
Lab_A(config-router)#passive-interface serial 0/0
```

- This command will stop RIP updates from being propagated out serial interface 0/0, but serial interface 0/0 can still receive RIP updates.

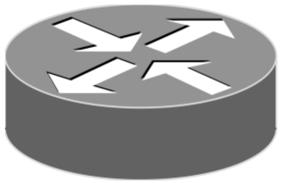


RIP Version 2 (RIPv2)

- RIP is an **open standard;** you can use RIP with any brand of router.
- RIP version 2 is mostly the same as RIP version 1. Both RIPv1 and RIPv2 are **distance-vector protocols**, which means that each router running RIP sends its complete routing tables out all active interfaces at periodic time intervals.
- Also, the timers and loop-avoidance schemes are the same in both RIP versions (i.e., holddown timers and split horizon rule).
- Both RIPv1 and RIPv2 are configured as classful addressing (but RIPv2 is considered classless because subnet information is sent with each route update),
- Both have the same administrative distance (120).

RIP Version 2

- Allows the use of variable length subnet masks (VLSM) by sending subnet mask information with each route update
- Distance Vector – same AD, and timers.
- Easy configuration, just add the command “version 2” under the router rip configuration
- RIPv2 is the preferred choice over RIPv1 because it supports VLSM and discontiguous networks.



router rip
network 10.0.0.0
version 2

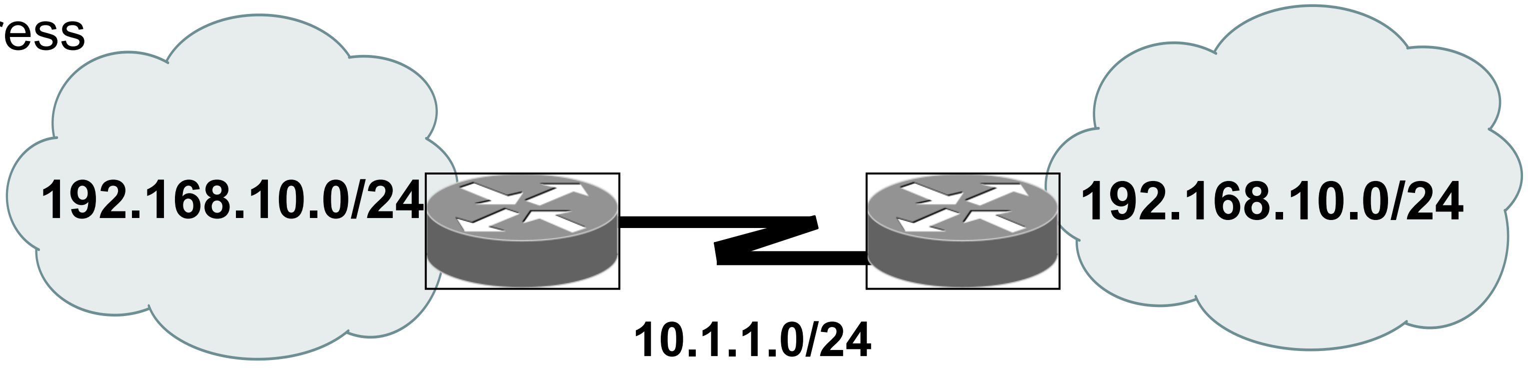
Configuring RIPv2

That's it; just add the command **version 2** under the (config-router)# prompt and you are now running RIPv2.

```
Lab_C(config)#router rip
Lab_C(config-router)#network 192.168.40.0
Lab_C(config-router)#network 192.168.50.0
Lab_C(config-router)#version 2
```

Discontiguous Addressing

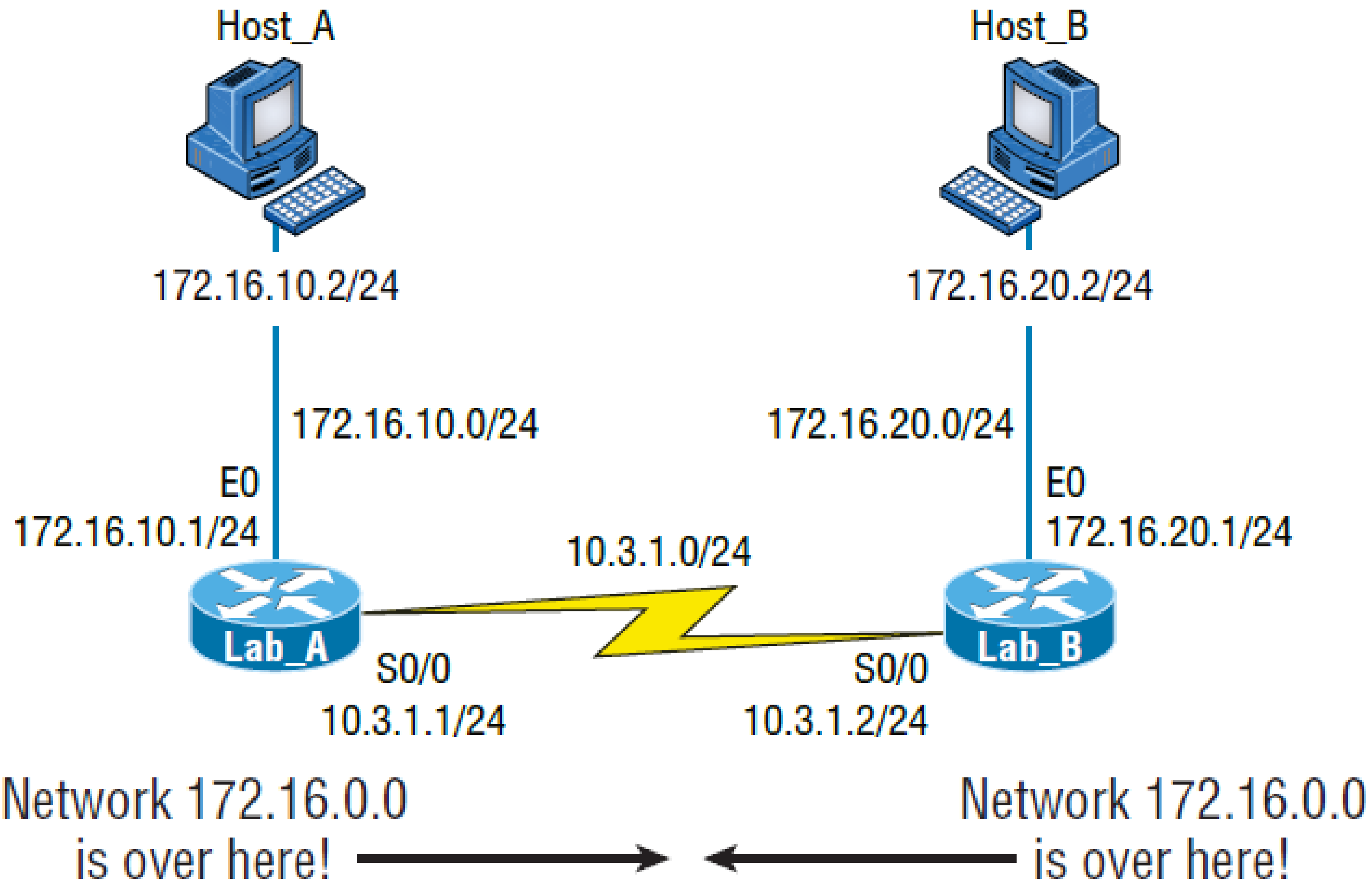
- If you create VLSM network, sometimes you may find that the backbone connecting buildings together is a different class of network. This is called discontiguous addressing.
- By default routing protocols will not work across discontiguous networks. By using the "no auto-summary" command on the network boundaries, routing protocols will be able do work across a discontiguous addressed network.
- Two networks of the same classful networks are separated by a different network address



  - RIPv1 and IGRP do not advertise subnet masks, and therefore cannot support discontiguous subnets.
  - OSPF, EIGRP, and RIPv2 can advertise subnet masks, and therefore can support discontiguous subnets.

Example of Discontiguous Network

- Now, what's a discontiguous network? It's one that has two or more subnetworks of a classful network connected together by different classful networks.



Discontiguous Network

- By default routing protocol like RIP and EIGRP summarize subnets into major classful network at classful boundary.

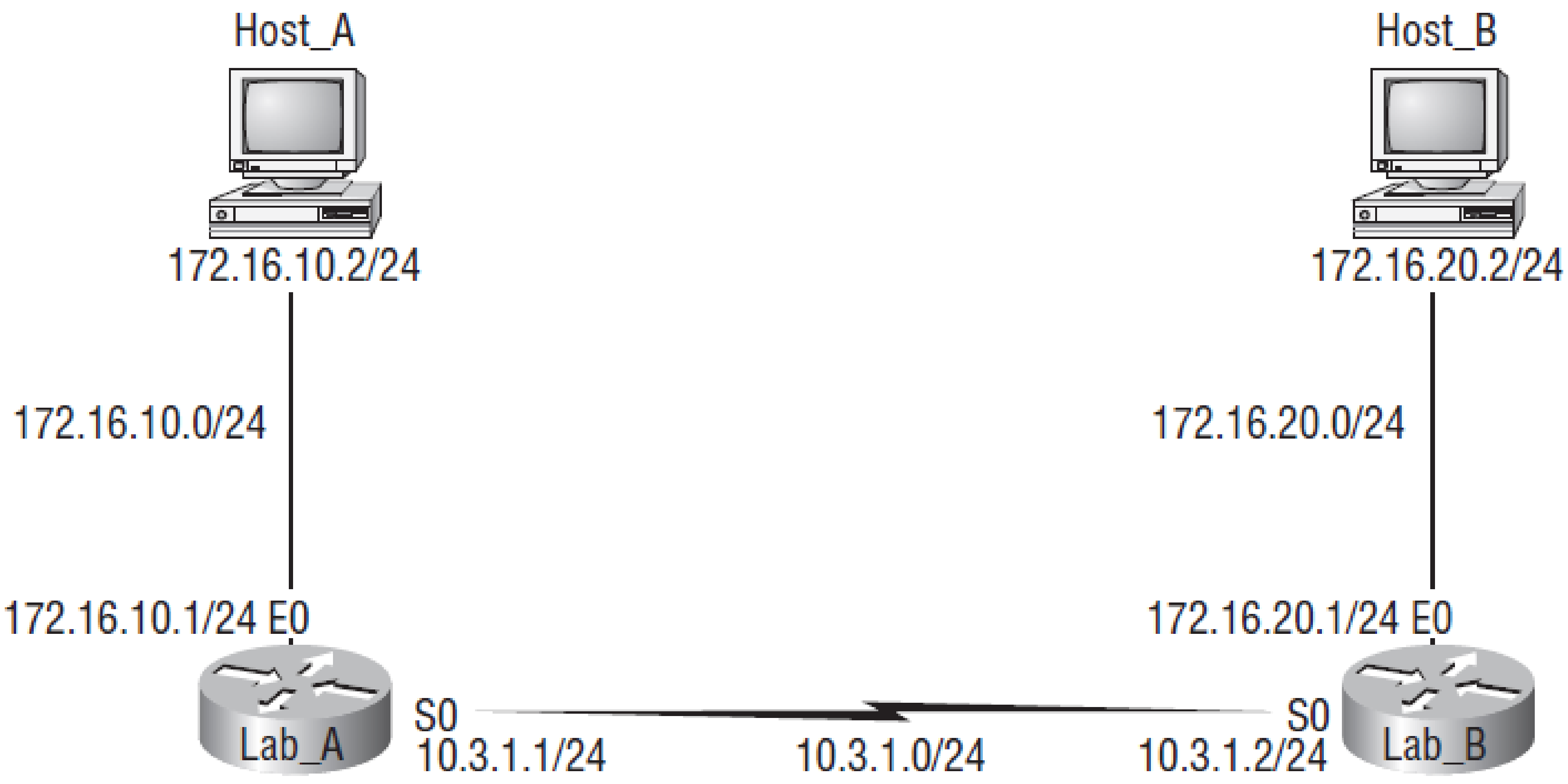
- In other word, these protocols perform an auto-summarization each time they crosses a border between two different major networks.

- To disable this behavior in RIP version 2 and advertise subnets, '**no auto-summary**' command is used.

- Let's say router has two subnets 172.16.8.0/24 and 172.16.4.0/24 of Class B network and one subnet 10.2.0.0/16 of Class A.

- When auto-summary is enabled, router will advertise only summarized major classful network 172.16.0.0/16 for class B addresses into its Class A interface but you can change this default behavior and advertise both subnets using this 'no auto-summary'.

You have an internetwork as shown in the following illustration. However, the two networks are not sharing routing table route entries. Which command is needed to fix the problem?



A. `version 2`

B. `no auto-summary`

C. `redistribute eigrp 10`

D. `default-information originate`

RIPv1 vs. RIPv2

RIPv1	RIPv2
Distance vector	Distance vector
Maximum hop count 15	Maximum hop count 15
Classful	Classless
Broadcast based	Multicast 224.0.0.9
No support for VLSM	Supports VLSM
No authentication	MD5 authentication
No support for discontiguous networks	Supports discontiguous networks

Interior Gateway Routing Protocol (IGRP)

- Interior Gateway Routing Protocol (**IGRP**) is a **Cisco-proprietary distance-vector routing protocol**. This means that to use IGRP in your network, all your routers must be Cisco routers.
- Cisco created this routing protocol to overcome the problems associated with RIP.
- IGRP has a **maximum hop count of 255** with the **default being** **100** (same as EIGRP). This is helpful in larger networks and solves the problem of 15 hops being the maximum possible in a RIP network.
- IGRP also uses a different metric than RIP. IGRP uses bandwidth and delay of the line by default as a metric for determining the best route to an internetwork. This is called a **composite metric**.
- Reliability, load, and maximum transmission unit (MTU) can also be used, although they are not used by default.

Interior Gateway Routing Protocol (IGRP)

The main difference between RIP and IGRP configuration is that when you configure IGRP, you supply the autonomous system number. All routers must use the same number in order to share routing table information.

IGRP	RIP
Can be used in large internetworks	Works best in smaller networks
Uses an autonomous system number for activation	Does not use autonomous system numbers
Gives a full route table update every 90 seconds	Gives a full route table update every 30 seconds
Has an administrative distance of 100	Has an administrative distance of 120
Uses bandwidth and delay of the line as metric (lowest composite metric), with a maximum hop count of 255	Uses only hop count to determine the best path to a remote network, with 15 hops being the maximum

```
R3(config)#router igrp 10
                    ^
% Invalid input detected at '^' marker.
R3(config)#
```

There's your reason—Cisco no longer supports IGRP. Why should it? All you have to do is put an *E* in front of *IGRP* and you're running a much, much better routing protocol. We'll get to EIGRP in the next chapter, but first, let's go through some verification commands for RIP.

Verifying your Configuration

The following list includes the commands you can use to verify the routed and routing protocols configured on your Cisco routers:

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

Verifying RIP

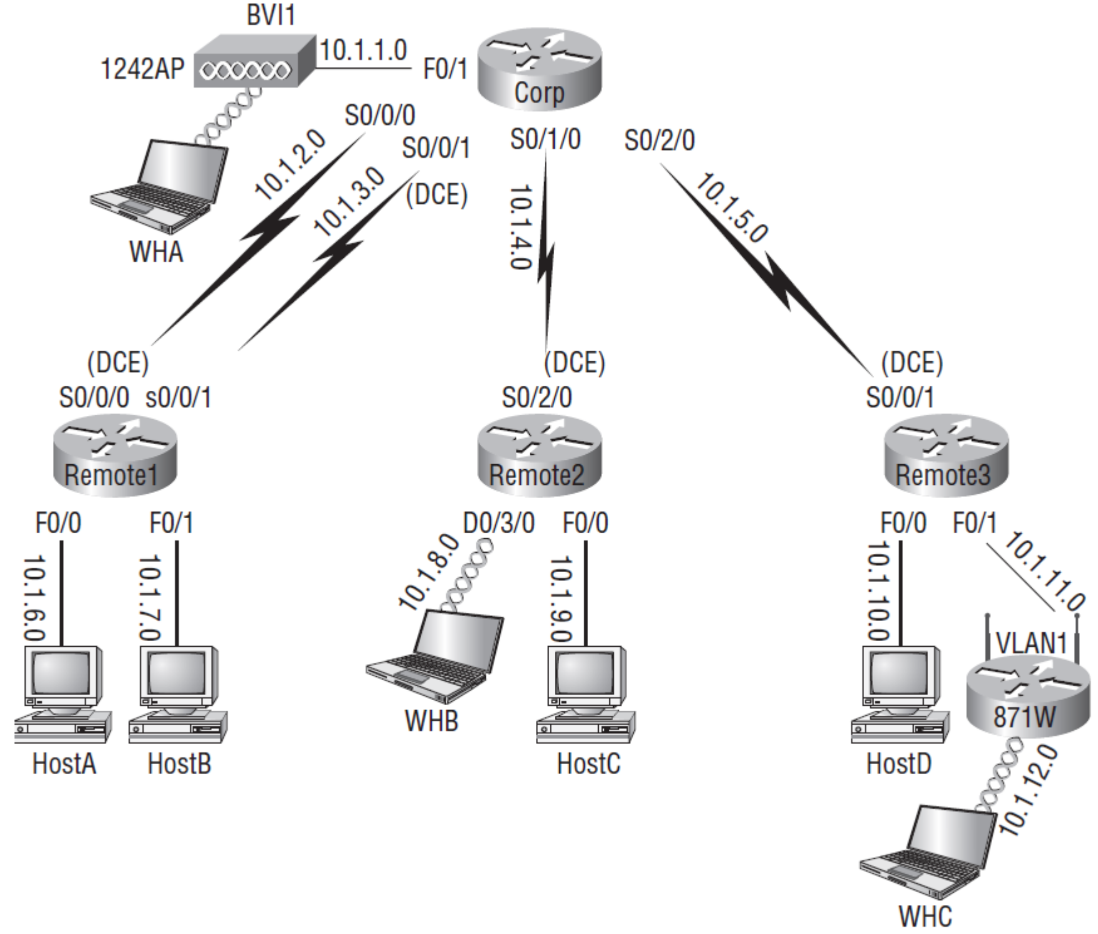
- Router#show ip protocols → show routing protocols information and timers
- Router#show ip route → displays the routing table
- Router#debug ip rip → show rip updates being sent and received on your router
- Router#undebug all (un all) → turns off debugging

The show ip protocols Command

The `show ip protocols` command shows you the routing protocols that are configured on your router.

```
R3#sh 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 24 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Redistributing: rip
  Default version control: send version 1, receive version 1
    Interface             Send  Recv  Triggered RIP  Key-chain
    FastEthernet0/1       1     1
    Serial0/0/1           1     1
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
    10.0.0.0
  Passive Interface(s):
    FastEthernet0/0
    Serial0/0/0
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.1.11.2            120      00:00:10
    10.1.5.1             120      00:00:22
  Distance: (default is 120)
```

```
R3#debug ip rip
RIP protocol debugging is on
R3#terminal monitor
*Mar 17 19:08:34.371: RIP: sending v1 update to 255.255.255.255 via
   Serial0/0/1 (10.1.5.2)
*Mar 17 19:08:34.371: RIP: build update entries
*Mar 17 19:08:34.371:   subnet 10.1.10.0 metric 1
*Mar 17 19:08:34.371:   subnet 10.1.11.0 metric 1
*Mar 17 19:08:34.371:   subnet 10.1.12.0 metric 2
*Mar 17 19:08:40.107: RIP: received v1 update from 10.1.5.1 on
   Serial0/0/1
*Mar 17 19:08:40.107:      10.1.1.0 in 1 hops
*Mar 17 19:08:40.107:      10.1.2.0 in 1 hops
*Mar 17 19:08:40.107:      10.1.3.0 in 1 hops
*Mar 17 19:08:40.107:      10.1.4.0 in 1 hops
*Mar 17 19:08:40.107:      10.1.6.0 in 2 hops
*Mar 17 19:08:40.107:      10.1.7.0 in 2 hops
*Mar 17 19:08:40.107:      10.1.8.0 in 2 hops
*Mar 17 19:08:40.107:      10.1.9.0 in 2 hops
*Mar 17 19:08:47.535: RIP: sending v1 update to 255.255.255.255 via
   FastEthernet0/1 (10.1.11.1)
*Mar 17 19:08:47.535: RIP: build update entries
*Mar 17 19:08:47.535:   subnet 10.1.1.0 metric 2
*Mar 17 19:08:47.535:   subnet 10.1.2.0 metric 2
*Mar 17 19:08:47.535:   subnet 10.1.3.0 metric 2
*Mar 17 19:08:47.535:   subnet 10.1.4.0 metric 2
*Mar 17 19:08:47.535:   subnet 10.1.5.0 metric 1
*Mar 17 19:08:47.535:   subnet 10.1.6.0 metric 3
*Mar 17 19:08:47.535:   subnet 10.1.7.0 metric 3
*Mar 17 19:08:47.535:   subnet 10.1.8.0 metric 3
*Mar 17 19:08:47.535:   subnet 10.1.9.0 metric 3
*Mar 17 19:08:47.535:   subnet 10.1.10.0 metric 1
```



Features	RIP V1	RIP V2	IGRP	OSPF	EIGRP
Classful/Classless	Classful	Classless	Classful	Classless	Classless
Metric	Hop	Hop	Composite Bandwidth, Delay	Bandwidth	Composite, Bandwidth, Delay
Periodic	30 seconds	30 seconds	90 seconds	None	30 seconds
Advertising Address	255.255.255.255.255	223.0.0.9	255.255.255.255.255	224.0.0.5 224.0.0.6	224.0.0.10
Category	Distance Vector	Distance Vector	Distance Vector	Link State	Hybrid
Default Distance	120	120	100	110	170