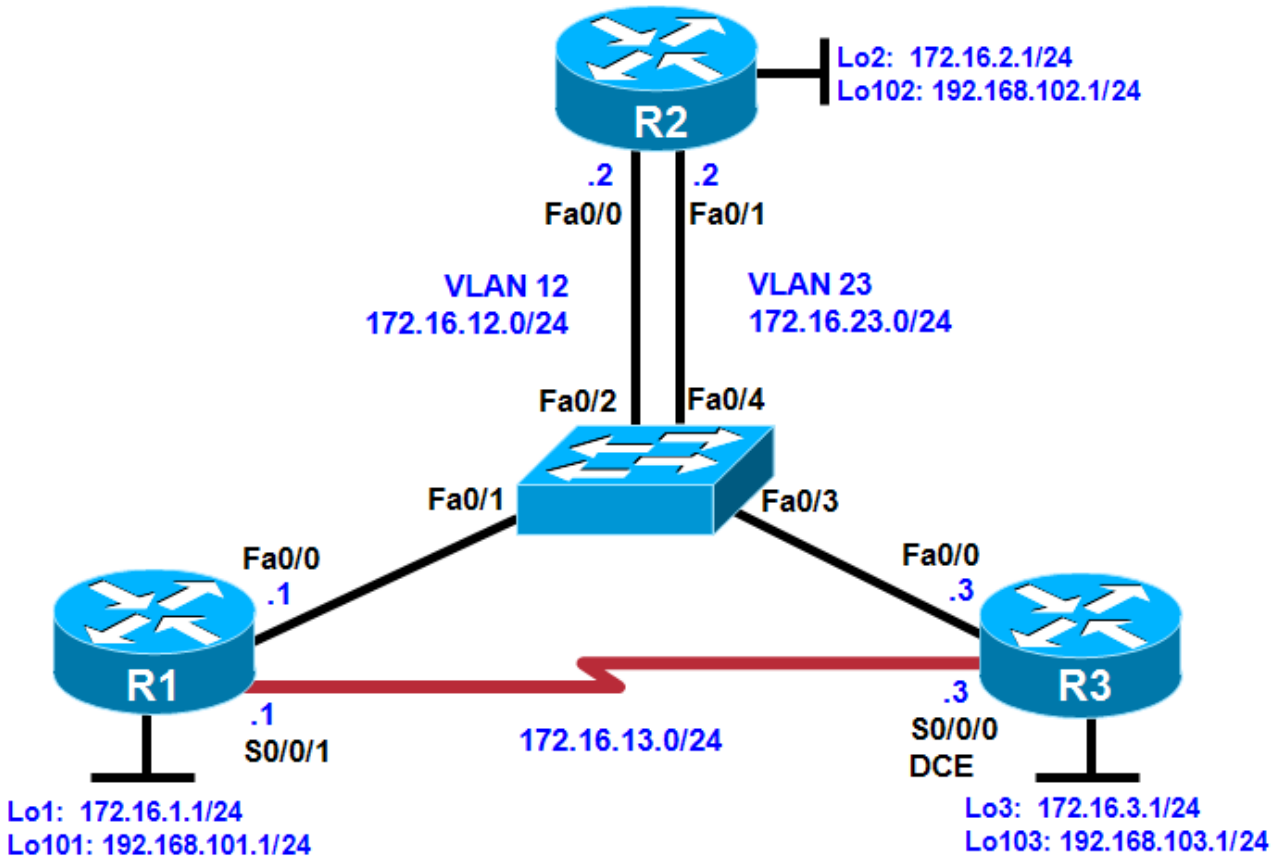
Chapter 4 Lab 4-3, Manipulating Administrative Distances

Topology



Objectives

- Configure RIP on a router.
- Configure OSPF on a router.
- Manipulate administrative distances.
- Compare routing protocol behavior.

Background

In this lab, you will compare the RIP and OSPF routing protocols based on how efficient they are at selecting routes, as well as what happens when you manipulate administrative distances in the routing table.

Note: This lab uses Cisco 1841 routers with Cisco IOS Release 12.4(24)T1 and the Advanced IP Services image c1841-advipservicesk9-mz.124-24.T1.bin. The switch is a Cisco WS-C2960-24TT-L with the Cisco IOS image c2960-lanbasek9-mz.122-46.SE.bin. You can use other routers (such as a 2801 or 2811), switches (such as 2950), and Cisco IOS Software versions if they have comparable capabilities and features.

Depending on the router or switch model and Cisco IOS Software version, the commands available and output produced might vary from what is shown in this lab.

Required Resources

- 3 routers (Cisco 1841 with Cisco IOS Release 12.4(24)T1 Advanced IP Services or comparable)
- 1 switch (Cisco 2960 with the Cisco IOS Release 12.2(46)SE C2960-LANBASEK9-M image or comparable)
- Serial and Ethernet cables

Step 1: Review default administrative distances.

Fill in the following table with all the administrative distances you can recall from your reading.

Protocol	Administrative Distance
Connected	
Static	
EIGRP Summary Route	
External BGP	
EIGRP	
IGRP	
OSPF	
IS-IS	
RIP	
EGP	
On-Demand Routing (ODR)	
External EIGRP	
Internal BGP	
Unknown	

Of the interior gateway protocols (IGPs) that you have studied, which one is considered the most trusted on a Cisco router and why?

Step 2: Configure router loopbacks and addressing.

Configure all loopback interfaces on the three routers in the diagram. Configure the serial interface with the IP addresses, bring them up, and set a clock rate where appropriate.

```
R1# conf t
R1(config)# interface loopback 1
```

```
R1(config-if)# ip address 172.16.1.1 255.255.255.0
R1(config-if)# interface loopback 101
R1(config-if)# ip address 192.168.101.1 255.255.255.0
R1(config-if)# interface fastethernet 0/0
R1(config-if)# ip address 172.16.12.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)# interface serial 0/0/1
R1(config-if)# bandwidth 64
R1(config-if)# ip address 172.16.13.1 255.255.255.0
R1(config-if)# no shutdown

R2# conf t
R2(config)# interface loopback 2
R2(config-if)# ip address 172.16.2.1 255.255.255.0
R2(config-if)# interface loopback 102
R2(config-if)# ip address 192.168.102.1 255.255.255.0
R2(config-if)# interface fastethernet 0/0
R2(config-if)# ip address 172.16.12.2 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)# interface fastethernet 0/1
R2(config-if)# ip address 172.16.23.2 255.255.255.0
R2(config-if)# no shutdown

R3# conf t
R3(config)# interface loopback 3
R3(config-if)# ip address 172.16.3.1 255.255.255.0
R3(config-if)# interface loopback 103
R3(config-if)# ip address 192.168.103.1 255.255.255.0
R3(config-if)# interface fastethernet 0/0
R3(config-if)# ip address 172.16.23.3 255.255.255.0
R3(config-if)# no shutdown
R3(config-if)# interface serial 0/0/0
R3(config-if)# bandwidth 64
R3(config-if)# ip address 172.16.13.3 255.255.255.0
R3(config-if)# clock rate 64000
R3(config-if)# no shutdown
```

Step 3: Configure switch VLANs.

a. Configure the switch VLANs, and place the correct access ports in each VLAN.

Note: The switch ports used are not important as long as the ports connecting to R1 Fa0/0 and R2 Fa0/0 are in VLAN 12 and the ports connecting to R3 Fa0/0 and R2 Fa0/1 are in VLAN 23.

```
Switch(config)# vlan 12
Switch(config-vlan)# name R1-R2
Switch(config-vlan)# vlan 23
Switch(config-vlan)# name R2-R3
Switch(config-vlan)# exit

Switch(config)# interface fastEthernet 0/1
Switch(config-if)# description To R1 Fa0/0
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 12

Switch(config-if)# interface fastEthernet 0/2
Switch(config-if)# description To R2 Fa0/0
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 12
```



```
Switch(config-if)# interface fastEthernet 0/3
Switch(config-if)# description To R3 Fa0/0
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 23

Switch(config-if)# interface fastEthernet 0/4
Switch(config-if)# description To R2 Fa0/1
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 23
```

b. Verify that you can ping across the local subnets.

Step 4: Configure RIP.

a. Configure RIPv2 on all three routers for the major networks. Disable automatic summarization.

```
R1(config)# router rip
R1(config-router)# version 2
R1(config-router)# no auto-summary
R1(config-router)# network 172.16.0.0
R1(config-router)# network 192.168.101.0

R2(config)# router rip
R2(config-router)# version 2
R2(config-router)# no auto-summary
R2(config-router)# network 172.16.0.0
R2(config-router)# network 192.168.102.0

R3(config)# router rip
R3(config-router)# version 2
R3(config-router)# no auto-summary
R3(config-router)# network 172.16.0.0
R3(config-router)# network 192.168.103.0
```

b. Verify the configuration using the **show ip route rip** command on each router.

```
R1# show ip route rip
     172.16.0.0/24 is subnetted, 6 subnets
R       172.16.23.0 [120/1] via 172.16.13.3, 00:02:29, Serial0/0/1
                    [120/1] via 172.16.12.2, 00:02:15, FastEthernet0/0
R       172.16.2.0 [120/1] via 172.16.12.2, 00:02:15, FastEthernet0/0
R       172.16.3.0 [120/1] via 172.16.13.3, 00:02:29, Serial0/0/1
R    192.168.102.0/24 [120/1] via 172.16.12.2, 00:02:15, FastEthernet0/0
R    192.168.103.0/24 [120/1] via 172.16.13.3, 00:02:29, Serial0/0/1

R2# show ip route rip
     172.16.0.0/24 is subnetted, 6 subnets
R       172.16.13.0 [120/1] via 172.16.23.3, 00:02:18, FastEthernet0/1
                    [120/1] via 172.16.12.1, 00:02:20, FastEthernet0/0
R       172.16.1.0 [120/1] via 172.16.12.1, 00:02:20, FastEthernet0/0
R       172.16.3.0 [120/1] via 172.16.23.3, 00:02:18, FastEthernet0/1
R    192.168.103.0/24 [120/1] via 172.16.23.3, 00:02:18, FastEthernet0/1
R    192.168.101.0/24 [120/1] via 172.16.12.1, 00:02:20, FastEthernet0/0

R3# show ip route rip
     172.16.0.0/24 is subnetted, 6 subnets
R       172.16.12.0 [120/1] via 172.16.23.2, 00:02:32, FastEthernet0/0
                    [120/1] via 172.16.13.1, 00:02:47, Serial0/0/0
R       172.16.1.0 [120/1] via 172.16.13.1, 00:02:47, Serial0/0/0
```

```
R       172.16.2.0 [120/1] via 172.16.23.2, 00:02:32, FastEthernet0/0
R    192.168.102.0/24 [120/1] via 172.16.23.2, 00:02:32, FastEthernet0/0
R    192.168.101.0/24 [120/1] via 172.16.13.1, 00:02:47, Serial0/0/0
```

Notice that on R1, RIP chooses the serial interface as the best next hop for the R3 loopback interface.

c. Verify that each router is receiving RIP routes from other routers using the **show ip protocols** 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 26 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
    FastEthernet0/0       2     2
    Serial0/0/1           2     2
    Loopback1             2     2
    Loopback101           2     2
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
    172.16.0.0
    192.168.101.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    172.16.12.2          120      00:00:21
    172.16.13.3          120      00:00:03
  Distance: (default is 120)

R2# 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
    FastEthernet0/0       2     2
    FastEthernet0/1       2     2
    Loopback2             2     2
    Loopback102           2     2
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
    172.16.0.0
    192.168.102.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    172.16.23.3          120      00:00:02
    172.16.12.1          120      00:00:24
  Distance: (default is 120)

R3# 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 22 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
    FastEthernet0/0       2     2
    Serial0/0/0           2     2
    Loopback3             2     2
    Loopback103           2     2
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
    172.16.0.0
    192.168.103.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    172.16.23.2          120      00:00:06
    172.16.13.1          120      00:00:17
  Distance: (default is 120)
```

Step 5: Configure OSPF.

a. Configure OSPF on all routers. Include the entire major network in area 0 on all three routers. Remember to change the network type on the loopback interfaces.

```
R1(config)# interface loopback 1
R1(config-if)# ip ospf network point-to-point
R1(config-if)# interface loopback 101
R1(config-if)# ip ospf network point-to-point
R1(config-if)# router ospf 1
R1(config-router)# network 172.16.0.0 0.0.255.255 area 0
R1(config-router)# network 192.168.101.0 0.0.0.255 area 0

R2(config)# interface loopback 2
R2(config-if)# ip ospf network point-to-point
R2(config-if)# interface loopback 102
R2(config-if)# ip ospf network point-to-point
R2(config-if)# router ospf 1
R2(config-router)# network 172.16.0.0 0.0.255.255 area 0
R2(config-router)# network 192.168.102.0 0.0.0.255 area 0

R3(config)# interface loopback 3
R3(config-if)# ip ospf network point-to-point
R3(config-if)# interface loopback 103
R3(config-if)# ip ospf network point-to-point
R3(config-if)# router ospf 1
R3(config-router)# network 172.16.0.0 0.0.255.255 area 0
R3(config-router)# network 192.168.103.0 0.0.0.255 area 0
```

b. Verify the configuration using the **show ip ospf neighbors** and **show ip route** commands on each router.

```
R1# show ip ospf neighbor

Neighbor ID     Pri   State      Dead Time   Address       Interface
192.168.103.1     0   FULL/  -   00:00:39    172.16.13.3   Serial0/0/1
192.168.102.1     1   FULL/DR    00:00:39    172.16.12.2   FastEthernet0/0
```

```
R1# show ip route
<output omitted>
     172.16.0.0/24 is subnetted, 6 subnets
O       172.16.23.0 [110/2] via 172.16.12.2, 00:00:48, FastEthernet0/0
C       172.16.12.0 is directly connected, FastEthernet0/0
C       172.16.13.0 is directly connected, Serial0/0/1
C       172.16.1.0 is directly connected, Loopback1
O       172.16.2.0 [110/2] via 172.16.12.2, 00:00:48, FastEthernet0/0
O       172.16.3.0 [110/3] via 172.16.12.2, 00:00:48, FastEthernet0/0
O    192.168.102.0/24 [110/2] via 172.16.12.2, 00:00:48, FastEthernet0/0
O    192.168.103.0/24 [110/3] via 172.16.12.2, 00:00:49, FastEthernet0/0
C    192.168.101.0/24 is directly connected, Loopback101

R2# show ip ospf neighbor

Neighbor ID     Pri   State      Dead Time   Address       Interface
192.168.103.1     1   FULL/DR    00:00:31    172.16.23.3   FastEthernet0/1
192.168.101.1     1   FULL/BDR   00:00:34    172.16.12.1   FastEthernet0/0

R2# show ip route
<output omitted>
     172.16.0.0/24 is subnetted, 6 subnets
C       172.16.23.0 is directly connected, FastEthernet0/1
C       172.16.12.0 is directly connected, FastEthernet0/0
O       172.16.13.0 [110/1563] via 172.16.23.3, 00:01:19, FastEthernet0/1
                    [110/1563] via 172.16.12.1, 00:01:19, FastEthernet0/0
O       172.16.1.0 [110/2] via 172.16.12.1, 00:01:19, FastEthernet0/0
C       172.16.2.0 is directly connected, Loopback2
O       172.16.3.0 [110/2] via 172.16.23.3, 00:01:19, FastEthernet0/1
C    192.168.102.0/24 is directly connected, Loopback102
O    192.168.103.0/24 [110/2] via 172.16.23.3, 00:01:20, FastEthernet0/1
O    192.168.101.0/24 [110/2] via 172.16.12.1, 00:01:20, FastEthernet0/0

R3# show ip ospf neighbor

Neighbor ID     Pri   State      Dead Time   Address       Interface
192.168.101.1     0   FULL/  -   00:00:36    172.16.13.1   Serial0/0/0
192.168.102.1     1   FULL/BDR   00:00:33    172.16.23.2   FastEthernet0/0

R3# show ip route
<output omitted>
     172.16.0.0/24 is subnetted, 6 subnets
C       172.16.23.0 is directly connected, FastEthernet0/0
O       172.16.12.0 [110/2] via 172.16.23.2, 00:02:10, FastEthernet0/0
C       172.16.13.0 is directly connected, Serial0/0/0
O       172.16.1.0 [110/3] via 172.16.23.2, 00:02:10, FastEthernet0/0
O       172.16.2.0 [110/2] via 172.16.23.2, 00:02:10, FastEthernet0/0
C       172.16.3.0 is directly connected, Loopback3
O    192.168.102.0/24 [110/2] via 172.16.23.2, 00:02:10, FastEthernet0/0
C    192.168.103.0/24 is directly connected, Loopback103
O    192.168.101.0/24 [110/3] via 172.16.23.2, 00:02:11, FastEthernet0/0
```

Notice that all the OSPF routes have replaced the RIP routes in the routing table. This is because OSPF has an administrative distance of 110, and RIP has an administrative distance of 120.

What is the best next hop on R1 for 172.16.3.1 with only RIP running?

What is the best next hop on R1 for 172.16.3.1 with OSPF running?

On R1, the best next hop for the R3 loopback is now through the VLAN between R1 and R2. This is because the sum of the costs for the two Ethernet links is still less than that of the single low-bandwidth (64 kb/s) serial link. This is one of the reasons why RIP's metric of a hop count is not very effective.

Which metric does R1 use to make routing decisions about whether to cross the serial link to R3 to reach R3's 172.16.3.1?

Use the following information for your answer.

```
R1# show ip ospf database router adv-router 192.168.103.1

            OSPF Router with ID (192.168.101.1) (Process ID 1)

                Router Link States (Area 0)

  LS age: 433
  Options: (No TOS-capability, DC)
  LS Type: Router Links
  Link State ID: 192.168.103.1
  Advertising Router: 192.168.103.1
  LS Seq Number: 80000003
  Checksum: 0xE87F
  Length: 84
  Number of Links: 5

    Link connected to: a Stub Network
     (Link ID) Network/subnet number: 192.168.103.0
     (Link Data) Network Mask: 255.255.255.0
      Number of TOS metrics: 0
       TOS 0 Metrics: 1

    Link connected to: a Stub Network
     (Link ID) Network/subnet number: 172.16.3.0
     (Link Data) Network Mask: 255.255.255.0
      Number of TOS metrics: 0
       TOS 0 Metrics: 1

    Link connected to: another Router (point-to-point)
     (Link ID) Neighboring Router ID: 192.168.101.1
     (Link Data) Router Interface address: 172.16.13.3
      Number of TOS metrics: 0
       TOS 0 Metrics: 1562
```



```
    Link connected to: a Stub Network
     (Link ID) Network/subnet number: 172.16.13.0
     (Link Data) Network Mask: 255.255.255.0
      Number of TOS metrics: 0
       TOS 0 Metrics: 1562

    Link connected to: a Transit Network
     (Link ID) Designated Router address: 172.16.23.3
     (Link Data) Router Interface address: 172.16.23.3
      Number of TOS metrics: 0
       TOS 0 Metrics: 1
```

Step 6: Modify the routing protocol distance.

The **distance** command is a protocol-independent way to manipulate routing protocol distances. This command is different from the routing protocol-specific commands such as **distance ospf** and **distance eigrp**. This command lets you globally change a routing protocol's distances, change only routes from a certain neighbor or those matching an access list, or a combination of any two of these three options.

Try applying the **distance** *distance* command, which changes the distance of every route. The previous output of the **show ip route** command shows that OSPF marks routes it injects into the routing table with a default administrative distance of 110. RIP injects routes into the routing table with a default administrative distance of 120.

What would happen if the administrative distance on each router for RIP were set to 100?

a. On all three routers, change the distance of RIP to 100.

```
R1(config)# router rip
R1(config-router)# distance 100

R2(config)# router rip
R2(config-router)# distance 100

R3(config)# router rip
R3(config-router)# distance 100
```

b. Examine the output of the **show ip route** command. Notice that *all* the routes have become RIP routes because RIP now has a lower distance than OSPF.

```
R1# show ip route
<output omitted>
     172.16.0.0/24 is subnetted, 6 subnets
R       172.16.23.0 [100/1] via 172.16.13.3, 00:00:17, Serial0/0/1
                    [100/1] via 172.16.12.2, 00:00:09, FastEthernet0/0
C       172.16.12.0 is directly connected, FastEthernet0/0
C       172.16.13.0 is directly connected, Serial0/0/1
C       172.16.1.0 is directly connected, Loopback1
R       172.16.2.0 [100/1] via 172.16.12.2, 00:00:09, FastEthernet0/0
R       172.16.3.0 [100/1] via 172.16.13.3, 00:00:17, Serial0/0/1
R    192.168.102.0/24 [100/1] via 172.16.12.2, 00:00:10, FastEthernet0/0
R    192.168.103.0/24 [100/1] via 172.16.13.3, 00:00:18, Serial0/0/1
C    192.168.101.0/24 is directly connected, Loopback101

R2# show ip route
```

```
<output omitted>
     172.16.0.0/24 is subnetted, 6 subnets
C       172.16.23.0 is directly connected, FastEthernet0/1
C       172.16.12.0 is directly connected, FastEthernet0/0
R       172.16.13.0 [100/1] via 172.16.23.3, 00:00:07, FastEthernet0/1
                    [100/1] via 172.16.12.1, 00:00:07, FastEthernet0/0
R       172.16.1.0 [100/1] via 172.16.12.1, 00:00:07, FastEthernet0/0
C       172.16.2.0 is directly connected, Loopback2
R       172.16.3.0 [100/1] via 172.16.23.3, 00:00:07, FastEthernet0/1
C    192.168.102.0/24 is directly connected, Loopback102
R    192.168.103.0/24 [100/1] via 172.16.23.3, 00:00:08, FastEthernet0/1
R    192.168.101.0/24 [100/1] via 172.16.12.1, 00:00:08, FastEthernet0/0

R3# show ip route
<output omitted>
     172.16.0.0/24 is subnetted, 6 subnets
C       172.16.23.0 is directly connected, FastEthernet0/0
R       172.16.12.0 [100/1] via 172.16.23.2, 00:00:07, FastEthernet0/0
                    [100/1] via 172.16.13.1, 00:00:02, Serial0/0/0
C       172.16.13.0 is directly connected, Serial0/0/0
R       172.16.1.0 [100/1] via 172.16.13.1, 00:00:02, Serial0/0/0
R       172.16.2.0 [100/1] via 172.16.23.2, 00:00:07, FastEthernet0/0
C       172.16.3.0 is directly connected, Loopback3
R    192.168.102.0/24 [100/1] via 172.16.23.2, 00:00:08, FastEthernet0/0
C    192.168.103.0/24 is directly connected, Loopback103
R    192.168.101.0/24 [100/1] via 172.16.13.1, 00:00:03, Serial0/0/0
```

c. You can display the new default distance for RIP using the **show ip protocols** 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 11 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
    FastEthernet0/0       2     2
    Serial0/0/1           2     2
    Loopback1             2     2
    Loopback101           2     2
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
    172.16.0.0
    192.168.101.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    172.16.13.3           100      00:00:14
    172.16.12.2           100      00:00:22
  Distance: (default is 100)
<output omitted>
```

Step 7: Modify distance based on route source.

You can also modify administrative distance based on route source using the **distance** *distance address wildcard* command, where *address* and *wildcard* represent the peer advertising the route. For OSPF, the address is the router ID.

a. On all three routers, change the OSPF administrative distance to 85 for any routes being advertised from routers with IDs in the range of 192.168.100.0/21.

```
R1(config)# router ospf 1
R1(config-router)# distance 85 192.168.100.0 0.0.3.255

R2(config)# router ospf 1
R2(config-router)# distance 85 192.168.100.0 0.0.3.255

R3(config)# router ospf 1
R3(config-router)# distance 85 192.168.100.0 0.0.3.255
```

b. Verify the change with the **show ip protocols** and **show ip route** commands.

```
R1# show ip route
<output omitted>

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 6 subnets
O       172.16.23.0 [85/2] via 172.16.12.2, 00:00:31, FastEthernet0/0
C       172.16.12.0 is directly connected, FastEthernet0/0
C       172.16.13.0 is directly connected, Serial0/0/1
C       172.16.1.0 is directly connected, Loopback1
O       172.16.2.0 [85/2] via 172.16.12.2, 00:00:31, FastEthernet0/0
O       172.16.3.0 [85/3] via 172.16.12.2, 00:00:31, FastEthernet0/0
O    192.168.102.0/24 [85/2] via 172.16.12.2, 00:00:31, FastEthernet0/0
O    192.168.103.0/24 [85/3] via 172.16.12.2, 00:00:32, FastEthernet0/0
C    192.168.101.0/24 is directly connected, Loopback101

R2# show ip route
<output omitted>

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 6 subnets
C       172.16.23.0 is directly connected, FastEthernet0/1
C       172.16.12.0 is directly connected, FastEthernet0/0
O       172.16.13.0 [85/1563] via 172.16.23.3, 00:00:53, FastEthernet0/1
                    [85/1563] via 172.16.12.1, 00:00:53, FastEthernet0/0
O       172.16.1.0 [85/2] via 172.16.12.1, 00:00:53, FastEthernet0/0
C       172.16.2.0 is directly connected, Loopback2
O       172.16.3.0 [85/2] via 172.16.23.3, 00:00:53, FastEthernet0/1
C    192.168.102.0/24 is directly connected, Loopback102
O    192.168.103.0/24 [85/2] via 172.16.23.3, 00:00:54, FastEthernet0/1
O    192.168.101.0/24 [85/2] via 172.16.12.1, 00:00:54, FastEthernet0/0
R3# show ip route
<output omitted>

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 6 subnets
C       172.16.23.0 is directly connected, FastEthernet0/0
```

```
O       172.16.12.0 [85/2] via 172.16.23.2, 00:01:15, FastEthernet0/0
C       172.16.13.0 is directly connected, Serial0/0/0
O       172.16.1.0 [85/3] via 172.16.23.2, 00:01:15, FastEthernet0/0
O       172.16.2.0 [85/2] via 172.16.23.2, 00:01:15, FastEthernet0/0
C       172.16.3.0 is directly connected, Loopback3
O    192.168.102.0/24 [85/2] via 172.16.23.2, 00:01:15, FastEthernet0/0
C    192.168.103.0/24 is directly connected, Loopback103
O    192.168.101.0/24 [85/3] via 172.16.23.2, 00:01:16, FastEthernet0/0

R1# show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.101.1
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    172.16.0.0 0.0.255.255 area 0
    192.168.101.0 0.0.0.255 area 0
 Reference bandwidth unit is 100 mbps
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.103.1         85      00:05:47
    192.168.102.1         85      00:05:47
  Distance: (default is 110)
    Address         Wild mask       Distance  List
    192.168.100.0         0.0.3.255       85
```

Each of the routers should have an entry similar to the one highlighted above.

Step 8: Modify distance based on an access list.

You can also modify administrative distance based on which routes match an access list using the **distance** *distance address wildcard acl* command. The way you list routes in an access list which will be used to modify distance is similar to how you list them when the access list is used to filter routes. For this lab, create an access list containing all the subnets of 172.16.0.0/16. Then associate the access list with the **distance** command, setting the address and wildcard to be any IP address (i.e., any route source).

a. On all three routers, change the distances of the affected routes to 65.

```
R1(config)# access-list 1 permit 172.16.0.0 0.0.255.255
R1(config)# router rip
R1(config-router)# distance 65 0.0.0.0 255.255.255.255 1

R2(config)# access-list 1 permit 172.16.0.0 0.0.255.255
R2(config)# router rip
R2(config-router)# distance 65 0.0.0.0 255.255.255.255 1

R3(config)# access-list 1 permit 172.16.0.0 0.0.255.255
R3(config)# router rip
R3(config-router)# distance 65 0.0.0.0 255.255.255.255 1
```

b. Verify the change with the **show ip protocols** and **show ip route** commands.

```
R1# show ip protocols
<output omitted>

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 22 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
    FastEthernet0/0       2     2
    Serial0/0/1           2     2
    Loopback1             2     2
    Loopback101           2     2
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
    172.16.0.0
    192.168.101.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    172.16.12.2           64      00:00:11
    172.16.13.3           64      00:00:12
  Distance: (default is 100)
    Address         Wild mask       Distance  List
    0.0.0.0         255.255.255.255       65  1

R1# show ip route
<output omitted>
     172.16.0.0/24 is subnetted, 6 subnets
R       172.16.23.0 [65/1] via 172.16.13.3, 00:00:20, Serial0/0/1
                    [65/1] via 172.16.12.2, 00:00:19, FastEthernet0/0
C       172.16.12.0 is directly connected, FastEthernet0/0
C       172.16.13.0 is directly connected, Serial0/0/1
C       172.16.1.0 is directly connected, Loopback1
R       172.16.2.0 [65/1] via 172.16.12.2, 00:00:19, FastEthernet0/0
R       172.16.3.0 [65/1] via 172.16.13.3, 00:00:20, Serial0/0/1
O    192.168.102.0/24 [85/2] via 172.16.12.2, 00:09:09, FastEthernet0/0
O    192.168.103.0/24 [85/3] via 172.16.12.2, 00:09:09, FastEthernet0/0
C    192.168.101.0/24 is directly connected, Loopback101

R2# show ip protocols
<output omitted>
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 27 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
    FastEthernet0/0       2     2
    FastEthernet0/1       2     2
    Loopback2             2     2
    Loopback102           2     2
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
    172.16.0.0
    192.168.102.0
  Routing Information Sources:
    Gateway         Distance      Last Update
```

```
    172.16.23.3           65      00:00:06
    172.16.12.1           65      00:00:22
  Distance: (default is 100)
    Address         Wild mask       Distance  List
    0.0.0.0         255.255.255.255       65  1

R2# show ip route
<output omitted>
     172.16.0.0/24 is subnetted, 6 subnets
C       172.16.23.0 is directly connected, FastEthernet0/1
C       172.16.12.0 is directly connected, FastEthernet0/0
R       172.16.13.0 [65/1] via 172.16.23.3, 00:00:10, FastEthernet0/1
                    [65/1] via 172.16.12.1, 00:00:00, FastEthernet0/0
R       172.16.1.0 [65/1] via 172.16.12.1, 00:00:00, FastEthernet0/0
C       172.16.2.0 is directly connected, Loopback2
R       172.16.3.0 [65/1] via 172.16.23.3, 00:00:10, FastEthernet0/1
C    192.168.102.0/24 is directly connected, Loopback102
O    192.168.103.0/24 [85/2] via 172.16.23.3, 00:09:35, FastEthernet0/1
O    192.168.101.0/24 [85/2] via 172.16.12.1, 00:09:35, FastEthernet0/0

R3# show ip protocols
<output omitted>
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 15 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
    FastEthernet0/0       2     2
    Serial0/0/0           2     2
    Loopback3             2     2
    Loopback103           2     2
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
    172.16.0.0
    192.168.103.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    172.16.23.2           65      00:00:24
    172.16.13.1           65      00:00:16
  Distance: (default is 100)
    Address         Wild mask       Distance  List
    0.0.0.0         255.255.255.255       65  1

R3# show ip route
<output omitted>
     172.16.0.0/24 is subnetted, 6 subnets
C       172.16.23.0 is directly connected, FastEthernet0/1
R       172.16.12.0 [65/1] via 172.16.23.2, 00:00:00, FastEthernet0/1
                    [65/1] via 172.16.13.1, 00:00:19, Serial0/0/0
C       172.16.13.0 is directly connected, Serial0/0/0
R       172.16.1.0 [65/1] via 172.16.13.1, 00:00:19, Serial0/0/0
R       172.16.2.0 [65/1] via 172.16.23.2, 00:00:00, FastEthernet0/1
C       172.16.3.0 is directly connected, Loopback3
O    192.168.102.0/24 [85/2] via 172.16.23.2, 00:09:43, FastEthernet0/1
```

```
C    192.168.103.0/24 is directly connected, Loopback103
O    192.168.101.0/24 [85/3] via 172.16.23.2, 00:09:43, FastEthernet0/1
```

c. Verify full connectivity with the following Tcl script.

```
R1# tclsh

foreach address {
172.16.1.1
172.16.2.1
172.16.3.1
172.16.12.1
172.16.12.2
172.16.13.1
172.16.13.3
172.16.23.2
172.16.23.3
192.168.101.1
192.168.102.1
192.168.103.1
} { ping $address }
```

Challenge

Attempt this exercise based on what you know about OSPF, Dijkstra's algorithm, and the **distance** command. Using only the **distance** command, write out the commands necessary to confuse the routers in this topology so that packets destined for 172.16.3.1 would continually bounce between R1 to R2?

Because it is possible to intentionally break routing in this way, what degree of caution should be exercised when manipulating administrative distances in a production network?

Router Interface Summary Table

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
1700	Fast Ethernet 0 (FA0)	Fast Ethernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
1800	Fast Ethernet 0/0 (FA0/0)	Fast Ethernet 0/1 (FA0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
2600	Fast Ethernet 0/0 (FA0/0)	Fast Ethernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)
2800	Fast Ethernet 0/0 (FA0/0)	Fast Ethernet 0/1 (FA0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
Note: To find out how the router is configured, look at the interfaces to identify the type of router and how many interfaces the router has. Rather than list all combinations of configurations for each router class, this table includes identifiers for the possible combinations of Ethernet and serial interfaces in the device. The table does not include any other type of interface, even though a specific router might contain one. For example, for an ISDN BRI interface, the string in parenthesis is the legal abbreviation that can be used in Cisco IOS commands to represent the interface.				