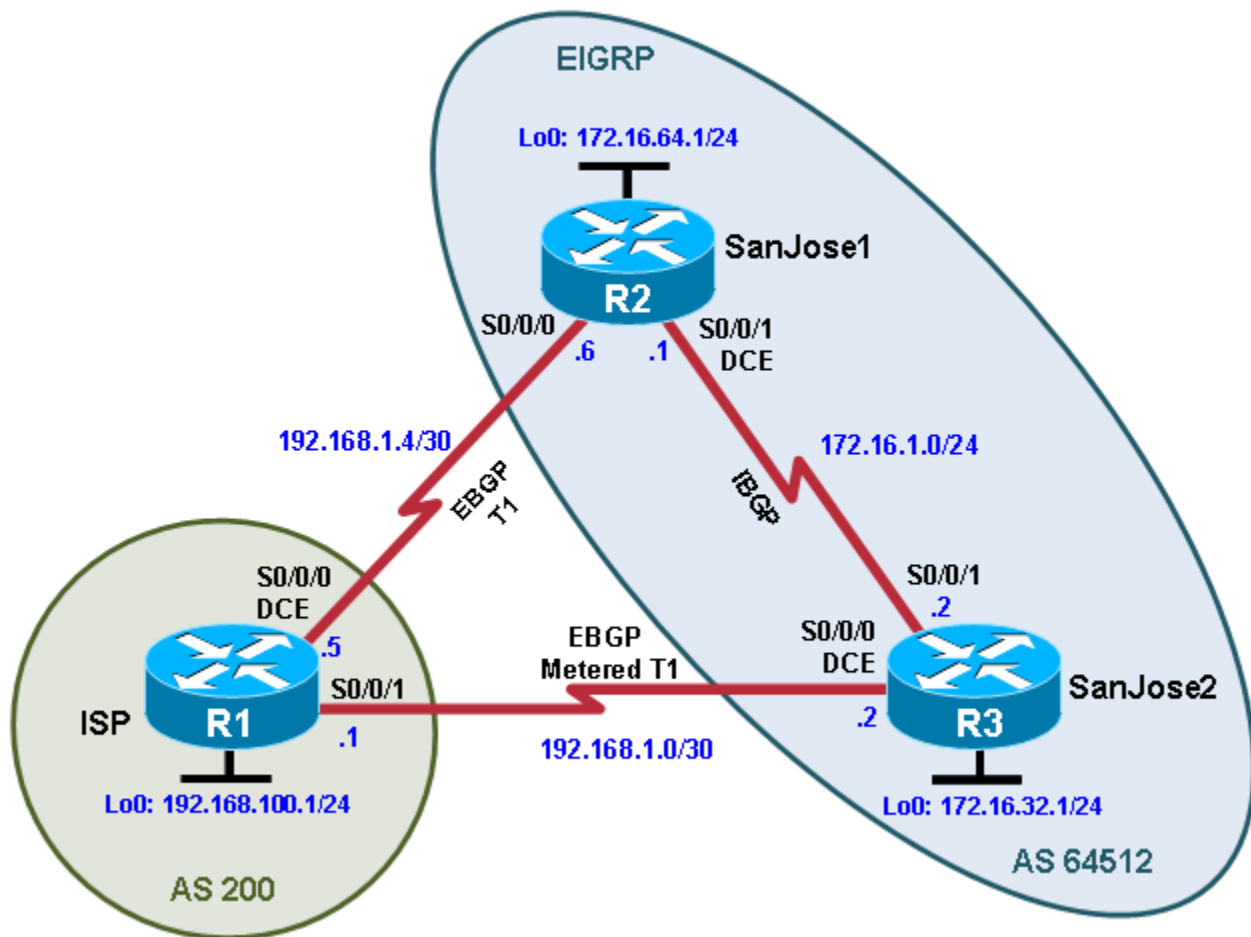


Chapter 6 Lab 6-3, Configuring IBGP and EBGP Sessions, Local Preference, and MED

Topology



Objectives

- For IBGP peers to correctly exchange routing information, use the **next-hop-self** command with the **Local-Preference** and **MED** attributes.
- Ensure that the flat-rate, unlimited-use T1 link is used for sending and receiving data to and from the AS 200 on ISP and that the metered T1 only be used in the event that the primary T1 link has failed.

Background

The International Travel Agency runs BGP on its SanJose1 and SanJose2 routers externally with the ISP router in AS 200. IBGP is run internally between SanJose1 and SanJose2. Your job is to configure both

EBGP and IBGP for this internetwork to allow for redundancy. The metered T1 should only be used in the event that the primary T1 link has failed. Traffic sent across the metered T1 link offers the same bandwidth of the primary link but at a huge expense. Ensure that this link is not used unnecessarily.

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. You can use other routers (such as 2801 or 2811) and Cisco IOS Software versions if they have comparable capabilities and features. Depending on the router 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)
- Serial and console cables

Step 1: Prepare the routers for the lab.

Cable the network as shown in the topology diagram. Erase the startup configuration and reload each router to clear previous configurations.

Step 2: Configure the hostname and interface addresses.

- a. You can copy and paste the following configurations into your routers to begin.

Router R1 (hostname ISP)

```
hostname ISP
!
interface Loopback0
 ip address 192.168.100.1 255.255.255.0
!
interface Serial0/0/0
 ip address 192.168.1.5 255.255.255.252
 clock rate 128000
 no shutdown
!
interface Serial0/0/1
 ip address 192.168.1.1 255.255.255.252
 no shutdown
```

Router R2 (hostname SanJose1)

```
hostname SanJose1
!
interface Loopback0
 ip address 172.16.64.1 255.255.255.0
!
interface Serial0/0/0
 ip address 192.168.1.6 255.255.255.252
 no shutdown
!
interface Serial0/0/1
 ip address 172.16.1.1 255.255.255.0
 clock rate 128000
 no shutdown
```

Router R3 (hostname SanJose2)

```
hostname SanJose2
!
interface Loopback0
 ip address 172.16.32.1 255.255.255.0
!
interface Serial0/0/0
 ip address 192.168.1.2 255.255.255.252
 clock rate 128000
 no shutdown
!
interface Serial0/0/1
 ip address 172.16.1.2 255.255.255.0
 no shutdown
```

- b. Use **ping** to test the connectivity between the directly connected routers. Both SanJose routers should be able to ping each other and their local ISP serial link IP address. The ISP router cannot reach the segment between SanJose1 and SanJose2.

Step 3: Configure EIGRP.

Configure EIGRP between the SanJose1 and SanJose2 routers.

```
SanJose1(config)# router eigrp 64512
SanJose1(config-router)# no auto-summary
SanJose1(config-router)# network 172.16.0.0

SanJose2(config)# router eigrp 64512
SanJose2(config-router)# no auto-summary
SanJose2(config-router)# network 172.16.0.0
```

Step 4: Configure IBGP and verify BGP neighbors.

- a. Configure IBGP between the SanJose1 and SanJose2 routers. On the SanJose1 router, enter the following configuration.

```
SanJose1(config)# router bgp 64512
SanJose1(config-router)# neighbor 172.16.32.1 remote-as 64512
SanJose1(config-router)# neighbor 172.16.32.1 update-source lo0
```

If multiple pathways to the BGP neighbor exist, the router can use multiple IP interfaces to communicate with the neighbor. The source IP address therefore depends on the outgoing interface. The **update-source lo0** command instructs the router to use the IP address of the interface Loopback0 as the source IP address for all BGP messages sent to that neighbor.

- b. Complete the IBGP configuration on SanJose2 using the following commands.

```
SanJose2(config)# router bgp 64512
SanJose2(config-router)# neighbor 172.16.64.1 remote-as 64512
SanJose2(config-router)# neighbor 172.16.64.1 update-source lo0
```

- c. Verify that SanJose1 and SanJose2 become BGP neighbors by issuing the **show ip bgp neighbors** command on SanJose1. View the following partial output. If the BGP state is not established, troubleshoot the connection.

```
SanJose2# show ip bgp neighbors
BGP neighbor is 172.16.64.1, remote AS 64512, internal link
  BGP version 4, remote router ID 172.16.64.1
  BGP state = Established, up for 00:00:01
```

<output omitted>

The link between SanJose1 and SanJose2 should be identified as an internal link, as shown in the output.

Step 5: Configure EBGP and verify BGP neighbors.

- a. Configure ISP to run EBGP with SanJose1 and SanJose2. Enter the following commands on ISP.

```
ISP(config)# router bgp 200
ISP(config-router)# neighbor 192.168.1.6 remote-as 64512
ISP(config-router)# neighbor 192.168.1.2 remote-as 64512
ISP(config-router)# network 192.168.100.0
```

Because EBGP sessions are almost always established over point-to-point links, there is no reason to use the **update-source** keyword in this configuration. Only one path exists between the peers. If this path goes down, alternative paths are not available.

- b. Configure SanJose1 as an EBGP peer to ISP.

```
SanJose1(config)# ip route 172.16.0.0 255.255.0.0 null0
SanJose1(config)# router bgp 64512
SanJose1(config-router)# neighbor 192.168.1.5 remote-as 200
SanJose1(config-router)# network 172.16.0.0
```

- c. Use the **show ip bgp neighbors** command to verify that SanJose1 and ISP have reached the established state. Troubleshoot if necessary.

```
SanJose1# show ip bgp neighbors
```

```
BGP neighbor is 172.16.32.1, remote AS 64512, internal link
  BGP version 4, remote router ID 172.16.32.1
  BGP state = Established, up for 00:03:10
<output omitted>
```

```
BGP neighbor is 192.168.1.5, remote AS 200, external link
  BGP version 4, remote router ID 192.168.100.1
  BGP state = Established, up for 00:03:10
<output omitted>
```

You should also see an informational message indicating the establishment of the BGP neighbor relationship.

```
*Mar  8 19:41:14.111: %BGP-5-ADJCHANGE: neighbor 192.168.1.5 Up
```

- d. Configure SanJose2 as an EBGP peer to ISP.

```
SanJose2(config)# ip route 172.16.0.0 255.255.0.0 null0
SanJose2(config)# router bgp 64512
SanJose2(config-router)# neighbor 192.168.1.1 remote-as 200
SanJose2(config-router)# network 172.16.0.0
```

Step 6: View BGP summary output.

In Step 5, the **show ip bgp neighbors** command was used to verify that SanJose1 and ISP had reached the established state. A useful alternative command is **show ip bgp summary**. The output should be similar to the following.

```
SanJose2# show ip bgp summary
```

```
BGP router identifier 172.16.32.1, local AS number 64512
BGP table version is 2, main routing table version 2
1 network entries and 1 paths using 137 bytes of memory
```

```

1 BGP path attribute entries using 60 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP activity 2/1 prefixes, 2/1 paths, scan interval 15 secs

```

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	
State/PfxRcd									
172.16.64.1	4	64512	21	24	2	0	0	00:03:02	2
192.168.1.1	4	200	14	15	2	0	0	00:03:36	1

Step 7: Verify which path the traffic takes.

- Clear the IP BGP conversation with the **clear ip bgp *** command on ISP. Wait for the conversations to reestablish with each SanJose router.
- Test whether ISP can ping the loopback 0 address of 172.16.64.1 on SanJose1 and the serial link between SanJose1 and SanJose2, 172.16.1.1.
- Now ping from ISP to the loopback 0 address of 172.16.32.1 on SanJose2 and the serial link between SanJose1 and SanJose2, 172.16.1.2.

You should see successful pings to each IP address on SanJose2 router. Ping attempts to 172.16.64.1 and 172.16.1.1 should fail. Why does this happen?

- Issue the **show ip bgp** command on ISP to verify BGP routes and metrics.

```
ISP# show ip bgp
```

```

BGP table version is 3, local router ID is 192.168.100.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal
Origin codes: i - IGP, e - EGP, ? - incomplete

```

Network	Next Hop	Metric	LocPrf	Weight	Path
*> 172.16.0.0	192.168.1.2	0		0	64512 i
*	192.168.1.6	0		0	64512 i
*> 192.168.100.0	0.0.0.0	0		32768	i

Notice that ISP has two valid routes to the 172.16.0.0 network, as indicated by the *. However, the link to SanJose2 has been selected as the best path. Why did the ISP prefer the link to SanJose2 over SanJose1?

Would changing the bandwidth metric on each link help to correct this issue? Explain.

BGP operates differently than all other protocols. Unlike other routing protocols that use complex algorithms involving factors such as bandwidth, delay, reliability, and load to formulate a metric, BGP is policy-based. BGP determines the best path based on variables, such as AS path, weight, local preference, MED, and so on. If all things are equal, BGP prefers the route leading to the BGP speaker

with the lowest BGP router ID. The SanJose2 router with BGP router ID 172.16.32.1 was preferred to the higher BGP router ID of the SanJose1 router (172.16.64.1).

- e. At this point, the ISP router should be able to get to each network connected to SanJose1 and SanJose2 from the loopback address 192.168.100.1. Use the extended **ping** command and specify the source address of ISP Lo0 to test.

```
ISP# ping 172.16.1.1 source 192.168.100.1
```

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 172.16.1.1, timeout is 2 seconds:

Packet sent with a source address of 192.168.100.1

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 20/21/24 ms

```
ISP# ping 172.16.32.1 source 192.168.100.1
```

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 172.16.32.1, timeout is 2 seconds:

Packet sent with a source address of 192.168.100.1

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 12/15/16 ms

```
ISP# ping 172.16.1.2 source 192.168.100.1
```

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 172.16.1.2, timeout is 2 seconds:

Packet sent with a source address of 192.168.100.1

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 12/15/16 ms

```
ISP#
```

```
ISP# ping 172.16.64.1 source 192.168.100.1
```

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 172.16.64.1, timeout is 2 seconds:

Packet sent with a source address of 192.168.100.1

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 20/21/24 ms

You can also use the extended ping dialogue to specify the source address, as shown in this example.

```
ISP# ping
```

Protocol [ip]:

Target IP address: **172.16.64.1**

Repeat count [5]:

Datagram size [100]:

Timeout in seconds [2]:

Extended commands [n]: **y**

Source address or interface: **192.168.100.1**

Type of service [0]:

Set DF bit in IP header? [no]:

Validate reply data? [no]:

Data pattern [0xABCD]:

Loose, Strict, Record, Timestamp, Verbose[none]:

Sweep range of sizes [n]:

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 172.16.64.1, timeout is 2 seconds:

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 48/48/52 ms

Complete reachability has been demonstrated between the ISP router and both SanJose1 and SanJose2.

Step 8: Configure the BGP next-hop-self feature.

SanJose1 is unaware of the link between ISP and SanJose2, and SanJose2 is unaware of the link between ISP and SanJose1. Before ISP can successfully ping all the internal serial interfaces of AS 64512, these serial links should be advertised via BGP on the ISP router. This can also be resolved via EIGRP on each SanJose router. The preferred method is for ISP to advertise these links.

- a. Issue the following commands on the ISP router.

```
ISP(config)# router bgp 200
ISP(config-router)# network 192.168.1.0 mask 255.255.255.252
ISP(config-router)# network 192.168.1.4 mask 255.255.255.252
```

- b. Issue the **show ip bgp** command to verify that the ISP is correctly injecting its own WAN links into BGP.

```
ISP# show ip bgp
BGP table version is 5, local router ID is 192.168.100.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal Origin codes: i - IGP, e - EGP, ? - incomplete
```

Network	Next Hop	Metric	LocPrf	Weight	Path
*> 172.16.0.0	192.168.1.2		0	0	64512 i
*	192.168.1.6		0	0	64512 i
*> 192.168.1.0/30	0.0.0.0		0	32768	i
*> 192.168.1.4/30	0.0.0.0		0	32768	i
*> 192.168.100.0	0.0.0.0		0	32768	i

- c. Verify on SanJose1 and SanJose2 that the opposite WAN link is included in the routing table. The output from SanJose2 is as follows.

```
SanJose2# show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route
```

Gateway of last resort is not set

```

      172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
C       172.16.32.0/24 is directly connected, Loopback0
S       172.16.0.0/16 is directly connected, Null0
C       172.16.1.0/24 is directly connected, Serial0/0/1
D       172.16.64.0/24 [90/2297856] via 172.16.1.1, 01:02:10, Serial0/0/1
      192.168.1.0/30 is subnetted, 2 subnets
C       192.168.1.0 is directly connected, Serial0/0/0
B       192.168.1.4 [20/0] via 192.168.1.1, 00:01:13
B       192.168.100.0/24 [20/0] via 192.168.1.1, 00:33:32
```

The next issue to consider is BGP policy routing between autonomous systems. The next-hop attribute of a route in a different AS is set to the IP address of the border router in the next AS toward the destination, and this attribute is not modified by default when advertising this route through IBGP. Therefore, for all IBGP peers, it is either necessary to know the route to that border router (in a different neighboring AS),

or our own border router needs to advertise the foreign routes using the next-hop-self feature, overriding the next-hop address with its own IP address. The SanJose2 router is passing a policy to SanJose1 and vice versa. The policy for routing from AS 64512 to AS 200 is to forward packets to the 192.168.1.1 interface. SanJose1 has a similar yet opposite policy: it forwards requests to the 192.168.1.5 interface. If either WAN link fails, it is critical that the opposite router become a valid gateway. This is achieved if the **next-hop-self** command is configured on SanJose1 and SanJose2.

- d. View the output before the **next-hop-self** command is issued.

```
SanJose2# show ip bgp
BGP table version is 11, local router ID is 172.16.32.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal Origin codes: i - IGP, e - EGP, ? - incomplete
```

Network	Next Hop	Metric	LocPrf	Weight	Path
*> 172.16.0.0	0.0.0.0	0		32768	i
* i192.168.1.0/30	192.168.1.5	0	100	0	200 i
*>	192.168.1.1	0		0	200 i
* i192.168.1.4/30	192.168.1.5	0	100	0	200 i
*>	192.168.1.1	0		0	200 i
* i192.168.100.0	192.168.1.5	0	100	0	200 i
*>	192.168.1.1	0		0	200 i

- e. Issue the **next-hop-self** command on SanJose1 and SanJose2.

```
SanJose1(config)# router bgp 64512
SanJose1(config-router)# neighbor 172.16.32.1 next-hop-self
```

```
SanJose2(config)# router bgp 64512
SanJose2(config-router)# neighbor 172.16.64.1 next-hop-self
```

- f. Reset BGP operation on either router with the **clear ip bgp * soft** command.
- g. After the routers have returned to established BGP speakers, issue the **show ip bgp** command to validate that the next hop has also been corrected.

```
SanJose2# show ip bgp
BGP table version is 11, local router ID is 172.16.32.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal
Origin codes: i - IGP, e - EGP, ? - incomplete
```

Network	Next Hop	Metric	LocPrf	Weight	Path
*> 172.16.0.0	0.0.0.0	0		32768	i
* i192.168.1.0/30	172.16.64.1	0	100	0	200 i
*>	192.168.1.1	0		0	200 i
* i192.168.1.4/30	172.16.64.1	0	100	0	200 i
*>	192.168.1.1	0		0	200 i
* i192.168.100.0	172.16.64.1	0	100	0	200 i
*>	192.168.1.1	0		0	200 i

Step 9: Set BGP local preference.

At this point, everything looks good, with the exception of default routes, the outbound flow of data, and inbound packet flow.

- a. Because the local preference value is shared between IBGP neighbors, configure a simple route map that references the local preference value on SanJose1 and SanJose2. This policy adjusts outbound traffic to prefer the link off the SanJose1 router instead of the metered T1 off SanJose2.


```
SanJose1(config)# route-map PRIMARY_T1_IN permit 10
SanJose1(config-route-map)# set local-preference 150
SanJose1(config-route-map)# exit
SanJose1(config)# router bgp 64512
SanJose1(config-router)# neighbor 192.168.1.5 route-map PRIMARY_T1_IN in
```

```
SanJose2(config)# route-map SECONDARY_T1_IN permit 10
SanJose2(config-route-map)# set local-preference 125
SanJose1(config-route-map)# exit
SanJose2(config)# router bgp 64512
SanJose2(config-router)# neighbor 192.168.1.1 route-map SECONDARY_T1_IN in
```

- b. Use the **clear ip bgp *** soft command after configuring this new policy. When the conversations have been reestablished, issue the **show ip bgp** command on SanJose1 and SanJose2.

```
SanJose1# clear ip bgp * soft
SanJose2# clear ip bgp * soft
```

```
SanJose1# show ip bgp
```

BGP table version is 8, local router ID is 172.16.64.1
 Status codes: s suppressed, d damped, h history, * valid, > best, i -
 internal Origin codes: i - IGP, e - EGP, ? - incomplete

Network	Next Hop	Metric	LocPrf	Weight	Path
* i172.16.0.0	172.16.32.1	0	100	0	i
*>	0.0.0.0	0		32768	i
*> 192.168.1.0/30	192.168.1.5	0	150	0	200 i
*> 192.168.1.4/30	192.168.1.5	0	150	0	200 i
*> 192.168.100.0	192.168.1.5	0	150	0	200 i

```
SanJose2# show ip bgp
```

BGP table version is 11, local router ID is 172.16.32.1
 Status codes: s suppressed, d damped, h history, * valid, > best, i -
 internal Origin codes: i - IGP, e - EGP, ? - incomplete

Network	Next Hop	Metric	LocPrf	Weight	Path
*> 172.16.0.0	0.0.0.0	0		32768	i
*i	172.16.64.1	0	100	0	i
*>i192.168.1.0/30	172.16.64.1	0	150	0	200 i
*	192.168.1.1	0	125	0	200 i
*>i192.168.1.4/30	172.16.64.1	0	150	0	200 i
*	192.168.1.1	0	125	0	200 i
*>i192.168.100.0	172.16.64.1	0	150	0	200 i
*	192.168.1.1	0	125	0	200 i

This now indicates that routing to the loopback segment for ISP 192.168.100.0 /24 can be reached only through the link common to SanJose1 and ISP.

Step 10: Set BGP MED.

How will traffic return from network 192.168.100.0 /24? Will it be routed through SanJose1 or SanJose2?

The simplest solution is to issue the **show ip bgp** command on the ISP router. What if access was not given to the ISP router? Traffic returning from the Internet should not be passed across the metered T1. Is there a simple way to verify before receiving the monthly bill? How can it be checked instantly?

- a. Use an extended **ping** command in this situation. Specify the **record** option and compare your output to the following.

```
SanJose2# ping
Protocol [ip]:
Target IP address: 192.168.100.1
Repeat count [5]: 2
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 172.16.32.1
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]: record
Number of hops [ 9 ]:
Loose, Strict, Record, Timestamp, Verbose[RV]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.100.1, timeout is 2 seconds:
Packet has IP options: Total option bytes= 39, padded length=40
Record route: <*>
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)

Reply to request 0 (48 ms). Received packet has options
Total option bytes= 40, padded length=40
Record route:
(172.16.1.2)
(192.168.1.6)
(192.168.100.1)
(192.168.1.1)
```

```
(172.16.32.1) <*>
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
End of list
```

```
Reply to request 1 (48 ms).  Received packet has options
Total option bytes= 40, padded length=40
Record route:
(172.16.1.2)
(192.168.1.6)
(192.168.100.1)
(192.168.1.1)
(172.16.32.1) <*>
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
End of list
```

If you are unfamiliar with the **record** option, the important thing to note is that each IP address in brackets is an outgoing interface. The output can be interpreted as follows:

1. A ping that is sourced from 172.16.32.1 exits SanJose2 through s0/0/1, 172.16.1.2. It then arrives at the s0/0/1 interface for SanJose1.
2. SanJose1 S0/0/0, 192.168.1.6, routes the packet out to arrive at the S0/0/0 interface of ISP.
3. The target of 192.168.100.1 is reached: 192.168.100.1.
4. The packet is next forwarded out the S0/0/1, 192.168.1.1 interface for ISP and arrives at the S0/0/0 interface for SanJose2.
5. SanJose2 then forwards the packet out the last interface, loopback 0, 172.16.32.1.

Although the unlimited use of the T1 from SanJose1 is preferred here, ISP currently takes the link from SanJose2 for all return traffic.

- b. Create a new policy to force the ISP router to return all traffic via SanJose1. Create a second route map utilizing the MED (metric) that is shared between EBGp neighbors.

```
SanJose1(config)#route-map PRIMARY_T1_MED_OUT permit 10
SanJose1(config-route-map)#set Metric 50
SanJose1(config-route-map)#exit
SanJose1(config)#router bgp 64512
SanJose1(config-router)#neighbor 192.168.1.5 route-map PRIMARY_T1_MED_OUT out

SanJose2(config)#route-map SECONDARY_T1_MED_OUT permit 10
SanJose2(config-route-map)#set Metric 75
SanJose2(config-route-map)#exit
SanJose2(config)#router bgp 64512
SanJose2(config-router)#neighbor 192.168.1.1 route-map SECONDARY_T1_MED_OUT
out
```

- c. Use the **clear ip bgp * soft** command after issuing this new policy. Issuing the **show ip bgp** command as follows on SanJose1 or SanJose2 does not indicate anything about this newly defined policy.

```
SanJose1# clear ip bgp * soft
SanJose2# clear ip bgp * soft
```

```
SanJose1# show ip bgp
BGP table version is 10, local router ID is 172.16.64.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal Origin codes: i - IGP, e - EGP, ? - incomplete
```

Network	Next Hop	Metric	LocPrf	Weight	Path
* i172.16.0.0	172.16.32.1	0	100	0	i
*>	0.0.0.0	0		32768	i
*> 192.168.1.0/30	192.168.1.5	0	150	0	200 i
*> 192.168.1.4/30	192.168.1.5	0	150	0	200 i
*> 192.168.100.0	192.168.1.5	0	150	0	200 i

- d. Reissue an extended **ping** command with the **record** command.

```
SanJose2# ping
Protocol [ip]:
Target IP address: 192.168.100.1
Repeat count [5]: 2
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 172.16.32.1
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]: record
Number of hops [ 9 ]:
Loose, Strict, Record, Timestamp, Verbose[RV]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.100.1, timeout is 2 seconds:
Packet has IP options: Total option bytes= 39, padded length=40
Record route: <*>
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
Reply to request 0 (64 ms). Received packet has options
Total option bytes= 40, padded length=40
Record route:
(172.16.1.2)
(192.168.1.6)
(192.168.100.1)
(192.168.1.5)
(172.16.1.1)
(172.16.32.1) <*>
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
End of list
Reply to request 1 (64 ms). Received packet has options
Total option bytes= 40, padded length=40
Record route:
```

```
(172.16.1.2)
(192.168.1.6)
(192.168.100.1)
(192.168.1.5)
(172.16.1.1)
(172.16.32.1) <*>
(0.0.0.0)
(0.0.0.0)
(0.0.0.0)
End of list
```

Does the output look correct? Does the 192.168.1.5 above mean that the ISP now prefers SanJose1 for return traffic?

There might not be a chance to use Telnet to the ISP router and to issue the **show ip bgp** command. However, the command on the opposite side of the newly configured policy MED is clear, showing that the lower value is considered best. The ISP now prefers the route with the lower MED value to AS 64512. This is just opposite from the **local-preference** command configured earlier.

ISP# **show ip bgp**

```
BGP table version is 12, local router ID is 192.168.100.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal      Origin codes: i - IGP, e - EGP, ? - incomplete
   Network          Next Hop              Metric LocPrf Weight Path
*  172.16.0.0        192.168.1.2                75           0 64512 i
*> 172.16.0.0        192.168.1.6                50           0 64512 i
*> 192.168.1.0/30    0.0.0.0                    0           32768 i
*> 192.168.1.4/30    0.0.0.0                    0           32768 i
*> 192.168.100.0     0.0.0.0                    0           32768 i
```

Step 11: Establish a default network.

The final step is to establish a default route that uses a policy statement that adjusts to changes in the network. Configure both SanJose1 and SanJose2 to use the 192.168.100.0 /24 network as the default network. The following steps configure the SanJose1 router. Do the same on the SanJose2 router.

- View the routing table prior to issuing the **ip default-network** statement.

```
SanJose1# show ip route
Gateway of last resort is not set
  172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
D    172.16.32.0/24 [90/20640000] via 172.16.1.2, 02:43:46, Serial0/1
B    172.16.0.0/16 [200/0] via 172.16.32.1, 00:12:32
C    172.16.1.0/24 is directly connected, Serial0/1
C    172.16.64.0/24 is directly connected, Loopback0
    192.168.1.0/30 is subnetted, 2 subnets
B    192.168.1.0 [20/0] via 192.168.1.5, 00:14:05
C    192.168.1.4 is directly connected, Serial0/0
B    192.168.100.0/24 [20/0] via 192.168.1.5, 00:14:05
```

- Configure the default network.

```
SanJose1(config)#ip default-network 192.168.100.0
```

Note: The above command works well only with remotely-learned classful networks. It should not be used with classless networks. An alternative to using the **ip default-network** command on SanJose1 is issuing the **neighbor X.X.X.X default-originate** configuration on the ISP router.

- c. View the routing table after issuing the **ip default-network** statement.

```
SanJose1# show ip route
Gateway of last resort is 192.168.1.5 to network 192.168.100.0
 172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
D    172.16.32.0/24 [90/20640000] via 172.16.1.2, 02:44:09, Serial0/1
B    172.16.0.0/16 [200/0] via 172.16.32.1, 00:12:55
C    172.16.1.0/24 is directly connected, Serial0/1
C    172.16.64.0/24 is directly connected, Loopback0
     192.168.1.0/30 is subnetted, 2 subnets
B     192.168.1.0 [20/0] via 192.168.1.5, 00:14:28
C     192.168.1.4 is directly connected, Serial0/0
B*   192.168.100.0/24 [20/0] via 192.168.1.5, 00:14:29
```

What would be required to add a future T3 link on SanJose2 and for it to have preference for incoming and outgoing traffic?

A newly added route is as easy as adding another route map for local preference with a value of 175 and a route map referencing a MED (metric) value of 35.

NOTE: By default, the MED is compared only when the route is being received from the same neighboring AS, although advertised by different border routers. The nondefault behavior of comparing the MED regardless of the AS advertising the route can be activated using the **bgp always-compare-med** command, however, the results of this command have to be carefully considered .

NOTE: Because the MED is an optional attribute, it might not be present in BGP updates. RFC 4271 requires that a missing MED is equivalent to having the MED set to 0. However, a missing MED can also be considered to be the worst possible MED, which is activated using the **bgp bestpath med missing-as-worst** command.

- d. Run the following Tcl script on all routers to verify full connectivity.

```
ISP# tclsh

foreach address {
192.168.100.1
172.16.64.1
172.16.32.1
192.168.1.1
192.168.1.2
192.168.1.5
192.168.1.6
172.16.1.1
172.16.1.2
} {
ping $address }
```

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.				