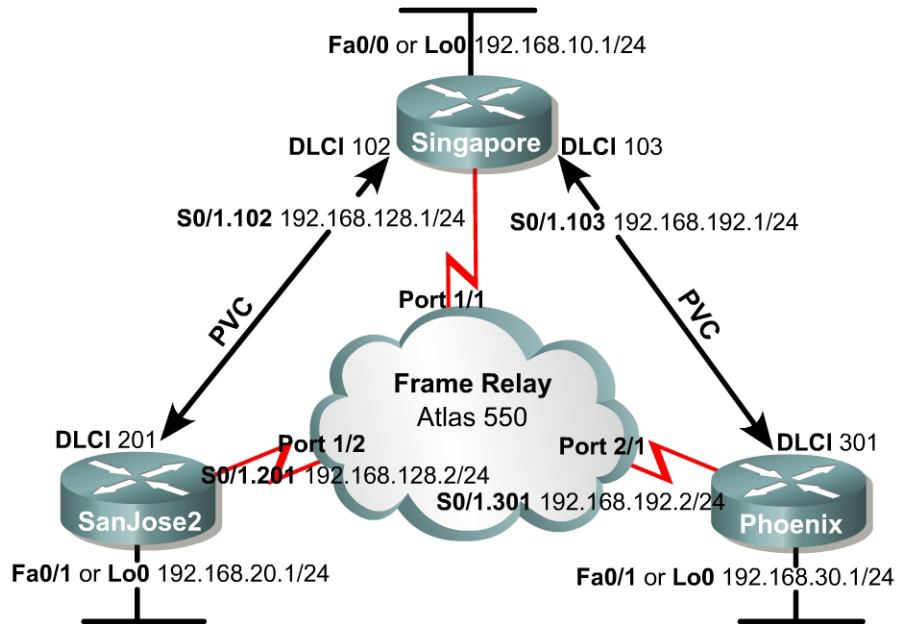
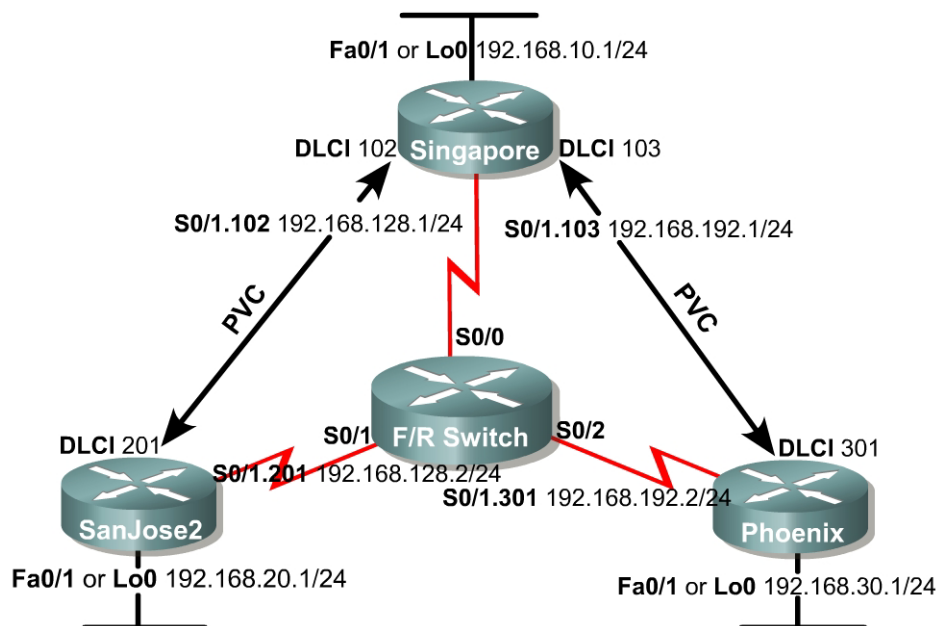


## Lab 7.7.3 Configuring IS-IS Over Frame Relay



### Alternate



## Objective

In this lab, you will configure IS-IS over a hub-and-spoke Frame Relay topology using point-to-point (p2p) subinterfaces. Multipoint configurations are not used with IS-IS as they are in OSPF.

## Scenario

International Travel Agency has just connected two regional headquarters to Singapore using Frame Relay in a hub-and-spoke topology. You are asked to configure IS-IS routing over this network.

## 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 and 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”.

This lab requires another router or device to act as a Frame Relay switch. The first diagram assumes that you will use an Adtran Atlas 550, which is preconfigured with the CCNP Version 3.0 Adtran configuration file. The second diagram assumes that you will configure a router with at least three serial interfaces as a Frame Relay switch (such as a 2600 router with two WIC-2A/S installed). See the configuration at the end of this lab for an example of how to configure a router as a Frame Relay switch. If desired, you can copy the configuration to a 2600 router for use in this lab.

## Step 1

Cable the network according to the diagram. Configure the hostnames according to the diagram. Configure the hostname, turn off DNS lookup, add the Telnet shortcuts as was done in Lab 7.7.1, configure the IP address on the FastEthernet or Loopback interfaces, whichever option was selected.

Configure each router's FastEthernet interface or Loopback interface as shown, but leave the serial interfaces and IS-IS routing unconfigured for now. Until you configure Frame Relay, you will not be able to use ping to test connectivity.

## Step 2

Singapore acts as the hub in this hub-and-spoke network. It reaches SanJose2 and Phoenix via two separate PVCs.

IS-IS can work only over NBMA clouds (such as Frame Relay) configured with a full mesh. Anything less than a full mesh can cause serious connectivity and routing issues. Even if a full mesh is configured, it is no guarantee that a full mesh will exist at all times. A failure in the underlying switched WAN network, or a misconfiguration on one or more routers, could break the full mesh either temporarily or permanently. Avoid NBMA multipoint configurations for IS-IS networks; use point-to-point subinterfaces.

Configure Frame Relay on Singapore's serial interface as shown here:

```
Singapore(config)#interface serial 0/1
```

```

Singapore(config-if)#encapsulation frame-relay
Singapore(config-if)#no shutdown
Singapore(config-if)#interface s0/1.102 point-to-point
Singapore(config-subif)#ip address 192.168.128.1 255.255.255.0
Singapore(config-subif)#frame-relay interface-dlci 102
Singapore(config-subif)#interface s0/1.103 point-to-point
Singapore(config-subif)#ip address 192.168.192.1 255.255.255.0
Singapore(config-subif)#frame-relay interface-dlci 103

```

Configure SanJose2's serial interface:

```

SanJose2(config)#interface serial 0/1
SanJose2(config-if)#encapsulation frame-relay
SanJose2(config-if)#no shutdown
SanJose2(config-if)#interface s0/1.201 point-to-point
SanJose2(config-subif)#ip address 192.168.128.2 255.255.255.0
SanJose2(config-subif)#frame-relay interface-dlci 201

```

Finally, configure Phoenix's serial interface:

```

Phoenix(config)#interface serial 0/1
Phoenix(config-if)#encapsulation frame-relay
Phoenix(config-if)#no shutdown
Phoenix(config-if)#interface s0/1.301 point-to-point
Phoenix(config-subif)#ip address 192.168.192.2 255.255.255.0
Phoenix(config-subif)#frame-relay interface-dlci 301

```

Verify Frame Relay operation with a ping from Singapore to SanJose2 and Phoenix.

1. Are you able to ping all the interfaces?

Issue a **show frame-relay pvc** and **show frame-relay map** to troubleshoot connectivity problems.

```
Singapore#show frame-relay pvc
```

```
PVC Statistics for interface Serial0/1 (Frame Relay DTE)
```

	Active	Inactive	Deleted	Static
Local	2	0	0	0
Switched	0	0	0	0
Unused	0	1	0	0

```
DLCI = 102, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/1.102
```

```

input pkts 51          output pkts 55          in bytes 14032
out bytes 15488        dropped pkts 0          in pkts dropped 0
out pkts dropped 0     out bytes dropped 0
in FECN pkts 0         in BECN pkts 0         out FECN pkts 0
out BECN pkts 0        in DE pkts 0           out DE pkts 0
out bcast pkts 50      out bcast bytes 14968
pvc create time 00:50:57, last time pvc status changed 00:31:03

```

```
DLCI = 103, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/1.103
```

```

input pkts 48          output pkts 49          in bytes 13093
out bytes 13811        dropped pkts 0          in pkts dropped 0
out pkts dropped 0     out bytes dropped 0
in FECN pkts 0         in BECN pkts 0         out FECN pkts 0

```

```

out BECN pkts 0          in DE pkts 0          out DE pkts 0
out bcast pkts 44        out bcast bytes 13291
pvc create time 00:51:00, last time pvc status changed 00:31:07

DLCI = 104, DLCI USAGE = UNUSED, PVC STATUS = INACTIVE, INTERFACE = Serial0/1

input pkts 0             output pkts 0             in bytes 0
out bytes 0              dropped pkts 0           in pkts dropped 0
out pkts dropped 0        out bytes dropped 0
in FECN pkts 0           in BECN pkts 0          out FECN pkts 0
out BECN pkts 0          in DE pkts 0            out DE pkts 0
out bcast pkts 0         out bcast bytes 0
switched pkts 0
Detailed packet drop counters:
no out intf 0            out intf down 0         no out PVC 0
in PVC down 0            out PVC down 0          pkt too big 0
shaping Q full 0         pkt above DE 0          policing drop 0
pvc create time 00:28:02, last time pvc status changed 00:28:02

Singapore#show frame-relay map
Serial0/1.103 (up): point-to-point dlci, dlci 103(0x67,0x1870), broadcast
status defined, active
Serial0/1.102 (up): point-to-point dlci, dlci 102(0x66,0x1860), broadcast
status defined, active

```

You can disregard the DLCI 104 information in the `show frame-relay pvc` output – it is discovered via LMI exchanges with the switch (the Adtran Atlas 550 is configured to advertise DLCI's 102, 103, and 104 out port 1/1). DLCI 104 is inactive because there is no device connected to port 2/2. The 550 is configured to support a 4-node full mesh.

### Step 3

Like OSPF, IS-IS is configured by enabling an IS-IS process and specifying which interfaces are to participate in the IS-IS process. Configure IS-IS to run over this point-to-point network with the following commands:

```

Singapore(config)#router isis
Singapore(config-router)#net 49.0001.1111.1111.1111.00
Singapore(config)#int serial 0/1.102
Singapore(config-if)#ip router isis
Singapore(config)#int serial 0/1.103
Singapore(config-if)#ip router isis
Singapore(config)#int lo0
Singapore(config-if)#ip router isis

SanJose2(config)#router isis
SanJose2(config-router)#net 49.0001.2222.2222.2222.00
SanJose2(config)#int serial 0/1.201
SanJose2(config-if)#ip router isis
SanJose2(config)#int lo0
SanJose2(config-if)#ip router isis

Phoenix(config)#router isis
Phoenix(config-router)#net 49.0001.3333.3333.3333.00
Phoenix(config)# int serial 0/1.301
Phoenix(config-if)#ip router isis
Phoenix(config)#int lo0
Phoenix(config-if)#ip router isis

```

Verify your IS-IS configuration by issuing the `show ip route` command on each of the routers:

```

Phoenix#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    192.168.192.0/24 is directly connected, Serial0/1.301
C    192.168.30.0/24 is directly connected, Loopback0
i L1 192.168.128.0/24 [115/20] via 192.168.192.1, Serial0/1.301
i L1 192.168.10.0/24 [115/20] via 192.168.192.1, Serial0/1.301
i L1 192.168.20.0/24 [115/30] via 192.168.192.1, Serial0/1.301

```

If each router has a complete table, including routes to 192.168.10.0/24, 192.168.20.0/24, and 192.168.30.0/24, you have successfully configured IS-IS to operate over Frame Relay.

Test these routes by pinging the FastEthernet/Loopback interfaces of each router from Phoenix's console.

2. Are you able to ping all the FastEthernet/Loopback interfaces?

---

Finally, issue the **show isis database** and **show isis topology** commands:

```

Singapore#show isis database

IS-IS Level-1 Link State Database:
LSPID      LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
Singapore.00-00  * 0x00000007  0x3B7A        737           0/0/0
SanJose2.00-00   0x00000004  0xA0ED        736           0/0/0
Phoenix.00-00    0x00000003  0x7603        666           0/0/0

IS-IS Level-2 Link State Database:
LSPID      LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
Singapore.00-00  * 0x00000009  0x2F3C        744           0/0/0
SanJose2.00-00   0x00000006  0x90E7        747           0/0/0
Phoenix.00-00    0x00000004  0x5B53        742           0/0/0

SanJose2#show isis topology

IS-IS paths to level-1 routers
System Id      Metric  Next-Hop      Interface  SNPA
Singapore      10      Singapore     Se0/1.201  DLCI 201
SanJose2       --
Phoenix        20      Singapore     Se0/1.201  DLCI 201

IS-IS paths to level-2 routers
System Id      Metric  Next-Hop      Interface  SNPA
Singapore      10      Singapore     Se0/1.201  DLCI 201
SanJose2       --
Phoenix        20      Singapore     Se0/1.201  DLCI 201

```

Note that no pseudonode LSP's (with non-zero circuit ID's) appear in the **show isis database** output because we are using p2p links to connect the routers.

3. How is the subnetwork point of attachment (SNPA) expressed in a Frame Relay network?
-

## Step 4

A common error with IS-IS configuration is mismatched interface types in an NBMA environment (normally Frame Relay or ATM). To illustrate this, switch SanJose2's point-to-point interface to a multipoint interface:

```
SanJose2(config)#interface s0/1.201
SanJose2(config-subif)#no ip address
SanJose2(config-subif)#no ip router isis
SanJose2(config-subif)#no frame-relay interface-dlci 201
SanJose2(config)#interface s0/1.2001 multipoint
SanJose2#(config)#ip address 192.168.128.2 255.255.255.0
SanJose2#(config)#ip router isis
SanJose2#(config)#frame-relay interface-dlci 201
```

Allow the Frame Relay PVC to become active. Then, view the output of **show clns neighbors** command on Singapore and SanJose2:

```
Singapore#show clns neighbors
```

System Id	Interface	SNPA	State	Holdtime	Type	Protocol
Phoenix	Se0/1.103	DLCI 103	Up	27	L1L2	IS-IS

```
SanJose2#show clns neighbors
```

System Id	Interface	SNPA	State	Holdtime	Type	Protocol
Singapore	Se0/1.2001	DLCI 201	Up	258	IS	ES-IS

The output indicates mismatched interface types! Recall from the curriculum that, since IOS Release 12.1(1)T, an Integrated IS-IS mismatch is indicated in this case:

- SanJose2 (multipoint) receives a point-to-point hello PDU, realizes it is the wrong hello type, and installs the neighbor as an ES. SanJose shows Singapore in the **show clns neighbors** with protocol "ES-IS".
- Singapore (point-to-point) receives the LAN hello PDU, recognizes the mismatch, and ignores the neighbor. SanJose2 does not appear at all in Singapore's **show clns neighbors** output. A **debug isis adj-packets** output shows the incoming LAN IIH PDU and R2 declaring the mismatch.

```
SanJose2#debug isis adj-packets
```

```
IS-IS Adjacency related packets debugging is on
```

```
00:31:58: ISIS-Adj: Sending L1 LAN IIH on Loopback0, length 1514
```

```
00:31:58: ISIS-Adj: Sending L2 LAN IIH on Loopback0, length 1514
```

```
00:31:59: ISIS-Adj: Encapsulation failed for L2 LAN IIH on Serial0/1.2001
```

```
00:31:59: ISIS-Adj: Encapsulation failed for L1 LAN IIH on Serial0/1.2001
```

```
00:32:01: ISIS-Adj: Sending L1 LAN IIH on Loopback0, length 1514
```

```
00:32:01: ISIS-Adj: Sending L2 LAN IIH on Loopback0, length 1514
```

```
00:32:02: ISIS-Adj: Encapsulation failed for L2 LAN IIH on Serial0/1.2001
```

```
00:32:03: ISIS-Adj: Encapsulation failed for L1 LAN IIH on Serial0/1.2001
```

```
00:32:04: ISIS-Adj: Sending L2 LAN IIH on Loopback0, length 1514
```

```
00:32:04: ISIS-Adj: Sending L1 LAN IIH on Loopback0, length 1514
```

```
00:32:04: ISIS-Adj: Rec serial IIH from DLCI 201 (Serial0/1.2001), cir type L1L2, cir id 00, length 1499
```

```
00:32:04: ISIS-Adj: Point-to-point IIH received on multi-point interface; ignored IIH
```

```
00:32:05: ISIS-Adj: Encapsulation failed for L2 LAN IIH on Serial0/1.2001
```

```
00:32:06: ISIS-Adj: Encapsulation failed for L1 LAN IIH on Serial0/1.2001
```

This completes the IS-IS over Frame Relay lab. Integrated IS-IS can be easily configured over a Frame Relay cloud. The only caveat is that IS-IS NBMA configurations, unlike OSPF, are essentially limited to point-to-point implementations. Mismatched interface types in an NBMA environment is a common problem – the symptoms are reflected in the output of the `show clns neighbors` command and the `debug isis adj-packets` command.

### Router as Frame Relay Switch Configuration

The following configuration enables a 2600 router with two WIC-2A/S to act as a Frame Relay switch for this lab.

```
Frame-Switch#show run
version 12.2
service timestamps debug uptime
service timestamps log uptime
service password-encryption
!
hostname Frame-Switch
!
ip subnet-zero
no ip domain-lookup
!
ip audit notify log
ip audit po max-events 100
frame-relay switching
!
process-max-time 200
!
interface Serial0/0
no ip address
no ip directed-broadcast
encapsulation frame-relay
clockrate 128000
frame-relay intf-type dce
frame-relay route 102 interface Serial0/1 201
frame-relay route 103 interface Serial0/2 301
!
interface Serial0/1
no ip address
no ip directed-broadcast
encapsulation frame-relay
clockrate 128000
frame-relay intf-type dce
frame-relay route 201 interface Serial0/0 102
!
interface Serial0/2
no ip address
no ip directed-broadcast
encapsulation frame-relay
clockrate 128000
frame-relay intf-type dce
frame-relay route 301 interface Serial0/0 103
!
interface Serial0/3
no ip address
no ip directed-broadcast
shutdown
!
ip classless
no ip http server
```

```
!  
line con 0  
  password cisco  
  login  
  transport input none  
line aux 0  
line vty 0 4  
  password cisco  
  login  
!  
no scheduler allocate  
end
```