Configuring Hub-and-Spoke Frame Relay

Fa0/0 192.168.0.1 /24

DLCI 18 **SanJose1** DLCI 17

.1 S0/0.1

PVC PVC

1/1

**Adtran Atlas 550
Frame Relay
192.168.192.0/24**

DLCI 16 1/2 2/1 DLCI 16

.2 .4

S0/0.16 S0/0.16

London **Singapore**

Fa0/0 192.168.200.1 /24 Fa0/0 192.168.232.1 /24

IGRP 234
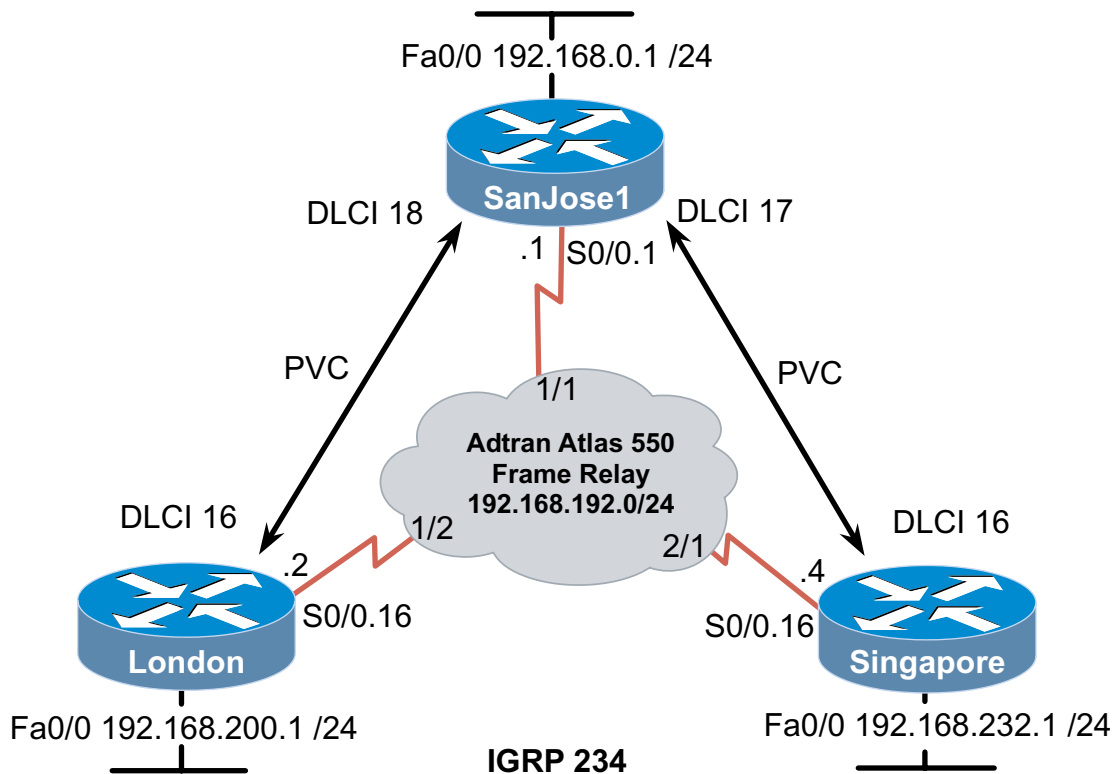
Objective

Configure Frame Relay on three routers in a hub-and-spoke topology.

Scenario

In an effort to cut costs, you monitor the International Travel Agency's internetwork traffic patters and determine that the PVC between London and Singapore is underutilized. By canceling the redundant PVC, you can save money and still provide connectivity among all regional sites with a hub-and-spoke topology. Any traffic destined for Singapore and originating in London would be relayed through SanJose1. The hub-and-spoke topology creates a single point of failure (the hub router), a risk ITA administration is willing to take.

Step 1

Before beginning this lab, it is recommended that you reload each router after erasing its startup configuration. This prevents you from having problems caused by residual configurations. Once you have prepared the equipment, proceed with Step 2.

Build the network according to the above diagram. This lab assumes use of an Adtran Atlas 550 as the Frame Relay cloud. You may use other WAN emulators or a router as a Frame Relay switch. If you are using the Atlas 550, be sure to connect each router's serial interfaces to the correct port on the Atlas (labeled in the diagram) using a V.35 cable.

Step 2

Configure SanJose1 for IGRP (AS 234) and Frame Relay. As the hub router, SanJose1 needs to direct packets through multiple PVCs. Configuring a multipoint subinterface allows one subinterface to be associated with more than one DLCI. Use the `frame-relay interface-dlci` command to specify local DLCIs, as shown here:

```
SanJose1(config)#interface serial 0/0
SanJose1(config-if)#encapsulation frame-relay
SanJose1(config)#interface serial 0/0.1 multipoint
SanJose1(config-subif)#ip address 192.168.192.1 255.255.255.0
SanJose1(config-subif)#frame-relay interface-dlci 17
SanJose1(config-fr-dlci)#exit
SanJose1(config-subif)#frame-relay interface-dlci 18
SanJose1(config-fr-dlci)#exit
SanJose1(config-subif)#exit
SanJose1(config)#router igrp 234
SanJose1(config-router)#network 192.168.192.0
SanJose1(config-router)#network 192.168.0.0
```

Next, configure London for IGRP (AS 234) and Frame Relay. Only one DLCI is needed on
the spoke routers, so you can use a point-to-point subinterface. Because this is a
subinterface configuration, include the **frame-relay interface-dlci** command, as
shown here:

```
London(config)#interface serial 0/0
London(config-if)#encapsulation frame-relay
London(config)#interface serial 0/0.16 point-to-point
London(config-subif)#ip add 192.168.192.2 255.255.255.0
London(config-subif)#frame-relay interface-dlci 16
London(config-fr-dlci)#exit
London(config-subif)#exit
London(config)#router igrp 234
London(config-router)#network 192.168.200.0
London(config-router)#network 192.168.192.0
```

Using the above commands as a guide, configure Singapore according to the
diagram.

Step 3

Test for connectivity with pings between routers.

```
London#ping 192.168.192.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.192.1, timeout is 2
      seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
      44/44/44 ms

London#ping 192.168.192.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.192.4, timeout is 2
      seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
88/90/92 ms
```

1. Do the pings demonstrate successful connectivity?

In order to have a functioning internetwork, hosts at each site must be able to
communicate. You can test the complete path, from LAN to LAN, with extended pings.

First, ping from SanJose1's LAN interface (192.168.0.1) to Singapore's LAN interface (192.168.232.1). This ping should be successful. Next, ping from SanJose1's LAN interface (192.168.0.1) to London's LAN interface (192.168.200.1). This ping should also be successful.

Finally, ping from London's LAN interface to Singapore's LAN interface, and vice versa:

```
London#ping
Protocol [ip]:
Target IP address: 192.168.232.1
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 192.168.200.1
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 192.168.232.1, timeout is 2
        seconds:
.....
Success rate is 0 percent (0/5)
```

These pings fail. Since users on the London LAN cannot access the Singapore LAN, your configuration is not complete.

To isolate the problem, view all three routing tables:

```
SanJose1#show ip route

Gateway of last resort is not set

C    192.168.192.0/24 is directly connected, Serial0/0.1
I    192.168.200.0/24 [100/80135] via 192.168.192.2, 00:01:19,
        Serial0/0.1
I    192.168.232.0/24 [100/80135] via 192.168.192.4, 00:00:53,
        Serial0/0.1
C    192.168.0.0/24 is directly connected, FastEthernet0/0

London#show ip route

Gateway of last resort is not set

C    192.168.192.0/24 is directly connected, Serial0/0.16
C    192.168.200.0/24 is directly connected, FastEthernet0/0
I    192.168.0.0/24 [100/80135] via 192.168.192.1, 00:00:18,
        Serial0/0.16


Singapore#show ip route

Gateway of last resort is not set

C    192.168.192.0/24 is directly connected, Serial0/0.16
C    192.168.232.0/24 is directly connected, FastEthernet0/0
I    192.168.0.0/24 [100/8486] via 192.168.192.1, 00:01:06,
        Serial0/0.16
```

London and Singapore have not received IGRP updates about each other's LANs. However, both of these networks are properly advertised via IGRP commands, and have been installed in SanJose1's routing table.

As the hub router, SanJose1 should forward information to the spoke routers, including routing advertisements. Recall that distance vector routing protocols combat routing loops with the split horizon rule, which states that a router cannot advertise a route through the same physical interface it was received on. When you configure an interface with the **encapsulation frame-relay** command, split horizon is automatically disabled on the major interface (Serial 0/0, etc). However, split horizon is enabled by default on Frame Relay subinterfaces.

Since both of the PVCs use the same multipoint subinterface on SanJose1, routes learned from one spoke router cannot be sent back through the same subinterface to the other spoke router. You must disable spilt horizon in order for SanJose1 to be able to send a route learned from one spoke to the other.

Disable split horizon on SanJose1's subinterface, Serial 0/0.1.

```
SanJose1(config)#interface serial 0/0.1 multipoint
SanJose1(config-subif)#no ip split-horizon
```

Verify your configuration by issuing the **show ip interface s0/0.1** command, as shown here:

```
SanJose1#show ip interface s0/0.1
Serial0/0.1 is up, line protocol is up
  Internet address is 192.168.192.1/24
  Broadcast address is 255.255.255.255
  Address determined by setup command
  MTU is 1500 bytes
  Helper address is not set
  Directed broadcast forwarding is disabled
  Outgoing access list is not set
  Inbound  access list is not set
  Proxy ARP is enabled
  Security level is default
  Split horizon is disabled
  ICMP redirects are always sent
  ICMP unreachables are always sent
  ICMP mask replies are never sent
  IP fast switching is enabled
  IP fast switching on the same interface is enabled
  IP Flow switching is disabled
  IP Feature Fast switching turbo vector
  IP multicast fast switching is enabled
  IP multicast distributed fast switching is disabled
  IP route-cache flags are Fast
  Router Discovery is disabled
```

Now check Singapore's routing table again:

```
Singapore#show ip route

Gateway of last resort is not set

C    192.168.192.0/24 is directly connected, Serial0/0.16
I    192.168.200.0/24 [100/82135] via 192.168.192.1, 00:00:19,
```

```
                Serial0/0.16
       C    192.168.232.0/24 is directly connected, FastEthernet0/0
       I    192.168.0.0/24 [100/8486] via 192.168.192.1, 00:00:19,
                Serial0/0.16
```

Confirm internetwork connectivity between the Singapore and London LANs with an extended ping.

```
       Singapore#ping
       Protocol [ip]:
       Target IP address: 192.168.200.1
       Repeat count [5]: 55
       Datagram size [100]:
       Timeout in seconds [2]:
       Extended commands [n]: y
       Source address or interface: 192.168.232.1
       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 55, 100-byte ICMP Echos to 192.168.200.1, timeout is 2
                seconds:
       !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
       Success rate is 100 percent (55/55), round-trip min/avg/max =
                92/93/108 ms
```

If this ping is successful, all three regional sites are communicating over a hub-and-spoke Frame Relay topology.