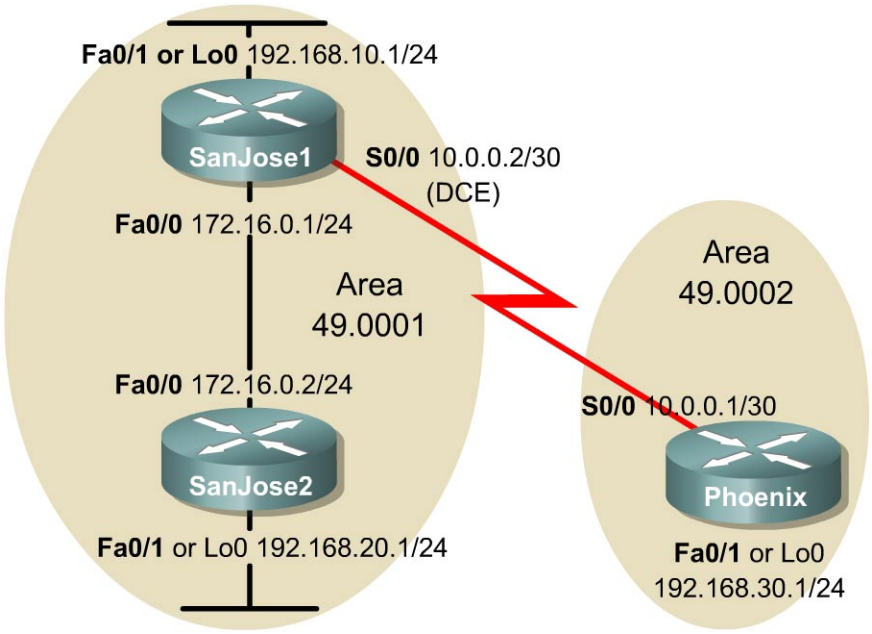
Lab 7.7.2 Configuring Multi-Area Integrated IS-IS



Objective

In this lab, multiarea Integrated IS-IS and level-specific routers will be configured.

Scenario

Previous tests demonstrated that Integrated IS-IS worked well with Level-2 routers in the ITA Ethernet core. Management now wants to establish a point-to-point connection between a new Phoenix office and SanJose1. Phoenix will be in a different area from the core so SanJose2 will now be configured as an L1 router, SanJose1 as an L1L2 router, and Phoenix as an L2 router.

Hardware and Software Requirements

Three Cisco 2620, 2621, 2620XM, or 2621XM routers or a combination may be used for this lab. Cisco IOS Release 12.2(12) with the Enterprise Plus or Enterprise Plus IPSec 56 feature set is used. The Enterprise Plus feature set is the minimum requirement for IS-IS support.

Cisco IOS 12.2(12) with the Enterprise Plus feature set requires a minimum of 16 MB of Flash and 48 MB of RAM. The Enterprise Plus IPSec 56 feature set requires a minimum of 16 MB of Flash and 64 MB of RAM.

The image names for the Cisco IOS Release 12.2(12) with the Enterprise Plus and Plus IPSec 56 feature sets are c2600-js-mz.122-12.bin and c2600-jk8s-mz.122-12.bin, respectively. The “j” indicates “Enterprise” and the “s” indicates “Plus”.

Step 1

Load the SanJose1 and SanJose2 configurations from the previous lab. Clear and reload the router to be used as Phoenix.

Configure the IP address and clock rate on the serial interface of SanJose1. Use loopback interfaces in place of FastEthernet 0/1 interfaces on SanJose2 and Phoenix. Configure the Telnet shortcut to Phoenix on SanJose1 and SanJose2. Configure the hostname, turn off DNS lookup, add the Telnet shortcuts, configure the IP address on the serial interface, and configure the loopback IP address on Phoenix.

```
SanJose1(config)#interface serial 0/0
SanJose1(config-if)#ip address 10.0.0.2 255.255.255.252
SanJose1(config-if)#clockrate 128000
SanJose1(config-if)#no shutdown
SanJose1(config-if)exit
SanJose1(config)#ip host r3 10.0.0.1

SanJose2(config)#ip host r3 10.0.0.1

Router(config)#hostname Phoenix
Phoenix(config)#no ip domain-lookup
Phoenix(config)#ip host r1 10.0.0.2
Phoenix(config)#ip host r2 172.16.0.2

Phoenix(config)#interface serial 0/0
Phoenix(config-if)#ip address 10.0.0.1 255.255.255.252
Phoenix(config-if)#no shutdown
Phoenix(config-if)#interface loopback 0
Phoenix(config-if)#ip address 192.168.30.1 255.255.255.0
```

Use **ping** to verify connectivity between directly connected interfaces. SanJose1 should also be able to reach the loopback address of SanJose2 and vice versa.

Step 2

Recall from Lab 7.1 that SanJose1 was configured to be the DIS by setting the **isis priority** to 100 on the FastEthernet 0/0 interface. SanJose1 and SanJose2 were also configured to be Level-2 only routers. Verify the configuration by issuing the **show clns neighbors** and **show isis database** commands on either router. Sample outputs are shown as follows:

Note: While not absolutely necessary, it may be a good idea to first issue a **clear isis *** command to force IS-IS to update its database.

```
SanJose1#show clns neighbors

System Id      Interface   SNPA            State  Holdtime  Type Protocol
SanJose2       Fa0/0       0004.9ad2.d0c0  Up     12        L2   IS-IS


SanJose1#show isis database

IS-IS Level-2 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
SanJose1.00-00      * 0x00000014   0xBCC5        409               0/0/0
SanJose1.01-00      * 0x00000015   0x1B0D        819               0/0/0
SanJose2.00-00        0x00000016   0x326D        698               0/0/0
```

Notice that the neighbor Type is still L2. There is only one L2 link-state database and SanJose1 is still the DIS, LSPID SanJose1.01-00 has a non-zero pseudonode ID. Also, the LSPID may

appear as SanJose1.02-00, depending on whether a loopback was used on SanJose1 in place of interface Fa0/0 and the timing of the configuration of the loopback interface.

Step 3

Configure IS-IS on Phoenix, area 2, and on the Serial 0/0 interface of SanJose1 as shown in the following:

```
Phoenix(config)#router isis
Phoenix(config-router)#net 49.0002.3333.3333.3333.00
Phoenix(config-router)#interface serial 0/0
Phoenix(config-if)#ip router isis
Phoenix(config-router)#interface loopback 0
Phoenix(config-if)#ip router isis

SanJose1(config)#inteface serial 0/0
SanJose1(config-if)#ip router isis
```

Step 4

Verify IS-IS operation between SanJose1 and Phoenix. A **ping** from Phoenix to loopback addresses on SanJose1 and SanJose2 should be successful. Issue various **show** commands on Phoenix as the following will show. Resulting output should be similar to the samples shown.

```
Phoenix#show clns neighbor

System Id      Interface   SNPA            State  Holdtime  Type Protocol
SanJose1       Se0/0       *HDLC*          Up     28        L2   IS-IS
```

Recall that serial interfaces do not have a MAC address so the encapsulation type for the serial link is listed in the SNPA column.

```
Phoenix#show isis database

IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
Phoenix.00-00       * 0x00000009   0x8FFA        1180              1/0/0
IS-IS Level-2 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
SanJose1.00-00        0x0000001C   0x25EC        1174              0/0/0
SanJose1.01-00        0x00000017   0x170F        965               0/0/0
SanJose2.00-00        0x00000018   0x2E6F        794               0/0/0
Phoenix.00-00       * 0x00000008   0x4551        1176              0/0/0
```

By default, Phoenix is an L1L2 router so it retains a separate link-state database for each level. Note too that SanJose1 is identified as the DIS. SanJose1 and SanJose2 are not listed in the IS-IS Level-1 link-state database because both were previously configured as L2-only routers.

```
Phoenix#show clns interface serial 0/0
Serial0/0 is up, line protocol is up
  Checksums enabled, MTU 1500, Encapsulation HDLC
  ERPDUs enabled, min. interval 10 msec.
  CLNS fast switching enabled
  CLNS SSE switching disabled
  DEC compatibility mode OFF for this interface
  Next ESH/ISH in 26 seconds
  Routing Protocol: IS-IS
    Circuit Type: level-1-2
    Interface number 0x0, local circuit ID 0x100
    Neighbor System-ID: SanJose1
    Level-1 Metric: 10, Priority: 64, Circuit ID: Phoenix.00
    Number of active level-1 adjacencies: 0
```



```
Level-2 Metric: 10, Priority: 64, Circuit ID: Phoenix.00
Number of active level-2 adjacencies: 1
Next IS-IS Hello in 7 seconds
```

Note that the circuit ID is “Phoenix.00”.

From SanJose1, **ping** 192.168.30.1 on Phoenix. The **ping** should not be successful.

Check the IP routing table of SanJose1.

```
SanJose1#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 not set

C    192.168.10.0/24 is directly connected, FastEthernet0/1
     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.0.0 is directly connected, FastEthernet0/0
i L2 192.168.20.0/24 [115/20] via 172.16.0.2, FastEthernet0/0
     10.0.0.0/30 is subnetted, 1 subnets
C       10.0.0.0 is directly connected, Serial0/0
```

All prior checks indicated IS-IS was working properly between SanJose1 and Phoenix. However, there is no entry in the routing table for the 192.168.30.0 network.

Step 5

Recall that domain password authentication was configured on both SanJose1 and SanJose2. If domain authentication is to be retained, Phoenix also needs to be configured appropriately as follows:

```
Phoenix(config)#router isis
Phoenix(config-router)#domain-password sanjose
```

Now examine the routing table of either SanJose1 or SanJose2. A sample for SanJose1 is shown as follows:

```
SanJose1#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 not set

i L2 192.168.30.0/24 [115/20] via 10.0.0.1, Serial0/0
C    192.168.10.0/24 is directly connected, FastEthernet0/1
     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.0.0 is directly connected, FastEthernet0/0
i L2 192.168.20.0/24 [115/20] via 172.16.0.2, FastEthernet0/0
     10.0.0.0/30 is subnetted, 1 subnets
C       10.0.0.0 is directly connected, Serial0/0
```


The route to 192.168.30.0 now appears and a **ping** from SanJose1 or SanJose2 to 192.168.30.1 should be successful.

Step 6

In this topology, SanJose1 is an L1L2 router. However, SanJose1 was previously configured as an L2-only router. Reconfigure SanJose1 to be an L1L2 router.

```
SanJose1(config)#router isis
SanJose1(config-router)#no is-type or is-type level-1-2
```

In this topology, SanJose2 is a Level-1 only router. However, SanJose2 was also configured as a Level-2 only router. Reconfigure SanJose2 to be a Level-1 only router.

```
SanJose2(config)#router isis
SanJose2(config-router)#is-type level-1
```

Note that "-**only**" is not part of the level-1 command as is required for the **is-type level-2-only** command

Recall that an interface password authentication for L2 was also configured on SanJose1 and SanJose2. Since SanJose2 is now an L1-only router, making the link with SanJose1 an L1 connection, the interface password authentication should be changed to L1 as the following shows:

```
SanJose1(config)#interface fastethernet0/0
SanJose1(config-if)#isis password cisco level-1

SanJose2(config)#interface fastethernet0/0
SanJose2(config-if)#isis password cisco level-1
```

Verify authentication with a **ping** from SanJose1 to 192.168.20.1. The **ping** should be successful, indicating authentication is working properly.

Issue the **clear isis *** command on all routers to force IS-IS to recalculate routers and to refresh its link-state databases. Wait a minute or two after issuing the **clear** command before continuing to issue the respective **show** commands on SanJose1 to verify the changes made.

```
Router#clear isis *


SanJose1#show clns neighbors

System Id      Interface   SNPA            State  Holdtime  Type Protocol
SanJose2       Fa0/0       0004.9ad2.d0c0  Up     14        L1   IS-IS
Phoenix        Se0/0       *HDLC*          Up     23        L2   IS-IS
```

SanJose2 is shown as an L1 Type of router. Although Phoenix is an L1L2 router, Phoenix shows up as Type L2 because of the inter-area connection between Phoenix and SanJose1.

```
SanJose1#show isis database

IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
SanJose1.00-00      * 0x00000002   0xDC22        1187              0/0/0
SanJose1.01-00      * 0x00000002   0xBDFD        1188              0/0/0
SanJose2.00-00        0x00000002   0x833B        1187              0/0/0
IS-IS Level-2 Link State Database:
```



```
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
SanJose1.00-00      * 0x00000005   0xD732        1198              0/0/0
SanJose1.01-00      * 0x00000001   0x890C        1183              0/0/0
Phoenix.00-00         0x00000004   0xD7B9        1193              0/0/0
```

The presence of L1 and L2 link-state databases confirm that SanJose1 is now an L1L2 router.

```
SanJose1#show clns interface fa0/0
FastEthernet0/0 is up, line protocol is up
  Checksums enabled, MTU 1497, Encapsulation SAP
  ERPDUs enabled, min. interval 10 msec.
  CLNS fast switching enabled
  CLNS SSE switching disabled
  DEC compatibility mode OFF for this interface
  Next ESH/ISH in 36 seconds
  Routing Protocol: IS-IS
    Circuit Type: level-1-2
    Interface number 0x0, local circuit ID 0x1
    Level-1 Metric: 10, Priority: 100, Circuit ID: SanJose1.01
    Number of active level-1 adjacencies: 1
    Level-2 Metric: 10, Priority: 100, Circuit ID: SanJose1.01
    Number of active level-2 adjacencies: 0
    Next IS-IS LAN Level-1 Hello in 938 milliseconds
    Next IS-IS LAN Level-2 Hello in 74 milliseconds
```

In addition to confirming SanJose1 is an L1L2 router, the priority of 100 and the SanJose1.01 circuit ID indicate that SanJose1 is the DIS. This would be the same for SanJose1.02, as noted in Step 2.

Issue the following to obtain neighbor adjacency information for SanJose2:

```
SanJose2#show clns neighbors

System Id      Interface   SNPA            State  Holdtime  Type Protocol
SanJose1       Fa0/0       0002.16de.3440  Up     4         L1   IS-IS
```

Although SanJose1 is an L1L2 router, the adjacency is an L1 connection.

```
SanJose2#show isis database

IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
SanJose1.00-00        0x0000001C   0xB02C        1024              1/0/0
SanJose1.01-00        0x0000001C   0x8918        1112              0/0/0
SanJose2.00-00      * 0x0000001B   0x5154        554               0/0/0
```

Only an L1 link-state database is maintained, confirming that SanJose2 is now an L1-only router.

```
SanJose2#show clns interface fa0/0
FastEthernet0/0 is up, line protocol is up
  Checksums enabled, MTU 1497, Encapsulation SAP
  ERPDUs enabled, min. interval 10 msec.
  CLNS fast switching enabled
  CLNS SSE switching disabled
  DEC compatibility mode OFF for this interface
  Next ESH/ISH in 41 seconds
  Routing Protocol: IS-IS
    Circuit Type: level-1-2
    Interface number 0x1, local circuit ID 0x2
    Level-1 Metric: 10, Priority: 64, Circuit ID: SanJose1.01
    Number of active level-1 adjacencies: 1
    Next IS-IS LAN Level-1 Hello in 2 seconds
```

In addition to confirming SanJose2 is an L1-only router, the circuit ID shows that SanJose1 is the DIS.

Step 7

Issue the **show clns interface serial0/0** command on the Phoenix router as follows:

```
Phoenix#show clns interface serial 0/0
Serial0/0 is up, line protocol is up
  Checksums enabled, MTU 1500, Encapsulation HDLC
  ERPDUs enabled, min. interval 10 msec.
  CLNS fast switching enabled
  CLNS SSE switching disabled
  DEC compatibility mode OFF for this interface
  Next ESH/ISH in 22 seconds
  Routing Protocol: IS-IS
    Circuit Type: level-1-2
    Interface number 0x0, local circuit ID 0x100
    Neighbor System-ID: SanJose1
    Level-1 Metric: 10, Priority: 64, Circuit ID: Phoenix.00
    Number of active level-1 adjacencies: 0
    Level-2 Metric: 10, Priority: 64, Circuit ID: Phoenix.00
    Number of active level-2 adjacencies: 1
    Next IS-IS Hello in 1 seconds
```

Since Phoenix is presently an L1L2 router, it will maintain information for both levels. This is unnecessary, since Phoenix should be an L2-only router. Configure Phoenix for L2-only routing as follows:

```
Phoenix(config)#router isis
Phoenix(config-router)#is-type level-2-only
```

Verify the configuration with the **show clns interface serial0/0** or **show isis database** command:

```
Phoenix#show clns interface serial0/0
Serial0/0 is up, line protocol is up
  Checksums enabled, MTU 1500, Encapsulation HDLC
  ERPDUs enabled, min. interval 10 msec.
  CLNS fast switching enabled
  CLNS SSE switching disabled
  DEC compatibility mode OFF for this interface
  Next ESH/ISH in 28 seconds
  Routing Protocol: IS-IS
    Circuit Type: level-1-2
    Interface number 0x0, local circuit ID 0x100
    Level-2 Metric: 10, Priority: 64, Circuit ID: Phoenix.00
    Number of active level-2 adjacencies: 1
    Next IS-IS Hello in 1 seconds


Phoenix#show isis database

IS-IS Level-2 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
SanJose1.00-00          0x00000021   0x9F4E        1117              0/0/0
SanJose1.01-00          0x0000001B   0x5526        741               0/0/0
Phoenix.00-00         * 0x00000021   0x9DD6        1119              0/0/0
```

Both outputs show only L2 information, confirming Phoenix is now an L2-only router.

A successful **ping** throughout the network indicates multi-area Integrated IS-IS with authentication has been properly configured.

Step 8

Issue the **show ip route** command on SanJose2:

```
SanJose2#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 172.16.0.1 to network 0.0.0.0

i L1 192.168.10.0/24 [115/20] via 172.16.0.1, FastEthernet0/0
     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.0.0 is directly connected, FastEthernet0/0
C    192.168.20.0/24 is directly connected, Loopback0
     10.0.0.0/30 is subnetted, 1 subnets
i L1    10.0.0.0 [115/20] via 172.16.0.1, FastEthernet0/0
i*L1 0.0.0.0/0 [115/10] via 172.16.0.1, FastEthernet0/0
```

The SanJose2 routing table shown would have included an entry for 192.168.30.0 as an L2 route if SanJose2 had been left as an L2-only router. However, since it was changed to an L1-only router, it no longer has any L2 routes.

Note that the gateway of last resort has been set in the SanJose2 routing table. L1-only routers, such as SanJose2, always learn a default route from a neighboring L1L2 router. In this case it was SanJose1. This is standard operating procedure for Integrated IS-IS. SanJose2 learns to exit area 49.0001 by way of SanJose1 as a result of the attached bit (ATT) being set in the L1 non-pseudonode LSP sent by SanJose1.

Issue the **show isis database** command on SanJose2:

```
SanJose2#show isis database

IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
SanJose1.00-00          0x0000001F   0xAA2F        690               1/0/0
SanJose1.01-00          0x0000001E   0x851A        900               0/0/0
SanJose2.00-00        * 0x0000001E   0x4B57        934               0/0/0
```

The attached bit (ATT) indicates that SanJose1 is also an L2 router and can reach other areas.

The attached bit can also be seen in the SanJose1 L1 link-state database:

```
SanJose1#show isis database

IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
SanJose1.00-00        * 0x0000001F   0xAA2F        640               1/0/0
SanJose1.01-00        * 0x0000001E   0x851A        849               0/0/0
SanJose2.00-00          0x0000001E   0x4B57        879               0/0/0
IS-IS Level-2 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
SanJose1.00-00        * 0x00000022   0x9D4F        583               0/0/0
SanJose1.01-00        * 0x0000001D   0x5128        890               0/0/0
Phoenix.00-00           0x00000022   0x9BD7        584               0/0/0
```


Save all configurations for future reference.

Reflection

Even though SanJose2 and Phoenix were configured as L1-only and L2-only routers, respectively, they could have been left with the default setting of L1L2. The result would have been each forming adjacencies for both levels, but unnecessarily. Why should unnecessary IS-IS adjacencies be eliminated?

