Lab 1.5.1 Introductory Lab 1 – Getting Started and Building Start.txt

Objective

This lab will introduce to the student the CCNP lab equipment and certain IOS features that might be new. This introductory activity also describes how to use a simple text editor to create all or part of a router configuration file. After creating a text configuration file, the student can apply that configuration to a router quickly and easily by using the techniques described in this lab.

Equipment Requirements

This lab requires the following equipment:

- A single router, preferably a 2600 series router, and a workstation running a Windows operating system
- One 3 1/2-inch floppy disk with a label

Preliminary

Modular interfaces
Cisco routers can come with a variety of interface configurations. Some models have only fixed interfaces, meaning that the interfaces cannot be changed or replaced by the user. Other models have one or more modular interfaces, allowing the user to add, remove, or replace interfaces as needed.

Fixed interface identification, such as Serial 0, S0, Ethernet 0, and E0, may already be familiar. Modular routers use notation such as Serial 0/0 or S0/1. The first number refers to the module and the second number refers to the interface. Both notations use 0 as their starting reference, so S0/1 indicates that there is another serial interface S0/0.

Fast Ethernet
Many routers today are equipped with Fast Ethernet, 10/100 Mbps auto sensing interfaces. Fast Ethernet 0/0 or Fa0/0 on routers with Fast Ethernet interfaces must be used.

The `ip subnet-zero` command
The **`ip subnet-zero`** command is enabled by default in IOS 12. This command allows the user to assign IP addresses in the first subnet, called subnet 0. Because subnet 0 uses only binary zeros in the subnet field, its subnet address can potentially be confused with the major network address. With the advent of classless IP, the use of subnet 0 has become more common. The labs in this manual assume that the student can assign addresses to the interfaces of the router using subnet 0. If any routers are used that have an IOS earlier than 12.0, then the global configuration command, `ip subnet-zero`, must be added to the configuration on the router.

No shutdown
Interfaces are shut down by default. A **`no shutdown`** command must be issued in interface configuration mode when the interface is ready to be brought up.

Passwords
The **`login`** command is applied to virtual terminals by default. This means that in order for the router to accept Telnet connections, a password must be configured. Otherwise, the router will not allow a Telnet connection and will reply with the error message “password required, but none set”.

Step 1

Take a few moments to examine the router. Become familiar with any serial, BRI (ISDN), PRI (ISDN), and CSU/DSU interfaces on the router. Pay particular attention to any connectors or cables that are unfamiliar.

Step 2

Establish a HyperTerminal session to the router.

Enter privileged EXEC mode.

Step 3

To clear the configuration, issue the **`erase start`** command.

Confirm the command when prompted, answer "no" if asked to save changes. The result should look something like the following:

```
Router#erase start
Erasing the nvram filesystem will remove all files! Continue? [confirm]
[OK]
Erase of nvram: complete
Router#
```

When the prompt returns, issue the **`reload`** command.

Confirm the command when prompted. After the router finishes the boot process, choose not to use the Auto install feature, shown as follows:

```
Would you like to enter the initial configuration dialog? [yes/no]: no
Would you like to terminate autoinstall? [yes]: ← Press Enter to accept
default.
Press RETURN to get started!
```

Step 4

In privileged mode, issue the **`show run`** command.

While scrolling through the running configuration, note the following default configurations:

- The version number of the IOS
- The **`ip subnet-zero`** command, which allows the use of subnet 0
- Each available interface and its name

  Note: Each interface has the **`shutdown`** command applied to its configuration.
- The **`no ip http server`** command, which prevents the router from being accessed by a Web browser
- No passwords are set for CON, AUX, and VTY sessions, as shown in the following:

```
line con 0
 transport input none
line aux 0
line vty 0 4
```


Using Copy and Paste with Notepad

In the next steps, the copy and paste feature will be used to edit router configurations. A text file will need to be created that can be pasted into the labs and used as a starting point for the router configuration. Specifically, the student must build a login configuration that can be used with every lab included in this manual.

Step 5

If necessary, issue the **show run** command again so that the console and vty line configurations appear on the screen as follows:

```
line con 0
 transport input none
line aux 0
line vty 0 4
!
end
```

Select this text and choose the **copy** command from HyperTerminal edit menu.

Next, open Notepad, which is typically found on the **Start** menu under **Programs**, **Accessories**. After Notepad opens, select **Paste** from the Notepad Edit menu.

Edit the lines in Notepad to look like the following lines:

> **Note:** The one-space indent is optional.

```
enable secret class
line con 0
 transport input none
 password cisco
 login
line aux 0
 password cisco
 login
line vty 0 4
 password cisco
 login
```

This configuration sets the enable secret to **class** and requires a login for all console, AUX port, and virtual terminal (Telnet) connections. The AUX port is usually a modem. The password for these connections is set to **cisco**.

> **Note:** Each of the passwords can be set to something else if so desired.

Step 6

Save the open file in Notepad to a floppy disk as **start.txt**.

Select all the lines in the Notepad document and choose **Edit** > **Copy**.

Step 7

Use the Windows taskbar to return to the HyperTerminal session, and then enter global configuration mode.

From HyperTerminal Edit menu, choose **Paste to Host**.

Issue the **show run** command to see if the configuration looks okay.

As a shortcut, the contents of the **start.txt** file can now be pasted to any router before getting started with a lab.

Other Useful Commands
To enhance the **start.txt** file, consider adding one of the following commands:

- **`ip subnet-zero`** ensures that an older IOS allows IP addresses from subnet 0.
- **`ip http server`** allows access the routers using a Web browser. Although this configuration might not be desirable on a production router, it gives the user an HTTP server for testing purposes in the lab.
- **`no ip domain-lookup`** prevents the router from attempting to query a DNS when a word that is not recognized as a command or a host table entry is input. This will save time if a typo or misspelling of a command is made.
- **`logging synchronous`** in the **`line con 0`** configuration will return to a fresh line when input is interrupted by a console-logging message.
- **`configure terminal`** (**`config t`**) can be used in the file so that a command does not need to be typed before pasting the contents of the file to the router.

Step 8

Use the Windows taskbar to return to Notepad and edit the lines so that they read as follows:

```
config t
!
enable secret class
ip subnet-zero
ip http server
no ip domain-lookup
line con 0
 logging synchronous
 password cisco
 login
 transport input none
line aux 0
password cisco
 login
line vty 0 4
password cisco
 login
!
end
copy run start
```

Save the file to the floppy disk so that no work is lost.

Select and copy all the lines, and then return to the HyperTerminal session.

Normally, the global configuration mode would be entered before pasting from Notepad. However, because the **`configure terminal`** command was included in the script, it is possible to paste in privileged mode.

If necessary, return to privileged EXEC mode. From the Edit menu, select **Paste to Host**.

After the paste is complete, the copy operation must be confirmed.

Use **`show run`** to see if the configuration looks okay.

Using Notepad to Assist in Editing
Understanding how to use Notepad can lessen typing and typos during editing sessions. Another major benefit is that an entire router configuration can be done in Notepad, whether the user is at home or at the office. This configuration can then be pasted to the console of the router when access is available. In the next steps, the student will look at a simple editing example.

Step 9

Configure the router with the following commands:

```
Router#config t
Router(config)#router rip
Router(config)#network 192.168.1.0
Router(config)#network 192.168.2.0
Router(config)#network 192.168.3.0
Router(config)#network 192.168.4.0
Router(config)#network 192.168.5.0
```

Press **Ctrl-sZ**, and verify the configuration with the **show run** command. This configuration enables RIP routing and specifies the networks that RIP will advertise to neighboring routers. What if the routing protocol is to be changed to IGRP? With the **no router rip** command, RIP can easily be removed. However, the **network** commands would still need to be typed. The next steps show an alternative.

Step 10

Issue the **show run** command and hold the output so that the **router rip** commands are displayed. Using the keyboard or mouse, select the **router rip** command and all **network** statements.

Copy the selection.

Use the taskbar to return to Notepad.

Open a new document and paste the selection onto the blank page.

Step 11

In the new document, type the word no and a space in front of the word router.

Press the **End** key, and press **Enter**.

Type **router igrp 100,** but do not press **Enter**. The result should look like as follows:

```
Router(config)#no router rip
Router(config)#router igrp 100
Router(config-router)# network 192.168.1.0
Router(config-router)# network 192.168.2.0
Router(config-router)# network 192.168.3.0
Router(config-router)# network 192.168.4.0
Router(config-router)# network 192.168.5.0
```

Step 12

Select the results and copy them.

Use the taskbar to return to the HyperTerminal session.

While in global configuration mode, paste the results.

Use the **show run** command to verify the configuration.

Reflection

How could using copy and paste with Notepad be helpful in other editing situations?

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Lab 1.5.2 Introductory Lab 2 – Capturing HyperTerminal and Telnet Sessions

Objective

This activity describes how to capture HyperTerminal and Telnet sessions.

Note: Be sure to master these techniques. These techniques will save a tremendous amount of typing in later labs and while working in the field.

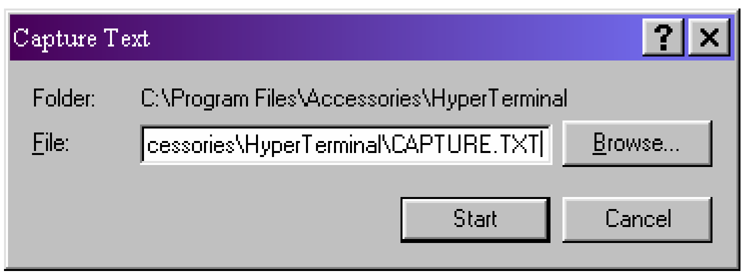
Step 1

Log in to a router using HyperTerminal.

It is possible to capture the results of the HyperTerminal session in a text file. These results can then be viewed and/or printed using Notepad, WordPad, or Microsoft Word.

Note: This feature captures future screens, not what is currently onscreen. In essence, a recording session is turned on.

To start a capture session, choose the **Menu** option, **Transfer**, **Capture Text**. The Capture Text dialog box appears, as shown in the following figure:



The default filename for a HyperTerminal capture is **CAPTURE.TXT**.

Note: When using Telnet, the command to begin a capture, or log, is Terminal, Start Logging. The document created has LOG as the extension. Other than the name and path of the capture file, the logging procedures are the same for both Telnet and HyperTerminal.

Make sure that the floppy disk is in the A: drive. When the Capture Text dialog box appears, change the File path to **A:\TestRun.txt**.

Click the **Start** button. Anything that appears onscreen after this point is copied to the file.

Step 2

Issue the `show running-config` command and view the entire configuration file.

From the **Transfer** menu, choose **Capture Text**, **Stop**.

Telnet users should select **Stop** Logging from the **Terminal** menu to end the session.

Step 3

Using the **Start** menu, launch Windows Explorer. Windows Explorer might be found under **Programs** or **Accessories**, depending on which version of Windows is used.

In the left pane, select the **3½" floppy (A:)** drive. On the right side, the file that was just created should now be seen.

Double-click the **TestRun.txt** document icon. The result should look something like the following:

```
Router#show running-config
Building configuration...

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Router
!
enable secret 5 $1$HD2B$6iXb.h6QEJJjtn/NnwUHO.
!
!
ip subnet-zero
no ip domain-lookup
!
interface FastEthernet0/0
 no ip address
 no ip directed-broadcast
 shutdown
```

Gibberish might be seen near the word "More". This is where the spacebar was pressed to see the rest of the list. Basic word processing techniques can be used to clean that up.

Suggestion

Consider capturing each router configuration for every lab that is done. Capture files can be valuable when reviewing configuration features and preparing for certification exams.

Reflection

Could the capture techniques be useful if a member of the lab team misses a lab session? Can capture techniques be used to configure an off-site lab?

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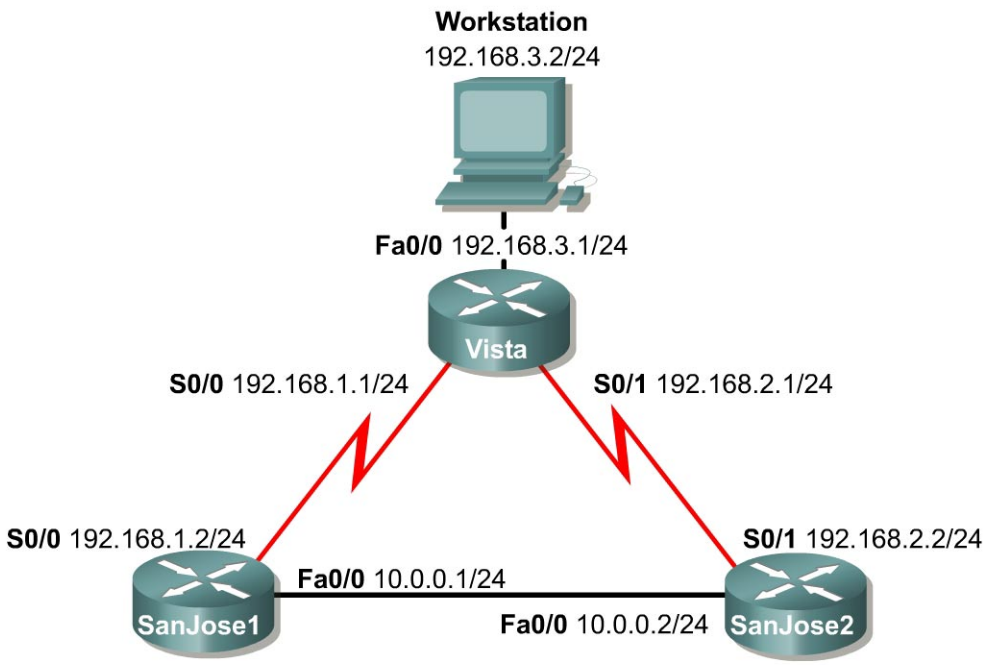
Lab 1.5.3 Introductory Lab 3 – Access Control List Basics and Extended Ping



Objective

This lab activity reviews the basics of standard and extended access lists, which are used extensively in the CCNP curriculum.

Scenario

The LAN users connected to the Vista router are concerned about access to the network from hosts on network 10.0.0.0. A standard access list must be used to block all access to the Vista LAN from network 10.0.0.0 /24.

Also, an extended ACL must be used to block network 192.168.3.0 host access to Web servers on the 10.0.0.0 /24 network.

Step 1

Build and configure the network according to the diagram. Use RIPv1, and enable updates on all active interfaces with the appropriate **network** commands. The commands necessary to configure SanJose1 are shown in the following example:

```
SanJose1(config)#router rip
SanJose1(config-router)#network 192.168.1.0
SanJose1(config-router)#network 10.0.0.0
```

Use the **ping** command to verify the work and test connectivity between all interfaces.

Step 2

Check the routing table on Vista using the **show ip route** command. Vista should have all four networks in the routing table. Troubleshoot, if necessary

Access Control List Basics
Access Control Lists (ACLs) are simple but powerful tools. When the access list is configured, each statement in the list is processed by the router in the order in which it was created. If an individual packet meets a statement's criteria, the permit or deny is applied to that packet, and no further list entries are checked. Each packet starts at the top of the list, every time.

It is not possible to reorder an access list, skip statements, edit statements, or delete statements from a numbered access list, while in the router configuration mode. With numbered access lists, any attempt to delete a single statement results in deletion of the entire list. Named ACLs (NACLs) do allow for the deletion of individual statements. It is suggested that ACLs, of all kinds, be created in an off-line editor and pasted into the configuration.

The following concepts apply to both standard and extended access lists:

Two step process
The access list may be created with one or more **access-list** commands while in global configuration mode. Second, the access list is applied to or referenced by other commands, such as the **ip access-group** command which applies the ACL to an interface. An example would be the following:

```
Vista#config terminal
Vista(config)#access-list 50 deny 10.0.0.0 0.0.0.255
Vista(config)#access-list 50 permit any
Vista(config)#interface fastethernet 0/0
Vista(config-if)#ip access-group 50 out
Vista(config-if)#^Z
```

Syntax and Keywords
The basic syntax for creating an access list entry is as follows:

```
router(config)#access-list # {permit | deny}ip address wildcard mask
```

The **permit** command allows packets matching the specified criteria to be accepted for whatever application the access list is being used for. The **deny** command discards packets matching the criteria on that line.

Two important keywords, **any** and **host**, can be used with IP addresses and the access list. The keyword **any** matches all hosts on all networks, equivalent to **0.0.0.0 255.255.255.255**. The keyword **host** can be used with an IP address to indicate a single host address. The syntax is **host** *ip address* (**host 192.168.1.10**). This is the same as entering 192.168.1.10 0.0.0.0.

Implicit deny statement
Every access list contains a final "deny" statement that matches all packets. This is called the implicit deny. Because the implicit deny statement is not visible in **show** command output, it is often overlooked, with serious consequences. As an example, consider the following single-line access list:

```
Router(config)#access-list 75 deny host 192.168.1.10
```

Access-list 75 clearly denies all traffic sourced from the host, 192.168.1.10. What might not be obvious is that all other traffic will be discarded as well. This is because the implicit **deny any** is the final statement in any access list.

At least one permit statement is required
There is no requirement that an ACL contain a **deny** statement. If nothing else, the implicit **deny any** statement takes care of that. But if there are no **permit** statements, the effect will be the same as if there were only a single **deny any** statement.

Wildcard mask
In identifying IP addresses, ACLs use a wildcard mask instead of a subnet mask. Initially, the masks might look the same, but closer observation reveals that they are very different. Remember that a binary 0 in a wildcard mask instructs the router to match the corresponding bit in the IP address.

In/out
When deciding whether an ACL should be applied to inbound or outbound traffic, always view things from the perspective of the router. In other words, determine whether traffic is coming into the router, inbound, or leaving the router, outbound.

Applying ACLs
Extended ACLs should be applied as close to the source as possible, thereby conserving network resources. Standard ACLs, by necessity, must be applied as close to the destination as possible. This is because the standard ACL can match only at the source address of a packet.

Step 3

On the Vista router, create the following standard ACL and apply it to the LAN interface:

```
Vista#config terminal
Vista(config)#access-list 50 deny 10.0.0.0 0.0.0.255
Vista(config)#access-list 50 permit any
Vista(config)#interface fastethernet 0/0
Vista(config-if)#ip access-group 50 out
Vista(config-if)#^Z
```

Try pinging 192.168.3.2 from SanJose1.

The ping should be successful. This result might be surprising, because all traffic from the 10.0.0.0/8 network was just blocked. The ping is successful because, even though it came from SanJose1, it is not sourced from the 10.0.0.0/8 network. A ping or traceroute from a router uses the closest interface to the destination as the source address. Therefore, the ping is coming from the 192.168.1.0/24, SanJose1's Serial 0/0.

```
SanJose1#ping 192.168.3.2
Sending 5, 100-byte ICMP Echos to 192.168.3.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/4 ms
```

Step 4

In order to test the ACL from SanJose1, the extended ping command must be used to specify a source interface as follows:

On SanJose1, issue the following commands:

Note: Remember that the extended ping works only in the privileged EXEC mode.

```
SanJose1#ping
Protocol [ip]:
Target IP address: 192.168.3.2
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 10.0.0.1
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 192.168.3.2, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

Step 5

Standard ACLs are numbered 1 - 99. IOS version 12.xx allows additional numbering from 1300 - 1699. Extended ACLs are numbered 100 - 199. IOS version 12.xx allows additional numbering from 2000 - 2699. Extended ACLs can be used to enforce highly specific criteria for filtering packets. In this step, configure an extended ACL to block access to a Web server. Before proceeding, issue the **no access-list 50** and **no ip access-group 50** commands on the Vista router to remove the ACL configured previously.

First, configure both SanJose1 and SanJose2 to act as Web servers, by using the **ip http server** command, as shown in the following:

```
SanJose1(config)#ip http server
SanJose2(config)#ip http server
```

From the workstation at 192.168.3.2, use a Web browser to view both Web servers on the router at 10.0.0.1 and 10.0.0.2. The Web login requires that the enable secret password for the router be entered as the password.

After verifying Web connectivity between the workstation and the routers, proceed to Step 6.

Step 6

On the Vista router, enter the following commands:

```
Vista(config)#access-list 101 deny tcp 192.168.3.0 0.0.0.255 10.0.0.0
0.0.0.255 eq www
Vista(config)#access-list 101 deny tcp 192.168.3.0 0.0.0.255 any eq ftp
Vista(config)#access-list 101 permit ip any any
Vista(config)#interface fastethernet 0/0
Vista(config-if)#ip access-group 101 in
```

From the workstation at 192.168.3.2, again attempt to view the Web servers at 10.0.0.1 and 10.0.0.2. Both attempts should fail.

Next, browse SanJose1 at 192.168.1.2. Why is this not blocked?

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Lab 2.5.1 Configuring an Asynchronous Dialup Connection

Objective

In this lab, the student will configure a Cisco router to support an out-of-band management EXEC session through a modem. The modem will be connected to the serial interface on the router that will be configured to support an asynchronous connection. The student will also use a workstation to remotely dial in to the router.

Scenario

The International Travel Agency wants the serial interface on the SanJose1 core router configured to accept dialup connections. This will allow it to be remotely managed in the event of a network failure. As the network administrator, configure the modem to allow management sessions only. Dial-on-demand routing (DDR) will not be set up.

Step 1

Before beginning this lab, it is recommended that the router be reloaded after erasing the startup configuration. This will prevent problems that may be caused by residual configurations. Build the network according to the diagram, but do not configure the interface on the router. Use the Adtran Atlas 550 or similar device to simulate the Public Switched Telephone Network (PSTN). If the Atlas 550 is being used, the line cables from both modems must be plugged into the octal FXS voice module ports of the Atlas 550 as labeled in the diagram.

Note: The diagram assumes the octal FXS voice module is installed in slot 3.

Cable Connection Notes: Be sure to use the appropriate cable to connect the modem to the serial interface on the router. The specific cable will depend upon the router model and type of physical serial interface. For example, different cables are used for a Smart Serial interface and a DB-60 serial interface.

Step 2

Configure the serial interface on SanJose1 for an asynchronous connection to assign a TTY line number to the serial interface as follows:

```
SanJose1(config)#interface s0/1
SanJose1(config-if)#physical-layer async
```


After entering these commands, issue the **show interface s0/1** command, as shown:

```
SanJose1#show interface s0/1
Serial0/1 is down, line protocol is down
  Hardware is PQUICC Serial in async mode
  MTU 1500 bytes, BW 9 Kbit, DLY 100000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation SLIP, loopback not set
  DTR is pulsed for 5 seconds on reset
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0 (size/max/drops); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
     Conversations  0/0/16 (active/max active/max total)
     Reserved Conversations 0/0 (allocated/max allocated)
<output omitted>
```

1. What is the default encapsulation type for an interface in physical-layer async mode?

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Once the serial interface has been configured as asynchronous, determine the line number being used for the interface. If unfamiliar with the numbering scheme for this router model, the **show line** command can be used to determine the line number, as shown in the following example:

```
SanJose1#show line
   Tty Typ     Tx/Rx    A Modem  Roty AccO AccI  Uses  Noise Overruns   Int
*    0 CTY              -   -      -    -    -    0       0     0/0       -
     2 TTY   9600/9600  -   -      -    -    -    0       0     0/0
Se0/1
    65 AUX   9600/9600  -   -      -    -    -    0       0     0/0       -
    66 VTY              -   -      -    -    -    0       0     0/0       -
    67 VTY              -   -      -    -    -    0       0     0/0       -
    68 VTY              -   -      -    -    -    0       0     0/0       -
    69 VTY              -   -      -    -    -    0       0     0/0       -
    70 VTY              -   -      -    -    -    0       0     0/0       -
```

Lines not in async mode -or- with no hardware support: 1 and 3 through 64.

The shaded portion of the sample **show line** command output shows that Serial 0/1 is TTY 2.

Use the **show line** output from the router to obtain the correct line number. Enter the line configuration mode, as shown in the following example:

```
SanJose1(config)#line 2
SanJose1(config-line)#
```

The router prompt indicates that it is now in line configuration mode.

Step 3

From the line configuration mode, configure the router to authenticate connections with the password **cisco** shown as follows:

```
SanJose1(config-line)#login
SanJose1(config-line)#password cisco
```


Set the line speed and flow control type as follows:

```
SanJose1(config-line)#speed 115200
SanJose1(config-line)#flowcontrol hardware
```

Next, configure the line for both incoming and outgoing calls and allow incoming calls using all available protocols. The following commands will allow reverse Telnet to the modem:

```
SanJose1(config-line)#modem inout
SanJose1(config-line)#transport input all
```

The default number of stopbits used by the asynchronous line of the router is two. Configure the line to use only one stopbit as follows:

```
SanJose1(config-line)#stopbits 1
```

Reducing the number of stopbits from two to one will improve throughput by reducing asynchronous framing overhead.

Step 4

In this step, configure a router interface for TCP/IP. The router must have an operational interface with a valid IP address in order to establish a reverse Telnet connection to the modem. Although a physical interface could be configured with an IP address, configure SanJose1 with a loopback interface. A loopback interface is the best way to assign an IP address to the router. This is because loopbacks are immune to link failure. Use the following commands to configure the loopback interface:

```
SanJose1(config-line)#interface loopback0
SanJose1(config-if)#ip address 192.168.0.1 255.255.255.255
```

Notice that a 32-bit mask is used when configuring a loopback IP address. If a 32-bit mask is not used, the router would be configured as if it were connected to an entire subnet or network.

Step 5

Before establishing a Telnet session, secure virtual terminal access with the following commands:

```
SanJose1(config-if)#line vty 0 4
SanJose1(config-line)#login
SanJose1(config-line)#password cisco
SanJose1(config-line)#exit
```

Use the following command to open the reverse Telnet session to line 2.

> **Note:** If the router is not using line 2, change the last number to the line number appropriate to the router.

```
SanJose1#telnet 192.168.0.1 2002
```

At this point, a prompt should appear for a login password. Type the password **cisco** and press the **Enter** key, this should begin a session with the modem. Although there is no prompt, issue the following command:

```
AT
```


If the modem responds with an **OK**, a successful reverse Telnet connection has been established. If an **OK** response is not received, troubleshoot the configuration.

Step 6

View the current configuration on the modem by issuing the command. The following is a sample output:

```
OK
AT&V

    Option              Selection       AT Cmd
    ---------------     ------------    --------
    Comm Standard       Bell            B
    CommandCharEcho     Enabled         E
    Speaker Volume      Medium          L
    Speaker Control     OnUntilCarrier  M
    Result Codes        Enabled         Q
    Dialer Type         Tone            T/P
    ResultCode Form     Text            V
    ExtendResultCode    Enabled         X
    DialTone Detect     Enabled         X
    BusyTone Detect     Enabled         X
    LSD Action          Standard RS232  &C
    DTR Action          Standard RS232  &D
Press any key to continue; ESC to quit.

    Option              Selection       AT Cmd
    ---------------     ------------    --------
    V22b Guard Tone     Disabled        &G
    Flow Control        Hardware        &K
    Error Control Mode  V42,MNP,Buffer  \N
    Data Compression    V42bis/MNP5     %C
    AutoAnswerRing#     0               S0
    AT Escape Char      43              S2
    CarriageReturn Char 13              S3
    Linefeed Char       10              S4
    Backspace Char      8               S5
    Blind Dial Pause    2 sec           S6
    NoAnswer Timeout    50 sec          S7
    "," Pause Time      2 sec           S8
Press any key to continue; ESC to quit.

    Option              Selection       AT Cmd
    ---------------     ------------    --------
    No Carrier Disc     2000 msec       S10
    DTMF Dial Speed     95 msec         S11
    Escape GuardTime    1000 msec       S12
    Data Calling Tone   Disabled        S35
    Line Rate           33600           S37
Press any key to continue; ESC to quit.

    Stored Phone Numbers
    --------------------
     &Z0=
     &Z1=
     &Z2=
```

The modem will output its configuration information, which is stored in NVRAM. Reset the modem to the factory defaults by entering the following command:

```
AT&F
```


Once the modem is reset, issue the **AT&V** command again. The following is a sample output from the command:

```
AT&V

    Option              Selection       AT Cmd
    ---------------     ------------    --------
    Comm Standard       Bell            B
    CommandCharEcho     Enabled         E
    Speaker Volume      Medium          L
    Speaker Control     OnUntilCarrier  M
    Result Codes        Enabled         Q
    Dialer Type         Tone            T/P
    ResultCode Form     Text            V
    ExtendResultCode    Enabled         X
    DialTone Detect     Enabled         X
    BusyTone Detect     Enabled         X
    LSD Action          Standard RS232  &C
    DTR Action          Standard RS232  &D
Press any key to continue; ESC to quit.

    Option              Selection       AT Cmd
    ---------------     ------------    --------
    V22b Guard Tone     Disabled        &G
    Flow Control        Hardware        &K
    Error Control Mode  V42,MNP,Buffer  \N
    Data Compression    V42bis/MNP5     %C
    AutoAnswerRing#     0               S0
    AT Escape Char      43              S2
    CarriageReturn Char 13              S3
    Linefeed Char       10              S4
    Backspace Char      8               S5
    Blind Dial Pause    2 sec           S6
    NoAnswer Timeout    50 sec          S7
    "," Pause Time      2 sec           S8
Press any key to continue; ESC to quit.

    Option              Selection       AT Cmd
    ---------------     ------------    --------
    No Carrier Disc     2000 msec       S10
    DTMF Dial Speed     95 msec         S11
    Escape GuardTime    1000 msec       S12
    Data Calling Tone   Disabled        S35
    Line Rate           33600           S37
Press any key to continue; ESC to quit.

    Stored Phone Numbers
    --------------------
     &Z0=
     &Z1=
     &Z2=
```

Note: Depending on the version of firmware, the preceding output may differ.

1. What is the Speaker Volume set to?

   ___

2. According to the output of the **AT&V** command, what is the **AT** command used to configure the speaker volume?

   ___

3. What is the AutoAnswerRing# set to?

   ___

4. What is the **AT** command used to configure the AutoAnswerRing#?

   ___

5. What is the Flow Control set to?

   ___

6. What is the **AT** command used to configure the Flow Control?

   ___

Notice that the ampersand (**&**) character, which denotes an “advanced” command, must be included in certain **AT** commands.

Configure the modem to answer on the second ring using the following command:

```
ATS0=2
```

Adjust the speaker volume on the modem by using the following command:

```
ATL3
```

Use the appropriate command, **AT&V,** to view the current settings on the modem and verify that the configurations have taken effect.

Finally, save the configurations to NVRAM with the following command:

```
AT&W
```

Step 7

Now that the modem is configured, suspend the reverse Telnet session by pressing **Control+Shift+6** at the same time, release, then press **X**. This should now return to the router prompt. From the router prompt, disconnect the reverse Telnet session to the modem as follows:

```
SanJose1#disconnect
```

If this session is not disconnected, the router will not be able to connect using the dialup.

On Host A, use the modem control panel to check that the modem is properly installed and working. Run HyperTerminal and select the modem from the “Connect To” window. Then configure HyperTerminal to dial the appropriate number. If the Adtran Atlas 550 is used, this number will be 555-6001.

At the password prompt, enter the **cisco** password. Next, the SanJose1 user mode prompt should be seen. Issue the **who** command shown as follows:

```
SanJose1>who

    Line       User       Host(s)              Idle Location
   0 con 0                idle                 00:26:49
*  2 tty 2                idle                 00:00:00

  Interface  User      Mode                     Idle Peer Address
```

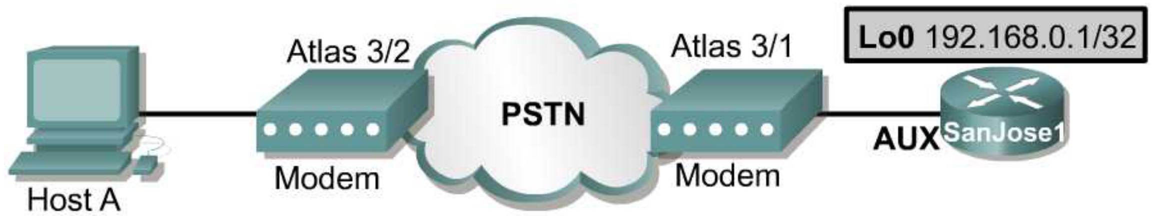
1. According to the output of this command, what TTY is being used to communicate with the router?

   ____

2. Since this connection cannot be used to route TCP/IP traffic, what is the benefit of configuring a serial interface to accept calls this way?

   ____

Lab 2.5.2 Configuring an Asynchronous Dialup Connection on the AUX Port



Objective

In this lab, the student will configure an AUX port on a Cisco router to support and out-of-band management EXEC session through a modem. The student will also configure the router to accept dial-in connections from a workstation.

Scenario

The International Travel Agency has configured the SanJose1 core router configured to accept dialup connections on its AUX port. This will allow it to be managed remotely in the event of a network failure. As the network administrator, configure the modem to allow management sessions only. Dial-on-demand routing (DDR) will not be set up.

Step 1

Before beginning this lab, it is recommended that each router be reloaded after erasing its startup configuration. This will prevent problems that may be caused by residual configurations. Build the network according to the diagram. Use the Adtran Atlas 550 or similar device to simulate the PSTN. If the Atlas 550 is used, be sure the line cables from both modems are plugged into the octal FXS voice module ports of the Atlas 550 as labeled in the diagram.

Use a rollover cable and DCE modem adapter to connect the external modem to the AUX port on the router.

Step 2

Configure the AUX port on SanJose1 for an asynchronous connection that will use authentication as follows:

```
SanJose1(config)#line aux 0
SanJose1(config-line)#login
SanJose1(config-line)#password cisco
```

Set the line speed, flow control type, and number of stopbits as follows:

```
SanJose1(config-line)#speed 115200
SanJose1(config-line)#flowcontrol hardware
SanJose1(config-line)#stopbits 1
```


Notice that the maximum speed supported by the AUX port varies depending on the model router being used. On the 2600 and 3600 series routers, 115200 bps is the maximum while other platforms may only support up to 38400 bps. Typically, the modem speed should be set to the maximum bit-rate supported by both the router and the modem. Next, configure the line for both incoming and outgoing calls. Allow incoming calls using all available protocols and set an enable secret password. Use the following configurations to perform this task:

```
SanJose1(config-line)#modem inout
SanJose1(config-line)#transport input all
SanJose1(config-line)#exit
SanJose1(config)#enable secret cisco
SanJose1(config)#exit
```

Step 3

On SanJose1, issue the **show line** command at the router prompt. A sample output is shown as follows.

```
SanJose1#show line
   Tty Typ     Tx/Rx    A Modem  Roty AccO AccI  Uses  Noise Overruns Int
*    0 CTY              -    -      -    -    -  1       0    0/0      -
*   65 AUX 115200/115200- inout     -    -    -  1        1    24/0       -
    66 VTY              -    -      -    -    -  0        0     0/0       -
    67 VTY              -    -      -    -    -  0        0     0/0       -
    68 VTY              -    -      -    -    -  0        0     0/0       -
    69 VTY              -    -      -    -    -  0        0     0/0       -
    70 VTY              -    -      -    -    -  0        0     0/0       -

Line(s) not in async mode -or- with no hardware support:
1-64
```

1. According to the output of this command, what is the line number for the AUX port on the router?

   ____

   Note: The line number may vary depending on the router platform.

At this point, have the router automatically configure the modem without establishing a reverse Telnet connection. Issue the **debug confmodem** command to monitor the autoconfiguration process. Now, refer to the displayed AUX line number and configure the modem to use the Cisco IOS autoconfiguration feature.

Enter the following commands:

```
SanJose1#debug confmodem
SanJose1#configure terminal
SanJose1(config)#line 65
SanJose1(config-line)#modem autoconfigure discovery
```

Once the **modem autoconfigure discovery** command has been typed, the debug output should be seen as the router queries and configures the modem. The entire process may take 30 seconds or more.

Notice that the IOS modem discovery feature is unlikely to provide an optimal modem configuration. Therefore, whenever possible, the modem should be configured manually using reverse Telnet or a specific modem configuration script.

Even though the modem autoconfiguration feature was used, a reverse Telnet session may need to be established to the modem through the AUX port.

2. What port number would be telnetted to in order to connect to the modem on the AUX port?

____

Step 4

In order to establish a reverse Telnet session with the modem, first disconnect the dial-up session and return to the console on SanJose1.

At the console of SanJose1, enter the following commands to enable a Telnet session with password authentication and an active interface:

```
SanJose1(config)#line vty 0 4
SanJose1(config-line)#login
SanJose1(config-line)#password cisco
SanJose1(config-line)#interface loopback 0
SanJose1(config-if)#ip address 192.168.0.1 255.255.255.255
```

1. Why should a password be assigned to the virtual terminals?

____

____

2. Why did an IP address need to be assigned to a loopback interface?

____

____

3. Why is a 32-bit mask used with the loopback address?

____

____

To simplify the reverse Telnet connection, create a static host entry called **auxmodem** with the **ip host** command. Use the port number 2000+ the TTY # and the loopback interface IP address. For example, on a Cisco 2600 series router the TTY number of the AUX port is 65. Therefore the port number would be 2065. Enter the following command to create a host table mapping that will include both the IP address and the reverse Telnet port number:

```
SanJose1(config)#ip host auxmodem 2065 192.168.0.1
```

Once the host table mapping has been configured, only the hostname will need to be typed to start a Telnet session. Enter the following hostname at the prompt:

```
SanJose1#auxmodem
```

This should open a reverse Telnet session with the modem. Issue the **AT&V** command to verify communication to the modem. Troubleshoot as necessary.

Now that the modem is configured, suspend the reverse Telnet session by pressing **Control+Shift+6** at the same time, release and press **X**. This should now return to the router prompt. From the router prompt, disconnect the reverse Telnet session to the modem as follows:

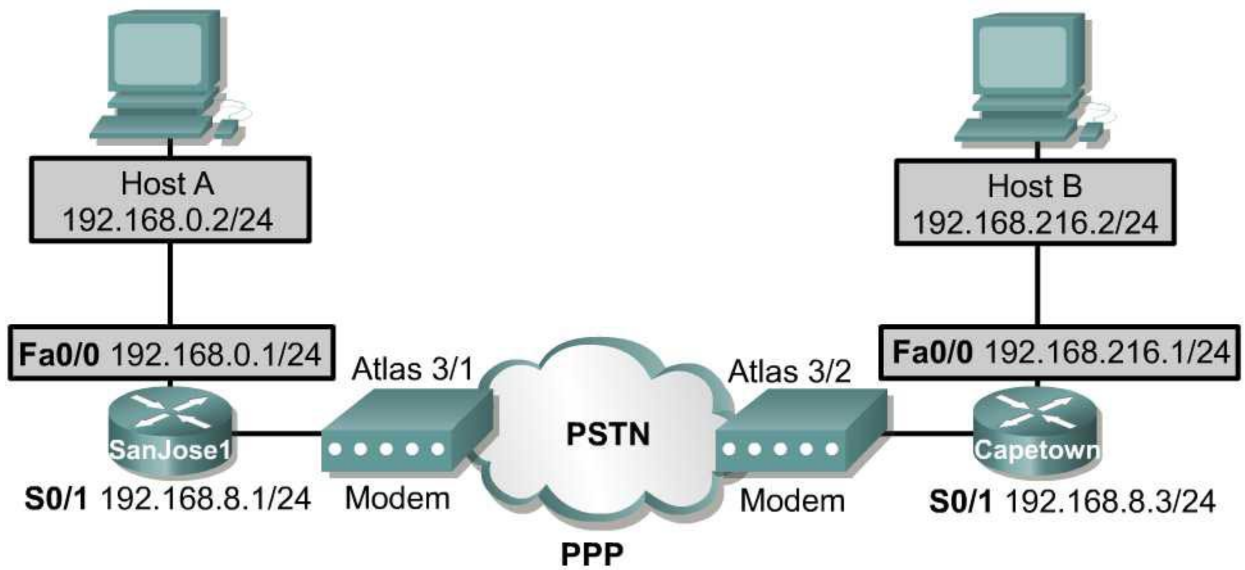
```
SanJose1#disconnect
```


Step 5

On Host A, use the modem control panel to check to see that the modem is properly installed and working. Run HyperTerminal and select the modem in the “Connect To” window. Then use HyperTerminal to dial the appropriate number. If the Adtran Atlas 550 is used, this number will be 555-6001.

If Host A successfully connects to SanJose1, a password prompt will be seen. At the password prompt, enter the **cisco** password to access the router. Troubleshoot, as necessary.

Lab 2.5.3 Configuring an Asynchronous Dialup PPP



Objective

In this lab, the student will configure two Cisco routers to connect to each other asynchronously using PPP. Two Cisco routers will also be configured to support in-band user sessions through modems connected to the SanJose1 and Capetown serial interfaces. The student will configure the asynchronous connections to support PPP encapsulation and Dial-on-demand routing (DDR).

Configure each router with their respective hostname and Fastethernet IP Addresses. Configure each workstation with the correct IP address and default gateway.

Scenario

The International Travel Agency wants to allow Capetown to access to the company headquarters, SanJose1. Capetown needs only occasional access to company email. As the network administrator, configure a dial-up PPP connection between the two sites. When finished, Capetown must be able to establish a DDR connection to SanJose1. Verify this configuration by pinging between the Capetown Host B and the SanJose1 Host A.

Step 1

Before beginning this lab, it is recommended that each router be reloaded after erasing its startup configuration. This will prevent problems that may be caused by residual configurations. Build and configure the network according to the diagram, but do not configure the serial interfaces on either router yet. Use the Adtran Atlas 550 or similar device to simulate the PSTN. If the Atlas 550 is used, be sure the line cables from both modems are plugged into the octal FXS voice module ports of the Atlas 550 as labeled in the diagram. Also, be sure to configure both workstations with the correct IP address and default gateway, router Fa0/0 IP address.

Step 2

Configure the serial interface on Capetown for an asynchronous connection as follows:

```
Capetown(config)#interface serial 0/1
Capetown(config-if)#physical-layer async
Capetown(config-if)#ip address 192.168.8.3 255.255.255.0
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#async mode dedicated
```

Notice that the serial interface uses PPP encapsulation.

1. What is the default encapsulation type for a serial interface when in physical-layer async mode?

   ____

   ____

The **`async mode dedicated`** command puts the interface in dedicated asynchronous network mode. In this mode, the interface will only use the specified encapsulation, which is PPP in this case. An EXEC prompt does not appear, and the router is not available for normal interactive use.

Since a low-bandwidth dialup connection is being configured, turn off CDP updates to reduce bandwidth usage as follows:

```
Capetown(config-if)#no cdp enable
```

Enter additional commands, as follows, so that Capetown can dial SanJose1:

```
Capetown(config-if)#dialer in-band
```

The **`dialer in-band`** command specifies that the interface will support DDR.

```
Capetown(config-if)#dialer idle-timeout 300
```

The **`dialer idle-timeout`** command specifies the number of seconds the router will allow the connection to remain idle before disconnecting. The default is 120 seconds.

```
Capetown(config-if)#dialer wait-for-carrier-time 60
```

The **`dialer wait-for-carrier-time`** command specifies the length of time the interface waits for a carrier when trying to establish a connection. The default wait time is 30 seconds. The routers in this lab will use a chat script to initialize the modem and cause it to dial.

> **Note:** A chat script will be configured later in this step. On asynchronous interfaces, the **`dialer wait-for-carrier-time`** command essentially sets the total time allowed for the chat script to run.

```
Capetown(config-if)#dialer hold-queue 50
```

The **`dialer hold-queue`** command is used to allow outgoing packets to be queued until a modem connection is established. If no hold queue is configured, packets are dropped during the time required to establish a connection. The 50 in this command specifies 50 packets.


```
Capetown(config-if)#dialer-group 1
```

The **dialer-group** command controls access by configuring an interface to belong to a specific dialing group. In Step 3, the dialer-list command will be used to configure interesting traffic that will trigger DDR for interfaces belonging to group 1.

```
Capetown(config-if)#dialer map ip 192.168.8.1 name SanJose1 modem-
script hayes56k broadcast 5556001
```

This **dialer map** command creates mapping between an IP address and the phone number that should be dialed to reach that address. It also tells the router to use the appropriate chat script. Chat scripts are used in DDR to issue commands to dial a modem and log on to remote systems.

Return to the global configuration mode to define the chat script. The following command should be used with Hayes 56K Accura modems:

```
Capetown(config)#chat-script hayes56k ABORT ERROR "" "AT Z" OK "ATDT \T"
TIMEOUT 30 CONNECT \c
```

Step 3

Once the serial interface and chat script have been configured for asynchronous PPP, configure the following line parameters:

```
Capetown(config)#line 2
Capetown(config-line)#speed 115200
Capetown(config-line)#flowcontrol hardware
Capetown(config-line)#modem inout
Capetown(config-line)#transport input all
Capetown(config-line)#stopbits 1
```

1. What is the default number of stopbits on a line?

____

____

Step 4

On Capetown, define interesting to establish a dial-up connection for IP traffic as follows:

```
Capetown(config)#dialer-list 1 protocol ip permit
```

Since this dialer list is number 1, it is linked to dialer group 1. The **dialer-list** command specifies the traffic that is to be permitted on interfaces that belong to the corresponding dialer group.

In order for Capetown to route traffic through the Serial 0/1 interface, configure this default route to the central site as follows:

```
Capetown(config)#ip route 0.0.0.0 0.0.0.0 192.168.8.1
```

This completes the Capetown router configuration.

Step 5

Configure the company headquarters router, SanJose1. Enter the following commands:

```
SanJose1(config)#interface s0/1
SanJose1(config-if)#physical-layer async
SanJose1(config-if)#ip address 192.168.8.1 255.255.255.0
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#async mode dedicated
SanJose1(config-if)#no cdp enable
SanJose1(config)#line 2
SanJose1(config-line)#speed 115200
SanJose1(config-line)#flowcontrol hardware
SanJose1(config-line)#modem inout
SanJose1(config-line)#transport input all
SanJose1(config-line)#stopbits 1
SanJose1(config-line)#modem autoconfigure discovery
SanJose1(config)#ip route 192.168.216.0 255.255.255.0 192.168.8.3
```

Step 6

Write the SanJose1 and Capetown configurations to NVRAM and reload the routers. Power cycle the modem and the Adtran Atlas 550. This will help avoid potential problems due to residual configurations.

Step 7

From the Capetown Host B, ping the SanJose1 Host A (192.168.0.2). The first set of pings will fail because the modems must perform the handshaking sequence to establish a connection (approximately 20 seconds). Once a connection is established, issue the ping command a second or third time. Eventually the ping should be successful which means the Capetown Host B has dialed the SanJose1 Host A and the configuration is working. Troubleshoot, as necessary.

Once successful pings have been verified, issue the **show dialer** command on Capetown. The following is a sample output:

```
Capetown#show dialer

Serial0/1 - dialer type = IN-BAND ASYNC NO-PARITY
Idle timer (300 secs), Fast idle timer (20 secs)
Wait for carrier (60 secs), Re-enable (15 secs)
Dialer state is data link layer up
Dial reason: ip (s=192.168.216.2, d=192.168.0.2)
Time until disconnect 217 secs
Connected to 5556001
Dial String      Successes   Failures    Last DNIS   Last status
5556001                  1          0    00:04:19       successful
```

1. What is the dialer type of S0/1?

____

____

2. What is the dialer state?

____

____

3. What is the dial reason?

____

____

4. How much longer will this connection remain up if it is idle?

____

____

Lab 3.7.1 Configuring PPP Interactive Mode

Objective

In this lab, the student will configure a Cisco router to connect asynchronously to a modem and use a workstation, Host A, to remotely dial into the router. The student will also configure PPP interactive mode, so that the user on Host A can select between a PPP session and a router management EXEC session when using HyperTerminal for dialing out.

Scenario

The International Travel Agency wants dialup access configured to the central router SanJose1. They would like access set up so that the remote user at Host A can dial up the router for either an EXEC management session on the router, or a PPP connection to the corporate LAN. This configuration will allow the dialup user to choose between configuring the router remotely and accessing the central site network. Since the user may choose to access International Travel Agency's TCP/IP-based network, this configuration must account for assigning an IP address to Host A.

Step 1

Before beginning this lab, it is recommended that the router be reloaded after erasing its startup configuration. This will prevent problems that may be caused by residual configurations. Build and configure the network according to the diagram, but do not configure SanJose1's serial interface yet. Configure SanJose1 with the appropriate hostname and Loopback 0 IP address. Use the Adtran Atlas 550, or similar device, to simulate the PSTN. If the Atlas 550 is being used, be sure the line cables from both modems are plugged into the octal FXS voice module ports of the Atlas 550 as labeled in the diagram.

Step 2

Configure the serial interface on SanJose1 for an asynchronous connection as follows:

```
SanJose1(config)#interface s0/1
SanJose1(config-if)#physical-layer async
SanJose1(config-if)#ip address 192.168.8.1 255.255.255.0
SanJose1(config-if)#async mode interactive
SanJose1(config-if)#peer default ip address 192.168.8.5
```


The **async mode interactive** command allows the remote user to select between a PPP session and an EXEC session with the router. The **peer default ip address** command configures the router to assign an IP address to the dial-in host. An IP address is required in order for the remote host to access the International Travel Agency corporate network.

Since Telnet and reverse Telnet will be used in this exercise, configure the virtual terminals on SanJose1 with the following commands:

```
SanJose1(config)#line vty 0 4
SanJose1(config-line)#login
SanJose1(config-line)#password Cisco
```

Step 3

Configure the appropriate line so that it can communicate with the modem as follows:

> **Note:** Line 2 is used here as an example, use **show line** to verify the actual number for the router.

```
SanJose1(config)#line 2
SanJose1(config-line)#login
SanJose1(config-line)#password cisco
SanJose1(config-line)#speed 115200
SanJose1(config-line)#flowcontrol hardware
SanJose1(config-line)#modem inout
SanJose1(config-line)#transport input all
SanJose1(config-line)#stopbits 1
```

For this scenario, also configure the following line to select PPP automatically:

```
SanJose1(config-line)#autoselect ppp
```

The **autoselect** command configures the Cisco IOS software to identify the type of connection being requested. This command is used on lines making different types of connections.

Finally, reverse Telnet to the modem, restore the factory default settings (AT&F) on the modem, and configure the modem to answer on the second ring (**ATS0=2**) as follows:

```
SanJose1#telnet 192.168.0.1 2002

Password: cisco
AT
OK
AT&F
ATS0=2
```

1. What port number will be used to establish a reverse Telnet session with the modem?

   ____

   ____

Now that the modem is configured, suspend the reverse Telnet session by pressing **Control+Shift+6** at the same time, release and press **X**. From the router prompt, disconnect the reverse Telnet session to the modem as follows:

```
SanJose1#disconnect
```


Step 4

In this step, verify that SanJose1 is accepting dialup PPP connections from Host A.

Change the TCP/IP Properties of the network card to obtain an IP address automatically.

Next, configure Dialup Networking (DUN) on Host A. The exact configuration steps for DUN will vary depending on the operating system used by Host A. If Windows 9x/2000/Me is being used, open the “Dialup Networking” folder and click on the **Make New Connection** icon. In Windows 2000, this folder is called Network and Dialup Connections. If the standard Adtran Atlas configuration is being used, configure the connection to dial 555-6001 (port 1). Since PPP authentication has not been configured, no username or password for this connection is required.

When the DUN configuration has been named and completed, double-click the connection icon and establish a dialup connection with SanJose1. If the connection fails, troubleshoot as necessary.

Once the connection is established, check IP address of Host A. Remember that this address will be bound to the dialup adapter not to the NIC.

1. What IP address has been assigned to the dialup adapter?

   ____

   ____

Verify that Host A has TCP/IP connectivity to the corporate network by pinging the loopback interface on SanJose1, 192.168.0.1. If Host A does not receive a reply, troubleshoot as necessary.

From Host A, Telnet to SanJose1 at 192.168.8.1 and enter the appropriate password. On SanJose1, issue the **`show interface s0/1`** command.

Note: The following is a partial sample output displayed on the workstation:

```
SanJose1#show interface s0/1
Serial0/1 is up, line protocol is up
  Hardware is PQUICC Serial in async mode (TTY2)
  Internet address is 192.168.8.1/24
  MTU 1500 bytes, BW 115 Kbit, DLY 100000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, loopback not set
  Keepalive not set
<output omitted>
```

2. According to the output of the **`show interface`** command, what is the encapsulation set to?

   ____

   ____

Now that TCP/IP connectivity has been verified, exit the Telnet session and disconnect the dialup link.

Step 5

Verify that SanJose1 is accepting dialup management (EXEC) sessions from Host A. Right-click on the connection icon in the Dialup Networking window and select **Properties**. If Windows 95/98 is being used, click the **Configure** button on the **General** tab. This will open the modem configuration window. In this window, select the **Options** tab, and check the box that says “Bring up terminal window after dialing”. If Windows 2000 is used, check the “Show terminal window” box on the **Security** tab. Finally, if you are using Windows ME, click on the Scripting tab and uncheck the "Start terminal screen minimized"

Now establish the dialup connection, as in Step 4. When the router answers the call, a terminal window should appear. Press the **Enter** key to trigger the router password prompt and then enter the appropriate password.

While still connected, issue the **`show interface s0/1`** command on SanJose1.

1. According to the output of the **`show interface`** command, what is the line encapsulation set to?

   ____

   ____

2. Notice that the interface is not in an up-and-up state even though a connection has been established. Why is this so?

   ____

   ____

3. Has the dialup adapter on Host A been assigned an IP address?

   ____

   ____

Finally, since SanJose1 is using asynchronous interactive mode, begin a PPP session with the router by entering the appropriate command while in the management session. In the dialup terminal window, type the following command:

```
SanJose1>ppp
```

Strings of character output will be displayed representing PPP frames. In Windows 9x/ME, click on the **Continue** button at the bottom of the Dial-Up Networking terminal window. Otherwise click on the **Done** button. After a few seconds, check the IP address of Host A. The dialup adapter should now have the address 192.168.8.5.

Verify that there is TCP/IP connectivity by telnetting from Host A to SanJose1 through 192.168.8.1.

Lab 3.7.2 Configuring PPP Options – Authentication and Compression

Objective

In this lab, the student will configure a Cisco router to accept PPP dialup connection over a PSTN cloud. The call is originating from a workstation using key PPP options: authentication and compression.

Scenario

The International Travel Agency wants dialup access configured to the central router SanJose1 using PPP. In order to secure dialup access, authentication needs to be configured. Also, compression needs to be configured in order to maximize the amount of data that can be transferred across the link.

Step 1

Before beginning this lab, it is recommended that the router be reloaded after erasing its startup configuration. This will prevent problems that may be caused by residual configurations. Build and configure the network according to the diagram, but do not configure SanJose1's serial interface yet. Configure SanJose1 with the appropriate hostname and IP addresses. Use the Adtran Atlas 550, or similar device, to simulate the PSTN. If the Atlas 550 is used, be sure the line cables from both modems are plugged into the respective octal FXS voice module ports of the Atlas 550 as labeled in the diagram.

Step 2

Configure the serial interface on SanJose1 for an asynchronous connection as follows:

```
SanJose1(config)#interface s0/1
SanJose1(config-if)#physical-layer async
SanJose1(config-if)#async mode dedicated
SanJose1(config-if)#ip address 192.168.8.1 255.255.255.0
SanJose1(config-if)#peer default ip address 192.168.8.5
```

Remember, the **`peer default ip address`** command is used to automatically assign the dialup host an IP address.

Configure the line as follows:

```
SanJose1(config)#line 2
SanJose1(config-line)#login
SanJose1(config-line)#password cisco
SanJose1(config-line)#speed 115200
SanJose1(config-line)#flowcontrol hardware
SanJose1(config-line)#modem inout
SanJose1(config-line)#transport input all
SanJose1(config-line)#stopbits 1
```

Since Telnet and reverse Telnet will be used during this exercise, configure the virtual terminals as follows:

```
SanJose1(config-line)#line vty 0 4
SanJose1(config-line)#login
SanJose1(config-line)#password cisco
```

Step 3

Configure PPP to use PAP authentication using the following commands:

```
SanJose1(config-line)#interface s0/1
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication pap
SanJose1(config-if)#exit
SanJose1(config)#username hosta password itsasecret
```

Recall that PPP supports two different authentication protocols, PAP and CHAP.

1. Which protocol, PAP or CHAP, is considered the most secure? Why?

____

____

When using PPP authentication, the router checks received username and password combinations against a database. In this exercise, the username and password database is stored locally on the router. The **username** *name* **password** *password* command is used to enter this local authentication information. In Lab 3.7.3, the router will be configured to use a non-local password/username database stored on a security server.

Step 4

Configure PPP to use compression, using the following commands:

```
SanJose1(config)#interface s0/1
SanJose1(config-if)#compress stac
```

The **compress stac** command specifies the compression algorithm to use with PPP. Both link partners must be configured to use the same compression algorithm. In this case, PPP will be configured to use the stacker algorithm. This is sometimes called the Lempel-Ziv algorithm, or LZS. Stacker is CPU-intensive.

1. What other methods of PPP compression are available?

____

____

The headers of the TCP/IP packets can also be compressed in order to reduce their size, thereby increasing performance. Header compression is particularly useful on networks with a large percentage of small packets, such as those supporting many Telnet connections. This feature only compresses the TCP header. Therefore, it has no effect on UDP packets or other protocol headers. Enable TCP header compression with the following command:

```
SanJose1(config-if)#ip tcp header-compression
```

Note: TCP header compression is often referred to as Van Jacobsen (VJ) compression.

Step 5

Reverse Telnet to the modem. Restore the factory default settings (**AT&F**) on the modem configure the modem to answer on the second ring (**ATS0=2**), then disconnect the session.

Note: Refer to Lab 3.7.1 for the procedure, if necessary.

At this point, all of the lab equipment may need to be rebooted in order to prevent potential problems with residual configurations. Save the SanJose1 configuration to NVRAM and reload the router, power cycle the modem and the Adtran Atlas 550.

Step 6

Before configuring Host A Dialup Networking, enable PPP **`debug`** on SanJose1's console using the following command:

```
SanJose1#debug ppp negotiation
```

After enabling **`debug`**, configure Dialup Networking on Host A to dial SanJose1. If the standard Adtran Atlas 550 configuration is used, configure Dialup Networking to dial 555-6001. Use the username **hosta**, and password **itsasecret**.

Be sure this connection is not configured to bring up a terminal window. From Host A, dial SanJose1. If the connection attempt fails, troubleshoot as necessary. Step 5 may need to be repeated. Once the connection is successful, examine the **`debug`** output. The output from SanJose1 should include the following:

```
<output omitted>
Se0/1 LCP: State is Open
Se0/1 PPP: Phase is AUTHENTICATING, by this end
Se0/1 PAP: I AUTH-REQ id 1 len 16 from "hosta"
Se0/1 PAP: Authenticating peer hosta
Se0/1 PAP: O AUTH-ACK id 1 len 5
Se0/1 PPP: Phase is UP
Se0/1 IPCP: O CONFREQ [Closed] id 8 len 16
Se0/1 IPCP: CompressType VJ 15 slots (0x0206002D0F00)
Se0/1 IPCP: Address 192.168.8.1 (0x03060A010101)
Se0/1 CCP: O CONFREQ [Closed] id 4 len 10
Se0/1 CCP: LZSDCP history 1 check mode SEQ process UNCOMPRESSSED
(0x170600010201)
<output omitted>
```


1. According to the **debug** output, who is the authenticating peer?

2. During the AUTHENTICATING phase, does the **debug** indicate the authentication protocol used?

3. What does CompressType VJ refer to?

4. What does LZSDCP refer to?

5. According to the **debug** output on SanJose1, during which PPP phase or phases are LCP frames exchanged?

6. According to the **debug** output on SanJose1, which kinds of NCPs were exchanged between Host A and SanJose1?

While Host A is still connected to SanJose1, issue the **show compress** command. If connection from Host A to SanJose1 is lost, reconnect. A sample output is shown as follows.

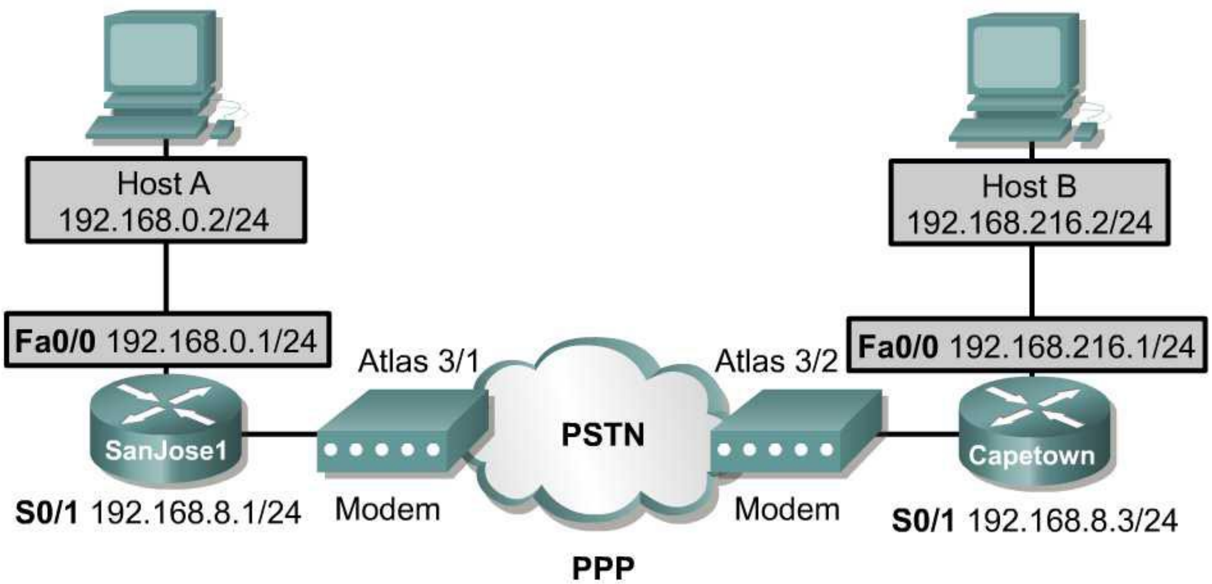
```
SanJose1#show compress
 Serial0/1
        Software compression enabled
        uncompressed bytes xmt/rcv 0/2357
<output omitted>
       Additional Stacker Stats:
       Transmit bytes:  Uncompressed = 0 Compressed = 0
       Received bytes:  Compressed = 564 Uncompressed = 0
```

7. According to the output of this command, is the compression method hardware or software-based?

Disconnect the dialup session and redial using the wrong password. Leave the PPP **debug** running on SanJose1. The connection should fail.

8. What indications as to why the connection failed are included in the **debug** output authenticating phase?

Lab 3.7.3 Configuring PPP Callback



Objective

In this lab, the student will configure a Cisco router for PPP callback over an asynchronous connection.

Scenario

The International Travel Agency has been incurring excessive toll charges whenever remote sites connect to the central site via a dialup connection. To reduce toll charges, ITA has secured lower call rates. Configure PPP callback between remote sites and the central site so that whenever a remote router calls the central router, the central router will hang up and call the remote site back to take advantage of the lower call rates.

Step 1

Before beginning this lab, it is recommended that the routers be reloaded after erasing their startup configuration. This will prevent problems that may be caused by residual configurations. Build and configure the network according to the diagram, but do not configure the serial interfaces on either router yet. Use the Adtran Atlas 550 or similar device to simulate the PSTN. If the Atlas 550 is used, be sure the line cables from both modems are plugged into the octal FXS voice module ports of the Atlas 550 as labeled in the diagram. Configure each router with their respective hostname and FastEthernet IP addresses. Finally, configure each workstation with the correct IP address and default gateway.

Step 2

Configure the serial interfaces on both routers for asynchronous connections. Be sure that the correct IP addresses for each router have been set. The following are an example of the commands for SanJose1:

```
SanJose1(config)#interface s0/1
SanJose1(config-if)#physical-layer async
SanJose1(config-if)#async mode dedicated
SanJose1(config-if)#ip address 192.168.8.1 255.255.255.0
```

Configure the following line parameters for both routers. The following are an example of the commands for SanJose1:

```
SanJose1(config)#line 2
SanJose1(config-line)#login
SanJose1(config-line)#password cisco
SanJose1(config-line)#speed 115200
SanJose1(config-line)#flowcontrol hardware
SanJose1(config-line)#modem inout
SanJose1(config-line)#transport input all
SanJose1(config-line)#stopbits 1
```

Configure the virtual terminals on both routers with passwords.

Next, reverse Telnet to both modems, restore their factory default settings, and configure the modems to answer on the second ring.

Step 3

Configure both routers to use their modems to initiate dialup connections. On both routers, enter the appropriate **dialer** commands. The following are example commands for SanJose1:

```
SanJose1(config)#interface serial 0/1
SanJose1(config-if)#no cdp enable
SanJose1(config-if)#dialer in-band
SanJose1(config-if)#dialer idle-timeout 300
SanJose1(config-if)#dialer wait-for-carrier-time 60
SanJose1(config-if)#dialer hold-queue 50
SanJose1(config-if)#dialer-group 1
SanJose1(config)#chat-script hayes56k ABORT ERROR "" "AT Z" OK "ATDT
\T" TIMEOUT 30 CONNECT \c
SanJose1(config)#dialer-list 1 protocol ip permit
```

Once the commands have been entered on both routers, configure the dialer map on Capetown as follows:

```
Capetown(config)#interface s0/1
Capetown(config-if)#dialer map ip 192.168.8.1 name SanJose1 modem-
script hayes56k broadcast 5556001
```

This command maps the IP address of SanJose1 to its phone number. It also specifies that the chat-script should be used to initialize the modem. Because SanJose1 will be the callback server, its dialer map configuration will require additional keywords. SanJose1’s dialer map configuration will be entered in the next step.

Step 4

Configure SanJose1's serial interface to act as a PPP callback server. First, use the following to configure PPP for PAP authentication:

```
SanJose1(config)interface s0/1
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication pap
SanJose1(config-if)#ppp pap sent-username SanJose1 password alpha
```

The **ppp pap sent-username** command configures SanJose1 to send the specified username and password combination if prompted during the PPP authentication phase.

Next, enter the PPP commands required to configure SanJose1 as a PPP callback server as shown in the following:

```
SanJose1(config-if)#ppp callback accept
SanJose1(config-if)#dialer callback-secure
SanJose1(config-if)#exit
SanJose1(config)#username Capetown password bravo
```

The **ppp callback accept** command configured SanJose1 to accept callback requests from clients. The **dialer callback-secure** command affects those users that are not authorized to receive a callback with the **dialer callback-server** command. If the username is not authorized for callback, the call will be disconnected. Next, configure authorization for callback service on SanJose1 as follows:

```
SanJose1(config)#map-class dialer dialback
SanJose1(config-map-class)#dialer callback-server username
SanJose1(config-map-class)#exit
SanJose1(config)#interface s0/1
SanJose1(config-if)#dialer map ip 192.168.8.3 name Capetown class
dialback modem-script hayes56k broadcast 5556002
```

Step 5

Configure Capetown for PPP with PAP authentication and callback request as follows, using the **ppp callback request** command:

```
Capetown(config)#interface s0/1
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication pap
Capetown(config-if)#ppp pap sent-username Capetown password bravo
Capetown(config-if)#ppp callback request
Capetown(config-if)#exit
Capetown(config)#username SanJose1 password alpha
```


Step 6

Set up static routes on both routers. For SanJose1, configure a static route to the Capetown LAN as follows:

```
SanJose1(config)#ip route 192.168.216.0 255.255.255.0 192.168.8.3
```

On Capetown, configure a default route to the central router as follows:

```
Capetown(config)#ip route 0.0.0.0 0.0.0.0 192.168.8.1
```

Step 7

At this point, reboot all of the lab equipment in order to prevent potential problems with residual configurations. Save the SanJose1 and Capetown configurations to NVRAM and reload the routers, power cycle the modems and Adtran Atlas 550.

After all the lab equipment have rebooted, enable debug on SanJose1's console as follows:

```
SanJose1#debug dialer
```

The **debug dialer** command will output dialup related information to the console. Now bring up the asynchronous connection by **pinging** from Host B to Host A (192.168.0.2).

1. Which of the routing table entries on Capetown will be used to route the ping packet from Host B to 192.168.0.2?

   ____

   ____

2. What is the next-hop IP address mapped to that route?

   ____

   ____

3. What is the phone number mapped to that address in the Capetown router configuration?

   ____

   ____

Capetown should call SanJose1, SanJose1 should disconnect the call, and then SanJose1 should call back Capetown. Troubleshoot, as necessary. The **debug dialer** output should reflect this process, as shown in the following example:

```
SanJose1#
01:07:06: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up

Dialer statechange to up Serial0/1
01:07:06: Serial0/1 DDR: Dialer received incoming call from <unknown>
01:07:08: Serial0/1 DDR: PPP callback Callback server starting to Capetown
5556002
01:07:08: Serial0/1 DDR: disconnecting call
01:07:10: %LINK-5-CHANGED: Interface Serial0/1, changed state to reset
01:07:15: %LINK-3-UPDOWN: Interface Serial0/1, changed state to down
01:07:30: Serial0/1 DDR: re-enable timeout
01:07:30: DDR: callback triggered by dialer_timers
01:07:30: Serial0/1 DDR: beginning callback to Capetown 5556002
```



```
01:07:30: Serial0/1 DDR: Attempting to dial 5556002
01:07:30: CHAT2: Attempting async line dialer script
01:07:30: CHAT2: Dialing using Modem script: hayes56k & System script: none
01:07:30: DDR: Freeing callback to Capetown 5556002
01:07:30: CHAT2: process started
01:07:30: CHAT2: Asserting DTR
01:07:30: CHAT2: Chat script hayes56k started
01:07:58: CHAT2: Chat script hayes56k finished, status = Success
01:08:00: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up

Dialer statechange to up Serial0/1Dialer call has been placed Serial0/1
```

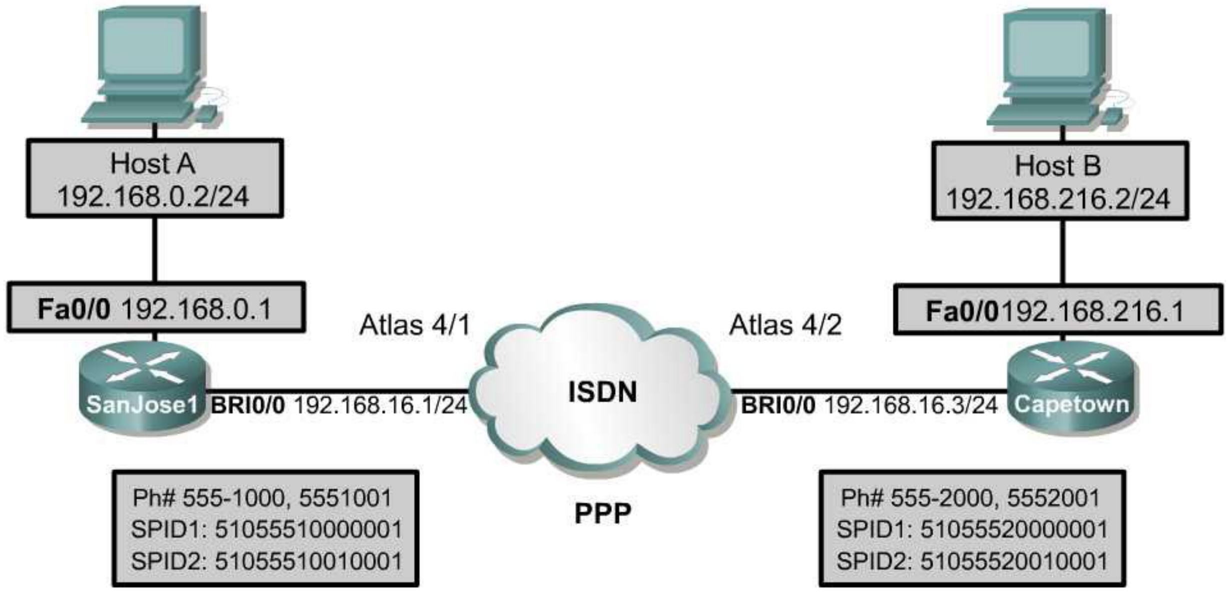
4. According to the **debug** output, what happens on SanJose1 immediately after it attempts to dial 555-6002?

   ____

   ____

Finally, test the connection by attempting to Telnet from Host B to 192.168.0.1. Once the dialup connection is established from SanJose1 to Capetown, the Telnet should be successful. Troubleshoot, as necessary.

Lab 4.9.1 Configuring ISDN BRI



Objective

In this lab, the student will configure two Cisco routers for DDR using ISDN BRI. The student will also configure PPP CHAP authentication.

Scenario

The International Travel Agency (ITA) wants an ISDN DDR connection configured between a remote office in Capetown and its corporate office known as SanJose1. For security reasons, and to keep ISDN charges to a minimum, suggest that only Web, e-mail, FTP, Telnet, and DNS traffic activate the link from the remote site. Also recommend configuring PPP CHAP authentication. Finally, Capetown connects to a stub network. For this reason, suggest that static and default routes be used between both sites.

Step 1

Before beginning this lab, it is recommended that the routers be reloaded after erasing their startup configuration. This will prevent problems that may be caused by residual configurations.

Build and configure the network according to the diagram, but do not configure the BRI interfaces for either router yet. Use the Adtran Atlas 550 or similar device to simulate the ISDN cloud. If the Atlas 550 is used, be sure to use straight-through cables. Connect both routers to the respective BRI module ports of the Atlas 550 as labeled in the diagram.

Configure the hostname and FastEthernet 0/0 interfaces on each router.

Configure both workstations with their respective IP addresses and default gateways. For example, the router Fa0/0 IP address. Have each host **`ping`** their default gateway to verify connectivity.

Step 2

In global configuration mode on SanJose1, use the following to configure the username and password information for the remote router and an enable password for SanJose1:

```
SanJose1(config)#username Capetown password cisco
SanJose1(config)#enable password cisco
SanJose1(config)#line vty 0 4
SanJose1(config-line)#password cisco
SanJose1(config-line)#login
SanJose1(config-line)#exit
```

Note: Use the enable secret password here, but for the purposes of this lab, an enable password is all that is needed. Later in the lab a telnet to SanJose1 will be preformed, therefore, the virtual terminal configuration is necessary.

Configure SanJose1 to use the appropriate ISDN switch type. The ISP will provide this information and in this case, the International Travel Agency has been told their provider is using the National switch type. Enter the following command:

```
SanJose1(config)#isdn switch-type basic-ni
```

Next, set up a dialer list to use with DDR. This dialer list will be used to identify interesting traffic, that is, traffic for which the ISDN link should be established. The International Travel Agency wants to restrict what constitutes "interesting" traffic. However, at this time use the following command:

```
SanJose1(config)#dialer-list 1 protocol ip permit
```

This permissive command will establish the link for any IP traffic that needs to be routed out the BRI interface. In Step 7, this dialer list will be reconfigured to fulfill the client's requirements completely.

Finally, configure a static route to the Capetown stub network (192.168.216.0/24) as follows:

```
SanJose1(config)#ip route 192.168.216.0 255.255.255.0 192.168.16.3
```

Step 3

Configure the SanJose1 BRI interface with IP address, encapsulation, and authentication settings as follows:

```
SanJose1(config)#interface bri0/0
SanJose1(config-if)#ip address 192.168.16.1 255.255.255.0
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication chap
```

In order for this BRI to establish a connection with the service provider's ISDN switch, configure at least one service profile identifier (SPID). With two B channels, configure two SPIDs. Enter the following commands on SanJose1:

```
SanJose1(config-if)#isdn spid1 51055510000001 5551000
SanJose1(config-if)#isdn spid2 51055510010001 5551001
```

Organizations are typically charged by the minute when making a DDR call. Therefore, it is very important to consider changing the dialer idle-timeout default value of 120 seconds to a lower value. If the connection is idle, the router will wait for this configurable period of time before closing the connection. The International Travel Agency would like an aggressive idle timeout set in order to reduce costs. Use the following command to change the timer:


```
SanJose1(config-if)#dialer idle-timeout 60
```

Next, configure the DDR setting on the BRI interface. Use the **dialer-group 1** command as follows, to associate this interface with the already configured **dialer-list 1**:

```
SanJose1(config-if)#dialer-group 1
```

The **dialer map** command is used by DDR whenever the interface encounters interesting traffic. Now, configure the **dialer map** for this interface:

```
SanJose1(config-if)#dialer map ip 192.168.16.3 name Capetown 5552000
```

Notice that this dialer map command is similar to the dialer maps that were created in previous labs. However, since a modem is not used, no modem-script is required.

Finally, activate the BRI 0/0 interface with the **no shutdown** command. Once the BRI interface is activated, the router will send the SPIDs to the ISDN switch. Informational messages should appear on the screen stating the status of the BRI 0/0 is up, but its B channels, BRI 0/0:1, BRI 0/0:2, are down. The following messages stating that the TEIs are up should be received:

```
01:26:09: %LINK-3-UPDOWN: Interface BRI0/0:1, changed state to down
01:26:09: %LINK-3-UPDOWN: Interface BRI0/0:2, changed state to down
01:26:09: %LINK-3-UPDOWN: Interface BRI0/0, changed state to up
01:26:09: %ISDN-6-LAYER2UP: Layer 2 for Interface BR0/0, TEI 64 changed to
up
01:26:09: %ISDN-6-LAYER2UP: Layer 2 for Interface BR0/0, TEI 65 changed to
up
```

If the preceding messages do not appear, or error messages appear, troubleshoot as necessary.

Next, use the **show isdn status** command to get more specific information regarding the established connection with the ISDN switch. The following shows a sample output:

```
SanJose1#show isdn status
Global ISDN Switchtype = basic-ni
ISDN BRI0/0 interface
       dsl 0, interface ISDN Switchtype = basic-ni
    Layer 1 Status:
       ACTIVE
    Layer 2 Status:
       TEI = 64, Ces = 1, SAPI = 0, State = MULTIPLE_FRAME_ESTABLISHED
       TEI = 65, Ces = 2, SAPI = 0, State = MULTIPLE_FRAME_ESTABLISHED
    Spid Status:
       TEI 64, ces = 1, state = 8(established)
           spid1 configured, spid1 sent, spid1 valid
           Endpoint ID Info: epsf = 0, usid = 70, tid = 1
       TEI 65, ces = 2, state = 8(established)
           spid2 configured, spid2 sent, spid2 valid
           Endpoint ID Info: epsf = 0, usid = 70, tid = 2
    Layer 3 Status:
       0 Active Layer 3 Call(s)
    Activated dsl 0 CCBs = 0
    The Free Channel Mask:  0x80000003
    Total Allocated ISDN CCBs = 0
```

If the SPID status is not established or, if the SPID configuration on the router is changed, issue the **clear interface** command to force the router to resend the SPID to the switch. Executing this command once should be sufficient. However, when using the Atlas 550 with the Cisco IOS, it may be necessary to repeat the command a second or third time.


```
SanJose1#clear interface bri0/0
```

The **debug isdn q921** command may also be used to troubleshoot Layer 2 issues between the router and the ISDN switch.

Once connectivity to the ISDN switch has been verified, issue the **show interface bri0/0** command, as follows:

```
SanJose1#show interface bri0/0
BRI0/0 is up, line protocol is up (spoofing)
Hardware is PQUICC BRI with U interface
Internet address is 10.1.1.1/24
MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec,
   reliability 255/255, txload 1/255, rxload 1/255
Encapsulation PPP, loopback not set
<output omitted>
```

The highlighted portion of the output shows that the BRI0/0 interface is up and the line protocol is up or spoofing.

1. Since no ISDN call has been made yet, why did the BRI show "up and up" (spoofing)?

____

____

Now issue the **show ip interface brief** command, as follows:

```
SanJose1#show ip interface brief
Interface         IP-Address     OK?    Method       Status       Protocol
FastEthernet0/0   192.168.0.1    YES    manual       up           up
Serial0/0         unassigned     YES    unset        down         down
BRI0/0            192.168.16.1   YES    manual       up           up
BRI0/0:1          unassigned     YES    unset        down         down
BRI0/0:2          unassigned     YES    unset        down         down
Serial0/1         unassigned     YES    unset        down         down
```

2. What do BRI0/0:1 and BRI0/0:2 refer to?

____

____

3. Why is BRI0/0 up, and BRI0/0:1 down?

____

____

Issue the **show dialer** command. The following shows a sample output:

```
SanJose1#show dialer
BRI0/0 - dialer type = ISDN

Dial String      Successes   Failures    Last DNIS   Last status
0 incoming call(s) have been screened.
0 incoming call(s) rejected for callback.

BRI0/0:1 - dialer type = ISDN
Idle timer (120 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is idle
```

```
BRI0/0:2 - dialer type = ISDN
Idle timer (120 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is idle
```

4. What is the idle timer set to for both BRI0/0:1 and BRI0/0:2?

____

____

Step 4

Now configure the Capetown router. The steps to accomplish this are basically the same as Steps 2 through 3. Therefore, complete the following:

```
Capetown(config)#isdn switch-type basic-ni
Capetown(config)#username SanJose1 password cisco
Capetown(config)#enable password cisco
Capetown(config)#line vty 0 4
Capetown(config-line)#password cisco
Capetown(config-line)#login
Capetown(config-line)#exit
Capetown(config)#interface bri0/0
Capetown(config-if)#ip address 192.168.16.3 255.255.255.0
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication chap
Capetown(config-if)#dialer-group 1
Capetown(config-if)#isdn spid1 51055520000001 5552000
Capetown(config-if)#isdn spid2 51055520010001 5552001
Capetown(config-if)#dialer idle-timeout 60
Capetown(config-if)#dialer map ip 192.168.16.1 name SanJose1 5551000
Capetown(config-if)#no shutdown
```

Capetown is a stub network. All traffic destined for other networks other than its own should be forwarded to SanJose1. For this reason, enter a default static route on Capetown pointing to SanJose1 as follows:

```
Capetown(config)#ip route 0.0.0.0 0.0.0.0 192.168.16.1
```

Finally, to test and confirm connectivity between both sites, configure a more permissive dialer-list as follows:

```
Capetown(config)#dialer-list 1 protocol ip permit
```

Once connectivity has been confirmed between the two routers, a more restrictive dialer-list will be configured on Capetown.

Step 5

Test the ISDN connection. Before bringing up the ISDN link, enable debugging on both routers. This will allow for troubleshooting more efficiently in the event problems are encountered. Issue the following command to view dialer information on both routers:

```
SanJose1#debug dialer
```

ISDN may need to be debugged with the following command:

```
SanJose1#debug isdn events
```


Finally, because PPP with CHAP authentication is being used, also debug PPP as follows:

```
SanJose1#debug ppp authentication
SanJose1#debug ppp negotiation
```

Now, ping Host A from Host B. There will be a number of debug outputs. These will include a dialer debug on Capetown that should report the following:

```
00:56:00: BRI0/0 DDR: Dialing cause ip (s=192.168.216.2, d=192.168.0.2)
00:56:00: BRI0/0 DDR: Attempting to dial 5551000
```

Also, Capetown should report that channel B1 is now up, as the following shows:

```
00:56:01: %LINEPROTO-5-UPDOWN:Line protocol on Interface BRI0/0:1,changed
state to up
00:56:06: %ISDN-6-CONNECT: Interface BRI0/0:1 is now connected to 5551000
SanJose1
```

Troubleshoot this connection as necessary. Use the debug output for clues. The **`clear interface bri0/0`** command may need to be used several times on both routers to reset the interfaces.

Note: To manually disconnect an ISDN call on BRI0/0, use the following command:

```
SanJose1#isdn disconnect interface bri0/0 [all, b1, b2]
```

Continue testing the ISDN connection, ping Host A from Host B and Host B from Host A.

The **`show isdn history`** command can also be issued to view all active and prior ISDN connections. The **`show isdn active`** command will output information about the current active connection. The following are sample outputs of both commands:

```
SanJose1#show isdn history
---------------------------------------------------------------------------
                                ISDN CALL HISTORY
---------------------------------------------------------------------------
History table has a maximum of 100 entries.
History table data is retained for a maximum of 15 Minutes.
---------------------------------------------------------------------------
Call    Calling      Called       Remote  Seconds Seconds Seconds Charges
Type    Number       Number       Name    Used    Left    Idle
Units/Currency
---------------------------------------------------------------------------
In                                          Failed
Out +ilable----     5551000     Capetown       60
Out +ilable----     5551000     Capetown       40      19      40
---------------------------------------------------------------------------

Capetown#show isdn active
---------------------------------------------------------------------------
                                ISDN ACTIVE CALLS
---------------------------------------------------------------------------
History table has a maximum of 100 entries.
History table data is retained for a maximum of 15 Minutes.
---------------------------------------------------------------------------
Call    Calling      Called       Remote  Seconds Seconds Seconds Charges
Type    Number       Number       Name    Used    Left    Idle
Units/Currency
---------------------------------------------------------------------------
Out                 5551000     SanJose1       18      44      15      0
---------------------------------------------------------------------------
```


Step 6

Now that there is a working ISDN connection, configure a more restrictive **dialer-list** on the Capetown remote router to keep ISDN charges to a minimum.

Create an access list to specifically permit web, DNS, FTP, Telnet, and mail traffic. For this to be done, reconfigure **dialer list 1** on Capetown, the remote router. The central site router, SanJose1, will continue to be allowed to establish DDR connections for any IP traffic.

Use the following to create an access list on Capetown that will permit the mission critical services:

```
Capetown(config)#access-list 101 permit tcp any any eq www
Capetown(config)#access-list 101 permit udp any any eq domain
Capetown(config)#access-list 101 permit tcp any any eq ftp
Capetown(config)#access-list 101 permit tcp any any eq telnet
Capetown(config)#access-list 101 permit tcp any any eq pop3
Capetown(config)#access-list 101 permit tcp any any eq smtp
```

Note: Transport layer keywords were specified instead of port numbers. Layer 4 keyword services are simpler to interpret when configuring extended access-lists. Use the "**?**" option after the **eq** parameter to receive a list of keywords and their associated port numbers.

Now enter a new dialer-list command that references this access list. The following shows a new dialer-list command automatically replacing the old one:

```
Capetown(config)#dialer-list 1 protocol ip list 101
```

Once the new dialer list has been configured, ping Host A from Host B.

1. The ping should fail, why?

____

____

From Host B initiate a Telnet session to SanJose1.

2. The Telnet request should bring up the ISDN connection, why?

____

____

With the connection still up, ping Host A from Host B once again.

3. Instead of failing as before, this ping should work. Why?

____

____

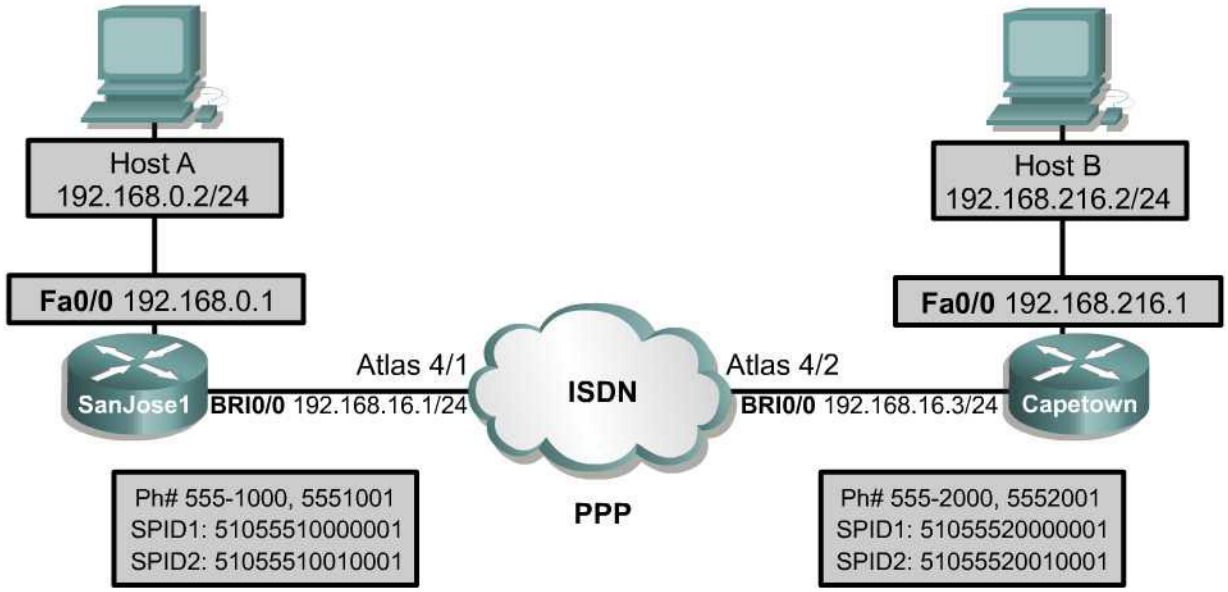
A ping to Host B from Host A should also be possible.

While connected, issue the **show dialer** command on both SanJose1 and Capetown.

4. According to the output of this command, what was the time until disconnect for SanJose1?

____

Lab 4.9.2 Configuring Snapshot Routing



Objective

In this lab, the student will configure two Cisco routers for DDR and snapshot routing using ISDN BRI.

Scenario

The International Travel Agency wants an ISDN DDR connection configured between its Capetown regional headquarters and the corporate network SanJose1 core router. Instead of configuring static routes, configure snapshot routing so that routing updates are exchanged between the routers without keeping the link up continuously. The company has also asked that PPP encapsulation and CHAP authentication be configured over this link.

Step 1

Before beginning this lab, it is recommended that the routers be reloaded after erasing their startup configuration. This will prevent problems that may be caused by residual configurations. Build and configure the network according to the diagram, but do not configure the BRI interfaces on either router yet. Use the Adtran Atlas 550 or similar device to simulate the ISDN cloud. If the Atlas 550 is used, be sure to use straight-through cables and connect both routers to the respective BRI module ports of the Atlas 550 as labeled in the diagram. Be sure to configure both workstations with the correct IP address and default gateway. Configure the Fa0/0 interfaces of the routers to match the diagram.

Step 2

Configure SanJose1 and Capetown for ISDN. Refer to the following commands to guide the configuration:

```
SanJose1(config)#username Capetown password cisco
SanJose1(config)#enable password cisco
SanJose1(config)#line vty 0 4
SanJose1(config-line)#password cisco
SanJose1(config-line)#login
SanJose1(config-line)#exit
SanJose1(config)#isdn switch-type basic-ni
SanJose1(config)#dialer-list 1 protocol ip permit
SanJose1(config)#interface bri0/0
SanJose1(config-if)#ip address 192.168.16.1 255.255.255.0
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication chap
SanJose1(config-if)#isdn spid1 51055510000001 5551000
SanJose1(config-if)#isdn spid2 51055510010001 5551001
SanJose1(config-if)#dialer-group 1
SanJose1(config-if)#dialer map ip 192.168.16.3 name Capetown 5552000
SanJose1(config-if)#no shutdown

Capetown(config)#username SanJose1 password cisco
Capetown(config)#enable password cisco
Capetown(config)#line vty 0 4
Capetown(config-line)#password cisco
Capetown(config-line)#login
Capetown(config-line)#exit
Capetown(config)#isdn switch-type basic-ni
Capetown(config)#dialer-list 1 protocol ip permit
Capetown(config)#interface bri0/0
Capetown(config-if)#ip address 192.168.16.3 255.255.255.0
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication chap
Capetown(config-if)#isdn spid1 51055520000001 5552000
Capetown(config-if)#isdn spid2 51055520010001 5552001
Capetown(config-if)#dialer-group 1
Capetown(config-if)#dialer map ip 192.168.16.1 name SanJose1 5551000
Capetown(config-if)#no shutdown
```

1. What does the keyword, **broadcast**, do when used with the **dialer map** command?

   ____

   ____

Use the **show isdn status** command to verify that the routers have established communication with the ISDN switch.

If either of the routers has not established communication with the ISDN switch, verify the running configuration file to verify that the configurations have been entered correctly. The **clear interface bri0/0** command can also be used multiple times if necessary to enable a valid and established SPID status.

Step 3

Once both routers have been properly configured for ISDN, issue the **debug dialer** command on both SanJose1 and Capetown. Then verify that DDR works by pinging SanJose1, 192.168.16.1, from Capetown. The **show isdn active** command may also be used to verify an active connection. Troubleshoot as necessary.

Leave **debug dialer** enabled. The output of this command will be used in Step 4.

Step 4

In this lab, static routes will not be used. The International Travel Agency has asked that dynamic routing be configured. This will allow routing table updates to occur automatically as new networks are added.

1. How often does IGRP send updates by default?

____

____

2. Are IGRP updates unicast, multicast, or broadcast?

____

____

3. What is the default setting of the **dialer idle-timeout**?

____

____

Starting with SanJose1, configure IGRP for AS 100 on both SanJose1 and Capetown. The following are commands for SanJose1:

```
SanJose1(config)#router igrp 100
SanJose1(config-router)#network 192.168.0.0
SanJose1(config-router)#network 192.168.16.0
```

The following are commands for Capetown:

```
Capetown(config)#router igrp 100
Capetown(config-router)#network 192.168.16.0
Capetown(config-router)#network 192.168.216.0
```

Issue the **show ip route** command on Capetown to verify its routing table as follows:

```
Capetown#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    192.168.216.0/24 is directly connected, FastEthernet0/0
     192.168.16.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.16.0/24 is directly connected, BRI0/0
C       192.168.16.1/32 is directly connected, BRI0/0
```

Notice that IGRP has not detected the Ethernet network of SanJose1. The reason for this is because of the dialer map statements that were entered on each router. IGRP builds its routing table based on broadcasts received by a peer. By default, the dialer map statements entered do not allow broadcasts traffic to leave the interface.

For this reason, the **dialer map** command has to include the optional **broadcast** keyword. On the BRI 0/0 interface of each router, enter the respective **dialer map** statements as follows:


```
SanJose1(config-if)#dialer map ip 192.168.16.3 name Capetown broadcast
5552000
```

```
Capetown(config-if)#dialer map ip 192.168.16.1 name SanJose1 broadcast
5551000
```

Once the dialer maps are configured, DDR activity should be seen as generated by the **`debug dialer`** command. The output from this command should be similar to the following:

```
BRI0/0 DDR: Dialing cause ip (s=192.168.16.3, d=255.255.255.255)
BRI0/0 DDR: Attempting to dial 5551000
```

4. According to the debug output, what is the destination of the packet that caused the attempt to dial?

____

____

5. What process on the router is causing this broadcast packet to be generated?

____

____

6. Under the current configuration, this DDR link should never go down, why?

____

____

With IGRP, the router broadcasts routing updates out every interface configured with IGRP. Therefore, IGRP broadcast routing updates will consistently keep the DDR link active.

Since IGRP routing process is initiating a DDR call, it could be assumed that IGRP routing updates are being exchanged between SanJose1 and Capetown. To verify this assumption, issue the **`show ip route`** command again as follows:

```
Capetown#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    192.168.216.0/24 is directly connected, FastEthernet0/0
I    192.168.0.0/24 [100/158260] via 192.168.16.1, 00:00:10, BRI0/0
     192.168.16.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.16.0/24 is directly connected, BRI0/0
C       192.168.16.1/32 is directly connected, BRI0/0
```

Notice that the routers have now converged and that Capetown now knows about the SanJose1 Ethernet network.

Step 5

Configure snapshot routing. As the core router, SanJose1 will act as the server and Capetown will be the client. Issue the following commands on SanJose1:

```
SanJose1(config)#interface bri0/0
SanJose1(config-if)#snapshot server 5
```

The **`snapshot server 5`** command tells the server that the active period is five minutes long.

1. What is the maximum interval that can be assigned using the snapshot server command?

   Note: The help feature can be used to find this.

   ____

   ____

Now use the following to configure Capetown as a snapshot routing client:

```
Capetown(config)#interface bri0/0
Capetown(config-if)#dialer map snapshot 1 name SanJose1 broadcast 5551000
Capetown(config-if)#snapshot client 5 10 suppress-statechange-update dialer
```

The **`dialer map snapshot`** command establishes a map that Capetown uses to connect for the exchange of routing updates with SanJose1. The **`snapshot client`** command configures the length of the active and quiet periods. In the previous command, the active period is set to five minutes. This value must match the value set in the configuration for the snapshot server. The length of the quiet period is set to ten minutes. Notice that the active period timer value must match the value that was set in the configuration for the snapshot server.

By default, snapshot routing takes advantage of each new connection that enters into an active window and will start the active interval every time. This could be problem in situations where the WAN link is often accessed and where some applications only require a short connection time of less than a minute.

The **`suppress-statechange-update`** keyword prevents the routers from exchanging updates during connections that are established to transfer user data. This allows snapshot routing to initiate the DDR link thereby starting an active period at the expiration of the quiet period.

The **`dialer`** keyword allows the client router to dial up the server router in the absence of regular traffic. Also, it is required when the **`suppress-statechange-update`** keyword is used.

Observe the result of this configuration. If the routers are still connected, use the **`show dialer`** command to determine how long the routers will wait until disconnecting an idle link.

Let the link remain idle for 120 seconds. After that time, the routers should disconnect.

Check the routing tables of SanJose1 and Capetown. Verify that routing is working within this network by pinging SanJose1, 192.168.16.1, from Capetown.

Issue the **`show snapshot`** command on both routers. Notice that the output of SanJose1differs significantly from the output of Capetown, as the following shows:

```
SanJose1#show snapshot
BRI0/0 is up, line protocol is upSnapshot server line state down
  Length of active period:          5 minutes
   For ip address: 192.168.16.3
    Current state: active, remaining time: 5 minutes

Capetown#show snapshot
BRI0/0 is up, line protocol is upSnapshot client
  Options: dialer support, stay asleep on carrier up
```



```
Length of active period:          5 minutes
Length of quiet period:           10 minutes
Length of retry period:           8 minutes
 For dialer address 1
  Current state: active, remaining/exchange time: 5/0 minutes
  Connected dialer interface:
     BRI0/0:1
```

2. According to the output of this command, what is the retry period set to?

____

____

After allowing the connection to time out, wait five minutes with **`debug dialer`** running on each router. The following are sample outputs for SanJose1 and Capetown when snapshot routing is activated:

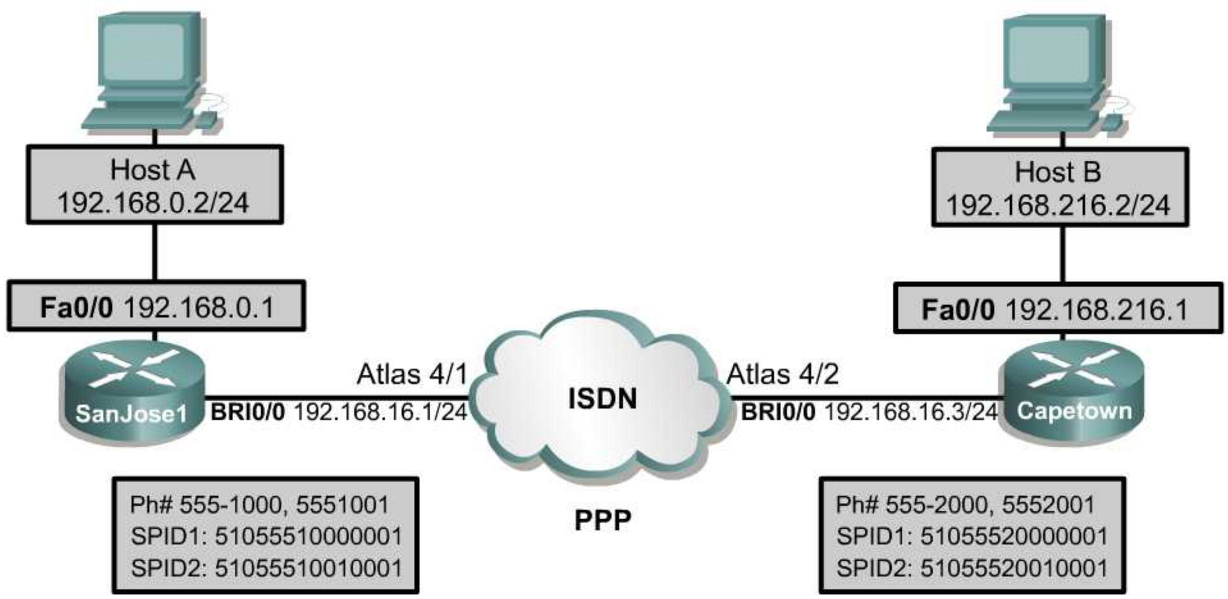
```
SanJose1#debug dialer
01:21:49: %LINK-3-UPDOWN: Interface BRI0/0:1, changed state to up
01:21:49: %ISDN-6-CONNECT: Interface BRI0/0:1 is now connected to unknown
01:21:49: isdn_call_connect: Calling lineaction of BRI0/0:1
01:21:49: BRI0/0:1 DDR: Authenticated host Capetown with no matching dialer
map
01:21:49: BR0/0:1 DDR: Dialer protocol up
01:21:49: BRI0/0:1 DDR: dialer protocol up
01:21:4w9: BRI0/0: dialer_ckt_swt_client_connect: incoming circuit switched
call
01:21:50: %LINEPROTO-5-UPDOWN: Line protocol on Interface BRI0/0:1, changed
state to up
01:21:55: %ISDN-6-CONNECT: Interface BRI0/0:1 is now connected to  Capetown

Capetown#debug dialer
00:29:27282767: isdn_call_connect: Calling lineaction of BRI0/0:1
00:29:00: BRI0/0:1 DDR: Authenticated host SanJose1 with no matching dialer
map
00:29:00: BR0/0:1 DDR: Dialer protocol up
00:29:00: BRI0/0:1 DDR: dialer protocol up
00:29:00: BRI0/0: dialer_ckt_swt_client_connect: incoming circuit switched
call
00:29:01: %LINEPROTO-5-UPDOWN: Line protocol on Interface BRI0/0:1, changed
state to up
00:29:06: %ISDN-6-CONNECT: Interface BRI0/0:1 is now connected to 5551000
SanJose1
```

3. Which router dials the other to receive snapshot routing information?

____

____

Lab 4.9.3 Using PPP Multilink for ISDN B Channel Aggregation



Objective

In this lab, the student will configure two Cisco routers for DDR using Multilink PPP (MLP) to use both B channels as a 128 kbps bundle.

Scenario

The International Travel Agency wants an ISDN DDR connection configured between a remote office in Capetown and its corporate office known as SanJose1. To maximize bandwidth, configure MLP to use both B channels for the data link.

Step 1

Before beginning this lab, it is recommended that the routers be reloaded after erasing their startup configuration. This will prevent problems that may be caused by residual configurations.

Build and configure the network according to the diagram, but do not configure the BRI interfaces on either router yet. Use the Adtran Atlas 550 or similar device to simulate the ISDN cloud. If the Atlas 550 is used, be sure to use straight-through cables. Connect both routers to the respective BRI module ports of the Atlas 550 as labeled in the diagram. Be sure to configure both workstations with the correct IP address and default gateway.

Step 2

Configure SanJose1 and Capetown for ISDN. Refer to the following commands to guide the configuration:


```
SanJose1(config)#username Capetown password cisco
SanJose1(config)#isdn switch-type basic-ni
SanJose1(config)#interface bri0/0
SanJose1(config-if)#ip address 192.168.16.1 255.255.255.0
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication chap
SanJose1(config-if)#isdn spid1 51055510000001 5551000
SanJose1(config-if)#isdn spid2 51055510010001 5551001
SanJose1(config-if)#dialer idle-timeout 60
SanJose1(config-if)#dialer-group 1
SanJose1(config-if)#dialer map ip 192.168.16.3 name Capetown 5552000
SanJose1(config-if)#no shutdown
SanJose1(config)#dialer-list 1 protocol ip permit
SanJose1(config)#ip route 192.168.216.0 255.255.255.0 192.168.16.3

Capetown(config)#enable password cisco
Capetown(config)#line vty 0 4
Capetown(config-line)#password cisco
Capetown(config-line)#exit
Capetown(config)#username SanJose1 password cisco
Capetown(config)#isdn switch-type basic-ni
Capetown(config)#interface bri0/0
Capetown(config-if)#ip address 192.168.16.3 255.255.255.0
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication chap
Capetown(config-if)#isdn spid1 51055520000001 5552000
Capetown(config-if)#isdn spid2 51055520010001 5552001
Capetown(config-if)#dialer idle-timeout 60
Capetown(config-if)#dialer-group 1
Capetown(config-if)#dialer map ip 192.168.16.1 name SanJose1 5551000
Capetown(config-if)#no shutdown
Capetown(config)#dialer-list 1 protocol ip permit
Capetown(config)#ip route 0.0.0.0 0.0.0.0 192.168.16.1
```

Use the **show isdn status** command to verify that the routers have established communication with the ISDN switch. If the routers have not established communication with the ISDN switch use the **clear interface bri0/0** command multiple times if necessary, to enable a valid and established SPID status. The **show running-config** command can also be used on each router to verify that the configurations have been entered correctly.

Verify that the routers have established communication with the ISDN switch with the **show isdn status** command. Use the **clear interface bri0/0** command multiple times if necessary to enable a valid and established SPID status.

Issue the **debug dialer** command on both SanJose1 and Capetown. Then test the DDR configuration by pinging Host A from Host B. Troubleshoot as necessary.

Step 3

Configure each router for multilink PPP. On both SanJose1 and Capetown, issue the following commands for PPP multilink:

```
SanJose1(config)#interface bri0/0
SanJose1(config-if)#ppp multilink
SanJose1(config-if)#dialer load-threshold 1 either
SanJose1(config-if)#dialer map ip 192.168.16.3 name Capetown 5552001
SanJose1(config-if)#dialer redial interval 5 attempts 3

Capetown(config)#interface bri0/0
Capetown(config-if)#ppp multilink
Capetown(config-if)#dialer load-threshold 1 either
Capetown(config-if)#dialer map ip 192.168.16.1 name SanJose1 5551001
Capetown(config-if)#dialer redial interval 5 attempts 3
```


The **ppp multilink** command is used on ISDN interfaces to bundle both 64 kbps B channels. When bundled, they function together as a 128 kbps pipe.

The **dialer load-threshold** command specifies how much traffic on the first B channel will force the second channel to be brought up. This command takes a numerical argument from 1 to 255. The number 1 is the minimum load and would enable the second channel automatically. The number 255 is a full load. Therefore, the value 128 would be approximately a fifty percent (50%) load.

If the threshold is set to 255, the second B channel will not be brought up until the first channel is completely loaded. By default, only outbound traffic is monitored. To monitor incoming and outgoing traffic, the keyword **either** is used. The option of specifying **inbound** or **outbound** instead is also available.

A second dialer map statement is entered to map the Layer 3 IP address to another Layer 2 destination SPID. Essentially, it configures the second B channel.

The **dialer redial** command was introduced in Cisco IOS® Software Release 12.1(2). Therefore, this command will not be available, and not required, if an older IOS version is used. The command sets the redial interval between dial attempts to five seconds, for a maximum of three attempts. This interval allows for the old call to be torn down completely before the redial is attempted.

Step 4

Ping Host A from Host B. This ping should bring up the DDR connection. Troubleshoot as necessary.

Once the connection is up, verify that both channels have been enabled. Use the **show ip interface brief** command on both routers. Notice that both B channels are up. If only channel 1 is up, clear the interface and send more pings to Host A from Host B. The following are sample outputs:

```
SanJose1#show ip interface brief
Interface              IP-Address    OK? Method Status           Protocol
FastEthernet0/0        192.168.0.1   YES NVRAM  up                   up
Serial0/0              unassigned    YES NVRAM  administratively
                                                down                 down
BRI0/0                 192.168.16.1  YES NVRAM  up                   up
BRI0/0:1               unassigned    YES unset  up                   up
BRI0/0:2               unassigned    YES unset  up                   up
Serial0/1              unassigned    YES NVRAM  administratively
                                                down                  down
Virtual-Access1        unassigned    YES TFTP   up                    up

Capetown#show ip interface brief
Interface              IP-Address    OK? Method Status           Protocol
FastEthernet0/0        192.168.216.1 YES NVRAM  up                   up
Serial0/0              unassigned    YES NVRAM  administratively
                                                down                 down
BRI0/0                 192.168.16.3  YES NVRAM  up                   up
BRI0/0:1               unassigned    YES unset  up                   up
BRI0/0:2               unassigned    YES unset  up                   up
Serial0/1              unassigned    YES NVRAM  administratively
                                                down                 down
Virtual-Access1        unassigned    YES TFTP   up                   up
```

Notice that both B channels show “up and up”.

1. A new interface has appeared in the output from the **show ip interface brief** command. What is it called?

____

____

With the ISDN connection still active, issue the **show dialer** command on both routers. The following are sample outputs:

```
SanJose1#show dialer
BRI0/0 - dialer type = ISDN
Dial String      Successes   Failures    Last DNIS   Last status
0 incoming call(s) have been screened.
0 incoming call(s) rejected for callback.

BRI0/0:1 - dialer type = ISDN
Idle timer (60 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is multilink member (Capetown)

BRI0/0:2 - dialer type = ISDN
Idle timer (60 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is multilink member
Connected to <unknown phone number> (Capetown)

Capetown#show dialer
BRI0/0 - dialer type = ISDN
Dial String      Successes   Failures    Last DNIS   Last status
5551001                  0          0    never                     -
5551000                 21          0    00:00:31       successful
0 incoming call(s) have been screened.
0 incoming call(s) rejected for callback.

BRI0/0:1 - dialer type = ISDN
Idle timer (60 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is multilink member
Dial reason: ip (s=192.168.216.2, d=192.168.0.2)
Connected to 5551000 (SanJose1)

BRI0/0:2 - dialer type = ISDN
Idle timer (60 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is multilink member
Dial reason: Multilink bundle overloaded
Connected to 5551000 (SanJose1)
```

2. Which part of the **show dialer** command output indicated that PPP multilink is functioning?

____

____

3. What was the "dial reason" for the first B channel? What was the "dial reason" for the second B channel?

____

____

Issue the **show ppp multilink** command on SanJose1 and on Capetown. The following are sample outputs:

```
SanJose1#show ppp multilink
Virtual-Access1, bundle name is Capetown
  Dialer interface is BRI0/0
  0 lost fragments, 0 reordered, 0 unassigned, sequence 0x3/0x0 rcvd/sent
  0 discarded, 0 lost received, 1/255 load
  Member links: 2 (max not set, min not set)
```



```
    BRI0/0:1
    BRI0/0:2

Capetown#show ppp multilink
Virtual-Access1, bundle name is SanJose1
  Dialer interface is BRI0/0
  0 lost fragments, 0 reordered, 0 unassigned, sequence 0x0/0x6 rcvd/sent
  0 discarded, 0 lost received, 1/255 load
  Member links: 2 (max not set, min not set)
    BRI0/0:1
    BRI0/0:2
```

4. According to the output of this command, how many channels are participating in the bundle?

____

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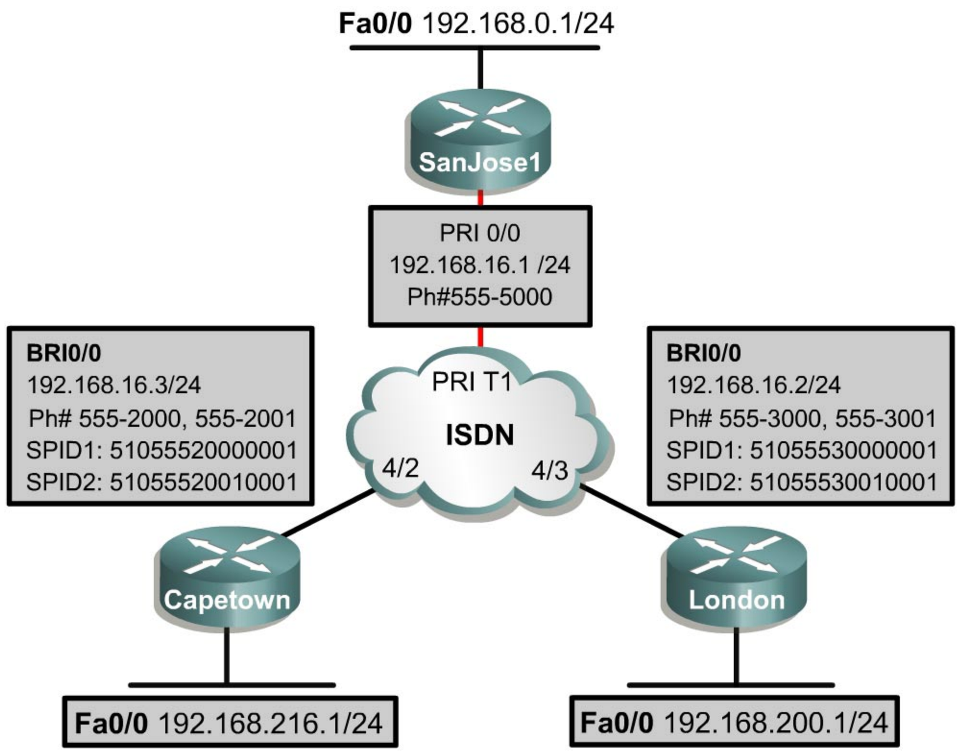
Lab 4.9.4 Configuring ISDN PRI



Objective

In this lab, the student will configure ISDN BRI on the remote site routers and ISDN PRI on the central site router.

Scenario

The International Travel Agency wants a connection configured between remote offices in Capetown and London and its corporate network router in SanJose1. The corporate office has just had an ISDN PRI provisioned so that SanJose1 can handle 23 ISDN BRI and/or V.90 asynchronous dial up calls simultaneously. The BRIs on the remote routers need to be configured, and the T1 controller and PRI D channel need to be configured on SanJose1. When the configuration is complete, each router should be able to dial the other two routers. SanJose1 should be able to receive calls from both London and Capetown.

Step 1

This lab assumes that SanJose1 has a T1 controller module installed.

Before beginning this lab, it is recommended that the routers be reloaded after erasing their startup configuration. This will prevent problems that may be caused by residual configurations. Build and configure the network according to the diagram, but do not configure the PRI and BRI interfaces on either router yet. Use the Adtran Atlas 550 or similar device to simulate the ISDN cloud. If the Atlas 550 is used, be sure to use straight-through cables. Connect both routers to the BRI module ports of the Atlas 550, as labeled in the diagram. Connect the T1 controller on SanJose to the T1 PRI port on the Atlas 550. This connection may require a DB-15-to-RJ45 adapter on the T1 controller module and the appropriate cable supplied with the Atlas 550.

Step 2

Configure the ISDN PRI connection. Specify the ISDN PRI switch type, which is determined by the carrier. The ISDN service provider connecting SanJose1 is using a Northern Telecom DMS100. The switch is running the National ISDN, version 1, software that is identified by the keyword **`primary-ni`**. Enter the following command:

```
SanJose1(config)#isdn switch-type primary-ni
```

Next, configure the local username and password database, so that SanJose1 can authenticate the remote routers with CHAP as follows:

```
SanJose1(config)#username Capetown password cisco
SanJose1(config)#username London password cisco
```

Specify what types of traffic will generate a call to the remote router. Configure a dialer list to specify any IP traffic as interesting with the following command:

```
SanJose1(config)#dialer-list 1 protocol ip permit
```

The SanJose1 router must have a route to both the Capetown and London Ethernet networks. Using the appropriate commands, configure two static routes to the LAN interfaces of these routers.

1. What are the commands to do this?

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   ____

Step 3

In this Step, configure the T1 controller. The controller must be configured according to the provider's framing and line coding.

In this case, use extended super frame and the binary 8-zero substitution linecode. Also, set the T1 controller to use all timeslots.

> **Note:** Remember that a T1 has twenty-four 64-kbps channels. To configure the PRI controller issue the following commands:

```
SanJose1(config)#controller t1 1/0
SanJose1(config-controller)#framing esf
SanJose1(config-controller)#linecode b8zs
SanJose1(config-controller)#pri-group timeslots 1-24
```

The final part of the configuration is to configure the PRI D channel. This channel is responsible for call setup and signaling. The D channel uses channel 23, which is the 24th channel, since they are numbered beginning with 0. Issue the following commands:

```
SanJose1(config)#interface serial 1/0:23
SanJose1(config-if)#ip address 192.168.16.1 255.255.255.0
SanJose1(config-if)#dialer-group 1
SanJose1(config-if) #dialer load-threshold 1 outbound
SanJose1(config-if)#dialer idle-timeout 60
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp multilink
```



```
SanJose1(config-if)#ppp authentication chap
```

Configure dialer map statements as follows, so that the router knows which numbers to dial to reach specific next-hop IP addresses:

```
SanJose1(config-if)#dialer map ip 192.168.16.3 name Capetown 5552000
SanJose1(config-if)#dialer map ip 192.168.16.3 name Capetown 5552001
SanJose1(config-if)#dialer map ip 192.168.16.2 name London 5553000
SanJose1(config-if)#dialer map ip 192.168.16.2 name London 5553001
```

Also configure as follows, static routes on SanJose1 to reach the Spoke office LAN:

```
SanJose1(config)#ip route 192.168.200.0 255.255.255.0 192.168.16.2
SanJose1(config)#ip route 192.168.216.0 255.255.255.0 192.168.16.3
```

Finally use the **show isdn status** command as follows, to verify that communication between the router and the ISDN switch has been successfully established:

```
SanJose1#show isdn status
Global ISDN Switchtype = primary-ni
ISDN Serial1/0:23 interface
        dsl 0, interface ISDN Switchtype = primary-ni
    Layer 1 Status:
        ACTIVE
    Layer 2 Status:
        TEI = 0, Ces = 1, SAPI = 0, State = MULTIPLE_FRAME_ESTABLISHED
    Layer 3 Status:
       0 Active Layer 3 Call(s)
    Activated dsl 0 CCBs = 0
    The Free Channel Mask:  0x801FFFFF
    Total Allocated ISDN CCBs = 2
```

1. How is the **show isdn status** output for layer 2 of a PRI different from a BRI?

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Step 4

Configure both of the remote routers to use the appropriate ISDN switch type, National ISDN-1. Since PPP encapsulation and CHAP will be used on the B channels, enter username and password information on both routers. The following configuration is for London:

Note: When configuring Capetown, be sure to substitute the appropriate information.

```
London(config)#enable password cisco
London(config)#line vty 0 4
London(config-line)#password cisco
London(config-line)#exit
London(config)#isdn switch-type basic-ni
London(config)#interface  bri0/0
London(config)#ip address 192.168.16.2 255.255.255.0
London(config-if)#encapsulation ppp
London(config-if)#ppp authentication chap
London(config-if)#isdn spid1 51055530000001 5553000
London(config-if)#isdn spid2 51055530010001 5553001
London(config-if)#dialer-group 1
London(config-if)#dialer idle-timeout 60
London(config-if)#no shutdown
```


1. PPP is the line encapsulation on the B channels. What is the encapsulation protocol used on the D channel?

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____

Configure dialer-list 1 as follows to identify all IP traffic as “interesting” on both routers:

```
London(config)#dialer-list 1 protocol ip permit
```

Configure both spoke routers with the username and password of SanJose1, so that they will each authenticate SanJose1 using CHAP. A static route to the central office LAN must also be configured on both routers. The following are example commands for Capetown:

```
Capetown(config)#username SanJose1 password cisco
Capetown(config)#username London password cisco
Capetown(config)#ip route 192.168.0.0 255.255.255.0 192.168.16.1
Capetown(config)#ip route 192.168.200.0 255.255.255.0 192.168.16.2
```

Finally, configure the BRI interfaces for the remote routers with the appropriate dialer map commands. The following are the commands required for Capetown:

```
Capetown(config)#interface bri 0/0
Capetown(config-if)#dialer map ip 192.168.16.1 name SanJose1 5555000
Capetown(config-if)#dialer map ip 192.168.16.2 name London 5553000
Capetown(config-if)#dialer map ip 192.168.16.2 name London 5553001
```

Step 5

Verify the configuration of the FastEthernet interface on SanJose1. Ping from both Capetown and London to 192.168.0.1. The pings should be successful. Troubleshoot as necessary.

After the pings, both Capetown and London will be connected to SanJose1 simultaneously. With multilink configured, Capetown and London should be using both of their B channels.

If either link is disconnected, ping the FastEthernet interface on SanJose1 again. Once both the Capetown and London links are up, issue the **show ip interface brief** command as follows on SanJose1:

```
SanJose1#show ip interface brief
Interface          IP-Address      OK? Method Status                Protocol
FastEthernet0/0    192.168.0.1     YES NVRAM  up                    up
Serial0/0          unassigned      YES NVRAM  administratively down down
Serial0/1          unassigned      YES NVRAM  administratively down down
Serial1/0:0        unassigned      YES unset  down                  down
Serial1/0:1        unassigned      YES unset  down                  down
Serial1/0:2        unassigned      YES unset  down                  down
Serial1/0:3        unassigned      YES unset  down                  down
Serial1/0:4        unassigned      YES unset  down                  down
Serial1/0:5        unassigned      YES unset  down                  down
Serial1/0:6        unassigned      YES unset  down                  down
Serial1/0:7        unassigned      YES unset  down                  down
Serial1/0:8        unassigned      YES unset  down                  down
Serial1/0:9        unassigned      YES unset  down                  down
Serial1/0:10       unassigned      YES unset  down                  down
Serial1/0:11       unassigned      YES unset  down                  down
Serial1/0:12       unassigned      YES unset  down                  down
Serial1/0:13       unassigned      YES unset  down                  down
Serial1/0:14       unassigned      YES unset  down                  down
Serial1/0:15       unassigned      YES unset  down                  down
Serial1/0:16       unassigned      YES unset  down                  down
```



```
Serial1/0:17      unassigned      YES unset  down                  down
Serial1/0:18      unassigned      YES unset  down                  down
Serial1/0:19      unassigned      YES unset  up                    up
Serial1/0:20      unassigned      YES unset  up                    up
Serial1/0:21      unassigned      YES unset  up                    up
Serial1/0:22      unassigned      YES unset  up                    up
Serial1/0:23      192.168.16.1    YES NVRAM  up                    up
Virtual-Access1   unassigned      YES TFTP   up                    up
```

1. According to the output of this command, which channels of the PRI are connected?

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2. Why does Serial1/0:23 have an IP address, and not Serial1/0:22 or Serial1/0:20?

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With both connections active, issue the **`show dialer`** command on SanJose1.

3. What is the dialer reason for Serial1/0:19?

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4. What is the dialer reason for Serial1/0:20?

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5. What is the dialer reason for Serial1/0:21?

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6. What is the dialer reason for Serial1/0:22?

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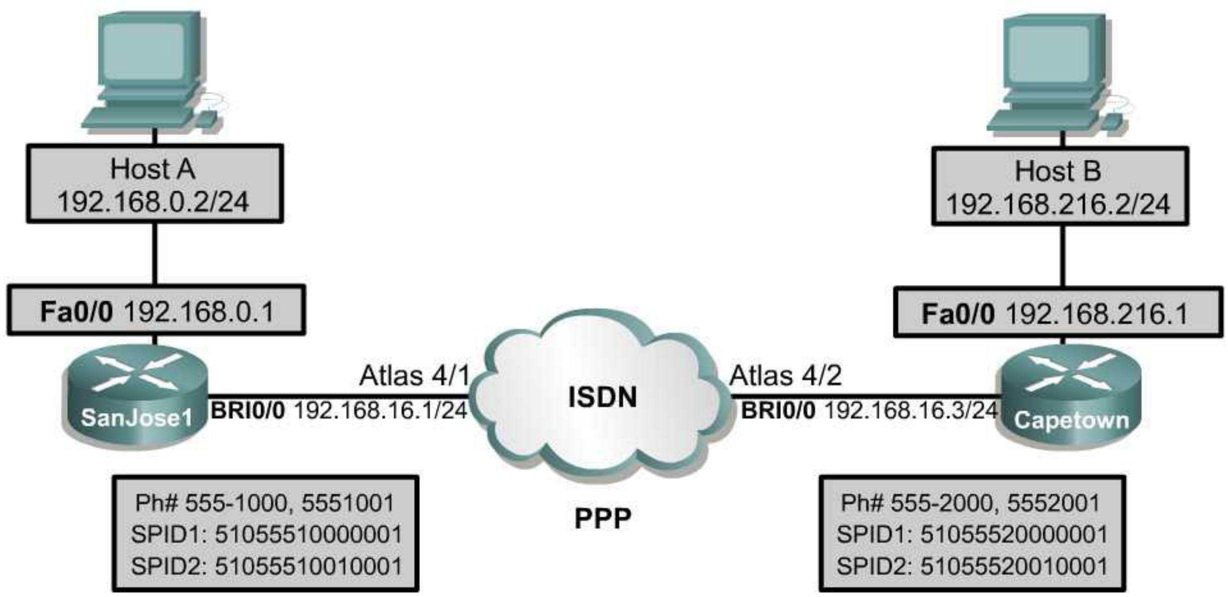
Lab 5.3.1 Configuring ISDN Using Dialer Profiles



Objective

In this lab, the student will configure two Cisco routers for ISDN BRI using dialer profiles.

Scenario

The International Travel Agency wants an ISDN DDR connection configured between a remote office in Capetown and its corporate network core router in SanJose1. They have asked that PPP encapsulation and CHAP authentication be configured over this link. Because the company plans to increase the number of ISDN connections at the central and remote sites, use dialer profiles to simplify future configurations.

Step 1

Before beginning this lab, it is recommended that the router be reloaded after erasing its startup configuration. This prevents problems that may be caused by residual configurations. Build and configure the network according to the diagram, but do not configure the BRI interfaces for either router yet. Use the Adtran Atlas 550 or a similar device to simulate the ISDN cloud. If the Atlas 550 is used, be sure to use straight-through cables. Connect both routers to the BRI module ports of the Atlas 550 as labeled in the diagram. Be sure to configure both workstations with the correct IP address and default gateway. Configure the Fa0/0 interfaces of the routers to match the diagram.

Step 2

Configure both routers to use the appropriate ISDN switch type, National ISDN-1. Because PPP encapsulation and CHAP will be used on the B channels, enter the case sensitive username and password information on both routers. The following are examples for SanJose1:


```
SanJose1(config)#isdn switch-type basic-ni
SanJose1(config)#username Capetown password cisco
SanJose1(config)#enable password cisco
SanJose1(config)#line vty 0 4
SanJose1(config)#password cisco
SanJose1(config)#login
SanJose1(config)#exit
```

1. PPP is the line encapsulation on the B channels. What is the encapsulation protocol used on the D channel?

   ____

   ____

Configure **dialer-list 1** to identify all IP traffic as "interesting" on both routers as shown in the following:

```
SanJose1(config)#dialer-list 1 protocol ip permit
```

Step 3

Configure the BRI on SanJose1 and Capetown to use a dialer profile as shown in the following:

Note: Do not assign an IP address to these interfaces.

```
SanJose1(config)#interface bri0/0
SanJose1(config-if)#isdn spid1 51055510000001 5551000
SanJose1(config-if)#isdn spid2 51055510010001 5551001
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication chap
SanJose1(config-if)#dialer pool-member 1
SanJose1(config-if)#no shutdown

Capetown(config)#interface bri0/0
Capetown(config-if)#isdn spid1 51055520000001 5552000
Capetown(config-if)#isdn spid2 51055520010001 5552001
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication chap
Capetown(config-if)#dialer pool-member 1
Capetown(config-if)#no shutdown
```

Dialer profiles were introduced in IOS version 11.2 and are the preferred way to configure DDR in complex environments. The dialer profile concept is based on a separation between logical and physical interface configuration. The use of dialer profiles allows the logical and physical configurations to be bound together dynamically on a per-call basis. When using a dialer profile, an interface is assigned to a dialer pool or pools. In this case, BRI0/0 has been assigned to be in dialer pool 1. All of the other logical configurations, such as IP address, dialer string, and dialer group, will be assigned by the dialer interface. Depending on the IOS version, the line encapsulation may need to be specified on both the physical interface and the logical interface.

In Cisco IOS software releases prior to IOS 12.0(7)T, dialer profiles in the same dialer pool will need encapsulation configuration information entered. This information must be entered under both the dialer profile interface and the ISDN interface. If any conflict arises between the logical and the physical interfaces, the dialer profile will not work. That is why Step 4 shows this configuration with **encapsulation ppp** configured on BRI0/0 and dialer interface 0:

In the new dialer profile model introduced by the dynamic multiple encapsulations feature, IOS 12.0(7)T and later, the configuration on the ISDN interface is ignored. Only the configuration on the profile interface is used, unless PPP name binding is used. Before a successful bind by calling line identification (CLID) occurs, no encapsulation type and configuration are assumed or taken from the physical interfaces.

Step 4

Configure the dialer interfaces for both routers, starting with SanJose1. The dialer interface receives the logical configuration that is applied to a physical interface. Issue the following commands on SanJose1:

```
SanJose1(config)#interface dialer 0
SanJose1(config-if)#dialer pool 1
SanJose1(config-if)#ip address 192.168.16.1 255.255.255.0
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication chap
SanJose1(config-if)#ppp multilink
SanJose1(config-if)#dialer load-threshold 1 either
SanJose1(config-if)#dialer-group 1
SanJose1(config-if)#dialer remote-name Capetown
SanJose1(config-if)#dialer string 5552000
SanJose1(config-if)#dialer string 5552001
```

Now create a dialer profile on Capetown as shown in the following:

```
Capetown(config)#interface dialer 0
Capetown(config-if)#dialer pool 1
Capetown(config-if)#ip address 192.168.16.3 255.255.255.0
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication chap
Capetown(config-if)#ppp multilink
Capetown(config-if)#dialer load-threshold 1 either
Capetown(config-if)#dialer-group 1
Capetown(config-if)#dialer remote-name SanJose1
Capetown(config-if)#dialer string 5551000
Capetown(config-if)#dialer string 5551001
```

Note: With a dialer interface, use the **dialer remote-name** and **dialer string** commands in place of a dialer map statement.

Use the **show isdn status** command to check ISDN Layer 2 and SPID status. Use the **clear interface bri0/0** command, multiple times if necessary, to enable a SPID status of established and valid.

1. How will SanJose1 know to use Capetown at 5552000 when it receives interesting traffic that must be routed to 192.168.16.3? In other words, is there anything in the dialer interface configuration that SanJose1 can use to determine that this dialer profile should be used to reach 192.168.16.3?

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Step 5

Configure static routing on both routers so that nodes on the remote network can reach nodes at the central site. Use a default route on the Capetown router, since it is a remote site stub network, as shown in the following:

```
SanJose1(config)#ip route 192.168.216.0 255.255.255.0 192.168.16.3
Capetown(config)#ip route 0.0.0.0 0.0.0.0 192.168.16.1
```


Step 6

Enable **debug dialer** on both SanJose1 and Capetown.

Test the ISDN connection by pinging Host B from Host A. This ping should eventually be successful. Once connected, issue the **show dialer** command.

1. According to the output from **show dialer**, what logical interface has been bound to interface BRI0/0:1?

   ____

   ____

Issue the **show ip interface brief** command. Since PPP multilink was configured, both B Channels should show “up and up”. Troubleshoot as necessary.

Allow the ISDN connection to time out, or manually disconnect both B channels by issuing the **isdn disconnect interface bri0/0 all** command at either router.

With both B Channels disconnected on each router, issue the **show ip interface brief** command a second time.

2. According to this command, interface dialer 0 is still “up and up”. Why?

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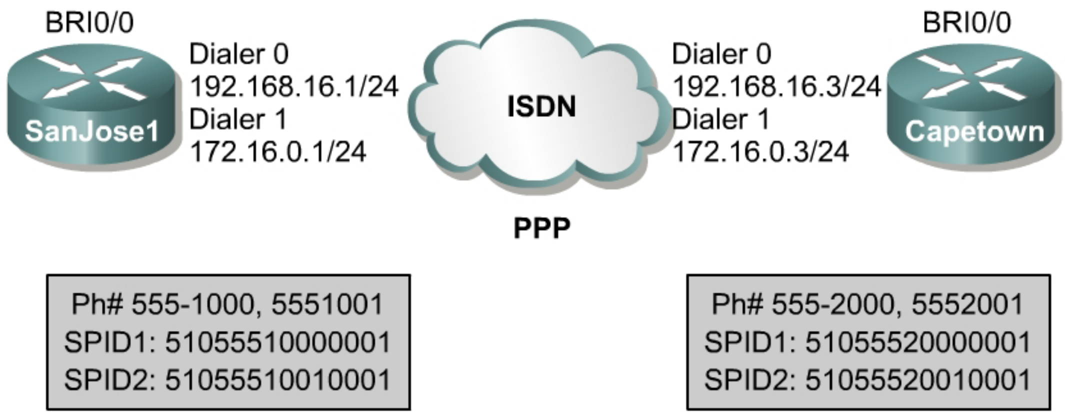
Lab 5.3.2 Using a Dialer Map-Class with Dialer Profiles



Objective

In this lab, the student will configure two Cisco routers for ISDN BRI using dialer profiles and a dialer map-class.

Scenario

The International Travel Agency wants an ISDN DDR connection configured between the corporate network router, SanJose1, and its remote office router in Capetown. They have asked that PPP encapsulation and CHAP authentication be configured over this link. Because the company plans to increase the number of ISDN connections at the central and remote sites, use dialer profiles to simplify future configurations.

The company has only one remote site connection at this time. However, two dialer profiles are to be configured in order to test its operation. Since router-to-router connectivity will be tested, the workstations will not need to be configured in this exercise.

Step 1

Before beginning this lab, it is recommended that the router be reloaded after erasing its startup configuration. This prevents problems that may be caused by residual configurations. Build the network according to the diagram, but do not configure the BRI interfaces on either router yet. Use the Adtran Atlas 550 or a similar device to simulate the ISDN cloud. If the Atlas 550 is used, be sure to use straight-through cables. Connect both routers to the BRI module ports of the Atlas 550, as labeled in the diagram.

Step 2

Configure both routers to use the appropriate ISDN switch type, National ISDN-1. PPP encapsulation and CHAP will be used on the B channels. For this reason, enter the case sensitive username and password information on both routers. Notice in the following, that this lab uses different passwords and username combinations than was done in previous labs:

```
SanJose1(config)#isdn switch-type basic-ni
SanJose1(config)#username Capetown password cisco
```



```
SanJose1(config)#username JULIET password cisco
SanJose1(config)#enable password cisco
SanJose1(config)#line vty 0 4
SanJose1(config-line)#password cisco
SanJose1(config-line)#login
Capetown(config)#isdn switch-type basic-ni
Capetown(config)#username SanJose1 password cisco
Capetown(config)#username ROMEO password cisco
Capetown(config)#enable password cisco
Capetown(config)#line vty 0 4
Capetown(config-line)#password cisco
Capetown(config-line)#login
```

Configure **dialer-list 5** on both routers to identify all IP traffic as "interesting". The following is an example for SanJose1:

```
SanJose1(config)#dialer-list 5 protocol ip permit
```

Step 3

Configure the BRI on SanJose1 and Capetown to use dialer profiles. In this lab, configure both BRIs to be members of two dialer pools as follows:

Note: Remember, that the encapsulation configuration commands must be entered for both the physical interface, BRI 0/0, and the logical interface such as dialer0.

```
SanJose1(config)#interface bri0/0
SanJose1(config-if)#isdn spid1 51055510000001 5551000
SanJose1(config-if)#isdn spid2 51055510010001 5551001
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication chap
SanJose1(config-if)#dialer pool-member 1
SanJose1(config-if)#no shutdown

Capetown(config)#interface bri0/0
Capetown(config-if)#isdn spid1 51055520000001 5552000
Capetown(config-if)#isdn spid2 51055520010001 5552001
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication chap
Capetown(config-if)#dialer pool-member 1
Capetown(config-if)#no shutdown
```

Step 4

On both routers, create a map-class called AGGRESSIVE that can be used to apply multiple dialer configurations to a dialer string easily. Issue the following commands on both routers. The following is an example for SanJose1:

```
SanJose1(config)#map-class dialer AGGRESSIVE
SanJose1(config-map-class)#dialer idle-timeout 30
SanJose1(config-map-class)#dialer fast-idle 10
SanJose1(config-map-class)#dialer wait-for-carrier-time 25
SanJose1(config-map-class)#exit
```

1. Other than a dialer **map-class**, what other types of **map-class** can be configured?

   Note: Use the Help feature to find the answer.

   ____

Step 5

Configure the dialer interfaces for both routers as follows, starting with SanJose1:

> **Note:** The dialer interface receives the logical configuration that is applied to a physical interface.

```
SanJose1(config)#interface dialer 0
SanJose1(config-if)#ip address 192.168.16.1 255.255.255.0
SanJose1(config-if)#dialer pool 1
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication chap
SanJose1(config-if)#dialer remote-name Capetown
SanJose1(config-if)#dialer-group 5
SanJose1(config-if)#dialer string 5552000 class AGGRESSIVE
SanJose1(config-if)#dialer string 5552001 class AGGRESSIVE

SanJose1(config)#interface dialer 1
SanJose1(config-if)#ip address 172.16.0.1 255.255.255.0
SanJose1(config-if)#dialer pool 1
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication chap
SanJose1(config-if)#ppp chap hostname ROMEO
SanJose1(config-if)#dialer remote-name JULIET
SanJose1(config-if)#dialer-group 5
SanJose1(config-if)#dialer string 5552000 class AGGRESSIVE
SanJose1(config-if) #dialer string 5552001 class AGGRESSIVE
```

1. By applying the map-class AGGRESSIVE to each dialer string, which timers are being configured?

   ____

   ____

2. What does the command **ppp chap hostname ROMEO** do?

   ____

   ____

Now create the dialer profiles on Capetown as shown in the following:

```
Capetown(config)#interface dialer 0
Capetown(config-if)#ip address 192.168.16.3 255.255.255.0
Capetown(config-if)#dialer pool 1
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication chap
Capetown(config-if)#dialer remote-name SanJose1
Capetown(config-if)#dialer-group 5
Capetown(config-if)#dialer string 5551000 class AGGRESSIVE
Capetown(config-if)#dialer string 5551001 class AGGRESSIVE
Capetown(config)#interface dialer 1
Capetown(config-if)#ip address 172.16.0.3 255.255.255.0

Capetown(config-if)#dialer pool 1
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication chap
Capetown(config-if)#ppp chap hostname JULIET
Capetown(config-if)#dialer remote-name ROMEO
Capetown(config-if)#dialer-group 5
Capetown(config-if)#dialer string 5551000 class AGGRESSIVE
Capetown(config-if)#dialer string 5551001 class AGGRESSIVE
```

Step 6

To simplify testing, create hostname mappings on both routers:

```
SanJose1(config)#ip host Capetown 192.168.16.3
SanJose1(config)#ip host JULIET 172.16.0.3

Capetown(config)#ip host SanJose1 192.168.16.1
Capetown(config)#ip host ROMEO 172.16.0.1
```

Note: Make sure that the host names configured here exactly match the previously configured chap and dialer remote host names.

Step 7

Before connecting, issue the **`show dialer`** command.

1. According to the output of this command, what is the dialer idle timeout for BRI0/0:1 set to?

____

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2. What is the fast idle timer for BRI0/0:1 set to?

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Use the **`show isdn status`** command on both routers to check the ISDN Layer 2 and SPID status. Use the **`clear interface bri0/0`** command, multiple times if necessary, to enable a SPID status of established and valid.

Now test the dialer profile operation. Enter the **`debug dialer`** and **`debug ppp authentication`** commands. **`Ping`** Capetown, 192.168.16.3, from SanJose1 using the following command:

```
SanJose1#ping Capetown
```

SanJose1 should dial Capetown and connect. The pings should eventually be successful, as the following shows:

```
Sending 5, 100-byte ICMP Echos to 192.168.16.3, timeout is 2 seconds:
00:49:26: BRI0/0 DDR: rotor dialout [priority]
00:49:26: BRI0/0 DDR: Dialing cause ip (s=192.168.16.1, d=192.168.16.3)
00:49:26: BRI0/0 DDR: Attempting to dial 5552000
00:49:111669149728: %LINK-3-UPDOWN: Interface BRI0/0:1, changed state to up
00:49:113835732748: BRI0/0:1: interface must be fifo queue, force fifo
00:49:113835732564: %DIALER-6-BIND: Interface BRI0/0:1 bound to
profile Dialer0
00:49:115964116991: %ISDN-6-CONNECT: Interface BRI0/0:1 is now
connected to 5552000
00:49:111698112601: isdn_call_connect: Calling lineaction of BRI0/0:1.
00:49:28: BR0/0:1 DDR: Dialer protocol up
00:49:28: BRI0/0:1 DDR: dialer protocol up
00:49:28: Dialer0: dialer_ckt_swt_client_connect: incoming circuit
switched call.!!!
Success rate is 60 percent (3/5), round-trip min/avg/max = 32/32/32 ms
```


3. According to the output of the **debug dialer** command, what logical interface has been bound to interface BRI0/0:1?

____

____

Troubleshoot as necessary. With SanJose1 still connected to Capetown, reconnect if necessary, **ping** JULIET from SanJose1 using the following command:

```
SanJose1#ping JULIET
```

Again, the connection and pings should eventually be successful, using the second B Channel, BRI0/0:2. Troubleshoot as necessary.

4. According to the output of the **debug dialer** command, what logical interface has been bound to interface BRI0/0:2?

____

With both connections still active, issue the **show dialer** command on SanJose1. A partial sample output is shown as follows:

```
SanJose1#show dialer
<output omitted>
BRI0/0:1 - dialer type = ISDN
Idle timer (30 secs), Fast idle timer (10 secs)
Wait for carrier (25 secs), Re-enable (15 secs)
Dialer state is data link layer up
Dial reason: ip (s=192.168.16.1, d=192.168.16.3)
Interface bound to profile Dialer0
Time until disconnect 4 secs
Current call connected 00:00:29
Connected to 5552000 (Capetown)

BRI0/0:2 - dialer type = ISDN
Idle timer (30 secs), Fast idle timer (10 secs)
Wait for carrier (25 secs), Re-enable (15 secs)
Dialer state is data link layer up
Dial reason: ip (s=172.16.0.1, d=172.16.0.3)
Interface bound to profile Dialer1
Time until disconnect 19 secs
Current call connected 00:00:13
Connected to 5552001 (JULIET)

Dialer0 - dialer type = DIALER PROFILE
Idle timer (120 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is data link layer up
Number of active calls = 0
Number of active circuit switched calls = 0
<output omitted>
```

5. According to the output of the **show dialer** command, what phone number is BRI0/0:1 connected to? What is the hostname of that router?

____

____

6. What phone number is BRI0/0:2 connected to? What is the hostname of that router?

____

____

7. According to the output of the **`show dialer`** command, what is the idle timer for BRI0/0:1 set to?

____

____

8. What is the fast idle timer for BRI0/0:1 set to?

____

____

9. Why did these values change when SanJose1 connected to Capetown?

____

____

____

10. What is one advantage of using a dialer profile instead of a dedicated configuration on the BRI?

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11. What is one advantage of using a dialer map-class?

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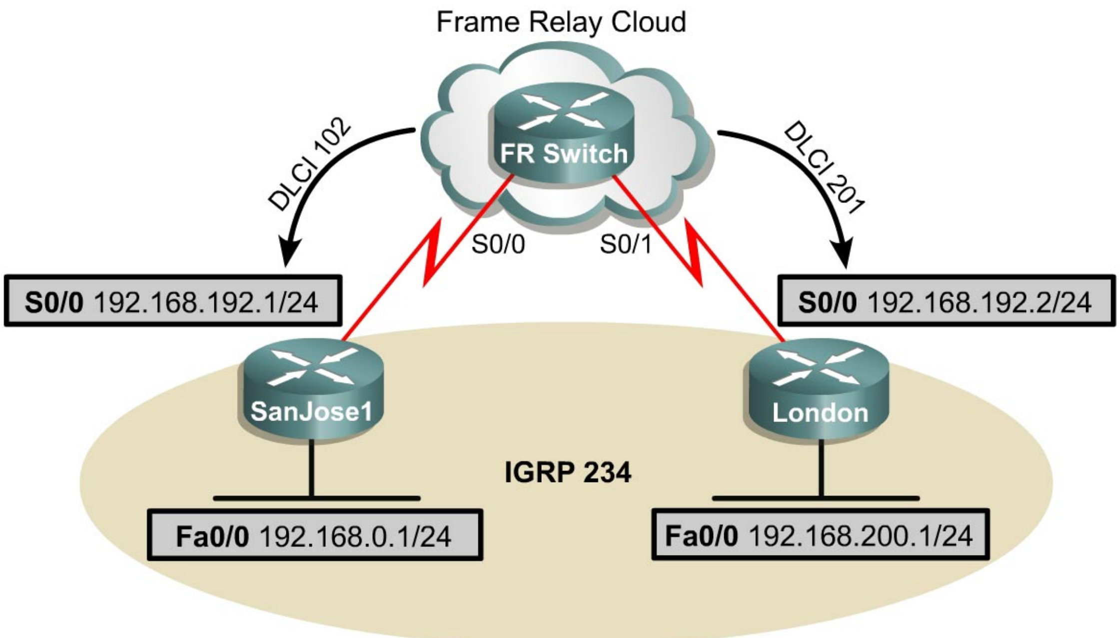
Lab 6.4.1 Basic Frame Relay Router and Switch Configuration



Objective

Configure a router as a Frame Relay switch, connecting two routers in a point-to-point topology.

Scenario

As the network engineer for International Travel Agency, prepare to deploy Frame Relay as the primary connectivity for the company WAN. While waiting for the service provider to provision T1 lines, create router configurations in advance. Since access to a Frame Relay switch is not available, a Cisco router must be configured as a Frame Relay switch to test router configurations. This network will use IGRP, autonomous system number 234, to advertise LANs at each location.

Step 1

Before beginning this lab, it is recommended that each router be reloaded after erasing its startup configuration. This prevents problems that may be caused by residual configurations. Once the equipment has been prepared, proceed with Step 2. Configure each router with their respective hostname and FastEthernet IP Addresses and connect the FastEthernet interface into a switch or a hub.

Step 2

Configure the Frame Relay switch with static mapping necessary to switch packets along the appropriate PVC.

Enable **`frame-relay switching`** on the router acting as the service provider Frame Relay cloud as follows:

```
FRswitch(config)#frame-relay switching
```


The remaining configurations on the Frame Relay switch are specific to the interfaces. On each serial interface, configure the encapsulation to Frame Relay, define the interface as a Frame Relay DCE, and set the clockrate. The following is an example:

```
FRswitch(config-if)#encapsulation frame-relay
FRswitch(config-if)#frame-relay intf-type dce
FRswitch(config-if)#clock rate 56000
```

Frame Relay switches identify inbound frames by their data-link connection identifier (DLCI). The DLCI is then referenced in a switching table to determine the outbound port. Statically define an end-to-end PVC between SanJose1 and London. A static route needs to be configured for each serial interface, as shown in the following:

```
FRswitch(config)#interface serial 0/0
FRswitch(config-if)#frame-relay route 102 interface serial 0/1 201
FRswitch(config-if)#interface serial 0/1
FRswitch(config-if)#frame-relay route 201 interface serial 0/0 102
```

The switch logic indicates that if the frame inbound to interface serial 0/0 is labeled DLCI 102, then send the frame to the outbound interface serial 0/1 labeled with DLCI 201. For traffic traveling in the opposite direction, the logic indicates that if the frame inbound to interface serial 0/1 is labeled DLCI 201, then send the frame to the outbound interface serial 0/0 labeled with DLCI 102. This can be confirmed with the **show frame-relay route** on the switch, as shown in the following:

```
FRswitch#show frame-relay route
Input Intf      Input Dlci      Output Intf     Output Dlci     Status
Serial0/0       102              Serial0/1       201            inactive
Serial0/1       201              Serial0/0       102            inactive
```

Step 3

Next, configure SanJose1 with IP addresses and a routing protocol as shown in the diagram. The default encapsulation for Cisco routers is HDLC. Therefore, the interface serial 0/0 needs to be configured for Frame Relay encapsulation, as the following shows:

```
SanJose1(config)#interface serial 0/0
SanJose1(config-if)#encapsulation frame-relay
SanJose1(config-if)#ip address 192.168.192.1 255.255.255.0
SanJose1(config-if)#exit
SanJose1(config)#router igrp 234
SanJose1(config-router)#network 192.168.0.0
SanJose1(config-router)#network 192.168.192.0
```

Configure London using the same command syntax.

Step 4

Use extended **pings** and **show ip route** to test Frame Relay connectivity and IGRP route propagation as follows:

```
London#show ip route
Gateway of last resort is not set
C    192.168.192.0/24 is directly connected, Serial0/0
C    192.168.200.0/24 is directly connected, FastEthernet0/0
I    192.168.0.0/24 [100/80135] via 192.168.192.1, 00:00:25,
Serial0/0
```



```
London#ping
Protocol [ip]:
Target IP address: 192.168.0.1
Repeat count [5]: 20
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 20, 100-byte ICMP Echos to 192.168.0.1, timeout is 2
seconds:
!!!!!!!!!!!!!!!!!!!!
Success rate is 100 percent (20/20), round-trip min/avg/max = 64/64/68 ms
```

That is the total process to configure an end-to-end Frame Relay network. This is a simple process, due to the ability of Cisco routers to dynamically learn information from the adjacent Frame Relay switch and neighboring routers.

Step 5

Many variables were defined through default configuration and discovery. However, those default values, such as Frame Relay encapsulation type, DLCI mapping, and LMI, can still be displayed.

Cisco routers support two Frame Relay encapsulation types: Cisco and Internet Engineering Task Force (IETF). Cisco is a proprietary encapsulation type. IETF is standards based. Use IETF whenever connecting to a non-Cisco router through a Frame Relay PVC. Since the Frame Relay encapsulation type has not been defined, the default must be in use. Issue **`show interface serial 0/0`** as follows, on SanJose1:

```
SanJose1#show interface serial 0/0
Serial0/0 is up, line protocol is up
  Hardware is PowerQUICC Serial
  Internet address is 192.168.192.1/24
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation FRAME-RELAY, loopback not set
  Keepalive set (10 sec)
!
<output ommited>
```

In this output, there is no indication of the encapsulation type other than FRAME-RELAY. Change SanJose1 Serial 0/0 Frame Relay encapsulation type to IETF.

```
SanJose1(config)#interface serial 0/0
SanJose1(config-if)#encapsulation frame-relay ietf
```

Now enter the **`show interface serial 0/0`** command again.

```
SanJose1#show interface serial 0/0
Serial0/0 is up, line protocol is up
Hardware is PowerQUICC Serial
Internet address is 192.168.192.1/24
MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
reliability 255/255, txload 1/255, rxload 1/255
Encapsulation FRAME-RELAY IETF, loopback not set
```



```
Keepalive set (10 sec)
!
<output ommited>
```

In this output, the IETF encapsulation type is declared. When only FRAME-RELAY is seen, the router is using the default encapsulation type, Cisco. Change the encapsulation type back to Cisco by not specifying a type:

```
SanJose1(config)#interface serial 0/0
SanJose1(config-if)#encapsulation frame-relay
```

DLCIs identify unique permanent virtual circuits (PVCs) or switched virtual circuits (SVCs). One device can support DLCIs ranging from 16 to 1007. The complete DLCI range is 0 to 1023, with 0 to 15 and 1008 to 1023 reserved for special purposes. For example, multicasts are identified with 1019 and 1020.

Issue the **show frame-relay map** command as follows on SanJose1:

```
SanJose1#show frame-relay map
Serial0/0 (up): ip 192.168.192.2 dlci 102(0x12,0x420), dynamic,
              broadcast,, status defined, active
```

The association between a DLCI and its next-hop network address is called mapping. The router logic indicates that if routing to the next-hop address 192.168.192.2, then tag the frame with DLCI 102. The Frame Relay switch does not understand IP addressing, but does know where to send frames tagged as DLCI 102. Recall the switch logic from Step 2.

1. Given the minimal commands executed on SanJose1, how does the router know which DLCI to use? How does the router know the IP address of the next-hop router using that PVC?

   ____

   ____

   ____

   ____

DLCIs have to be configured on the Frame Relay switch. If DLCIs are not configured on the router, they are learned dynamically from the switch through LMI as defined in the next paragraph. Once the router has a DLCI number identifying a virtual circuit, the router sends an Inverse ARP through that circuit requesting information from whatever DTE is on the other end. When the process is completed in both directions, the circuit is ready for traffic.

Local Management Interface (LMI) is the Layer 2 protocol between the router (DTE) and the Frame Relay switch (DCE). LMI exchanges keepalives every ten seconds, with DLCI information conveyed every 60 seconds. There are three different LMI types: Cisco, ANSI, and Q933a. DTE devices must match the LMI type of the DCE. Since the LMI type was not explicitly configured on the Frame Relay switch, the network must be using the default LMI type. Execute the **show frame-relay lmi** command as follows on SanJose1:

```
SanJose1#show frame-relay lmi
LMI Statistics for interface Serial0/0 (Frame Relay DTE) LMI TYPE
= CISCO
  Invalid Unnumbered info 0            Invalid Prot Disc 0
  Invalid dummy Call Ref 0             Invalid Msg Type 0
  Invalid Status Message 0             Invalid Lock Shift 0
  Invalid Information ID 0             Invalid Report IE Len 0
  Invalid Report Request 0             Invalid Keep IE Len 0
  Num Status Enq. Sent 325             Num Status msgs Rcvd 326
  Num Update Status Rcvd 0             Num Status Timeouts 0
```


The default LMI type is Cisco. Notice that LMI type is interface-specific. This same router could use a different LMI type on another serial interface. This could happen when connected to a second Frame Relay switch for redundancy. The LMI type is also identified by a DLCI, communicated from the switch to the router.

2. Which DLCI does the Cisco LMI type use?

____

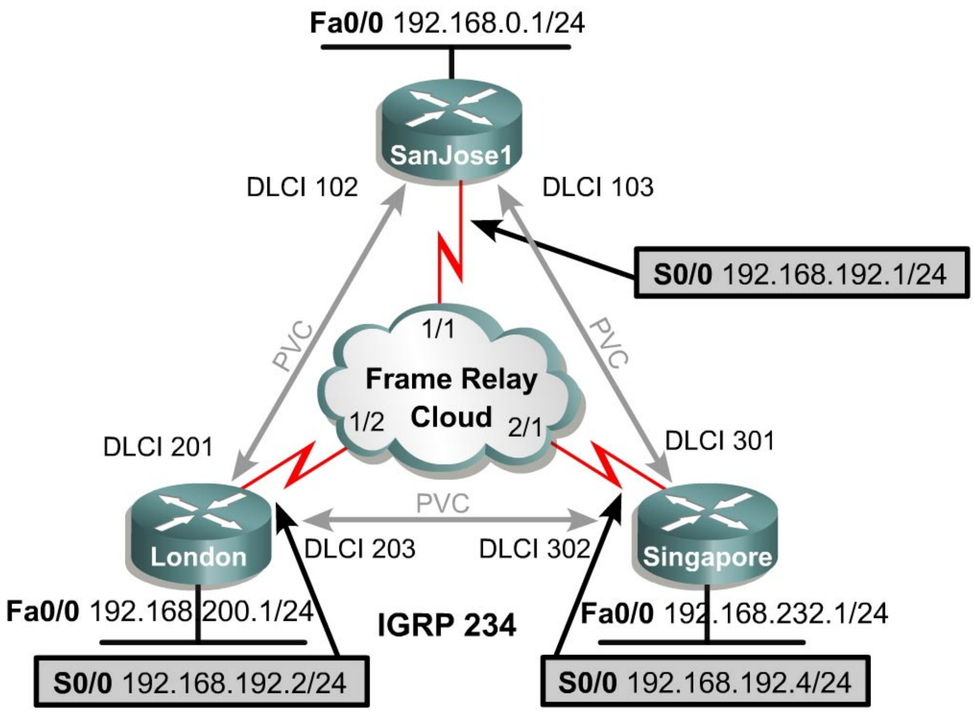
If the answer is not already known, issue the **show interface serial 0/0** command as follows on SanJose1:

```
SanJose1#show interface serial 0/0
Serial0/0 is up, line protocol is up
  Hardware is PowerQUICC Serial
  Internet address is 192.168.192.1/24
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation FRAME-RELAY, loopback not set
  Keepalive set (10 sec)
  LMI enq sent  109, LMI stat recvd 109, LMI upd recvd 0, DTE
       LMI up
  LMI enq recvd 0, LMI stat sent  0, LMI upd sent  0
  LMI DLCI 1023  LMI type is CISCO  frame relay DTE
  Broadcast queue 0/64, broadcasts sent/dropped 36/0, interface
broadcasts 17
  Last input 00:00:05, output 00:00:05, output hang never
  Last clearing of "show interface" counters 00:18:15
!
<output ommited>
```

The Cisco LMI type is using DLCI 1023.

Frame Relay can be implemented in four basic topologies. They are point-to-point, hub and spoke (star), full mesh, and partial mesh. Frame Relay is easy to configure in a simple topology, but it has many variations. Complication is introduced when multiple PVCs share one physical interface or when implementing a nonbroadcast multiaccess network (NBMA) over Frame Relay. Common variations are addressed in the following labs.

Lab 6.4.2 Configuring Full Mesh Frame Relay



Objective

Configure three routers with Frame Relay in a full mesh topology.

Scenario

ISP has provisioned Frame Relay PVCs for the International Travel Agency WAN. The administrator has the responsibility of configuring Frame Relay between offices located in North America, Asia, and Europe. The design calls for all three routers to be placed on the same logical IP network in a full mesh topology. Also, use IGRP (AS 234) to dynamically exchange routes. The ISP Frame Relay switch uses the ANSI LMI-type, and is configured with the DLCIs displayed in the diagram.

Step 1

Before beginning this lab, it is recommended that each router be reloaded after erasing its startup configuration. This will prevent problems that may be caused by residual configurations. After the equipment is prepared, proceed with Step 2. Cable the network according to the diagram. This lab assumes an Adtran Atlas 550 will be used to emulate the Frame Relay cloud. A router with three serial interfaces can also be used as a Frame Relay switch. If the Atlas 550 is used, be sure to connect the serial interfaces on the router to the port on the Atlas using a V.35 cable as labeled in the diagram. Even if a WAN emulator is used, perform the lab both ways if possible. Being able to configure a router as a Frame Relay switch in a full mesh topology is beneficial to understanding Frame Relay connectivity.

Step 2

On SanJose1, apply IP addressing to the interfaces. Configure IGRP as the routing protocol and encapsulate the Serial 0/0 WAN link as Frame Relay, as shown in the following:

```
SanJose1(config)#interface serial 0/0
SanJose1(config-if)#ip address 192.168.192.1 255.255.255.0
SanJose1(config-if)#encapsulation frame-relay
SanJose1(config-if)#interface fastethernet 0/0
SanJose1(config-if)#ip address 192.168.0.1 255.255.255.0
SanJose1(config-if)#exit
SanJose1(config)#router igrp 234
SanJose1(config-router)#network 192.168.0.0
SanJose1(config-router)#network 192.168.192.0
```

Configure Frame Relay on Singapore and London using the same command syntax.

Step 3

Verify the complete configuration of the full mesh Frame Relay WAN.

Verify router connectivity using extended pings between FastEthernet interfaces. Do not ping the Frame Relay serial interfaces as they will not reply. The following is an extended ping example between London and Singapore:

```
London#ping
Protocol [ip]:
Target IP address: 192.168.232.1
Repeat count [5]: 50
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 50, 100-byte ICMP Echos to 192.168.232.1, timeout is 2
seconds:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Success rate is 100 percent (50/50), round-trip min/avg/max = 56/60/80 ms
```

All pings should be successful. With only one physical connection to the Frame Relay cloud, two different next-hop routers can be reached.

Issue the **show frame-relay lmi** command on Singapore. Output should be similar to the following:

```
Singapore#show frame-relay lmi
LMI Statistics for interface Serial0/0 (Frame Relay DTE) LMI TYPE = ANSI
  Invalid Unnumbered info 0              Invalid Prot Disc 0
  Invalid dummy Call Ref 0               Invalid Msg Type 0
  Invalid Status Message 0               Invalid Lock Shift 0
  Invalid Information ID 0               Invalid Report IE Len 0
  Invalid Report Request 0               Invalid Keep IE Len 0
  Num Status Enq. Sent 2523              Num Status msgs Rcvd 2522
  Num Update Status Rcvd 0               Num Status Timeouts 7
  The LMI type is ANSI.
```


1. On Cisco routers, the default LMI type is Cisco. However, LMI type ANSI was selected but not explicitly configured. Why did the router select ANSI?

____

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If a router is running Cisco IOS release 11.2 or later, it can autosense the LMI type as either Cisco, ANSI T1.617 Annex D (ANSI), or ITU-T Q.933 Annex A (q933a).

Issue the **show frame-relay pvc** command as follows on Singapore:

```
Singapore#show frame-relay pvc
PVC Statistics for interface Serial0/0 (Frame Relay DTE)
              Active     Inactive      Deleted       Static
  Local          2            0            0            0
  Switched       0            0            0            0
  Unused         0            0            0            0
DLCI = 301, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/0

  input pkts 676           output pkts 470          in bytes 92211
  out bytes 86466          dropped pkts 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 372        out bcast bytes 76274
  pvc create time 03:32:04, last time pvc status changed 03:32:04
DLCI = 302, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/0

  input pkts 433           output pkts 436          in bytes 81309
  out bytes 82942          dropped pkts 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 371        out bcast bytes 76182
  pvc create time 03:32:05, last time pvc status changed 03:32:05
```

Singapore S0/0 is using DLCI 301 and 302. These were not explicitly configured. The router dynamically learned about the DLCIs from the Frame Relay switch. Recall that a DLCI identifies the PVCs through the Frame Relay cloud.

Issue the **show frame-relay map** command as follows on Singapore:

```
Singapore#show frame-relay map
Serial0/0 (up): ip 192.168.192.1 dlci 301(0x10,0x400), dynamic,
              broadcast,, status defined, active
Serial0/0 (up): ip 192.168.192.2 dlci 302(0x11,0x410), dynamic,
                     broadcast,, status defined, active
```

Recall that mapping is the association between a DLCI and the next-hop DTE router. The next hop is identified by its IP address.

2. Since mapping was not explicitly configured, how was this mapping achieved?

____

Once a router receives a list of DLCIs, it sends an Inverse ARP through every identified PVC. The Inverse ARP requests information regarding the DTE at the other end. The returned IP address and status information is displayed in the map table. According to the **show frame-relay map** command output , these maps were created dynamically.

Note: Broadcasts and multicasts are supported on these PVCs, enabling routing protocols to exchange updates between regional sites.

Now issue the **`show ip route`** command as follows on Singapore:

```
Singapore#show ip route
Gateway of last resort is not set
C    192.168.192.0/24 is directly connected, Serial0/0
I    192.168.200.0/24 [100/8486] via 192.168.192.2, 00:00:03, Serial0/0
C    192.168.232.0/24 is directly connected, FastEthernet0/0
I    192.168.0.0/24 [100/8486] via 192.168.192.1, 00:00:05, Serial0/0
```

Singapore should have a complete routing table, indicating that the full mesh Frame Relay configuration is complete. If the routing table is not complete, it could be because IGRP has not yet converged.

Step 4

Network engineers may not be comfortable with implicit configurations. The benefits of dynamic mapping are minor due to the static nature of most WANs. Once a link is established, there may not be a change for years. Also, if variables are not explicitly defined with configuration commands, the configuration file will not yield much information about the Frame Relay network.

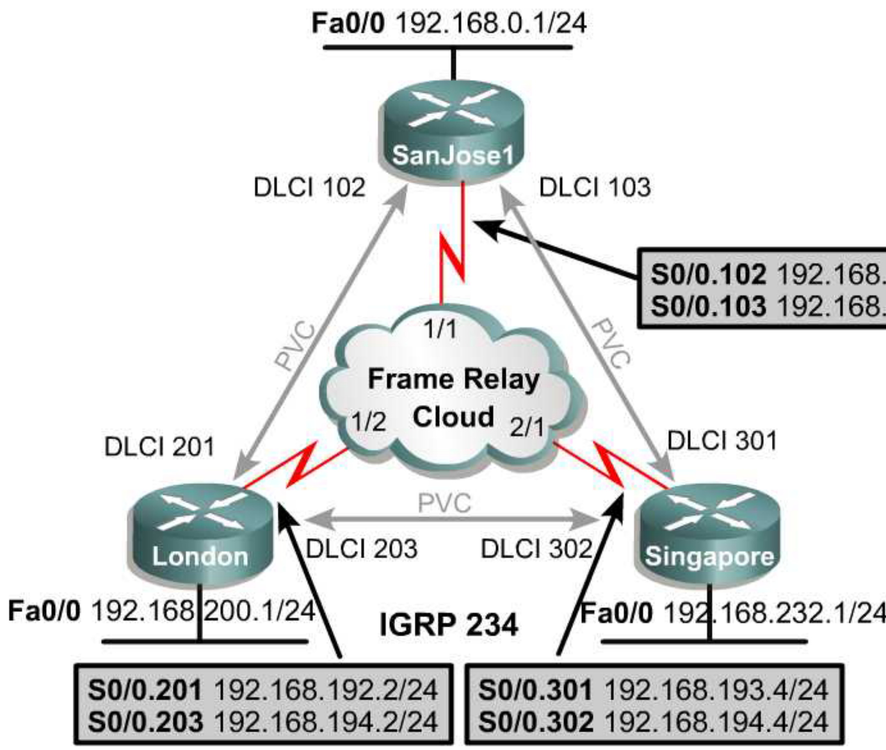
The routers can be explicitly configured to define elements discussed previously. The following is an example of how SanJose1 could be manually configured:

```
SanJose1(config)#interface fastethernet 0/0
SanJose1(config-if)#ip address 192.168.0.1 255.255.255.0
SanJose1(config-if)#interface serial 0/0
SanJose1(config-if)#encapsulation frame-relay
SanJose1(config-if)#frame-relay map ip 192.168.192.2 102 broadcast
SanJose1(config-if)#frame-relay map ip 192.168.192.4 103 broadcast
SanJose1(config-if)#frame-relay lmi-type ansi
SanJose1(config-if)#exit
SanJose1(config)#router igrp 234
SanJose1(config-router)#network 192.168.192.0
SanJose1(config-router)#network 192.168.0.0
SanJose1(config-router)#passive-interface fastethernet 0/0
```

The **`frame-relay map`** command associates next-hop IP addresses with a local DLCI. The **`broadcast`** keyword allows multicasts and broadcasts to be propagated through that PVC. The **`frame-relay lmi-type`** command statically defines the DTE (router) LMI protocol, which must match the DCE (Frame Relay switch).

Notice that in this configuration, IGRP routing updates are blocked from exiting FastEthernet 0/0. This saves bandwidth on the LAN, as there are no IGRP neighbors on that network.

Lab 6.4.3 Configuring Full Mesh Frame Relay with Subinterfaces



Objective

Configure three routers with Frame Relay in a full mesh using subinterfaces.

Scenario

Rather than fine-tuning traffic flow among regional sites connected to the International Travel Agency WAN, it is realized that greater control could be implemented if there was an individual physical leased line between each site. Unfortunately, the cost of an additional leased line will not be approved.

However, by using subinterfaces, separate logical connections can be configured between the sites. Each router will have one physical interface connected to the Frame Relay switch. To allow each router to reach the other sites, the single physical interface (s0/0) will require two logical subinterfaces configured. Physical redundancy is achieved in the carrier's Frame Relay cloud. This is possible by using multiple PVCs for each physical interface on the routers. Although the service provider charges for each additional PVC, the fee is typically less than the cost of a leased line.

Step 1

Before beginning this lab, it is recommended that each router be reloaded after erasing its startup configuration. This prevents problems that may be caused by residual configurations. After the equipment is prepared, proceed with Step 2.

Build the network according to the diagram. This lab assumes an Adtran Atlas 550 will be used to emulate the Frame Relay cloud. Other WAN emulators or a router may also be used as a Frame

Relay switch. If the Atlas 550 is used, be sure to connect the serial interface of each router to the port on the Atlas using a V.35 cable as labeled in the diagram.

Step 2

Configure the FastEthernet interface and IGRP (AS 234) on each router as shown in the diagram. Configure serial interfaces to use Frame Relay with subinterfaces. Enter the following commands on SanJose1:

```
SanJose1(config)#interface serial 0/0
SanJose1(config-if)#encapsulation frame-relay
SanJose1(config-if)#frame-relay lmi-type ansi
SanJose1(config-if)#no shutdown
```

There is no need to configure this interface with an IP address. The IP addresses will be assigned to each subinterface.

Frame Relay interfaces can be entered as either a point-to-point or as a multipoint configuration. Some versions of the IOS allow a subinterface to be created without specifying either type. This will result in a multipoint subinterface, which is the default.

In this scenario, a point-to-point subinterface using DLCI 103 will be configured. A common practice is to the number the subinterface by referencing its DLCI number. This makes it easier to determine which PVC each subinterface it is using. For example, subinterface 0.103 uses DLCI 103.

Configure the DLCI 103 subinterface with the keyword **point-to-point** as shown in the following:

```
SanJose1(config)#interface s0/0.103 point-to-point
SanJose1(config-subif)#ip address 192.168.193.1 255.255.255.0
SanJose1(config-subif)#frame-relay interface-dlci 103
```

The **frame-relay interface-dlci** command is used to specify which DLCI is used by each subinterface. Point-to-point subinterfaces can each use only one DLCI. If a subinterface for a DLCI is not specified, it will be associated with its major interface (e.g., s0/0).

Configure the DLCI 102 subinterface as follows:

```
SanJose1(config)#interface s0/0.102 point-to-point
SanJose1(config-subif)#ip address 192.168.192.1 255.255.255.0
SanJose1(config-subif)#frame-relay interface-dlci 102
```

Configure London and Singapore according to the diagram. Use the command syntax in this step as a guide.

Step 3

Verify PVC status by issuing the following **show frame-relay pvc** command on SanJose1:

```
SanJose1#show frame-relay pvc
PVC Statistics for interface Serial0/0 (Frame Relay DTE)
              Active     Inactive      Deleted       Static
  Local          2           1            0             0
  Switched       0           0            0             0
  Unused         0           0            0             0

DLCI = 104, DLCI USAGE = LOCAL, PVC STATUS = INACTIVE, INTERFACE =
Serial0/0
  input pkts 0             output pkts 0             in bytes 0
  out bytes 0              dropped pkts 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
  pvc create time 00:48:21, last time pvc status changed 00:48:21

DLCI = 103, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0.103
  input pkts 167           output pkts 179          in bytes 21552
  out bytes 19871          dropped pkts 5           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 59         out bcast bytes 10890
  pvc create time 00:48:34, last time pvc status changed 00:29:13

DLCI = 102, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0.102
  input pkts 156           output pkts 135          in bytes 27757
  out bytes 18758          dropped pkts 5           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 55         out bcast bytes 10718
  pvc create time 00:48:35, last time pvc status changed 00:07:14
```

The output of this command will show how the router perceives the PVC status. The different states are ACTIVE, INACTIVE, and DELETED. ACTIVE is a successful end-to-end (DTE to DTE) circuit. INACTIVE is a successful connection to the Frame Relay switch (DTE to DCE) without a DTE detected on the other end of the PVC. This state can occur if the router dynamically learns of a DLCI not intended for its network. This could be due to a residual or incorrect configuration on the Frame Relay switch. The DELETED state is when the DTE is configured for a DLCI the switch does not recognize as valid for that interface.

If any INACTIVE DLCIs are seen that are not to be used, check with the service provider regarding their status. In this configuration, SanJose1 detects DLCI 104, which is not used in this lab. To keep the router from dynamically creating a PVC with whatever DTE is on the other end, disable Inverse-ARP for DLCI 104, as shown in the following:

```
SanJose1(config)#interface serial 0/0
SanJose1(config-if)#no frame-relay inverse-arp ip 104
```

Issue the **show frame-relay map** command on SanJose1 to determine if Frame Relay has mapped the appropriate DLCIs to the correct IP address.

```
SanJose1#show frame-relay map
Serial0/0.103 (up): point-to-point dlci, dlci 103(0x11,0x410),
Broadcast status defined, active
Serial0/0.102 (up): point-to-point dlci, dlci 102(0x12,0x420),
broadcast status defined, active
```

1. According to the output, are DLCI 103 and DLCI 102 mapped to next hop IP addresses?

____

With point-to-point subinterfaces, there is no mapping between a local DLCI and a next-hop address. Each subinterface is treated as if it was a separate physical interface and each Frame Relay PVC contains only two hosts. There is no need to explicitly identify the next hop. Point-to-point subinterfaces can also be implemented using IP unnumbered.

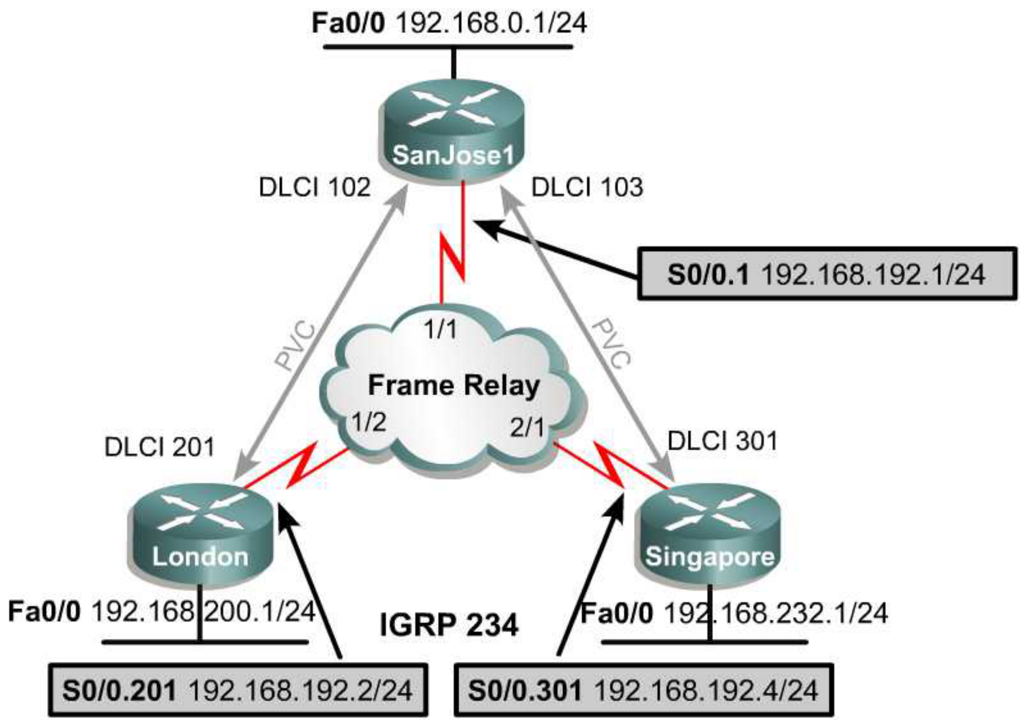
Step 4

Make sure IGRP is working by issuing the **`show ip route`** command as follows on SanJose1:

```
SanJose1#show ip route
Gateway of last resort is not set
C    192.168.192.0/24 is directly connected, Serial0/0.102
C    192.168.193.0/24 is directly connected, Serial0/0.102
I    192.168.194.0/24 [100/82125] via 192.168.192.2, 00:00:00,
Serial0/0.102
                      [100/82125] via 192.168.193.4, 00:01:25,
Serial0/0.103
I    192.168.200.0/24 [100/80135] via 192.168.192.2, 00:00:00,
Serial0/0.102
I    192.168.232.0/24 [100/80135] via 192.168.193.4, 00:01:25,
Serial0/0.103
C    192.168.0.0/24 is directly connected, FastEthernet0/0
```

Verify round-trip connectivity with an extended ping between the FastEthernet interfaces of SanJose1 and London. This ping should be successful. Troubleshoot as necessary.

Lab 6.4.4 Configuring Hub and Spoke Frame Relay



Objective

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

Scenario

In an effort to cut costs, the International Travel Agency has been monitoring the internetwork traffic patterns of its full mesh Frame Relay topology. It was determined that the PVC between London and Singapore is underutilized and that canceling the redundant PVC and implementing a hub and spoke topology could reduce costs. Any traffic destined for Singapore and originating in London would be relayed through SanJose1. Unfortunately, the hub in a hub and spoke topology creates a single point of failure. However, this is a risk ITA administration is willing to take.

Step 1

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

Build the network according to the diagram. This lab assumes an Adtran Atlas 550 will be used to emulate the Frame Relay cloud. Other WAN emulators or a router can be used as a Frame Relay switch. If the Atlas 550 is used, be sure to connect the serial interfaces on each router to the port on the Atlas using a V.35 cable as labeled in the diagram. Configure the appropriate hostnames and FastEthernet IP addresses on each router.

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 in the following:

```
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 103
SanJose1(config-fr-dlci)#exit
SanJose1(config-subif)#frame-relay interface-dlci 102
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. Therefore, a point-to-point subinterface can be used. Because this is a subinterface configuration, include the **`frame-relay interface-dlci`** command, as shown in the following:

```
London(config)#interface serial 0/0
London(config-if)#encapsulation frame-relay
London(config)#interface serial 0/0.201 point-to-point
London(config-subif)#ip add 192.168.192.2 255.255.255.0
London(config-subif)#frame-relay interface-dlci 201
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 these commands as a guide and configure Singapore according to the diagram.

Step 3

Test for connectivity as follows 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. The complete path can be tested, 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 back from Singapore to London. Output should be similar to the following:

```
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 should fail. Since users on the London LAN cannot access the Singapore LAN, this configuration is not complete.

To isolate the problem, view the routing tables of each router. Output should be similar to the following:

```
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, Serial0/0.201
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, Serial0/0.201


Singapore#show ip route

Gateway of last resort is not set
C    192.168.192.0/24 is directly connected, Serial0/0.301
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, Serial0/0.301
```

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

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

Both of the PVCs are using the same multipoint subinterface on SanJose1. Therefore, routes learned from one spoke router cannot be sent back through the same subinterface to the other spoke router. Split horizon must be disabled in order for SanJose1 to be able to send a route learned from one spoke to the other.

Split horizon can be disabled on SanJose1's subinterface, Serial 0/0.1 by issuing the following commands:

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

Verify this configuration by issuing the **show ip interface s0/0.1** command as follows:

```
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
```

Enter the following command to 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, Serial0/0.301
I    192.168.200.0/24 [100/82135] via 192.168.192.1, 00:00:19,
Serial0/0.301
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, Serial0/0.301
```

Confirm internetwork connectivity between the Singapore and London LANs with an extended **ping** as follows:

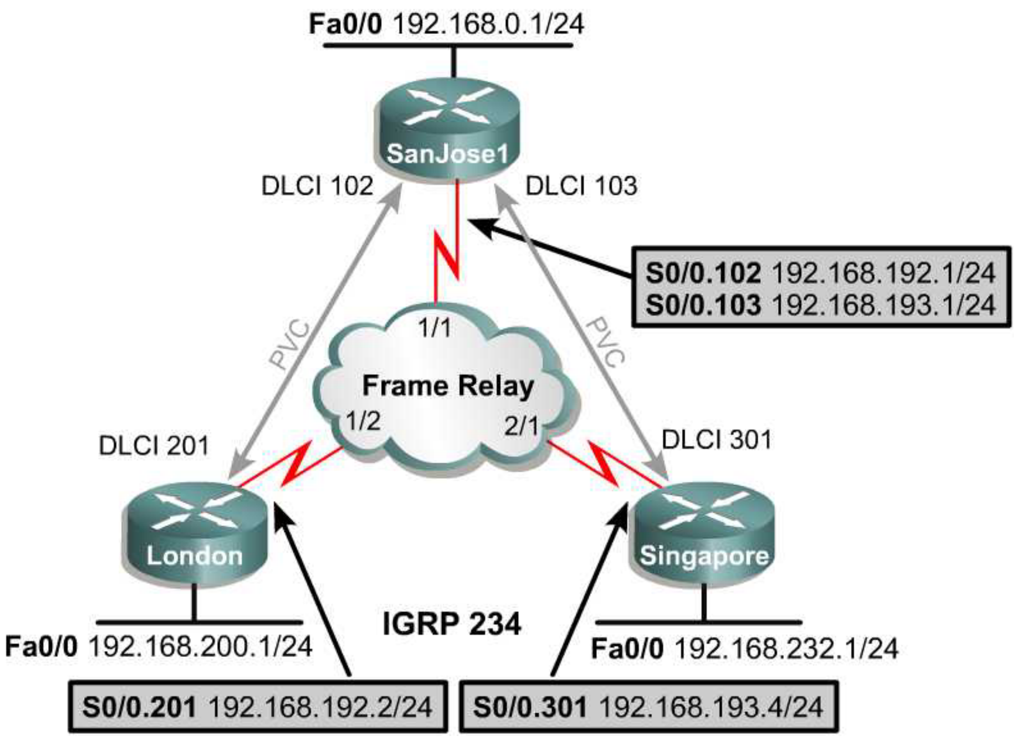
```
Singapore#ping
Protocol [ip]:
Target IP address: 192.168.200.1
Repeat count [5]: 55
Datagram size [100]:
```



```
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, then all three regional sites are communicating over a hub and spoke Frame Relay topology.

Lab 7.2.1 Frame Relay Subinterfaces and Traffic Shaping



Objective

Configure Frame Relay on three routers in a hub-and-spoke topology using subinterfaces and map-classes.

Configure rate enforcement to control traffic rates on a per-PVC basis.

Scenario

Each Frame Relay link in the International Travel Agency (ITA) WAN is a T1 (1.544 mbps). After monitoring traffic patterns on the ITA WAN, it is noticed that the PVC between SanJose1 and Singapore has a low average throughput. In an effort to cut costs, it is decided to revise the contract with the service provider to reduce the Committed Information Rate (CIR) from 1.544 Mbps to 19.2 kbps.

SanJose1 transmits 80 times faster than Singapore can receive. Therefore, either the Frame Relay switches will need to buffer the frames or Singapore could be flooded with traffic. Not wanting to rely on the traffic management of the Frame Relay service provider, it is decided to throttle back the rate at which SanJose1 transmits to Singapore. This will reduce congestion before it becomes an issue in the WAN.

Step 1

Before beginning this lab, it is recommended that each router be reloaded after erasing its startup configuration. This prevents problems that may be caused by residual configurations.

Build the network according to the diagram. This lab assumes use of an Adtran Atlas 550 as the Frame Relay cloud. Other WAN emulators or a router may be used as a Frame Relay switch. If the Atlas 550 is used, be sure to connect the serial interfaces on the router to the port on the Atlas using a V.35 cable as labeled in the diagram.

Step 2

Configure the router with basic information such as router name and passwords as well as the LAN interfaces. In this lab, use Cisco Frame Relay encapsulation. The LMI-type may be explicitly configured as ANSI, or the router can be allowed to autosense it. Use the basic Frame Relay information that follows to configure the routers.

> **Note:** Each PVC exists as a point-to-point network on its own logical IP subnet. The following is a partial configuration for SanJose1, London, and Singapore:

On SanJose1:

```
SanJose1(config)#interface serial 0/0
SanJose1(config-if)#encapsulation frame-relay
SanJose1(config-if)#no shut

SanJose1(config)#interface serial 0/0.103 point-to-point
SanJose1(config-subif)#ip address 192.168.193.1 255.255.255.0
SanJose1(config-subif)#frame-relay interface-dlci 103
SanJose1(config-fr-dlci)#exit

SanJose1(config-subif)#interface serial 0/0.102 point-to-point
SanJose1(config-subif)#ip address 192.168.192.1 255.255.255.0
SanJose1(config-subif)#frame-relay interface-dlci 102

SanJose1(config)#router igrp 234
SanJose1(config-router)#network 192.168.0.0
SanJose1(config-router)#network 192.168.192.0
SanJose1(config-router)#network 192.168.193.0
```

On London:

```
London(config)#interface serial 0/0
London(config-if)#encapsulation frame-relay
London(config-if)#no shut

London(config)#interface serial 0/0.201 point-to-point
London(config-subif)#ip address 192.168.192.2 255.255.255.0
London(config-subif)#frame-relay interface-dlci 201
London(config-fr-dlci)#exit

London(config)#router igrp 234
London(config-router)#network 192.168.200.0
London(config-router)#network 192.168.192.0
```

On Singapore:

```
Singapore(config)#interface serial 0/0
Singapore(config-if)#encapsulation frame-relay
Singapore(config-if)#no shut
```



```
Singapore(config)#interface serial 0/0.301 point-to-point
Singapore(config-subif)#ip address 192.168.193.4 255.255.255.0
Singapore(config-subif)#frame-relay interface-dlci 301
Singapore(config-fr-dlci)#exit

Singapore(config)#router igrp 234
Singapore(config-router)#network 192.168.232.0
Singapore(config-router)#network 192.168.193.0
```

Step 3

Test connectivity with extended pings between the LANs of the different regional sites. From SanJose1, use an extended ping to test connectivity with London. To measure throughput, send several large packets with datagram sizes over 1000-byte each:

```
SanJose1#ping
Protocol [ip]:
Target IP address: 192.168.200.1
Repeat count [5]: 55
Datagram size [100]: 1111
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 192.168.0.1
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, 1111-byte ICMP Echoes to 192.168.200.1, timeout is 2
seconds:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Success rate is 100 percent (55/55),round-trip min/avg/max = 176/179/192 ms
```

Make note of the round-trip times in milliseconds. ______________________________

Using the same parameters ping from SanJose1 to Singapore. Make note of the round-trip times in milliseconds. ______________________________

Finally, repeat the process and ping from London to Singapore. Make note of the round-trip times in milliseconds. ______________________________

Round-trip times will vary, primarily due to the WAN interface card in the router. The router probably contains either a WIC-2A/S supporting up to 128 kbps or a WIC-2T supporting up to 2.048 mbps. For the purposes of this lab, either WIC is fine. The round-trip times will become relevant when compared to the results of later tests.

Step 4

The Committed Information Rate (CIR) between SanJose1 and Singapore must be changed from 1.544 Mbps to 19.2 kbps. Create a map-class in global configuration mode defining the CIR on both Singapore and SanJose1. A logical name must be assigned to uniquely identify each map-class. Use **CIR** as the map-class name.

```
Singapore(config)#map-class frame-relay CIR
Singapore(config-map-class)#frame-relay traffic-rate 19200

SanJose1(config)#map-class frame-relay CIR
SanJose1(config-map-class)#frame-relay traffic-rate 19200
```


A Frame Relay map-class can be used by any Frame Relay interface. In this case, the map-class will be applied to Singapore's subinterface, as shown in the following configuration. Since the map-class specifies rate enforcement, Frame Relay traffic shaping must be enabled on the major interface.

```
Singapore(config)#interface serial 0/0
Singapore(config-if)#frame-relay traffic-shaping
Singapore(config-if)#interface serial 0/0.301 point-to-point
Singapore(config-subif)#frame-relay class CIR
```

Configure the other end of this PVC, on SanJose1, using the same commands as follows:

```
SanJose1(config)#interface serial 0/0
SanJose1(config-if)#frame-relay traffic-shaping
SanJose1(config-if)#interface serial 0/0.103 point-to-point
SanJose1(config-subif)#frame-relay class CIR
```

Step 5

Test connectivity and throughput with extended pings as before, recording round-trip times. The average and round-trip times should have increased as traffic was buffered due to slow WAN links. The following are some sample results:

```
SanJose1#ping
<output omitted>
Sending 55, 1111-byte ICMP Echoes to 192.168.232.1, timeout is 2 seconds:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Success rate is 100 percent (55/55),round-trip min/avg/max = 184/460/520 ms

London#ping
<output omitted>
Sending 55, 1111-byte ICMP Echoes to 192.168.232.1, timeout is 2 seconds:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Success rate is 100 percent (55/55),round-trip min/avg/max = 356/464/540 ms
```

1. How are these **ping** results different from the first set of **pings** that were run in Step 3?

____

____

Step 6

To observe detailed traffic shaping statistics, issue **show frame-relay pvc 103** on SanJose1. Although traffic shaping is enabled, it is only active if traffic is buffered. For this reason, "shaping inactive" may be displayed in the output of this command, as in the following sample output:

```
SanJose1#show frame-relay pvc 103

PVC Statistics for interface Serial0/0 (Frame Relay DTE)

DLCI = 103, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0.103
  input pkts 82            output pkts 80           in bytes 14127
  out bytes 13930          dropped pkts 1           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 66         out bcast bytes 12983
  pvc create time 00:39:54, last time pvc status changed 00:03:00
  cir 19200     bc 19200     be 0         limit 300    interval 125
  mincir 9600      byte increment 300   BECN response no
  pkts 17        bytes 2828      pkts delayed 0         bytes delayed 0
```

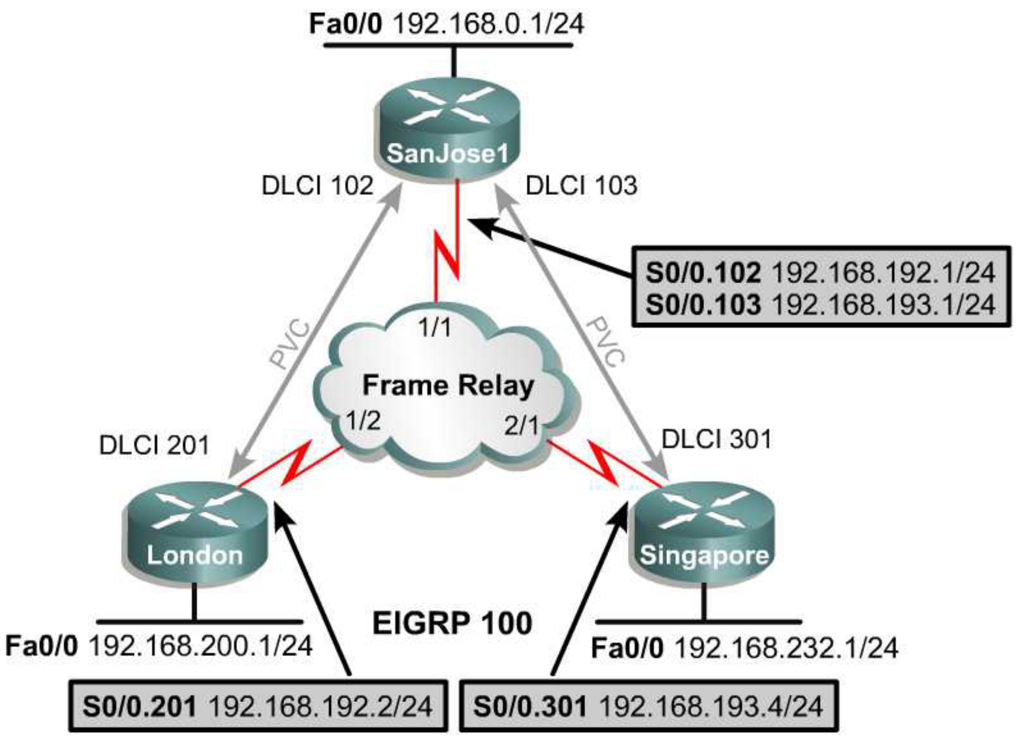


```
shaping inactive
traffic shaping drops 0
Serial0/0.102 dlci 102 is first come first serve default queuing
Output queue 0/40, 0 drop, 0 dequeued
```

1. According to the output of this command, what is the CIR of this PVC?

   ____

Lab 7.2.2 Frame Relay Traffic Shaping with Class Based Weighted Fair Queuing



Objective

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

Configure class-based weighted fair queuing (CBWFQ) with Frame Relay traffic shaping.

Scenario

It is noticed that SanJose1 transmits data 80 times faster than Singapore or London can receive. The Frame Relay switches need to buffer the excess frames or Singapore and London could be flooded with traffic. It is not advisable to rely on the traffic management of the Frame Relay service provider. Therefore, it is decided to use CBWFQ with Frame Relay traffic shaping to throttle back the rate at which SanJose1 transmits to Singapore and London. This will reduce congestion before it becomes an issue in the Frame Relay WAN.

Step 1

Before beginning this lab, it is recommended that each router be reloaded after erasing its startup configuration. This prevents problems that may be caused by residual configurations.

Build the network according to the diagram. This lab assumes use of an Adtran Atlas 550 as the Frame Relay cloud. Other WAN emulators or a router may be used as a Frame Relay switch. If the Atlas 550 is used, be sure to connect the serial interfaces on the routers to the port on the Atlas using a V.35 cable as labeled in the diagram.

Step 2

Configure the router with basic information such as router name and passwords as well as the LAN interfaces. In this lab, use Cisco Frame Relay encapsulation. Use the basic Frame Relay information that follows to configure all three routers.

On SanJose1:

```
SanJose1(config)#interface serial 0/0
SanJose1(config-if)#encapsulation frame-relay
SanJose1(config-if)#no shut

SanJose1(config-subif)#interface serial 0/0.102 point-to-point
SanJose1(config-subif)#ip address 192.168.192.1 255.255.255.0
SanJose1(config-subif)#frame-relay interface-dlci 102
SanJose1(config-fr-dlci)#exit

SanJose1(config)#interface serial 0/0.103 point-to-point
SanJose1(config-subif)#ip address 192.168.193.1 255.255.255.0
SanJose1(config-subif)#frame-relay interface-dlci 103
```

On London:

```
London(config)#interface serial 0/0
London(config-if)#encapsulation frame-relay
London(config-if)#no shut

London(config)#interface serial 0/0.201 point-to-point
London(config-subif)#ip address 192.168.192.2 255.255.255.0
London(config-subif)#frame-relay interface-dlci 201
London(config-fr-dlci)#exit
```

On Singapore:

```
Singapore(config)#interface serial 0/0
Singapore(config-if)#encapsulation frame-relay
Singapore(config-if)#no shut

Singapore(config)#interface serial 0/0.301 point-to-point
Singapore(config-subif)#ip address 192.168.193.4 255.255.255.0
Singapore(config-subif)#frame-relay interface-dlci 301
Singapore(config-fr-dlci)#exit
```

Step 3

Configure EIGRP on all routers as indicated for AS 100. The following configuration displays the EIGRP configurations for SanJose1:

```
SanJose1(config)#router eigrp 100
SanJose1(config-router)#network 192.168.0.0
SanJose1(config-router)#network 192.168.192.0
SanJose1(config-router)#network 192.168.193.0
```

Use **ping** and **show ip route** to verify the work and to test connectivity between all routers.

Step 4

Define a class map that will establish the match criteria for identifying data belonging in a policy class. It is decided to place all traffic from the SanJose1 192.168.0.0 network, that is destined for the Singapore and the London LAN, into a policy class. Enter the following to create an extended access list that will be used to identify data that belongs in a class:

```
SanJose1(config)#access-list 101 permit ip 192.168.0.0 0.0.0.255
192.168.200.0 0.0.0.255
SanJose1(config)#access-list 101 permit ip 192.168.0.0 0.0.0.255
192.168.232.0 0.0.0.255

SanJose1(config)#class-map CBWFQ
SanJose1(config-cmap)#match access-group 101
```

The **class-map** command creates a class called CBWFQ. The **match** command is use to identify access list 101 as packets that belong in a class.

Step 5

Configure a class policy by specifying CBWFQ-TS as the name of the policy map. The class policy will be defined by specifying the bandwidth guarantee for the CBWFQ traffic class.

```
SanJose1(config)#policy-map CBWFQ-TS
SanJose1(config-pmap)#class CBWFQ
SanJose1(config-pmap-c)#bandwidth 50
```

The **bandwidth** command specifies the bandwidth for traffic in the CBWFQ class. CBWFQ derives the weight for packets belonging to the class from the bandwidth allocated to the class. CBFWQ then uses the weight to ensure that the queue for the class is serviced fairly.

To attach the policy map to a frame-relay serial interface, you must apply the **service-policy** command to a frame-relay map class.

Step 6

On SanJose1, create a **map-class** in global configuration mode defining Frame Relay traffic shaping parameters. A logical name must be assigned to uniquely identify each map-class. Use FRTS as the name. The following configuration displays the traffic shaping parameters for SanJose1:

```
SanJose1(config)#map-class frame-relay FRTS
SanJose1(config-map-class)#frame-relay adaptive-shaping becn
SanJose1(config-map-class)#frame-relay cir 64000
SanJose1(config-map-class)#frame-relay bc 8000
SanJose1(config-map-class)#frame-relay mincir 56000
SanJose1(config-map-class)#service-policy output CBWFQ-TS
```

The **frame-relay adaptive-shaping becn** command uses BECN notices from the Frame Relay switch as the congestion backward notification mechanism. From these notices, traffic shaping will adapt. The optional **frame-relay cir** command sets the CIR to 64 kbps. The **frame-relay bc optional** command sets the committed burst rate to 8000 bps. The **frame-relay mincir** command sets the minimum acceptable CIR to 56 kbps. The **service-policy output** command attaches the CBWFQ-TS policy class to the frame-relay map-class.

Step 7

A Frame Relay map-class can be used by any Frame Relay interface. In this case, the map-class FRTS will be applied to both of the SanJose1 subinterfaces, as follows:

> **Note:** Since the map-class specifies traffic shaping parameters, Frame Relay traffic shaping must be enabled on the major interface.

```
SanJose1(config)#interface serial 0/0
SanJose1(config-if)#frame-relay traffic-shaping
SanJose1(config-if)#interface serial 0/0.102
SanJose1(config-subif)#frame-relay class FRTS
SanJose1(config-if)#interface serial 0/0.103
SanJose1(config-subif)#frame-relay class FRTS
```

Step 8

To observe detailed traffic shaping statistics, issue **show frame-relay pvc 103** on SanJose1.

```
SanJose1#show frame pvc 103

PVC Statistics for interface Serial0/0 (Frame Relay DTE)

DLCI = 103, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0.103

  input pkts 52            output pkts 6            in bytes 4732
  out bytes 1836           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 6         out bcast bytes 1836
  Shaping adapts to BECN
  pvc create time 00:06:00, last time pvc status changed 00:03:38
  cir 64000     bc 8000      be 0         byte limit 1000   interval 125
  mincir 56000      byte increment 1000  Adaptive Shaping BECN
  pkts 6        bytes 1836      pkts delayed 0          bytes delayed 0
  shaping inactive
  traffic shaping drops 0
  service policy CBWFQ-TS
 Serial0/0.103: DLCI 103 -

  Service-policy output: CBWFQ-TS

    Class-map: CBWFQ (match-all)
      0 packets, 0 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: access-group 101
      Queueing
        Output Queue: Conversation 25
        Bandwidth 50 (kbps) Max Threshold 64 (packets)
        (pkts matched/bytes matched) 0/0
        (depth/total drops/no-buffer drops) 0/0/0

    Class-map: class-default (match-any)
      6 packets, 1836 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: any
  Output queue size 0/max total 600/drops 0
```

1. According to the output of this command, what is the CIR of this PVC 103?

   ____

Step 9

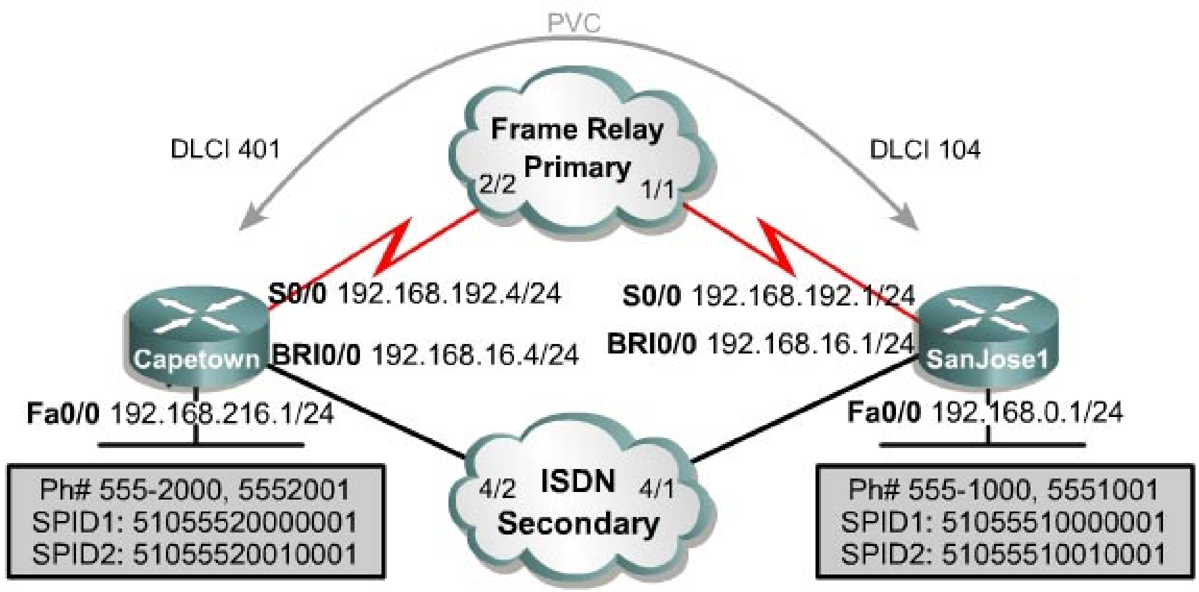
To display the configuration of the service policy map, use the **`show policy-map`** command. This will display all class configurations comprising of any existing service policy maps, shown as follows:

```
SanJose1#show policy-map
  Policy Map CBWFQ-TS
    Class CBWFQ
      Bandwidth 50 (kbps) Max Threshold 64 (packets)
```

The configuration of all policy classes can also be displayed on an interface configured for service policy. The following output displays the configurations for the CBWFQ-TS class:

```
SanJose1#show policy-map interface
 Serial0/0.102: DLCI 102 -

  Service-policy output: CBWFQ-TS

    Class-map: CBWFQ (match-all)
      0 packets, 0 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: access-group 101
      Queueing
        Output Queue: Conversation 25
        Bandwidth 50 (kbps) Max Threshold 64 (packets)
        (pkts matched/bytes matched) 0/0
        (depth/total drops/no-buffer drops) 0/0/0

    Class-map: class-default (match-any)
      9 packets, 2718 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: any
 Serial0/0.103: DLCI 103 -

  Service-policy output: CBWFQ-TS

    Class-map: CBWFQ (match-all)
      0 packets, 0 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: access-group 101
      Queueing
        Output Queue: Conversation 25
        Bandwidth 50 (kbps) Max Threshold 64 (packets)
        (pkts matched/bytes matched) 0/0
        (depth/total drops/no-buffer drops) 0/0/0

    Class-map: class-default (match-any)
      8 packets, 2448 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: any
```


Lab 8.7.1 Configuring ISDN Dial Backup



Objective

Configure ISDN dial backup for a fixed Frame Relay WAN link.

Scenario

The network engineer for the International Travel Agency (ITA) is responsible for full-time WAN connectivity between regional headquarters and San Jose company headquarters. Frame Relay permanent virtual circuits (PVC) have been made into a star topology, with SanJose1 as the hub router. To provide fault tolerance, each Frame Relay PVC is backed up with ISDN BRI.

Step 1

Build the network as shown in the diagram. If the Atlas 550 is used as a WAN emulator, be sure to use the ports as indicated in the diagram. Before beginning this lab, it is recommended that each router be reloaded after erasing its startup configuration. This will prevent problems that may be caused by residual configurations.

Step 2

Use the following to configure and test ISDN BRI on Capetown, using CHAP authentication:

```
Capetown(config)#isdn switch-type basic-ni
Capetown(config)#username SanJose1 password cisco
Capetown(config)#dialer-list 1 protocol ip permit
Capetown(config)#interface bri 0/0
Capetown(config-if)#ip address 192.168.16.4 255.255.255.0
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication chap
Capetown(config-if)#isdn spid1 51055520000001 5552000
```



```
Capetown(config-if)#isdn spid2 51055520010001 5552001
Capetown(config-if)#dialer map ip 192.168.16.1 name SanJose1 broadcast
5551000
Capetown(config-if)#dialer idle-timeout 60
Capetown(config-if)#dialer-group 1
```

Next, configure SanJose1 as shown in the following:

Note: SanJose1 will only accept BRI calls, so do not configure a phone number with the **`dialer map`** statement.

```
SanJose1(config)#isdn switch-type basic-ni
SanJose1(config)#username Capetown password cisco
SanJose1(config)#dialer-list 1 protocol ip permit
SanJose1(config)#interface bri 0/0
SanJose1(config-if)#ip address 192.168.16.1 255.255.255.0
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication chap
SanJose1(config-if)#isdn spid1 51055510000001 5551000
SanJose1(config-if)#isdn spid2 51055510010001 5551001
SanJose1(config-if)#dialer map ip 192.168.16.4 name Capetown broadcast
SanJose1(config-if)#dialer idle-timeout 60
SanJose1(config-if)#dialer-group 1
```

Ping across the ISDN link from Capetown to SanJose1 (192.168.16.1). This ping should be successful. Troubleshoot as necessary.

Step 3

Configure and test Frame Relay connectivity on both routers. The following is an example of the Capetown configuration:

```
Capetown(config)#interface s0/0
Capetown(config-if)#ip address 192.168.192.4 255.255.255.0
Capetown(config-if)#encapsulation frame-relay
Capetown(config-if)#frame-relay map ip 192.168.192.1 401 broadcast
```

Use **`ping`** to verify that the Frame link is operational. **`Ping`** one serial interface from the other.

Step 4

Configure and test static routing between the Capetown spoke router and the SanJose1 hub router. Because Capetown supports a stub network, create a static route to all unknown networks pointing at SanJose1. SanJose1 will use a specific static route to return packets to the Capetown LAN, as shown in the following:

```
SanJose1(config)#ip route 192.168.216.0 255.255.255.0 192.168.192.4
Capetown(config)#ip route 0.0.0.0 0.0.0.0 192.168.192.1
```

Verify that the static routing configuration works by performing extended pings between LANs.

Step 5

Configure ISDN dialup backup routing.

The Frame Relay link has adequate bandwidth for normal traffic. The ISDN BRI is deployed only for fault tolerance. The service provider will charge for each minute of ISDN call time if the defined data transfer levels are exceeded. Having a redundant path is worth the cost, but use of the line needs to be minimized to avoid associated charges.

Use the following configuration to place floating static routes between SanJose1 and Capetown, utilizing the ISDN link:

```
Capetown(config)#ip route 0.0.0.0 0.0.0.0 192.168.16.1 222
SanJose1(config)#ip route 192.168.216.0 255.255.255.0 192.168.16.4 222
```

The following are views of the routing tables:

```
SanJose1#show ip route
Gateway of last resort is not set
C    192.168.192.0/24 is directly connected, Serial0/0
S    192.168.216.0/24 [1/0] via 192.168.192.4
C    192.168.16.0/24 is directly connected, BRI0/0
C    192.168.0.0/24 is directly connected, FastEthernet0/0

Capetown#show ip route
Gateway of last resort is 192.168.192.1 to network 0.0.0.0
C    192.168.192.0/24 is directly connected, Serial0/0
C    192.168.216.0/24 is directly connected, FastEthernet0/0
C    192.168.16.0/24 is directly connected, BRI0/0
S*   0.0.0.0/0 [1/0] via 192.168.192.1
```

1. Although two static routes have been configured on each router, only one of those routes is installed in each routing table. Why?

   ____

   ____

The static routes using the Frame Relay link have a default administrative distance of one (1). This is preferred over all routes except directly connected routes, which have an administrative distance of zero (0). If the Frame Relay link fails, associated routes will eventually be removed from the routing table. ISDN routes with an administrative distance of 222 will then be placed in the routing table. Connectivity will be restored, although at a much slower rate.

The ISDN link is to be active only in the event of a Frame Relay link failure. Enter the following configuration to make BRI 0/0 a backup interface to Serial0/0 on Capetown:

```
Capetown(config)#interface s0/0
Capetown(config-if)#backup interface bri0/0
Capetown(config-if)#backup delay 6 8
```

Only Capetown is configured with the **backup interface** and **backup delay** commands. The first backup delay value six (6) represents the number of seconds between Serial 0/0 failure and the backup link (BRI 0/0) becoming active. The second value eight (8) is the number of seconds after Serial 0/0 is restored before bringing down the backup link. If the SanJose1 BRI were configured as a backup interface, Capetown could not establish a dialup connection with SanJose1. The SanJose1 BRI would either be in standby mode or trying to make a dialup call. In either case, Capetown would not be able to connect with it.

The following is another look at the Capetown routing table:

```
Capetown#show ip route
Gateway of last resort is 192.168.192.1 to network 0.0.0.0
C    192.168.192.0/24 is directly connected, Serial0/0
C    192.168.216.0/24 is directly connected, FastEthernet0/0
S*   0.0.0.0/0 [1/0] via 192.168.192.1
```


The directly connected route for the ISDN link has disappeared. Enter the following to check to see if the BRI is down by issuing the **show interface** command on Capetown:

```
Capetown#show interface bri0/0
BRI0/0 is standby mode, line protocol is down
  Hardware is PQUICC BRI with U interface
  Internet address is 192.168.16.4/24
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, loopback not set
<output omitted>
```

The output of this command shows that the line is down, but standing by, in the event the serial interface goes down.

On Capetown, issue the **show backup** command as shown in the following:

```
Capetown#show backup
Primary Interface   Secondary Interface   Status
-----------------   -------------------   ------
Serial0/0           BRI0/0                normal operation
```

Step 6

Enter the following to test dial backup with an extended ping between Capetown and SanJose1:

Note: While the ping progresses, disconnect the serial cable from both routers.

```
Capetown#ping
Protocol [ip]:
Target IP address: 192.168.0.1
Repeat count [5]: 555
Datagram size [100]:
Timeout in seconds [2]: 1
Extended commands [n]: y
Source address or interface: 192.168.216.1
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 555, 100-byte ICMP Echos to 192.168.0.1, timeout is 1
seconds:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!..........!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Success rate is 98 percent (545/555), round-trip min/avg/max = 32/39/60 ms
```

It took over five seconds for ISDN to become active after Frame Relay failed. While active, the backup interface is in backup mode. Issue the **show backup** command on Capetown, as shown in the following:

```
Capetown#show backup
Primary Interface   Secondary Interface   Status
-----------------   -------------------   ------
Serial0/0           BRI0/0                backup mode
```


1. How did Capetown get to SanJose1 if the only route was through the failed Frame Relay link?

____

To verify the answer to Question 2, issue **show ip route** on Capetown. The following route should now be in the Capetown routing table:

```
C    192.168.16.0/24 is directly connected, BRI0/0
```

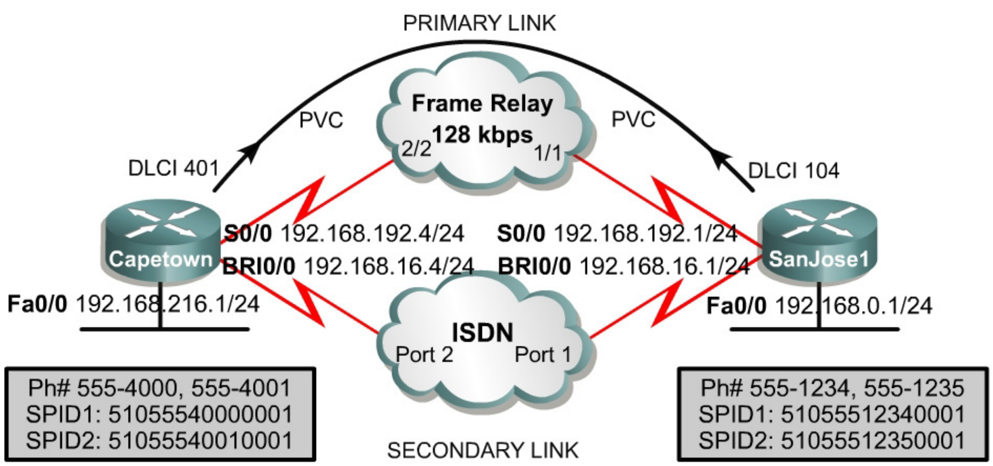
When Serial 0/0 failed, its associated static route was removed from the routing table and replaced by the floating static route over the ISDN link.

Enter the following to verify that the SanJose1 ISDN interface is up by issuing the **show interface bri0/0** command:

```
SanJose1#show interface bri0/0
BRI0/0 is up, line protocol is up (spoofing)
  Hardware is PQUICC BRI with U interface
  Internet address is 192.168.16.1/24
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, loopback not set
<output ommited>
```

The dial backup for WAN connectivity has now been successfully implemented.

Lab 8.7.2 Using Secondary Links for On-Demand Bandwidth



Objective

Configure ISDN dial-on-demand bandwidth supporting overload traffic from the primary Frame Relay link.

Scenario

The International Travel Agency (ITA) has expanded, increasing traffic between Capetown and SanJose1. ITA is waiting for the service provider to provision greater bandwidth on the Frame Relay link. In the meantime configure ISDN to carry traffic in case the Frame Relay link becomes saturated.

Step1

Build the network as shown in the diagram. If the Atlas 550 is used as a WAN emulator, be sure to use the ports as indicated in the diagram. Before beginning this lab, it is recommended that each router be reloaded after erasing its startup configuration. This will prevent problems that may be caused by residual configurations.

Step 2

Use the following to configure and test ISDN BRI on Capetown, using CHAP authentication:

```
Capetown(config)#isdn switch-type basic-ni
Capetown(config)#username SanJose1 password cisco
Capetown(config)#dialer-list 1 protocol ip permit
Capetown(config)#interface bri 0/0
Capetown(config-if)#ip address 192.168.16.4 255.255.255.0
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication chap
Capetown(config-if)#isdn spid1 51055520000001 5552000
Capetown(config-if)#isdn spid2 51055520010001 5552001
```



```
Capetown(config-if)#dialer map ip 192.168.16.1 name SanJose1 broadcast
5551000
Capetown(config-if)#dialer idle-timeout 60
Capetown(config-if)#dialer-group 1
Capetown(config-if)#exit
Capetown(config)#dialer-list 1 protocol ip permit
```

Next, configure SanJose1 as shown in the following:

> **Note:** SanJose1 will only accept BRI calls, so do not configure a phone number with the **`dialer map`** statement.

```
SanJose1(config)#isdn switch-type basic-ni
SanJose1(config)#username Capetown password cisco
SanJose1(config)#dialer-list 1 protocol ip permit
SanJose1(config)#interface bri 0/0
SanJose1(config-if)#ip address 192.168.16.1 255.255.255.0
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication chap
SanJose1(config-if)#isdn spid1 51055510000001 5551000
SanJose1(config-if)#isdn spid2 51055510010001 5551001
SanJose1(config-if)#dialer map ip 192.168.16.4 name Capetown broadcast
SanJose1(config-if)#dialer idle-timeout 60
SanJose1(config-if)#dialer-group 1
SanJose1(config-if)#exit
SanJose1(config)#dialer-list 1 protocol ip permit
```

Ping across the ISDN link from Capetown to SanJose1 (192.168.16.1). This ping should be successful. Troubleshoot as necessary.

ISDN is to become active as the Frame Relay link reaches a predefined traffic threshold. Configure Capetown with the following syntax:

```
Capetown(config)#interface serial 0/0
Capetown(config-if)#backup load 2 1
```

The first number in the **`backup load`** command is the percentage of bandwidth utilization necessary on Serial 0/0 to trigger the activation of backup interface BRI 0/0. The second number is the percentage of bandwidth utilization on Serial 0/0 required to deactivate BRI 0/0. Due to the sporadic nature of data communications, percentages are evaluated, by default, during a sliding five-second window.

> **Note:** The **`backup load`** values configured in this lab are set low to demonstrate functionality. In a production network, load values would be defined to avoid saturation of the Frame Relay link. An example would be **`backup load 60 20`**.

Confirm backup configuration by using the following command:

```
Capetown#show interface serial 0/0
Serial0/0 is up, line protocol is up
  Hardware is PowerQUICC Serial
  Internet address is 192.168.192.4/24
  Backup interface BRI0/0, failure delay 0 sec, secondary disable
delay 0 sec,
  kickin load 2%, kickout load 1%
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation FRAME-RELAY, loopback not set
```


Step 3

Both routes need to be available during times of excessive traffic. This can be accomplished with equal administrative distances. Configure static routes associated with BRI 0/0 interfaces on both routers, as shown in the following:

```
Capetown(config)#ip route 0.0.0.0 0.0.0.0 192.168.192.1
Capetown(config)#ip route 0.0.0.0 0.0.0.0 192.168.16.1
Capetown(config)#interface serial 0/0
Capetown(config-if)#backup interface bri0/0

SanJose1(config)#ip route 192.168.216.0 255.255.255.0 192.168.192.4
SanJose1(config)#ip route 192.168.216.0 255.255.255.0 192.168.16.4
```

As the backup interface is activated, both routes can coexist in the routing table. This allows load balancing between the two equal cost paths.

Step 4

Test the dial-on-demand bandwidth by loading the Frame Relay link over two percent with an extended ping from Capetown to SanJose1. Watch the BRI router interface while pinging. One channel light will activate when ISDN is triggered. As soon as the ping is complete, issue the **show backup** and **show ip route** commands, as follows:

```
Capetown#ping
Protocol [ip]:
Target IP address: 192.168.0.1
Repeat count [5]: 55
Datagram size [100]: 1500
Timeout in seconds [2]: 1
Extended commands [n]: y
Source address or interface: 192.168.216.1
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, 1500-byte ICMP Echos to 192.168.0.1, timeout is 1
seconds:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!..!!!!!!!!!!!!!!!!!!!!!!!!!
Success rate is 96 percent (53/55), round-trip min/avg/max = 380/418/444 ms

Capetown#show backup
Primary Interface   Secondary Interface   Status
-----------------   -------------------   ------
Serial0/0           BRI0/0                overload mode


Capetown#show ip route
Gateway of last resort is 192.168.192.1 to network 0.0.0.0
C    192.168.192.0/24 is directly connected, Serial0/0
C    192.168.216.0/24 is directly connected, FastEthernet0/0
     192.168.16.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.16.0/24 is directly connected, BRI0/0
C       192.168.16.1/32 is directly connected, BRI0/0
S*   0.0.0.0/0 [1/0] via 192.168.192.1
               [1/0] via 192.168.16.1
```

There are two parallel routes to SanJose1 while the BRI 0/0 interface is up. ISDN activated at about the same time the two packets were dropped due to congestion.

As follows, issue **show backup** after one minute, or after the BRI 0/0 channel light turns off:

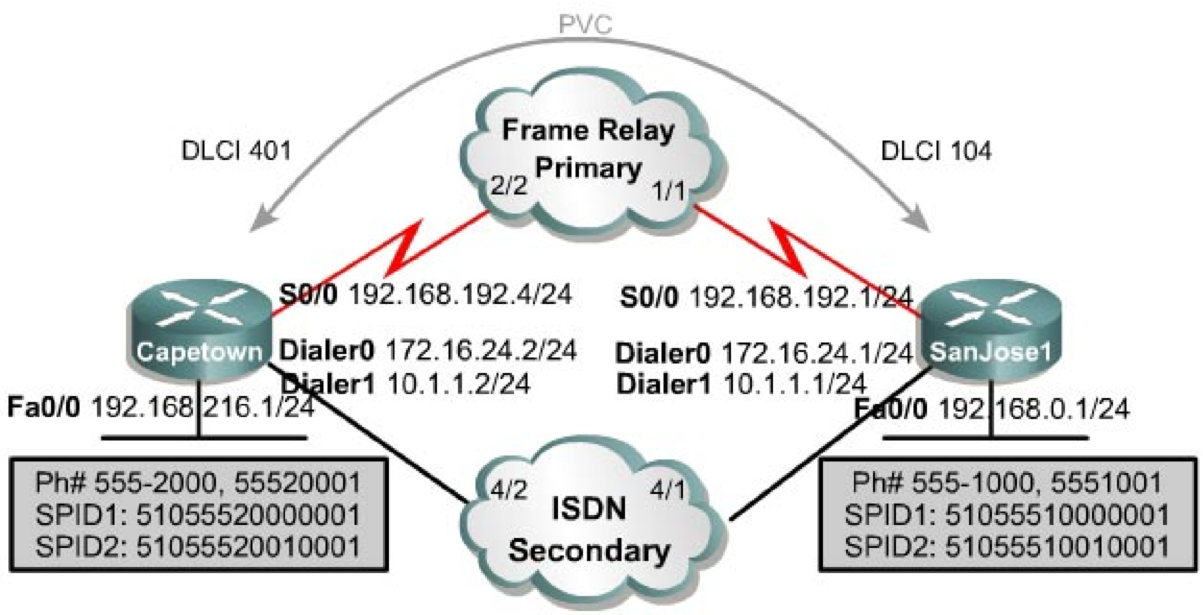
```
Capetown#show backup
Primary Interface   Secondary Interface   Status
-----------------   -------------------   ------
Serial0/0           BRI0/0                normal operation
```

The BRI 0/0 interface has deactivated and returned to standby mode. The **show ip interface brief** command, as the following shows, is another command that can be used to check interface status:

```
Capetown#show ip interface brief
Interface              IP-Address      OK? Method Status           Protocol
FastEthernet0/0        192.168.216.1   YES NVRAM  up               up
Serial0/0              192.168.192.4   YES NVRAM  up               up
BRI0/0                 192.168.16.4    YES NVRAM  standby mode     down
BRI0/0:1               unassigned      YES unset  administratively down down
BRI0/0:2               unassigned      YES unset  administratively down down
Serial0/1              unassigned      YES NVRAM  administratively down down
```

Dial-on-demand bandwidth has now been successfully configured.

Lab 8.7.3 Configuring Dialer Backup with Dialer Profiles



Objective

In this lab, the student will configure ISDN dial backup with dialer profiles.

Scenario

To ensure full time point-to-point WAN connectivity between SanJose1 and Capetown, configure ISDN dial backup using the physical BRI interface. By configuring the physical BRI interface for dial backup, only dial backup or traffic overload can be enabled, but not both. To overcome this limitation, configure dial backup using dialer profiles. By utilizing dialer profiles for dial backup, an idle ISDN connection can be used for load balancing and dial backup.

Step 1

Build the network as shown in the diagram. If the Atlas 550 is used as a WAN emulator, be sure to use the ports as indicated in the diagram. Before beginning this lab, it is recommended that each router be reloaded after erasing its startup configuration. This will prevent problems that may be caused by residual configurations.

Step 2

Configure SanJose1 and Capetown to use the appropriate ISDN switch type, National ISDN-1. PPP encapsulation and CHAP will be used on the B channels. Therefore, enter the case sensitive username and password information on both routers as shown in the following:

```
SanJose1(config)#isdn switch-type basic-ni
SanJose1(config)#username Capetown password cisco
SanJose1(config)#username jill password cisco
SanJose1(config)#enable password cisco
```



```
Capetown(config)#isdn switch-type basic-ni
Capetown(config)#username SanJose1 password cisco
Capetown(config)#username jack password cisco
Capetown(config)#enable password cisco
```

On both routers, configure **dialer-list 1** to identify all IP traffic as "interesting". The following configuration will initiate a dialup session:

```
SanJose1(config)#dialer-list 1 protocol ip permit
```

Step 3

Configure the physical BRI interface on SanJose1 and Capetown to use dialer profiles. Be sure to enter encapsulation configuration commands for both the physical interface (BRI 0/0) and the logical interface, such as dialer0 and so on. Also, remember to use the **dialer pool-member** command as follows to bind the physical BRI interface with the logical dialer interfaces:

```
SanJose1(config)#interface bri0/0
SanJose1(config-if)#isdn spid1 51055510000001 5551000
SanJose1(config-if)#isdn spid2 51055510010001 5551001
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication chap
SanJose1(config-if)#dialer pool-member 1
SanJose1(config-if)#no shutdown

Capetown(config)#interface bri0/0
Capetown(config-if)#isdn spid1 51055520000001 5552000
Capetown(config-if)#isdn spid2 51055520010001 5552001
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication chap
Capetown(config-if)#dialer pool-member 1
Capetown(config-if)#no shutdown
```

Now the physical BRI interfaces have been configured for ISDN. Next, use the following commands to configure Frame Relay on both routers:

```
SanJose1(config-if)#interface serial 0/0
SanJose1(config-if)#encapsulation frame-relay
SanJose1(config-if)#frame-relay map ip 192.168.192.4 104 broadcast
SanJose1(config-if)#ip address 192.168.192.1 255.255.255.0
```

Step 4

Configure dialer profiles for both routers, starting with SanJose1. Create two dialer interfaces for both routers. Each dialer interface will be configured to support a specific dial backup feature. Interface dialer 0 will be configured for process switching that will enable load balancing. Interface dialer 1 will be used as the backup interface. Configurations are shown as follows:

```
SanJose1(config)#interface dialer 0
SanJose1(config-if)#ip address 172.16.24.1 255.255.255.0
SanJose1(config-if)#dialer pool 1
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication chap
SanJose1(config-if)#dialer remote-name Capetown
SanJose1(config-if)#dialer-group 1
SanJose1(config-if)#dialer string 5552000
SanJose1(config)#interface dialer 1
SanJose1(config-if)#ip address 10.1.1.1 255.255.255.0
SanJose1(config-if)#dialer pool 1
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication chap
```



```
SanJose1(config-if)#ppp chap hostname jack
SanJose1(config-if)#dialer remote-name jill
SanJose1(config-if)#dialer-group 1
SanJose1(config-if)#dialer string 5552001
```

Now create two dialer profiles on Capetown that will be used to communicate with SanJose1, as shown in the following:

```
Capetown(config)#interface dialer 0
Capetown(config-if)#ip address 172.16.24.2 255.255.255.0
Capetown(config-if)#dialer pool 1
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication chap
Capetown(config-if)#dialer remote-name SanJose1
Capetown(config-if)#dialer-group 1
Capetown(config-if)#dialer string 5551000
Capetown(config)#interface dialer 1
Capetown(config-if)#ip address 10.1.1.2 255.255.255.0
Capetown(config-if)#dialer pool 1
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication chap
Capetown(config-if)#ppp chap hostname jill
Capetown(config-if)#dialer remote-name jack
Capetown(config-if)#dialer-group 1
Capetown(config-if)#dialer string 5551001
```

Step 5

Configure multiple static routes on SanJose1 to use both dialer interfaces and the serial interface as the exit interface to the Capetown LAN as follows:

```
SanJose1(config)#ip route 192.168.216.0 255.255.255.0 192.168.192.4
SanJose1(config)#ip route 192.168.216.0 255.255.255.0 Dialer1
SanJose1(config)#ip route 192.168.216.0 255.255.255.0 Dialer0
```

Static routes must also be configured on Capetown, as follows, so that it has a route to reach the SanJose1 LAN:

```
Capetown(config)#ip route 192.168.0.0 255.255.255.0 192.168.192.1
Capetown(config)#ip route 192.168.0.0 255.255.255.0 Dialer1
Capetown(config)#ip route 192.168.0.0 255.255.255.0 Dialer0
```

View the following routing table on SanJose1 to verify that both dialer interfaces and the serial interface are used as exit interfaces to the Capetown LAN:

```
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    192.168.192.0/24 is directly connected, Serial0/0
     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.24.0 is directly connected, Dialer0
S    192.168.216.0/24 is directly connected, Dialer0
                      is directly connected, via 192.168.192.4
                      is directly connected, Dialer1
```



```
     10.0.0.0/24 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, Dialer1
C    192.168.0.0/24 is directly connected, FastEthernet0/0
```

Step 6

Enable process switching on all WAN interfaces on SanJose1. With emerging Layer 3 technologies, process switching will rarely be used on a production network. For the purpose of this lab, enter the following to configure SanJose1 to load-balance on a per-packet basis over the point-to-point and the ISDN connection:

```
SanJose1(config)#interface serial 0/0
SanJose1(config-if)#no ip route-cache
SanJose1(config-if)#interface dialer 0
SanJose1(config-if)#no ip route-cache
SanJose1(config-if)#interface dialer 1
SanJose1(config-if)#no ip route-cache
```

By enabling process switching on both dialer interfaces and on the serial interface, half the packets will be sent out through the serial interface. The other half of the packets will travel over the dialer interfaces. The path selection alternates with each packet received.

Step 7

Make the secondary ISDN link active in the event the primary link fails. Issue the following to configure the physical BRI 0/0 interface as a backup interface to Serial0/0 on SanJose1:

```
SanJose1(config)#interface s0/0
SanJose1(config-if)#backup interface dialer 1
SanJose1(config-if)#backup delay 6 8
```

Use the **show ip route** command as follows to examine SanJose1's routing table:

Note: The static route that utilizes interface dialer 1 has been flushed from the SanJose1 routing table.

```
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    192.168.192.0/24 is directly connected, Serial0/0
     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.24.0 is directly connected, Dialer0
S    192.168.216.0/24 is directly connected, Serial0/0
                      is directly connected, Dialer0
C    192.168.0.0/24 is directly connected, FastEthernet0/0
```

Step 8

SanJose1 has two routes to the destination network in the table. Verify that SanJose1 is load balancing incoming traffic over both primary and secondary links. Observe the load balancing process by using the **debug ip packet** command. The following command outputs information about IP packets sent and received by the router:

```
SanJose1#debug ip packet
```


With the **debug** running, send a few packets from SanJose1 to the Capetown 192.168.216.0 network and observe the output. Notice that the **debug** output shows that IP packets are sent out through the serial 0/0 and dialer 0 interface.

```
SanJose1#ping 192.168.216.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.216.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/34/36 ms
SanJose1#
IP: s=192.168.192.1 (local), d=192.168.216.1 (Serial0/0), len 100, sending
IP: s=192.168.216.1 (Serial0/0), d=192.168.192.1 (Serial0/0), len 100, rcvd
3
IP: s=192.168.192.1 (local), d=192.168.216.1 (Dialer0), len 100, sending
IP: s=192.168.216.1 (Serial0/0), d=192.168.192.1 (Serial0/0), len 100, rcvd
3
IP: s=192.168.192.1 (local), d=192.168.216.1 (Serial0/0), len 100, sending
IP: s=192.168.216.1 (Serial0/0), d=192.168.192.1 (Serial0/0), len 100, rcvd
3
IP: s=192.168.192.1 (local), d=192.168.216.1 (Dialer0), len 100, sending
IP: s=192.168.216.1 (Serial0/0), d=192.168.192.1 (Serial0/0), len 100, rcvd
3
IP: s=192.168.192.1 (local), d=192.168.216.1 (Serial0/0), len 100, sending
IP: s=192.168.216.1 (Serial0/0), d=192.168.192.1 (Serial0/0), len 100, rcvd
3
```

Step 9

Prior to testing the backup configuration, use the **debug backup** command as follows to monitor the backup process on SanJose1:

```
SanJose1#debug backup
Backup events debugging is on
```

To test dial backup with dialer profiles, unplug the serial cable on both routers. Notice the **debug** output on SanJose1. The following shows that interface dialer 1 has changed its state from a backup passive mode to an active state: Interface dialer 0

```
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,changed state to
down
BACKUP(Serial0/0): event = primary went down
BACKUP(Serial0/0): changed state to "waiting to backup"
BACKUP(Serial0/0): event = timer expired
BACKUP(Serial0/0): secondary interface (Dialer1) made active
BACKUP(Serial0/0): changed state to "backup mode"
%LINK-3-UPDOWN: Interface Dialer1, changed state to up
BACKUP(Dialer1): event = primary came up
```

Step 10

Interface dialer 1 has now become the primary link. Verify that SanJose1 is load balancing between the dialer 0 interface and dialer 1 interface. With the **debug ip packet** command still enabled on SanJose1, ping 192.168.216.1 from SanJose1 as follows:

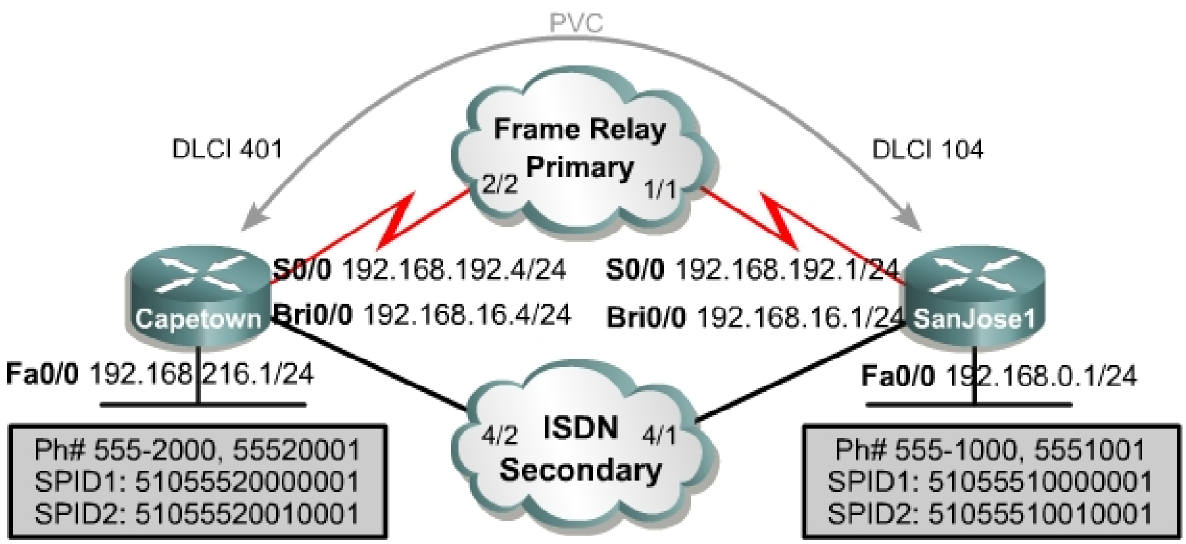
```
SanJose1#ping 192.168.216.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.216.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/33/36 ms
SanJose1#
```



```
07:03:27: IP: s=10.1.1.1 (local), d=192.168.216.1 (Dialer1), len 100,
sending
07:03:27: IP: s=192.168.216.1 (Dialer1), d=10.1.1.1 (Dialer1), len 100,
rcvd 3
07:03:27: IP: s=10.1.1.1 (local), d=192.168.216.1 (Dialer0), len 100,
sending
07:03:27: IP: s=192.168.216.1 (Dialer1), d=10.1.1.1 (Dialer1), len 100,
rcvd 3
07:03:27: IP: s=10.1.1.1 (local), d=192.168.216.1 (Dialer1), len 100,
sending
07:03:28: IP: s=192.168.216.1 (Dialer1), d=10.1.1.1 (Dialer1), len 100,
rcvd 3
07:03:28: IP: s=10.1.1.1 (local), d=192.168.216.1 (Dialer0), len 100,
sending
07:03:28: IP: s=192.168.216.1 (Dialer1), d=10.1.1.1 (Dialer1), len 100,
rcvd 3
07:03:28: IP: s=10.1.1.1 (local), d=192.168.216.1 (Dialer1), len 100,
sending
07:03:28: IP: s=192.168.216.1 (Dialer1), d=10.1.1.1 (Dialer1), len 100,
rcvd 3
```

From the **debug** output, packet flow from SanJose1 is sent out the dialer 0 interface and dialer 1 interface.

Lab 8.7.4 Configuring DDR Backup Using BRIs and Dialer Watch



Objective

Configure ISDN physical BRI interface for dialer watch.

Scenario

The International Travel Agency (ITA) asked for the primary route to the SanJose1 LAN to be backed up. They have asked for dialer watch to be configured on its Capetown router to monitor dynamic EIGRP routes to the SanJose1 LAN.

Step 1

Build the network as shown in the diagram. If using the Atlas 550 as a WAN emulator, be sure to use the ports as indicated in the diagram. Before beginning this lab, it is recommended that each router be reloaded after erasing its startup configuration. This will prevent problems that may be caused by residual configurations.

Step 2

Configure both routers to use the appropriate ISDN switch type, National ISDN-1. PPP encapsulation and CHAP authentication will be used on the B channels. Therefore, enter the case sensitive username and password information on both routers, as follows:

```
SanJose1(config)#isdn switch-type basic-ni
SanJose1(config)#username Capetown password cisco
SanJose1(config)#enable password cisco

Capetown(config)#isdn switch-type basic-ni
Capetown(config)#username SanJose1 password cisco
Capetown(config)#enable password cisco
```


On both routers, configure **dialer-list 1** as follows, to use an extended access-list to identify interesting traffic that will initiate a DDR session:

```
SanJose1(config)#dialer-list 1 protocol ip list 101
SanJose1(config)#access-list 101 deny eigrp any any
SanJose1(config)#access-list 101 permit ip any any
```

The first access-list deny statement will mark all EIGRP packets as uninteresting. This will prevent EIGRP updates from keeping the secondary link up.

Step 3

Configure and test ISDN BRI on Capetown as follows:

```
Capetown(config)#interface bri 0/0
Capetown(config-if)#ip address 192.168.16.4 255.255.255.0
Capetown(config-if)#encapsulation ppp
Capetown(config-if)#ppp authentication chap
Capetown(config-if)#isdn spid1 51055520000001 5552000
Capetown(config-if)#isdn spid2 51055520010001 5552001
Capetown(config-if)#dialer map ip 192.168.16.1 name SanJose1 broadcast
5551000
Capetown(config-if)#dialer idle-timeout 60
Capetown(config-if)#dialer-group 1
```

Next, enter the following to configure SanJose1:

> **Note:** SanJose1 will only accept BRI calls, so do not configure a phone number with the dialer map statement.

```
SanJose1(config)#interface bri 0/0
SanJose1(config-if)#ip address 192.168.16.1 255.255.255.0
SanJose1(config-if)#encapsulation ppp
SanJose1(config-if)#ppp authentication chap
SanJose1(config-if)#isdn spid1 51055510000001 5551000
SanJose1(config-if)#isdn spid2 51055510010001 5551001
SanJose1(config-if)#dialer map ip 192.168.16.4 name Capetown broadcast
SanJose1(config-if)#dialer idle-timeout 60
SanJose1(config-if)#dialer-group 1
```

Ping across the ISDN link from Capetown to the SanJose1 192.168.16.1 LAN. The ping should be successful. Troubleshoot as necessary.

Step 4

Configure and test Frame Relay connectivity on both routers. The Capetown configuration is shown here as an example:

```
Capetown(config)#interface s0/0
Capetown(config-if)#ip address 192.168.192.4 255.255.255.0
Capetown(config-if)#encapsulation frame-relay
Capetown(config-if)#frame-relay map ip 192.168.192.1 401 broadcast
```

Once there is verification that the Frame link is operational between SanJose1 and Capetown, use EIGRP on both routers and enable updates on all active interfaces with the following commands:

```
Capetown(config)#router eigrp 100
Capetown(config-router)#network 192.168.192.0
Capetown(config-router)#network 192.168.16.0
Capetown(config-router)#network 192.168.216.0
```


Use the **ping** command to verify connectivity between all interfaces. Troubleshoot as necessary.

Verify there is connectivity between all interfaces. Use the **show ip route** command as follows to verify the Capetown routing table:

```
Capetown#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, Serial0/0
C    192.168.216.0/24 is directly connected, FastEthernet0/0
D    192.168.0.0/24 [90/2172416] via 192.168.192.1, 00:01:15, Serial0/0
C    192.168.16.0/24 is directly connected, BRI0/0
```

1. According to the output, what route is Capetown using to reach the 192.168.0.0 network?

____

____

Step 5

Configure **dialer watch** to immediately initiate a dial up session when the primary link goes down. When the primary link goes down, the EIGRP routing protocol immediately notifies the dialer watch enabled router to bring up the secondary link.

Define the network the dialer watch enabled router is to monitor. Use the following command to watch the SanJose1 LAN:

```
Capetown(config)#dialer watch-list 2 ip 192.168.0.0 255.255.255.0
```

Next, enable **dialer watch** on the Capetown BRI interface using the following command:

```
Capetown(config)#interface bri0/0
Capetown(config-if)#dialer watch-group 2
Capetown(config-if)#dialer watch-disable 15
```

The watch group number tells Capetown to watch the route specified with the dialer watch-list 2. The optional dialer watch-disable command sets the disable timer on the backup interface. This delays disconnecting the backup interface for the set number of seconds after the primary interface becomes active.

Step 6

To complete the **dialer watch** configuration, create a dialer map statement as follows, for the network specified by **dialer watch-list 2**:

```
Capetown(config)#interface bri0/0
Capetown(config-if)#dialer map ip 192.168.0.0 name SanJose1 broadcast
5551000
Capetown(config-if)#dialer map ip 192.168.0.0 name SanJose1 broadcast
5551001
```


The dialer map statement specifies the network being watched by the **dialer watch-list** command. When the “watched route” disappears, the Capetown router knows to dial the specified number to reach the lost network.

Step 7

Test the **dial watch** configuration by unplugging the serial cable from Capetown. Wait for a few seconds, and then verify the Capetown routing table as follows:

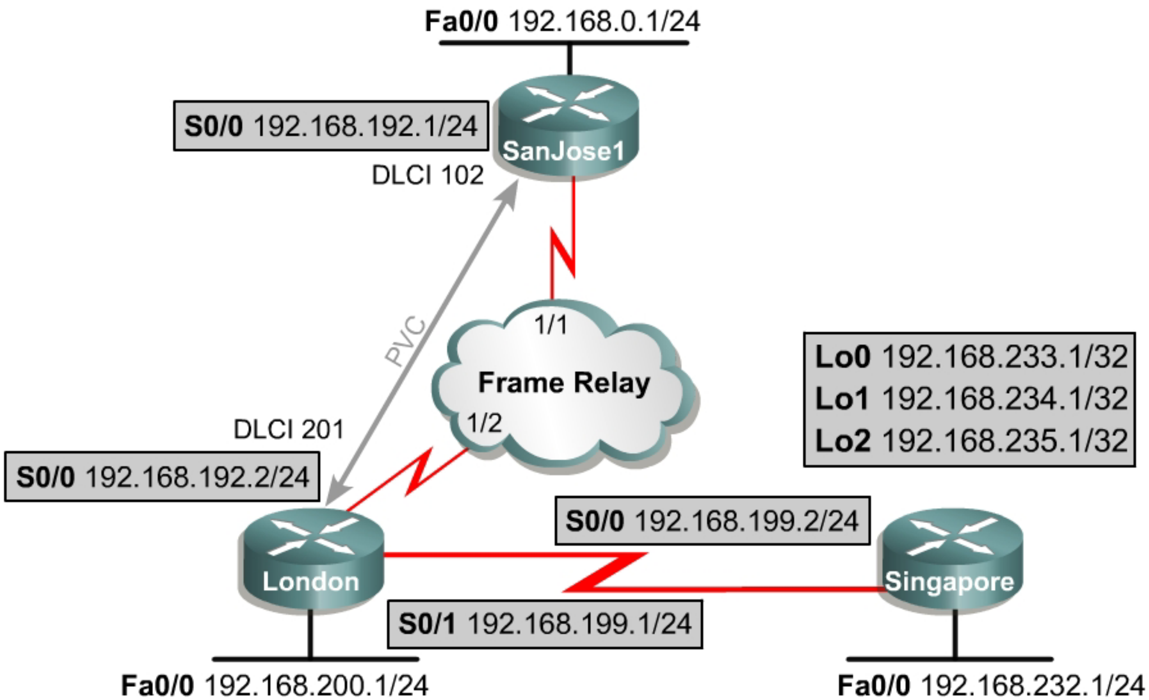
```
Capetown#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, 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
D    192.168.192.0/24 [90/41024000] via 192.168.16.1, 03:36:57, BRI0/0
C    192.168.216.0/24 is directly connected, FastEthernet0/0
     192.168.0.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.0.0/32 is directly connected, BRI0/0
D       192.168.0.0/24 [90/40514560] via 192.168.16.1, 03:37:23, BRI0/0
C    192.168.16.0/24 is directly connected, BRI0/0
```

The backup link has been activated. Notice that the SanJose1 192.168.192.0 network has been installed in the Capetown routing table using the backup link BRI 0/0.

The **show dialer** command can also be used to verify that the DDR interface has been activated by dialing on a watched route loss as shown in the following:

```
Capetown#show dialer
BRI0/0 - dialer type = ISDN
Dial String      Successes   Failures    Last DNIS   Last status
5551001                  0          0    never                 -
5551000                221          0    00:00:49       successful
0 incoming call(s) have been screened.
0 incoming call(s) rejected for callback.

BRI0/0:1 - dialer type = ISDN
Idle timer (60 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is data link layer up
Dial reason: Dialing on watched route loss
Time until disconnect 57 secs
Connected to 5551000 (SanJose1)

BRI0/0:2 - dialer type = ISDN
Idle timer (60 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is idle
```


Lab 9.8.1 Managing Network Performance Using Class-Based Weighted Fair Queuing (CBWFQ) and Low Latency Queuing (LLQ)



Objective

Use an access list to define the traffic of interest that is to be classified and configure a class map that associates the access list to a content class. Configure a policy map that associates a content class to a queue and guarantees bandwidth. Configure class-based weighted fair queuing (CBWFQ) on an interface and verify class-based weighted fair queuing operation.

Scenario

Users at the London office of the International Travel Agency (ITA) are reporting problems with traffic coming from the SanJose1 site. HTTP packets are being dropped due to other network traffic that is on the Frame Relay link. Users at the SanJose1 office have also been complaining that Telnet traffic going to the London office is also being degraded.

After studying traffic patterns, ITA management has decided to allocate 50 percent of the available Frame Relay bandwidth for HTTP network traffic going to the London office from the SanJose1 office LAN connection. Another 25 percent of all network traffic traversing the Frame Relay link will be allocated to Telnet traffic coming from the SanJose1 LAN connection. All other traffic will contend for the remaining available Frame Relay bandwidth.

ITA has been decided to implement class-based weighted fair queuing (CBWFQ) to support the management defined QoS requirements.

The Singapore site is directly connected to the London. The Singapore router will be used to generate IP traffic to test the queuing on the Frame Relay connection. Three loopback interfaces will be configured on the Singapore router for the extended ping tests.

Step 1

Before beginning this lab, it is recommended that each router be reloaded after erasing its startup configuration. This prevents problems that may be caused by residual configurations. Cable the network according to the diagram. This lab assumes an Adtran Atlas 550 will be used to emulate the Frame Relay cloud. Be sure to connect the serial interfaces on the router to the port as labeled in the diagram. On each router, configure their respective hostname and FastEthernet address.

On the SanJose1 router, configure the following:

```
SanJose1(config)#int s 0/0
SanJose1(config-if)#ip address 192.168.192.1 255.255.255.0
SanJose1(config-if)#encapsulation frame-relay
SanJose1(config-if)#frame-relay lmi-type ansi
SanJose1(config-if)#no shut
```

For convenience sake, configure a default route to London as follows:

```
SanJose1(config)#ip route 0.0.0.0 0.0.0.0 192.168.192.2
```

On the London router, configure the serial interfaces and static routes as follows:

```
London(config)#int s0/0
London(config-if)#ip address 192.168.192.2 255.255.255.0
London(config-if)#encapsulation frame-relay
London(config-if)#frame-relay lmi-type ansi
London(config-if)#no shut
London(config-if)#exit

London(config)#int s 0/1
London(config-if)#ip address 192.168.199.1 255.255.255.0
London(config-if)#no shut
London(config-if)#exit

London(config)#ip route 192.168.0.0 255.255.255.0 192.168.192.1
London(config)#ip route 192.168.232.0 255.255.248.0 192.168.199.2
```

On the Singapore router, configure the serial interface, enable password, Telnet services, loopback interfaces and the default route as follows:

```
Singapore(config)#int s0/1
Singapore(config-if)#ip address 192.168.199.2 255.255.255.0
Singapore(config-if)#clock rate 56000
Singapore(config-if)#no shut
Singapore(config-if)#exit

Singapore(config)#interface lo 0
Singapore(config-if)#ip address 192.168.233.1 255.255.255.255
Singapore(config)#interface lo 1
Singapore(config-if)#ip address 192.168.234.1 255.255.255.255
Singapore(config)#interface lo 2
Singapore(config-if)#ip address 192.168.235.1 255.255.255.255

Singapore(config)#enable password cisco
Singapore(config)#line vty 0 4
Singapore(config)#password cisco
Singapore(config)#login
Singapore(config)#ip route 0.0.0.0 0.0.0.0 192.168.199.1
```

With the extended **ping** command, verify connectivity between the FastEthernet LAN on SanJose1 and the FastEthernet LAN and Loopback addresses on Singapore.w

Step 2

In this step, the class-map and policy-map for class-based weighted fair queuing will be configured on the SanJose1 router. On the SanJose1 router, create an extended ip access list 100 to permit HTTP traffic requests coming from the SanJose1 LAN network going to the London LAN network.

```
SanJose1(config)#access-list 100 permit tcp 192.168.0.0 0.0.0.255
192.168.200.0 0.0.0.255 eq www
```

Create another extended ip access list 101 to permit **Telnet** traffic requests originating from the SanJose1 LAN network going to London LAN network.

```
SanJose1(config)#access-list 101 permit tcp 192.168.0.0 0.0.0.255
192.168.200.0 0.0.0.255 eq telnet
```

Create a class-map named HTTP-CLASS and configure a match condition with access list 100.

```
SanJose1(config)#class-map match-all HTTP-CLASS
SanJose1(config-cmap)#match access-group 100
```

Create a class-map named TELNET-CLASS and configure a match condition with access list 101.

```
SanJose1(config-cmap)#class-map match-all TELNET-CLASS
SanJose1(config-cmap)#match access-group 101
SanJose1(config-cmap)#exit
```

Create a policy-map named CBWFQ-CENTRAL. In the policy map, create a traffic policy for class HTTP-CLASS to allocate a minimum of 50 percent of the available bandwidth. Under the same policy map, create a traffic policy for class TELNET-CLASS allocating a minimum of 25 percent of the available bandwidth.

```
SanJose1(config)#policy-map CBWFQ-CENTRAL
SanJose1(config-pmap)#class HTTP-CLASS
SanJose1(config-pmap-c)#bandwidth percent 50
SanJose1(config-pmap-c)#class TELNET-CLASS
SanJose1(config-pmap-c)#bandwidth percent 25
SanJose1(config-pmap-c)#exit
```

Create a Frame Relay traffic shaping map-class called **TSLAB**. Set the CIR to 9600, the traffic rate to 9600, and the adaptive shaping to BECN. Finally apply the service policy **CBWFQ-CENTRAL** as follows:

```
SanJose1(config)#map-class frame-relay TSLAB
SanJose1(config-map-class)#frame-relay cir 9600
SanJose1(config-map-class)#frame-relay traffic-rate 9600 9600
SanJose1(config-map-class)#frame-relay adaptive-shaping becn
SanJose1(config-map-class)#service-policy output CBWFQ-CENTRAL
SanJose1(config-map-class)#exit
```

Enable Frame Relay traffic shaping on the S0/0 interface and configure the interface to use the Frame Relay class TSLAB as follows:

```
SanJose1(config)#interface serial0/0
SanJose1(config-if)#frame-relay class TSLAB
SanJose1(config-if)#frame-relay traffic-shaping
```


Verify the CBWFQ configuration on the SanJose1 router as follows:

```
SanJose1#show policy-map int s0/0
 Serial0/0: DLCI 102 -

  Service-policy output: CBWFQ-CENTRAL

    Class-map: HTTP-CLASS (match-all)
      0 packets, 0 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: access-group 100
      Queueing
        Output Queue: Conversation 25
        Bandwidth 50 (%) Max Threshold 64 (packets)
        (pkts matched/bytes matched) 0/0
        (depth/total drops/no-buffer drops) 0/0/0

    Class-map: TELNET-CLASS (match-all)
      0 packets, 0 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: access-group 101
      Queueing
        Output Queue: Conversation 26
        Bandwidth 25 (%) Max Threshold 64 (packets)
        (pkts matched/bytes matched) 0/0
        (depth/total drops/no-buffer drops) 0/0/0

    Class-map: class-default (match-any)
      0 packets, 0 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: any
```

Verify that CBWFQ is applied correctly to the Frame Relay interface as follows:

```
SanJose1#show frame-relay pvc 102

PVC Statistics for interface Serial0/0 (Frame Relay DTE)

DLCI = 102, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/0

  input pkts 12            output pkts 10           in bytes 1108
  out bytes 1040           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
  Shaping adapts to BECN
  pvc create time 00:18:05, last time pvc status changed 00:15:47
  cir 9600      bc 9600      be 0         byte limit 150    interval 125
  mincir 4800      byte increment 150   Adaptive Shaping BECN
  pkts 0         bytes 0         pkts delayed 0         bytes delayed 0
  shaping inactive
  traffic shaping drops 0
  service policy CBWFQ-CENTRAL
 Serial0/0: DLCI 102 -

  Service-policy output: CBWFQ-CENTRAL
<Output Omitted >
```


Step 3

In this step, Low Latency Queuing will be implemented on the London router. On the London router, create an extended ip access list 102 to simulate all low latency traffic such as voice over IP. To do so, the access-list will permit traffic from the London site's loopback 0 interface to SanJose1 site's LAN network.

```
London(config)#access-list 102 permit ip host 192.168.233.1  192.168.0.0
0.0.0.255
```

Create an extended ip access list 103 to permit traffic from the London site's loopback 1 interface to SanJose1 site's LAN network.

```
London(config)#access-list 103 permit ip host 192.168.234.1  192.168.0.0
0.0.0.255
```

Create an extended ip access list 104 to permit traffic from the London site's loopback 2 interface to SanJose1 site's LAN network.

```
London(config)#access-list 104 permit ip host 192.168.235.1  192.168.0.0
0.0.0.255
```

Three class maps need to be created to match the conditions of the access-lists. Create the first class-map named LLQ-102-CLASS and configure a match condition with access list 102. Create the second class-map named LLQ-103-CLASS and configure a match condition with access list 102. Create the third class-map named LLQ-104-CLASS and configure a match condition with access list 102.

```
London(config)#class-map match-all LLQ-102-CLASS
London(config-cmap)#match access-group 102
London(config-cmap)#class-map match-all CBWFQ-103-CLASS
London(config-cmap)#match access-group 103
London(config-cmap)#class-map match-all CBWFQ-104-CLASS
London(config-cmap)#match access-group 104
```

Create a policy-map named **CBWFQ-LONDON** and configure a traffic policy for the class of traffic named LLQ-102-CLASS specifying a priority of 8.

```
London(config-pmap)#policy-map CBWFQ-LONDON
London(config-pmap)#class LLQ-102-CLASS
London(config-pmap-c)#priority 8
London(config-pmap-c)#class CBWFQ-103-CLASS
London(config-pmap-c)#bandwidth percent 25
London(config-pmap-c)#class CBWFQ-104-CLASS
London(config-pmap-c)#bandwidth percent 25
```

Create a Frame Relay traffic shaping map-class called TSLAB. Set the CIR to 28000, the minimum cir 18000, and the adaptive shaping to BECN. Finally, apply the service policy CBWFQ-LONDON as follows:

```
London(config)#map-class frame-relay TSLAB
London(config-map-class)#frame-relay cir 28000
London(config-map-class)#frame-relay mincir 18000
London(config-map-class)#frame-relay adaptive-shaping becn
London(config-map-class)#service-policy output CBWFQ-LONDON
```


Step 4

Verifying the CBWFQ/LLQ configuration on the Branch router.

```
London#show policy-map
  Policy Map CBWFQ-LONDON
    Class LLQ-102-CLASS
      Strict Priority
      Bandwidth 8 (kbps) Burst 200 (Bytes)
    Class CBWFQ-103-CLASS
      Bandwidth 25 (%) Max Threshold 64 (packets)
    Class CBWFQ-104-CLASS
      Bandwidth 25 (%) Max Threshold 64 (packets)

  Policy Map CBWFQ-BRANCH
```

Step 5

Generate traffic from the Singapore router to congest the London to the SanJose1 Frame Relay link.

Establish three connections to the Singapore router to generate significant network traffic. This must be accomplished on all three extended ping sessions in a timely manner to congest the Frame Relay link between the London and SanJose1 sites.

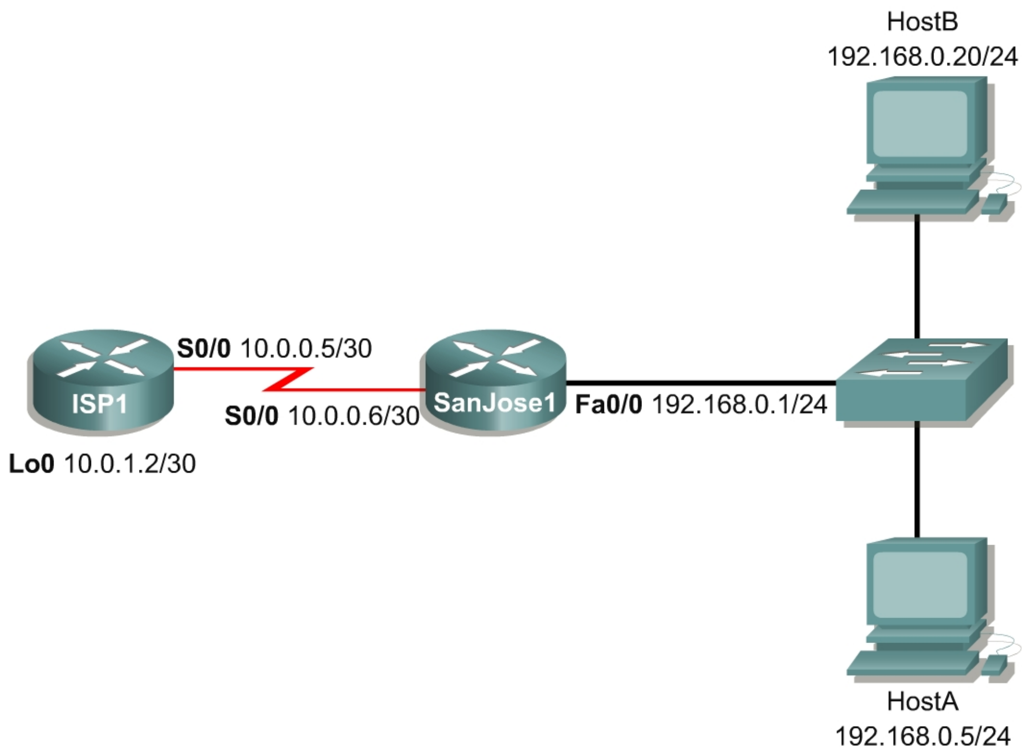
Note: It is very important that the following steps be read and understood before being attempted:

1. Establish a console session to the Singapore router.
2. Execute an extended ping to the SanJose1 router LAN interface using the loopback 0 address as the source address. In addition, use 10,000 as the ping count with a byte size of 60 bytes. This will simulate a voice over IP data flow.
3. While the extended ping is ongoing, exit the Singapore console connection and console to the SanJose1 router.
4. Establish a Telnet session to the Singapore router from the SanJose1 router.
5. Execute an extended ping to the SanJose1 router LAN interface using the loopback 1 address as the source address. In addition, use 10,000 as the ping count with a byte size of 1500 bytes. This will simulate another IP data flow.
6. While the extended ping is ongoing, suspend the Telnet session by pressing **Ctrl+Shift+6** twice and then press **X**. This will go to the prompt on the SanJose1 router.
7. Establish a second Telnet session into the Singapore router from the SanJose1 router.
8. Execute an extended ping to the SanJose1 router LAN interface using the loopback 2 address as the source address. In addition, use 10,000 as the ping count with a byte size of 1500 bytes. This will simulate another IP data flow.
9. Exit the console session on the SanJose1 router.
10. Enter the London router through the console session.
11. On the London site router, use the `show` commands listed in the command list to complete the following information:

```
Bandwidth allocated to the LLQ-102-CLASS: ______________
Bandwidth allocated to the CBWFQ-103-CLASS: ____________
Bandwidth allocated to the CBWFQ-104-CLASS: ____________
Drop rate for the CBWFQ-103-CLASS: ____________
Drop rate for the CBWFQ-104-CLASS: ____________
```

12. Erase the SanJose1, London, and Singapore router configurations and reload the routers.

Lab 10.5.1 Configuring Static NAT



Objective

Configure Network Address Translation (NAT) static translation to provide reliable outside access to three shared company servers.

Scenario

The International Travel Agency (ITA) has expanded and updated their network. They chose to use the 192.168.0.0 /24 private addresses and NAT to handle connectivity with the outside world. In order to secure the outside IP addresses from their ISP, ITA must pay a monthly fee for each IP address. ITA has asked for a series of prototypes to be set up to test the capabilities of NAT to meet their requirements. The company hopes to be able to get by with 14 real IP addresses, 42.0.0.48 /28. For a variety of reasons, including security concerns, the company wishes to hide the internal network from the outside.

Step 1

Build and configure the network according to the diagram. This configuration requires the use of subnet zero. Depending on the version of IOS being used, the **`ip subnet-zero`** command may need to be entered.

Configure SanJose1 to use a default route to ISP1, as shown in the following:

```
SanJose1(config)#ip route 0.0.0.0 0.0.0.0 10.0.0.5
```


Host A represents one of the proposed shared servers that will be part of a FastEthernet LAN attached to SanJose1. Host B represents a user in the ITA network.

Step 2

Verify the configurations with the **`show running-config`** command.

Verify that SanJose1 can ping to the serial interface for ISP1, 10.0.0.5, and that ISP1 can ping SanJose1's serial interface, 10.0.0.6.

At this time, ISP1 cannot ping workstation or SanJose1's Fast Ethernet interface, 192.168.0.1.

1. Both workstations can ping each other and 10.0.0.6, but cannot ping 10.0.0.5. Why does the later ping fail?

   ____

   ____

In fact, the ping request should be getting to 10.0.0.5. Because ISP1 has no entry in its routing table for the 192.168.0.0 /24, ISP1 cannot reply. To solve this problem, a static route will be configured in Step 7.

Step 3

SanJose1 is the boundary router where NAT will be configured. The router will be translating the inside local addresses to inside global addresses. This is essentially converting the internal private addresses into legal public addresses for use on the Internet.

On SanJose1, create static translations between the inside local addresses, the servers to be shared, and the inside global addresses using the following commands:

```
SanJose1(config)#ip nat inside source static 192.168.0.3 42.0.0.49
SanJose1(config)#ip nat inside source static 192.168.0.4 42.0.0.50
SanJose1(config)#ip nat inside source static 192.168.0.5 42.0.0.51
```

1. If a static translation is needed for a fourth server, 192.168.0.6, what would be the appropriate command?

   ____

   ____

Step 4

Next, enter the following to specify an interface on SanJose1 to be used by inside network hosts requiring address translation:

```
SanJose1(config)#interface fastethernet0/0
SanJose1(config-if)#ip nat inside
```

Enter the following to specify an interface to be used as the outside NAT interface:

```
SanJose1(config)#interface serial0/0
SanJose1(config-if)#ip nat outside
```


Step 5

To see the static translations, use the **show ip nat translations** command. The results should look similar to the following:

```
SanJose1#show ip nat translations
Pro Inside global      Inside local       Outside local      Outside global
---  42.0.0.49          192.168.0.3        ---                ---
---  42.0.0.50          192.168.0.4        ---                ---
---  42.0.0.51          192.168.0.5        ---                ---
```

Use the **show ip nat statistics** command to see what NAT activity has occurred.

The results should look similar to the following:

```
SanJose1#show ip nat statistics
Total active translations: 3 (3 static, 0 dynamic; 0 extended)
Outside interfaces:
  Serial0/0
Inside interfaces:
  FastEthernet0/0
Hits: 0  Misses: 0
Expired translations: 0
Dynamic mappings:
```

Notice that the Hits value is currently zero (0).

Step 6

From Host A, ping 10.0.0.5, which is ISP1's serial interface. The pings should still fail because ISP1 has no route for 192.168.0.0 /24 in its routing table.

Return to the console connection of SanJose1 and type **show ip nat statistics,** as follows:

```
SanJose1#show ip nat statistics
Total active translations: 3 (3 static, 0 dynamic; 0 extended)
Outside interfaces:
  Serial0/0
Inside interfaces:
  FastEthernet0/0
Hits: 4  Misses: 0
Expired translations: 0
Dynamic mappings:
```

It should be seen that the hits equal four (4). This indicates that the translation was made even though a response was not received. Remember that the ping replies are not sent because ISP1 does not have a route back to SanJose1.The following will fix this situation.

Step 7

On ISP1, configure the following static route to the global addresses used by SanJose1 for NAT:

```
ISP1(config)#ip route 42.0.0.48 255.255.255.240 10.0.0.6
```

The subnet mask defines the pool of IP addresses as 42.0.0.48 /28.

A ping to 42.0.0.51 should now be successful. This is the translated address of the shared server, 192.168.0.5.

The **show ip route** command confirms that the static route is present, as the following shows:


```
ISP1#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
     42.0.0.0/28 is subnetted, 1 subnets
S       42.0.0.48 [1/0] via 10.0.0.6
     10.0.0.0/30 is subnetted, 2 subnets
C       10.0.1.0 is directly connected, Loopback0/0
C       10.0.0.4 is directly connected, Serial0/0
```

Step 8

From Host A, ping the ISP1 router at 10.0.0.5. This ping should now be successful.

A ping to the loopback address for ISP1, 10.0.1.2, should be successful as well.

From the console connection to SanJose1, issue the **show ip nat statistics** command and look over the statistics. The number of hits should be much larger than before.

Try the **show ip nat translations verbose** command. The results should look similar to the following:

```
SanJose1#show ip nat translations verbose
Pro Inside global      Inside local       Outside local      Outside global
--- 42.0.0.49          192.168.0.3        ---                ---
    create 00:40:25, use 00:40:25,
    flags:
static, use_count: 0
--- 42.0.0.50          192.168.0.4        ---                ---
    create 00:40:25, use 00:40:25,
    flags:
static, use_count: 0
--- 42.0.0.51          192.168.0.5        ---                ---
    create 00:40:25, use 00:06:46,
    flags:
static, use_count: 0
```

Note: The verbose option includes information about how recently each translation was used.

Step 9

From SanJose1, use the **show ip nat statistics** command and make a note of the number of hits.

From Host B, ping both 10.0.0.5 and 10.0.1.2.

1. Both pings should fail. Why?

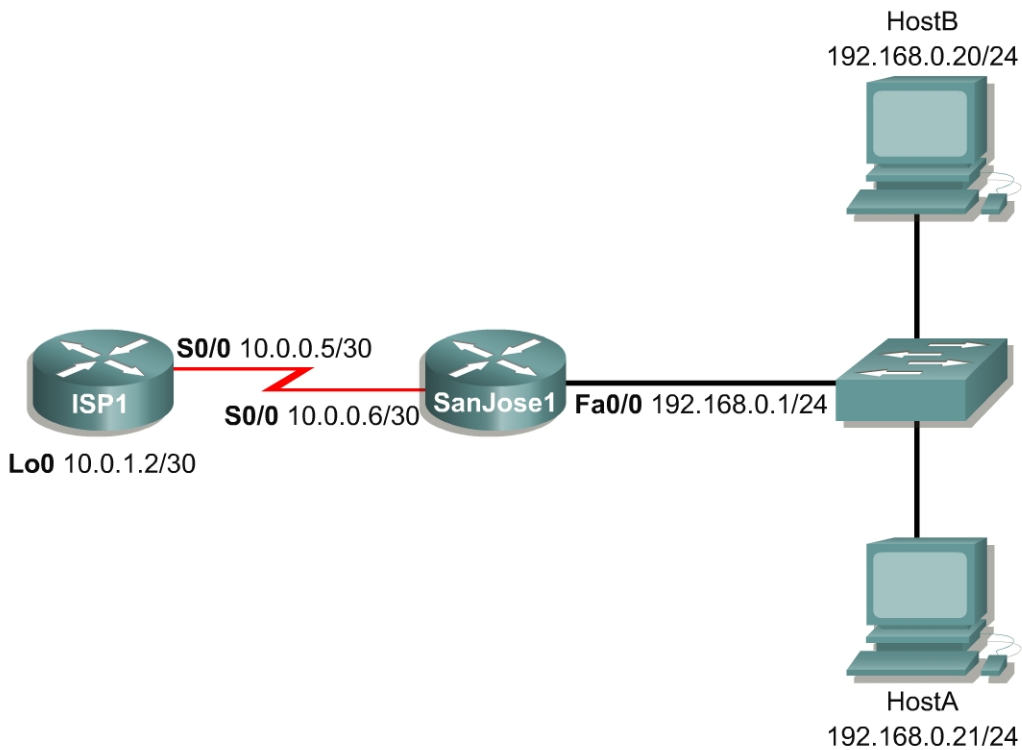
____

____

From SanJose1, issue the **show ip nat statistics** command again and notice that the number of hits has not changed. The problem is that NAT did not translate Host B's IP address, 192.168.0.20, to one of the global addresses. The **show ip nat translations** command should confirm this.

A static translation has not been set up for Host B, which represents a LAN user. A static translation for this single end user could be quickly configured. However, configuring a static translation for every user on the LAN could be a huge task, resulting in hundreds of configuration commands. Dynamic NAT allows the router to be configured to assign global addresses dynamically, on an as needed basis. While static translation may be appropriate for servers, dynamic translation is almost always used with end-user stations. Dynamic NAT will be discussed in the next lab exercise.

Lab 10.5.2 Configuring Dynamic NAT



Objective

Configure dynamic NAT to provide privately addressed users with access to outside resources.

Scenario

The International Travel Agency (ITA) has expanded and updated their network. They chose to use the 192.168.0.0 /24 private addresses and NAT to handle connectivity with the outside world. In securing the outside IP addresses from their ISP, ITA has to pay a monthly fee for each IP address. ITA has asked for a series of prototypes to be set up to test the capabilities of NAT to meet their requirements. The company hopes to be able to get by with 14 real IP addresses, 42.0.0.48 /28. For a variety of reasons, including security concerns, the company wishes to hide the internal network from the outside.

ITA is hoping to limit user access to the Internet and other outside resources by limiting the number of connections. The basic dynamic translation is to be prototyped to see if it will meet ITA objectives.

Step 1

Build and configure the network according to the diagram. This configuration requires the use of subnet zero. Depending on the IOS version used, the **`ip subnet-zero`** command may need to be entered. Both Host A and Host B represent users on the ITA network.

Enter the following to configure SanJose1 to use a default route to ISP1:


```
SanJose1(config)#ip route 0.0.0.0 0.0.0.0 10.0.0.5
```

On ISP1, configure a static route to the global addresses used by SanJose1 for NAT as follows:

```
ISP1(config)#ip route 42.0.0.48 255.255.255.240 10.0.0.6
```

Step 2

Define a pool of global addresses to be allocated by the dynamic NAT process. Issue the following command on SanJose1:

```
SanJose1(config)#ip nat pool MYNATPOOL 42.0.0.55 42.0.0.55 netmask
255.255.255.240
```

The name MYNATPOOL is the name of the address pool. If preferred, a different word can be used. The first 42.0.0.55 in the command is the first IP address in the pool. The second 42.0.0.55 is the last IP address in the pool. This command creates a pool that contains only a single address. Typically, a larger range of addresses will be configured in a pool. However, at this time, only one address will be used.

Next, configure a standard access list to define which internal source addresses can be translated. Since any users on the ITA network are being translated, use the following command:

```
SanJose1(config)#access-list 2 permit 192.168.0.0 0.0.0.255
```

To establish the dynamic source translation, link the access list to the name of the NAT pool, as shown in the following:

```
SanJose1(config)#ip nat inside source list 2 pool MYNATPOOL
```

Finally, specify an interface on SanJose1 to be used by inside network hosts requiring address translation:

```
SanJose1(config)#interface fastethernet0/0
SanJose1(config-if)#ip nat inside
```

Also specify an interface to be used as the outside NAT interface as follows:

```
SanJose1(config)#interface serial0/0
SanJose1(config-if)#ip nat outside
```

Step 3

On SanJose1, enter the **show ip nat translations** command. This should result in no output. Static translations are permanent and always remain in the translations table. Dynamic translations are only assigned as needed, and only appear when active.

From Host A, ping the serial and loopback IP addresses on ISP1. Both pings should work. Troubleshoot as necessary.

Issue the **show ip nat translations** command on SanJose1 again. A single translation for that workstation should be received. The result may be similar to the following:

```
SanJose1#show ip nat trans
Pro Inside global      Inside local       Outside local     Outside global
--- 42.0.0.55          192.168.0.21       ---                ---
```


From Host B, ping the serial and loopback IP addresses on ISP1. Both pings should fail. The one available IP address in the pool is being used by the other workstation. If a larger pool of addresses had been assigned, Host B could be assigned an address from the pool.

Step 4

Issue the **show ip nat translations verbose** command as follows and examine the output:

```
SanJose1#show ip nat translations verbose
Pro Inside global      Inside local       Outside local      Outside global
--- 42.0.0.55          192.168.0.21       ---                 ---
    create 00:13:18, use 00:13:06, left 23:46:53,
    flags: none, use_count: 0
```

1. According to the output of this command, how much time is left before the dynamic translation times out?

   ____

The default timeout value for dynamic NAT translations is 24 hours. This means the second workstation will have to wait until the next day before it can be assigned the address.

Next, issue the **show ip nat statistics** command. Notice that it summarizes the translation information, shows the pool of global addresses, and indicates that only one address has been allocated or translated, shown as follows:

```
SanJose1#show ip nat statistics
Total active translations: 1 (0 static, 1 dynamic; 0 extended)
Outside interfaces:
  Serial0/0
Inside interfaces:
  FastEthernet0/0
Hits: 45  Misses: 0
Expired translations: 0
Dynamic mappings:
-- Inside Source
access-list 2 pool MYNATPOOL refcount 1
 pool MYNATPOOL: netmask 255.255.255.240
        start 42.0.0.55 end 42.0.0.55
     type generic, total addresses 1, allocated 1 (100%), misses 4
```

To change the default NAT timeout value from 24 hours, or 86,400 seconds to 120 seconds, issue the following command:

```
SanJose1(config)#ip nat translation timeout 120
```

The existing address allocation must be cleared before the new timer can take effect. To immediately clear the translation table, type **clear ip nat translation ***.

Now, from Host B, ping either interface of ISP1 again. The **ping** should be successful.

Use the **show ip nat translations** and **show ip nat translations verbose** commands to confirm the translation and to see that the new translations expire in two minutes.

Next, perform a ping from Host B and issue the **show ip nat translations verbose** command again. This will show that the "time left" timer has been reset. This means that additional hosts will not be allocated an address until a translation has been inactive for the timeout period.

Step 5

In this step, clear the ip nat translations and configure the NAT pool to include the complete range of global addresses available to ITA. Issue the following command on SanJose1:

```
SanJose1(config)#ip nat pool MYNATPOOL 42.0.0.55 42.0.0.62 netmask
255.255.255.240
```

This command redefines MYNATPOOL to include a range of eight addresses. Both workstations should now be able to **ping** ISP1.

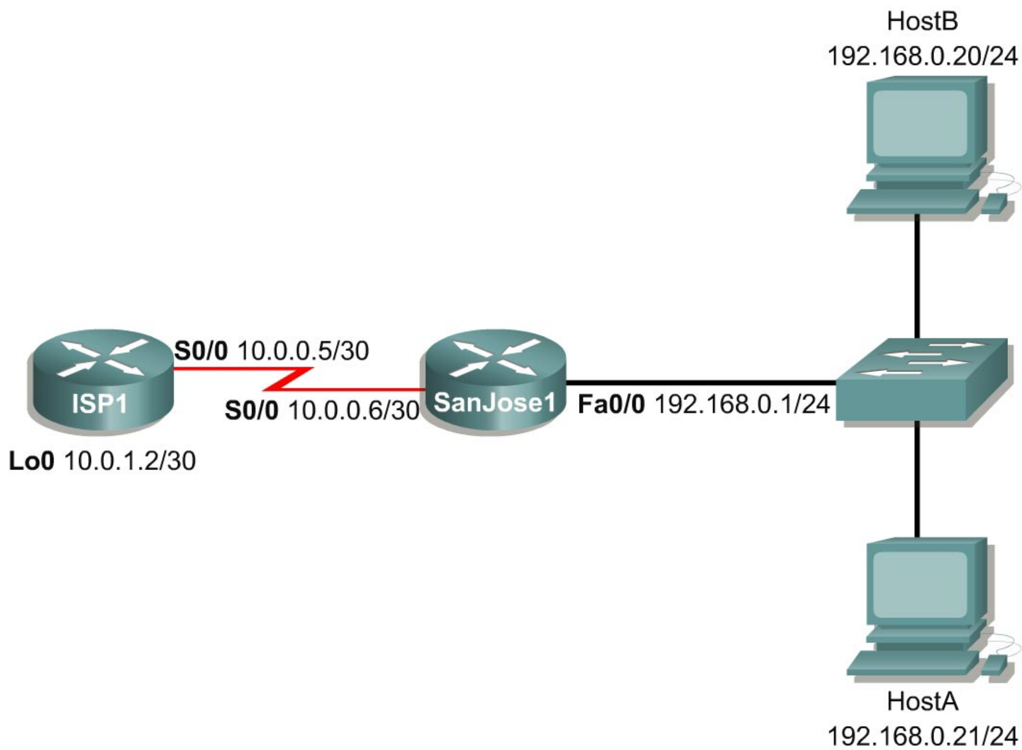
The **show ip nat translations** command confirms that two translations have occurred, shown as follows:

```
SanJose1#show ip nat translations
Pro Inside global      Inside local       Outside local      Outside global
--- 42.0.0.55          192.168.0.20       ---                ---
--- 42.0.0.56          192.168.0.21       ---                ---
```

Increasing the address range in the pool allows more hosts to be translated. However, if every address in the pool is allocated, the timeout period must expire before any other hosts can be allocated an address. As seen in Step 5, an allocated address cannot be released until its host is inactive for the duration of the timeout period.

The next lab will show how to use many-to-one NAT, or NAT overload. An overload configuration can allow hundreds of hosts to use a handful of global addresses, without hosts waiting for timeouts.

Lab 10.5.3 Configuring NAT Overload



Objective

Configure dynamic NAT with overload.

Scenario

The International Travel Agency (ITA) expanded and updated their network. They chose to use the 192.168.0.0 /24 private addresses and NAT to handle connectivity with the outside world. In securing the outside IP addresses from their ISP, ITA has to pay a monthly fee for each IP address. ITA has asked for a series of prototypes to be set up to test the capabilities of NAT to meet their requirements. The company hopes to be able to get by with 14 real IP addresses, 42.0.0.48 /28. For a variety of reasons, including security concerns, the company wishes to hide the internal network from the outside.

It appears that the basic dynamic NAT translations will be too limiting and cumbersome to meet ITA needs. Therefore, the prototype needs to be modified to use the overload feature.

Step 1

Build and configure the network according to the diagram. Depending on the IOS version used, the **`ip subnet-zero`** command may need to be entered. Both Host A and Host B represent users on the ITA network.

Enter the following to configure SanJose1 to use a default route to ISP1:


```
SanJose1(config)#ip route 0.0.0.0 0.0.0.0 10.0.0.5
```

On ISP1, enter the following to configure a static route to the global addresses used by SanJose1 for NAT:

```
ISP1(config)#ip route 42.0.0.48 255.255.255.240 10.0.0.6
```

Define a pool of global addresses to be allocated by the dynamic NAT process. Issue the following command on SanJose1:

```
SanJose1(config)#ip nat pool MYNATPOOL 42.0.0.55 42.0.0.62 netmask
255.255.255.240
```

Configure a standard access list to define which internal source addresses can be translated. Because all users are being translated on the ITA network, use the following command:

```
SanJose1(config)#access-list 2 permit 192.168.0.0 0.0.0.255
```

Enter the following to specify an interface on SanJose1 to be used by inside network hosts requiring address translation:

```
SanJose1(config)#interface fastethernet0/0
SanJose1(config-if)#ip nat inside
```

Also enter the following to specify an interface to be used as the outside NAT interface:

```
SanJose1(config)#interface serial0/0
SanJose1(config-if)#ip nat outside
```

Step 2

In the last exercise, a pool of “real” global IP addresses was created. These address are used to provide internally addressed hosts with access to the Internet and other outside resources. However, in the previous implementation, each global address could be allocated to only one host at a time.

The most powerful feature of NAT is address overloading, or port address translation (PAT). Overloading allows multiple inside addresses to map to a single global address. With PAT, literally hundreds of privately addressed nodes can access the Internet using only one global address. The NAT router keeps track of the different conversations by mapping TCP and UDP port numbers.

Configure address overloading on SanJose1 with the following command:

```
SanJose1(config)#ip nat inside source list 2 pool MYNATPOOL overload
```

After the overload feature is configured, ping both interfaces of ISP1, 10.0.1.2 and 10.0.0.5, from Host A. The pings should be successful. Next, issue the **show ip nat translations** command as follows:

```
SanJose1#show ip nat translations
Pro Inside global      Inside local        Outside local      Outside global
icmp 42.0.0.55:1536    192.168.0.21:1536   10.0.0.5:1536      10.0.0.5:1536
icmp 42.0.0.55:1536    192.168.0.21:1536   10.0.1.2:1536      10.0.1.2:1536
```


1. What port number is the source of the ping?

2. What port number is the destination of the ping?

In addition to tracking the IP addresses translated, the translations table also records the port numbers being used. Also notice that the first column "Pro" shows the protocol used.

Look at the following output from the **show ip nat translations verbose** command:

```
SanJose1#show ip nat translations verbose
Pro Inside global      Inside local       Outside local      Outside global
icmp 42.0.0.55:1536    192.168.0.21:1536  10.0.0.5:1536      10.0.0.5:1536
    create 00:00:09, use 00:00:06, left 00:00:53,
    flags:
extended, use_count: 0
icmp 42.0.0.55:1536    192.168.0.21:1536  10.0.1.2:1536      10.0.1.2:1536
    create 00:00:04, use 00:00:01, left 00:00:58,
    flags:
extended, use_count: 0
```

Note: The timeout for these overloaded dynamic translations of ICMP is 60 seconds. Also notice that there is a timeout timer for each session. New activity only resets the time for that session. Another ping may be needed again to see the result on router.

From the MS-DOS prompt of Host A, quickly issue the following commands and then return to the SanJose1 console to issue the **show ip nat translations** command:

Note: Work fast, because there is a 60-second timeout.

```
HostA:\>ping 10.0.0.5
HostA:\>telnet 10.0.0.5     (Do not login. Return to command window)
HostA:\>ftp: 10.0.0.5       (It will fail. Do not worry about it)
```

Note: To quit the Windows FTP program, type **bye** and press **Enter**.

After these three sessions are initiated, the output of the **show ip nat translations** command should look similar to the following:

```
SanJose1#show ip nat translations
Pro Inside global      Inside local       Outside local      Outside global
icmp 42.0.0.55:1536    192.168.0.21:1536  10.0.0.5:1536      10.0.0.5:1536
tcp 42.0.0.55:1095     192.168.0.21:1095  10.0.0.5:21        10.0.0.5:21
tcp 42.0.0.55:1094     192.168.0.21:1094  10.0.0.5:23        10.0.0.5:23
```

The NAT router has a pool of eight IP addresses to work with. However, it chooses to continue to use the 42.0.0.55 for both workstations. The Cisco IOS will continue to overload the first address in the pool until it is maxed out and then move to the second address, and so on.

Step 3

In this step, the timeout values will be examined in more detail. From Host A, initiate FTP and HTTP sessions as follows with ISP1 at 10.0.0.5:

Note: Since ISP1 is not configured as an FTP server or Web server, both sessions will fail

```
HostA:\>ftp 10.0.0.5
```

To open an HTTP session, type the IP address for ISP1 in the URL field of a Web browser window.

After both FTP and HTTP sessions are attempted, use the **show ip nat translations verbose** command. Examine the following time left entries, as shown:

```
SanJose1# show ip nat translatiosn verbose
Pro Inside global      Inside local       Outside local      Outside global
icmp 42.0.0.55:1536    192.168.0.21:1536  10.0.0.5:1536      10.0.0.5:1536
    create 00:00:29, use 00:00:26, left 00:00:33,
    flags:
extended, use_count: 0
tcp 42.0.0.55:1114     192.168.0.21:1114  10.0.0.5:21        10.0.0.5:21
    create 00:00:16, use 00:00:15, left 00:00:44,
    flags:
extended, timing-out, use_count: 0
tcp 42.0.0.55:1113     192.168.0.21:1113  10.0.0.5:23        10.0.0.5:23
    create 00:00:22, use 00:00:22, left 23:59:37,
    flags:
extended, use_count: 0
tcp 42.0.0.55:1115     192.168.0.21:1115  10.0.0.5:80        10.0.0.5:80
    create 00:00:12, use 00:00:11, left 23:59:48,
    flags:
extended, use_count: 0
```

Notice that some of the TCP transactions are using a 24-hour timeout timer. To see the other timers that can be set, use the **ip nat translation ?** command while in global configuration mode, as the following shows:

```
SanJose1(config)#ip nat translation ?
  dns-timeout    Specify timeout for NAT DNS flows
  finrst-timeout Specify timeout for NAT TCP flows after a FIN or RST
  icmp-timeout   Specify timeout for NAT ICMP flows
  max-entries    Specify maximum number of NAT entries
  port-timeout   Specify timeout for NAT TCP/UDP port specific flows
  syn-timeout    Specify timeout for NAT TCP flows after a SYN and no
further data
  tcp-timeout    Specify timeout for NAT TCP flows
  timeout        Specify timeout for dynamic NAT translations
  udp-timeout    Specify timeout for NAT UDP flows
```

The actual timeout options vary with versions of the IOS. The defaults for some of the more common times are as follows:

- **dns-timeout** DNS session (60 seconds)
- **finrst-timeout** TCP session after a FIN or RST / end of session (60 seconds)
- **icmp-timeout** ICMP session (60 seconds)
- **tcp-timeout** TCP port session (86,400 seconds or 24 hours)
- **timeout** Dynamic NAT translations (86,400 seconds or 24 hours)
- **udp-timeout** UDP port session (300 seconds or 5 minutes)

The finrst-timeout timer makes sure that TCP sessions close the related port 60 seconds after the TCP termination sequence.

Dynamic NAT sessions can only be initiated by an internal host. It is not possible to initiate a NAT translation from outside the network. To some extent, this adds a level of security to the internal network. It may also help to explain why the dynamic timeout timer for overload sessions is so short. The translation stays open just long enough to make sure that legitimate replies like web pages, FTP and TFTP sessions, and ICMP messages can get in.

In Lab 10.5.1 it was seen that outside hosts can ping static NAT translations at any time, provided the inside host is up. This is so Web, FTP, TFTP, DNS, and other types of servers can be shared with the outside world.

With dynamic NAT not configured for overload, the translation stays up for 24 hours. This could allow an outside host to try to access the translation and thereby get access to the host. But with the overload option, the outside host has to be able to re-create the NAT IP address plus the port number. This would reduce the likelihood of an unwanted host gaining access to the system.

Step 4

To see the actual translation process and troubleshoot NAT problems, use the **`debug ip nat`** command and its related options.

Remember as with all debug commands, this can seriously impair the performance of the production router and should be used carefully. The **`undebug all`** command turns off all debugging.

On SanJose1, use the **`debug ip nat`** command to turn on the **`debug`** feature.

From Host A, ping the serial interface for ISP1 and observe the following translations:

```
SanJose1#debug ip nat
IP NAT debugging is on
06:37:40: NAT:  s=192.168.0.21->42.0.0.55, d=10.0.0.5 [63]
06:37:40: NAT*: s=10.0.0.5, d=42.0.0.55->192.168.0.21 [63]
06:37:41: NAT*: s=192.168.0.21->42.0.0.55, d=10.0.0.5 [64]
06:37:41: NAT*: s=10.0.0.5, d=42.0.0.55->192.168.0.21 [64]
06:37:42: NAT*: s=192.168.0.21->42.0.0.55, d=10.0.0.5 [65]
06:37:42: NAT*: s=10.0.0.5, d=42.0.0.55->192.168.0.21 [65]
06:37:43: NAT*: s=192.168.0.21->42.0.0.55, d=10.0.0.5 [66]
06:37:43: NAT*: s=10.0.0.5, d=42.0.0.55->192.168.0.21 [66]
06:38:43: NAT: expiring 42.0.0.55 (192.168.0.21) icmp 1536 (1536)
```

Issue the following to turn off **`debugging`**:

```
SanJose1#undebug all
All possible debugging has been turned off
```

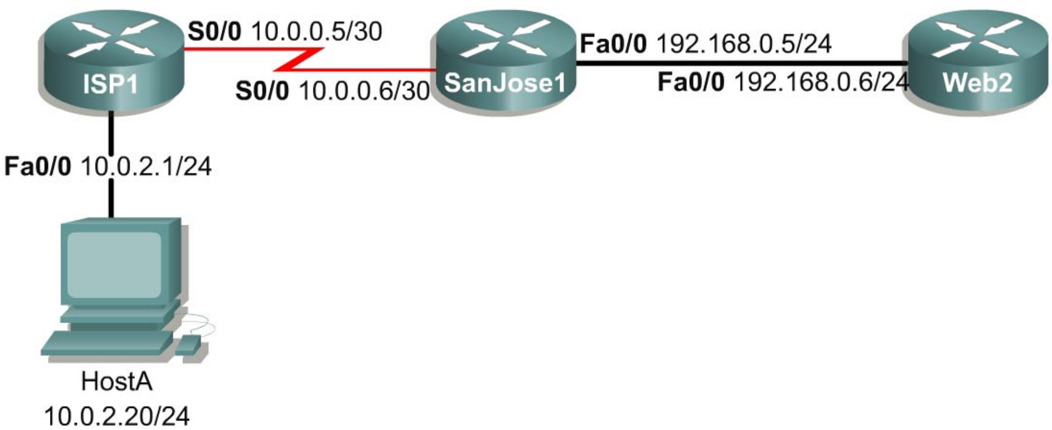
Notice that both translations can be seen as the pings pass both ways through the NAT router. Notice that the number at the end of the row is the same for both translations of each ping. The **s=** indicates the source, **d=** indicates the destination, and **->** shows the translation.

The **06:38:43** entry shows the expiration of the NAT translation.

The detailed option can be used with **`debug ip nat`** to provide the port numbers as well as the IP address translations, as shown in the following:

```
SanJose1#debug ip nat detailed
IP NAT detailed debugging is on
07:03:50: NAT:  i: icmp (192.168.0.21, 1536) -> (10.0.0.5, 1536) [101]
07:03:50: NAT:  address not stolen for 192.168.0.21, proto 1 port 1536
07:03:50: NAT:  ipnat_allocate_port: wanted 1536 got 1536
07:03:50: NAT*: o: icmp (10.0.0.5, 1536) -> (42.0.0.55, 1536) [101]
07:03:51: NAT*: i: icmp (192.168.0.21, 1536) -> (10.0.0.5, 1536) [102]
07:03:51: NAT*: o: icmp (10.0.0.5, 1536) -> (42.0.0.55, 1536) [102]
07:03:52: NAT*: i: icmp (192.168.0.21, 1536) -> (10.0.0.5, 1536) [103]
07:03:52: NAT*: o: icmp (10.0.0.5, 1536) -> (42.0.0.55, 1536) [103]
07:03:53: NAT*: i: icmp (192.168.0.21, 1536) -> (10.0.0.5, 1536) [104]
07:03:53: NAT*: o: icmp (10.0.0.5, 1536) -> (42.0.0.55, 1536) [104]
```


Lab 10.5.4 Configuring TCP Load Distribution



Objective

In this lab, the student will configure NAT with the TCP Load Distribution option. The student will also learn to use the prefix-length option as an alternative to the **`netmask`** option of the **`ip nat pool`** command.

Scenario

The International Travel Agency (ITA) expanded and updated their network. They chose to use the 192.168.0.0/24 private addresses and NAT to handle connectivity with the outside world. In securing the outside IP addresses from their ISP, ITA is required to pay a monthly fee for each IP address. ITA has asked for a series of prototypes to be set up to test the capabilities of NAT to meet their requirements. The company hopes to be able to get by with 14 real IP addresses, 42.0.0.48/28. For a variety of reasons including security concerns, the company wishes to hide the internal network from the outside.

The ITA Web server, 192.168.0.5, is overwhelmed by outside traffic. A pool of two mirrored servers needs to be created to handle the load. These servers will be addressed as 192.168.0.5 and 192.168.0.6.

Outside users and DNS use the global IP address, 42.0.0.51, to access the Web server. ITA would like to continue using the single address and have the NAT router distribute the requests between the two mirrored servers. A prototype needs to be created that will demonstrate TCP load distribution using NAT.

Step 1

Build and configure the network according to the diagram. Host A represents a user outside of the ITA network. Be sure to configure Host A with the correct default gateway.

Step 2

Issue the following to configure SanJose1 to use a default route to ISP1:

```
SanJose1(config)#ip route 0.0.0.0 0.0.0.0 10.0.0.5
```

On ISP1, issue the following to configure a static route to the global addresses used by SanJose1 for NAT:

```
ISP1(config)#ip route 42.0.0.48 255.255.255.240 10.0.0.6
```

Step 3

For testing purposes, configure SanJose1 as a Web server at 192.168.0.5, as shown in the following:

```
SanJose1(config)#ip http server
```

For the purposes of this lab, another router will act as the second Web server. Configure this router as shown in the following:

```
Router(config)#hostname Web2
Web2(config)#enable password cisco
Web2(config)#ip default-gateway 192.168.0.5
Web2(config)#no ip routing
Web2(config)#interface fastethernet0/0
Web2(config-if)#ip address 192.168.0.6 255.255.255.0
Web2(config-if)#no shutdown
Web2(config-if)#exit
Web2(config)#ip http server
```

Step 4

Create a NAT pool to represent the planned Web servers, as the following shows:

```
SanJose1(config)#ip nat pool WebServers 192.168.0.5 192.168.0.6 prefix-
length 24 type rotary
```

Note: In this command, the keyword **prefix-length** is used instead of the keyword **netmask**. Both keywords specify the subnet mask. The **prefix-length** option allows the mask to be specified as a bitcount, 24 instead of 255.255.255.0. The type rotary sets up a round-robin rotation through the designated pool. The name **WebServers** is a user-defined variable, so it can be any useful word.

Next, create an access list to define the global address that will be used to access the server pool. Remember, that 42.0.0.51 is to be used. The following was the original Web server IP address that is known to the outside users:

```
SanJose1(config)#access-list 50 permit 42.0.0.51
```

The following is the command that links the pool and the global address:

```
SanJose1(config)#ip nat inside destination list 50 pool WebServers
```

The **inside destination** indicates that the NAT translations will be established from the outside network to the inside network.

Issue the following to specify an interface on SanJose1 that is to be used by inside network hosts requiring address translation:

```
SanJose1(config)#interface fastethernet0/0
SanJose1(config-if)#ip nat inside
```

Issue the following to specify an interface to be used as the outside NAT interface:

```
SanJose1(config)#interface serial0/0
SanJose1(config-if)#ip nat outside
```

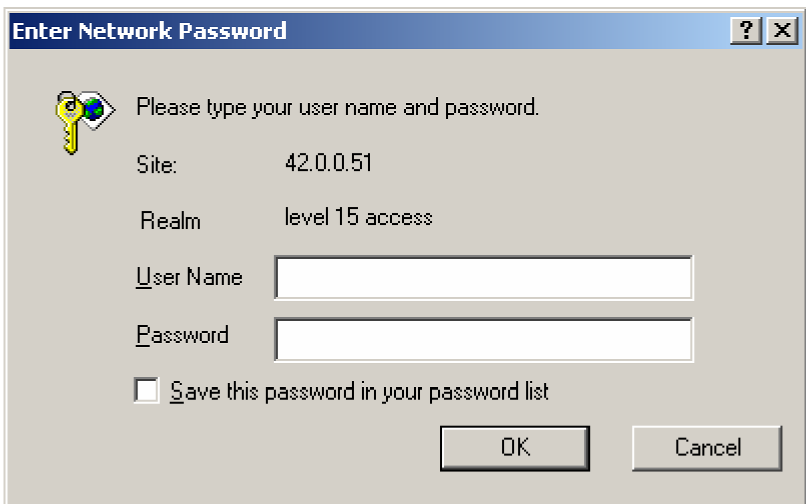
Verify that the workstation can **`ping`** 10.0.0.5 and 10.0.0.6. Troubleshoot as necessary.

Step 5

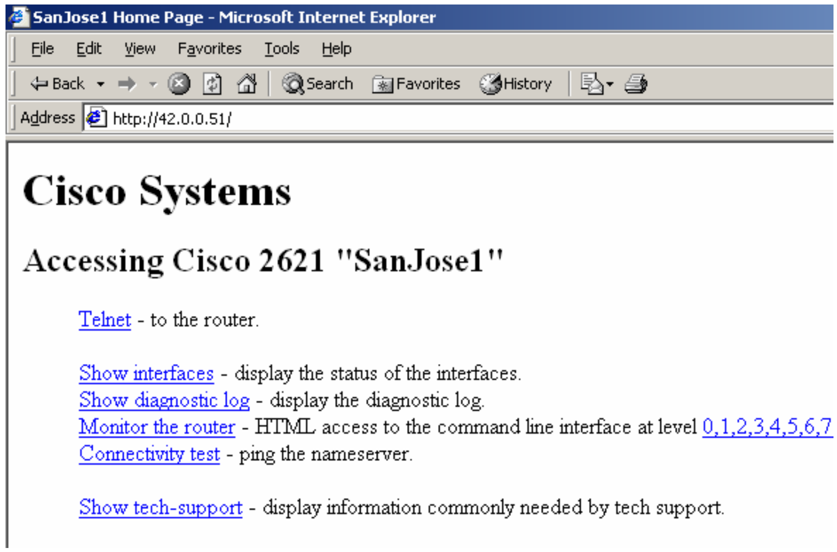
`Ping` 42.0.0.51 from Host A. The **`ping`** should fail because **`ping`** uses ICMP and not TCP. TCP is the only protocol supported by the NAT load distribution feature. To test this configuration, have Host A open a Web browser window.

On the address line of the Web browser on Host A, enter **42.0.0.51**. When the following screen appears, use any username and **cisco** as the password.

Note: The password is case sensitive. If the router is not configured with **cisco** as the enable secret/password, then enter the password that it is configured with instead.



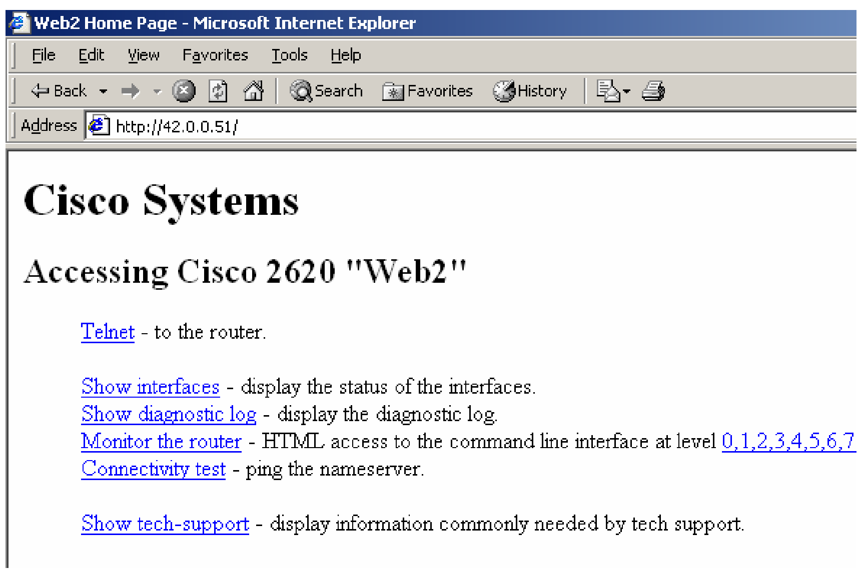
After the router has been authenticated, a page similar to the following should be seen:



1. What is the inside address of the router for the Web server being viewed?

____

Click on the **Refresh** button on the Web browser. A new page should appear, as shown in the following figure:



2. What is the inside address of the router for the Web server being viewed?

____

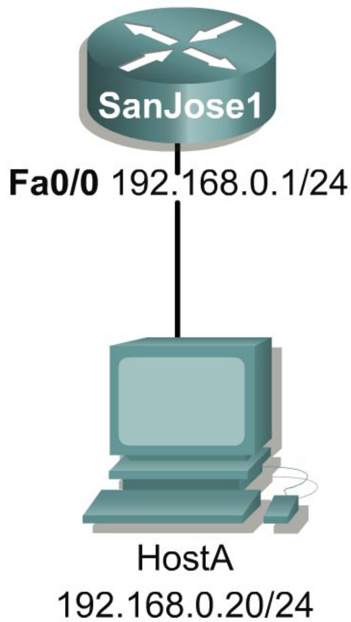
3. If **Refresh** is clicked again, what will happen?

____

Issue the **`show ip nat translations`** command as follows to verify that SanJose1 is distributing the TCP load to itself and Web2:


```
SanJose1#show ip nat translations
Pro Inside global      Inside local       Outside local      Outside global
tcp 42.0.0.51:80       192.168.0.5:80     10.0.2.20:1322     10.0.2.20:1322
tcp 42.0.0.51:80       192.168.0.6:80     10.0.2.20:1323     10.0.2.20:1323
tcp 42.0.0.51:80       192.168.0.5:80     10.0.2.20:1324     10.0.2.20:1324
tcp 42.0.0.51:80       192.168.0.6:80     10.0.2.20:1325     10.0.2.20:1325
tcp 42.0.0.51:80       192.168.0.5:80     10.0.2.20:1326     10.0.2.20:1326
tcp 42.0.0.51:80       192.168.0.6:80     10.0.2.20:1327     10.0.2.20:1327
tcp 42.0.0.51:80       192.168.0.5:80     10.0.2.20:1328     10.0.2.20:1328
tcp 42.0.0.51:80       192.168.0.6:80     10.0.2.20:1329     10.0.2.20:1329
tcp 42.0.0.51:80       192.168.0.5:80     10.0.2.20:1330     10.0.2.20:1330
tcp 42.0.0.51:80       192.168.0.6:80     10.0.2.20:1331     10.0.2.20:1331
tcp 42.0.0.51:80       192.168.0.5:80     10.0.2.20:1332     10.0.2.20:1332
tcp 42.0.0.51:80       192.168.0.6:80     10.0.2.20:1333     10.0.2.20:1333
```


Lab 11.3.1 Router Security and AAA Authentication



Objective

In this lab, the student will use the **`login local`** command to configure authentication and access levels.

Also, the student will be introduced to the Cisco IOS AAA security authentication features, including custom prompts and debug features.

Scenario

The International Travel Agency (ITA) is concerned about the security of their routers and switches. A prototype of Cisco's login security features including AAA is to be created.

Step 1

Before beginning this lab, it is recommended that the routers be reloaded after erasing their startup configuration. This prevents problems that may be caused by residual configurations.

Build and configure the network according to the diagram. Configure the router's FastEthernet interface and the host's IP address, subnet mask and default gateway. Use the following commands to configure SanJose1:

```
SanJose1(config)#enable password cisco
SanJose1(config)#line vty 0 4
SanJose1(config-line)#login
SanJose1(config-line)#password cisco
SanJose1(config-line)#line aux 0
SanJose1(config-line)#login
SanJose1(config-line)#password cisco
SanJose1(config-line)#exit
```


Verify that the router can ping the workstation.

Step 2

Security for the user EXEC mode can be configured for each of the three access methods: VTY (Telnet), AUX, and console. VTYs and AUX port access require a login password by default. If no password is set, the router will not establish a session. Instead, it will return an error message explaining that a password is required but none is set.

By default, the console port is not configured to request a login password. However, it is recommended to configure the console port with the **`login`** command to enforce password security. Without it, anyone with a laptop and a console cable can easily gain access to the device.

The following table displays each of the three access methods, their associated command syntax, and a configuration example for each access method. For convenience sake, the same password was used in all three examples. Although it is possible to do so, the recommended practice is to set different passwords for each access method.

Password Type	Access Method	Syntax	Example
Console session	Console port	**`line con 0`** **`password`** *`password`* **`login`**	**`line con 0`** **`password`** *`cisco`* **`login`**
Telnet session	VTY interfaces. The example syntax sets all five virtual interfaces at once	**`line vty 0 4`** **`password`** *`password`* **`login`**	**`line vty 0 4`** **`password`** *`cisco`* **`login`**
AUX session	AUX port If one is present, it can be accessed through a modem	**`line AUX 0`** **`password`** *`password`* **`login`**	**`line AUX 0`** **`password`** *`cisco`* **`login`**

The **`login`** command requires that the user authenticate when connecting to the line. When the **`login`** command is used without optional keywords, the password must be defined by the **`password`** command. This is shown in the Example column of the table.

Telnet to SanJose1 from Host A. Verify that the password, **cisco**, must be changed to gain user-level access to the router.

Step 3

It is possible to require a username as well as a password for logins to the router. Furthermore, different username/password combinations can be configured for different users. These username/password combinations can be stored locally, in the database on the router, or remotely, on a specialized security server.

Configure a local username/password database for SanJose1, as follows:

```
SanJose1(config)#username remote password access
SanJose1(config)#username scott password wolfe
```

To finish the configuration, issue the **`login local`** command for line con 0, as the following shows:

```
SanJose1(config)#line con 0
SanJose1(config-line)#login local
```

The keyword **local** instructs the router to check username/password combinations against the local database. Now only the defined combinations of usernames and passwords can be used to access the user mode from the console on the router. Like all passwords in the Cisco IOS, these passwords are case sensitive and can include text and/or numbers. The usernames are not case sensitive.

Exit out of the session and then log in to SanJose1 from the console port. The new access prompts will look like the following:

```
User Access Verification
Username: remote
Password:
SanJose1>exit
User Access Verification
Username: ScOtT
Password:
% Login invalid             (Used the wrong case on the password)
Username: Scott
Password:
SanJose1>             (Used the correct case on the password)
```

From Host A, Telnet to SanJose1. Confirm that the only prompt is for a password. The password **cisco** should still work.

Configure the AUX and VTYs to check username/password combinations against the local database. Enter the following commands, on SanJose1:

```
SanJose1(config)#line aux 0
SanJose1(config-line)#login local
SanJose1(config)#line vty 0 4
SanJose1(config-line)#login local
```

From Host A, Telnet to SanJose1 and authenticate using one of the locally defined username and password combinations.

Step 4

The Cisco IOS AAA feature offers several security measures. In this step, the authentication feature will be examined. The AAA authentication feature is used to validate users.

> **Warning:** It is important to have a plan when configuring AAA because configuration commands take effect immediately. It is possible to get locked out of the router.

Enter the following lines in SanJose1:

```
SanJose1(config)#aaa new-model
SanJose1(config)#username admin password aaacisco
SanJose1(config)#aaa authentication login default local enable
```

The **`aaa new-model`** command enables AAA. Once this command is entered, the console, VTY, AUX, and TTY ports require a username and password for access.

The **`aaa authentication login default`** command defines how the username/password will be verified. Multiple options can be used with this command. The first option (local) will be tried first. In the event the attempt to check a username/password using this method returns an error, the second method (enable) will be tried, and so on. It is very important to note that an authentication failure is not an error. An error results only if the specified source, such as a remote server, cannot be read. The available options for the **`aaa authentication login default`** command are as follows:


```
SanJose1(config)#aaa authentication login default ?
  enable     Use enable password for authentication.
  group      Use Server-group(used to access TACACS or RADIUS servers
  line       Use line password for authentication.
  Local      Use local username authentication.
  local-case Use case-sensitive local username authentication.
```

If a TACACS+ server was configured with username/password combinations, the router could be configured with the command, **`aaa authentication login default group`** *`tacacs+`* **`local enable`**. The **`group`** keyword indicates a server group while the *`tacacs+`* parameter specifies the type of security server. As the second specified option in this example command, the local database would only be used if the TACACS+ server could not be reached.

From Host A, Telnet to SanJose1. Confirm that there is a prompt for a username and password. Confirm that **admin** and **aaacisco** grant access to the router.

Disconnect from SanJose1 and then attempt to log in again. This time, verify that the username is not case sensitive but the password is.

In some cases, case sensitive usernames may be desired. AAA can be configured to make usernames case sensitive by adding the **local-case** option as follows:

```
SanJose1(config)#aaa authentication login default local-case enable
```

After entering this command, log out and then log back in to the router. Verify that both the username and password are now case sensitive.

Step 5

The default login prompt looks like the following:

```
User Access Verification

Username:
```

When using AAA, there is an option to present a more specific and/or user-friendly prompt. Issue the following command on SanJose1:

```
SanJose1(config)#aaa authentication username-prompt "Enter your NT
username:"
```

To verify the new prompt, exit out of the console session and log back in.

Step 6

In this step, the **`debug aaa authentication`** command feature will be examined. On SanJose1 activate the **`debug`** feature with the following command:

```
SanJose1#debug aaa authentication
AAA Authentication debugging is on
```

From Host A, Telnet to SanJose1. When prompted for a username, press **Enter**. The second time there is a prompt, enter a fake username/password combination. On the third and final attempt, log in correctly.

The following is a sample partial display of the **`debug`** output.

Note: The output may vary depending on the router platform and IOS used.


```
02:48:32: AAA: parse name=tty2 idb type=-1 tty=-1
02:48:32: AAA: name=tty2 flags=0x11 type=5 shelf=0 slot=0 adapter=0 port=2
channel=0
02:48:32: AAA/MEMORY: create_user (0x1FEC44) user=''
ruser=''port='tty2'rem_ad
dr='192.168.0.10' authen_type=ASCII service=LOGIN priv=1
02:48:32: AAA/AUTHEN/START (1421093628): port='tty2' list=''action=LOGIN
service=LOGIN
02:48:32: AAA/AUTHEN/START (1421093628): using "default" list 02:48:32:
AAA/AUTHEN/START (1421093628): Method=LOCALCASE
02:48:32: AAA/AUTHEN (1421093628): status = GETUSER
02:48:33: AAA/AUTHEN/CONT (1421093628): continue_login (user='(undef)')
02:48:33: AAA/AUTHEN (1421093628): status = GETUSER
02:48:33: AAA/AUTHEN/CONT (1421093628): Method=LOCALCASE
02:48:33: AAA/AUTHEN/LOCAL (1421093628): no username: GETUSER
02:48:33: AAA/AUTHEN (1421093628): status = GETUSER
SanJose1#
02:48:45: AAA/AUTHEN/CONT (1421093628): continue_login (user='')
02:48:45: AAA/AUTHEN (1421093628): status = GETUSER
02:48:45: AAA/AUTHEN/CONT (1421093628): Method=LOCALCASE
02:48:45: AAA/AUTHEN (1421093628): User not found, emulating local-
override
02:48:45: AAA/AUTHEN (1421093628): status = ERROR
02:48:45: AAA/AUTHEN/START (297482216): port='tty2' list=''
action=LOGIN service
=LOGIN
```

The first four lines set up the login session. Notice that the number (1421093628) tracks the session until the failed password and a new tracking number are generated.

The (297482216) attempt ends up as a failed attempt or bad password, as shown in the following:

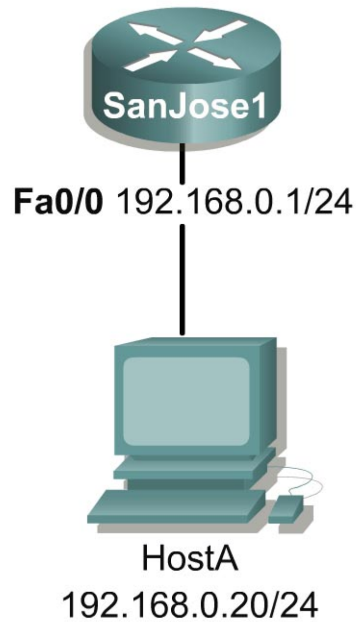
```
<Output omitted>
02:48:49: AAA/AUTHEN (297482216): password incorrect
02:48:49: AAA/AUTHEN (297482216): status = FAIL
```

The following lines are a partial display of the successful attempt:

```
<Output omitted>
02:48:57: AAA/AUTHEN/CONT (782251026): continue_login (user='bob')
02:48:57: AAA/AUTHEN (782251026): status = GETPASS
02:48:57: AAA/AUTHEN/CONT (782251026): Method=LOCALCASE
02:48:57: AAA/AUTHEN (782251026): status = PASS
```

Use **`undebug all`** to turn off all debugging.

Lab 11.3.2 AAA Authorization and Accounting



Objective

In this lab, the student will use the **`exec-timeout`** command to control the amount of time before an idle telnet or console session is terminated.

The student will also be introduced to the Cisco IOS AAA security authorization and accounting features. These can be implemented to limit the EXEC commands that a user is permitted to use.

Scenario

The International Travel Agency (ITA) is becoming concerned about the security of its routers and switches. A prototype of Cisco's login security features including AAA and Cisco Secure is to be created.

Step 1

Before beginning this lab, it is recommended that the routers be reloaded after erasing their startup configurations. Configure the router's FastEthernet interface and the host's IP address, subnet mask and default gateway. This prevents problems that may be caused by residual configurations.

Build and configure the network according to the diagram. Use the following commands to configure SanJose1:

```
SanJose1(config)#line con 0
SanJose1(config-line)#exec-timeout 0 0
SanJose1(config-line)#password cisco
SanJose1(config-line)#logging synchronous
SanJose1(config-line)#enable password cisco
SanJose1(config-line)#line vty 0 4
SanJose1(config-line)#login
```



```
SanJose1(config-line)#password cisco
SanJose1(config-line)#exec-timeout 0 0
SanJose1(config-line)#line aux 0
SanJose1(config-line)#exec-timeout 0 0
SanJose1(config-line)#login
SanJose1(config-line)#password cisco
```

The **exec-timeout 0 0** commands configure the amount of time a router will wait before terminating an idle EXEC session. The first number specifies the number of minutes, and the second number specifies the number of seconds. Therefore, the command **exec-timeout 0 45** would configure the idle timer to 45 seconds. Using two zeros, as shown, will configure the router so that the EXEC sessions never time out. Such a configuration is a security risk, because unattended sessions will remain open and a malicious user could potentially exploit this. While configuring **exec-timeout 0 0** is uncommon on production routers, it is a useful configuration when performing lab exercises.

It is possible to set different timeout values for each of the CON, VTY, and AUX sessions. The default timeout for all three of these lines is 10 minutes.

Step 2

The AAA feature can be used to limit a user's options based on the username/password entered during login.

By default, there are three privilege levels on the router, as follows:

Privilege Level	Result
1	User level only (prompt is router>), the default level for login
15	Privileged level (prompt is router#), the level after going into enable mode
0	Seldom used, but includes five commands: disable, enable, exit, help, and logout

Levels 2 through 14 can be defined by "moving" commands from one of the default privilege levels to the new level. Configuring custom privilege levels can involve significant administration on the router.

To determine the current privilege level, type the show privilege command as follows:

```
SanJose1#show privilege
Current privilege level is 15
```

1. While in user EXEC mode, what is the privilege level?

   ____

2. While in privileged EXEC mode, what is the privilege level?

   ____

Configure custom privilege levels, by adding the following entries to the authentication database on SanJose1:

```
SanJose1(config)#username cisco0 privilege 0 password cisco0
SanJose1(config)#username cisco15 privilege 15 password cisco15
SanJose1(config)#username cisco7 privilege 7 password cisco7
SanJose1(config)#aaa new-model
SanJose1(config)#aaa authentication login default local
```


When login in as **cisco0**, a user will only have access to the disable, enable, exit, help, and logout commands. When login in as **cisco15**, a user will have regular EXEC privilege access. The **cisco7** login will be used to custom define which commands a user will have access to.

It is important to realize that we have only created the local database. No restrictions have been applied to those usernames yet.

To prevent a lock out on the router when the configuration for AAA authorization is started, exit out completely from EXEC mode and log back into the router using the username **cisco15** and password **cisco15**.

> **Note:** It is important to log in as a user with privilege level 15 in order to modify the default privilege level of IOS commands. Failure to do so will result in console session lockout when the **`aaa authorization exec default local`** command is entered.

After authenticating as **cisco15** and entering privilege EXEC mode, configure AAA authorization and create a custom privilege level. First, enter the following configuration command:

```
SanJose1(config)#aaa authorization exec default local
```

Next, specify which commands will be authorized. On SanJose1, issue the following commands from the console:

```
SanJose1(config)#aaa authorization commands 0 default local
SanJose1(config)#aaa authorization commands 15 default local
SanJose1(config)#aaa authorization commands 7 default local
```

After issuing these commands, a user must be “authorized” to use commands in privilege levels 0, 7, and 15.

The following is an example of the command to configure the router to query a TACACS+ server:

```
aaa authorization commands 0 default group tacacs+ local enable
```

The **group** keyword indicates a server group while the **tacacs+** keyword indicates the type of security server. If configured with this command, the local database on SanJose1 would only be used if the TACACS+ server were unavailable.

The final step is to specify which commands will exist in privilege level 7. On SanJose1, issue the following commands from the console:

```
SanJose1(config)#privilege configure level 7 snmp-server host
SanJose1(config)#privilege configure level 7 snmp-server enable
SanJose1(config)#privilege configure level 7 snmp-server
SanJose1(config)#privilege exec level 7 ping
SanJose1(config)#privilege exec level 7 configure terminal
SanJose1(config)#privilege exec level 7 configure
```

Now enter the **`debug aaa authorization`** command so the authorization process can be observed.

Step 3

From Host A, Telnet to SanJose1. Log in as **cisco15**. Because privilege level 15 was used, privileged EXEC access is immediately given.

Enter the **`show privilege`** command and verify the privilege level. Enter global configuration mode and then exit. Make note of the **`debug`** results on SanJose1’s console session.

Exit out of the Telnet session.

Now, again from Host A, Telnet into the router as **cisco0**.

1. After authenticated as **cisco0**, can the privileged EXEC mode be entered?

____

As **cisco0**, enter the **?** command at the router prompt.

2. How many commands are available to privilege level 0?

____

Exit out of the Telnet session, and Telnet in as **cisco7** from Host A. Notice that this user, like **cisco15**, begins an EXEC session in privileged mode.

Enter global configuration and use the **?** command to see which commands are available in privilege level 7, as shown in the following:

```
SanJose1#config terminal

SanJose1(config)#?
Configure commands:
  default      Set a command to its defaults
  end          Exit from configure mode
  exit         Exit from configure mode
  help         Description of the interactive help system
  no           Negate a command or set its defaults
  snmp-server  Modify SNMP parameters
```

Notice the **debug** output on SanJose1. Use the **undebug all** command to turn off all debugging.

Step 4

In this step, configure AAA accounting on SanJose1. Enter privilege EXEC mode by either consoling in or by telnetting in as **cisco15**.

> **Note:** If a TACACS+ server is not available, the results will not be stored but the recording will occur.

Enter the following:

```
SanJose1(config)#aaa accounting exec default start-stop group tacacs+
SanJose1(config)#aaa accounting commands 15 default start-stop group
tacacs+
SanJose1(config)#aaa accounting network default start-stop group tacacs+
SanJose1(config)#aaa accounting connection default start-stop group tacacs+
SanJose1(config)#aaa accounting system default start-stop group tacacs+
```


The following is a brief description of each of the command options:

Option	Result
AAA	Identifies a AAA command
accounting	Accounting or tracking feature of AAA
exec	Tracks EXEC commands on the device
commands 15	Tracks commands by privilege level 15 users, can be 0 through 15
network	Tracks network services like PPP
connection	Tracks outbound Telnet sessions
system	Tracks system events like reload
start-stop	Include both Start and Stop recordings (compared to *stop-only*)
default	Use the default list as compared to a custom list
group	Use a group of servers
TACACS+	Use TACACS+ instead of a RADIUS server

On SanJose1, enable **debug aaa accounting** with the following command:

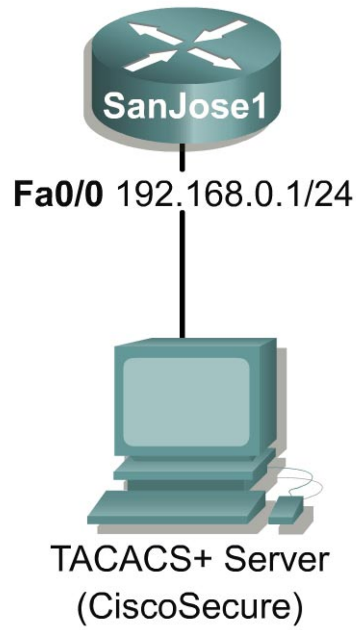
```
SanJose1#debug aaa accounting
AAA Accounting debugging is on
```

From Host A, Telnet to SanJose1 and authenticate as **cisco15**. In the Telnet session, perform a couple of simple commands like **show run**. Return to the console session on SanJose1 and examine the **debug** output. The following is a partial sample **debug** output that resulted from **cisco15** entering the **show running-config** and **copy running-config startup-config** commands.

Note: The output may vary depending on the router platform and IOS used.

```
01:04:59: AAA/ACCT/CMD: User cisco15, Port tty2, Priv 15:"show running-
config <cr>"
01:04:59: AAA/ACCT/CMD: Found list "default"
01:04:59: AAA/ACCT: user cisco15, acct type 3 (3901449983):
Method=tacacs+ (tacacs+)
01:05:20: AAA/ACCT/CMD: User cisco15, Port tty2, Priv 15:"copy running-
config startup-config <cr>"
01:05:20: AAA/ACCT/CMD: Found list "default"
01:05:20: AAA/ACCT: user cisco15, acct type 3 (2545785330):
Method=tacacs+ (tacacs+)
```


Lab 11.3.3 AAA TACACS+ Server



Objective

In this lab, the student will configure AAA to use a TACACS+ server.

Scenario

The International Travel Agency (ITA) has set up and configured a Cisco Secure TACACS+ server. ITA needs to place the routers under the control of the TACACS+ server. The host name and IP address of the router may need to be modified.

Step 1

The host shown in the diagram can be running Cisco Secure software to provide TACACS+ services. Configure SanJose1 using the following commands as an example:

```
SanJose1(config)#line con 0
SanJose1(config-line)#exec-timeout 0 0
SanJose1(config-line)#password cisco
SanJose1(config-line)#logging synchronous

SanJose1(config-line)#enable password cisco
SanJose1(config-line)#line vty 0 4
SanJose1(config-line)#login
SanJose1(config-line)#password cisco
SanJose1(config-line)#exec-timeout 0 0
SanJose1(config-line)#line aux 0
SanJose1(config-line)#exec-timeout 0 0
SanJose1(config-line)#login
SanJose1(config-line)#password cisco
```


Confirm that SanJose1 can ping the TACACS+ server.

The instructor will provide the IP address of the TACACS+ server and an encryption key. This key is required to establish a connection between the router and the server. The instructor will also provide a username/password combination, which is already entered in the Cisco Secure database.

Step 2

On SanJose1, enter the following configuration lines:

> **Note:** Ask the instructor to obtain the IP address and server key for Taccacs+ or Radius server.

```
SanJose1(config)#aaa new-model
SanJose1(config)#username admin password aaacisco
SanJose1(config)#aaa authentication login default group tacacs+ local
enable
SanJose1(config)#tacacs-server host xxx.xxx.xxx.xxx
SanJose1(config)#tacacs-server key xxxxx
```

Exit from SanJose1 and then try to log in with the username of **nobody** and the password **nothing**. This should fail if there is a working connection to the TACACS+ server. If the login does not fail, reload the routers and try again.

After the login using **nobody** fails, log in as the user assigned by the instructor. This login should work, indicating that SanJose1 has successfully queried the TACACS+ server, and authenticated using the username and password.

1. If none of the valid username/password combinations stored on the TACACS+ server were known, how can access be gained to the router?

   ____

Simulate a network outage by disconnecting the cable from SanJose1's Fast Ethernet interface. Attempt to log in to the router a second time through the console port.

2. Because the attempt to query the TACACS+ server by the router will fail, which authentication method should be used? Why?

   ____

When attempting to log in, SanJose1 will try to query the TACACS+ server first. Because the network connection to the server is unavailable, this query returns an error. The second method of authentication defined by the `aaa authentication` command specifies that the local database should be consulted next. Therefore, authentication as **admin** using the password **aaacisco** should now be available.

Once authenticated, enter the following command on SanJose1:

```
SanJose1(config)#no username admin password aaacisco
```

3. If no TCP/IP connection to the TACACS+ server is available, and no local username/password database exists on the router, which authentication method will be used? Why?

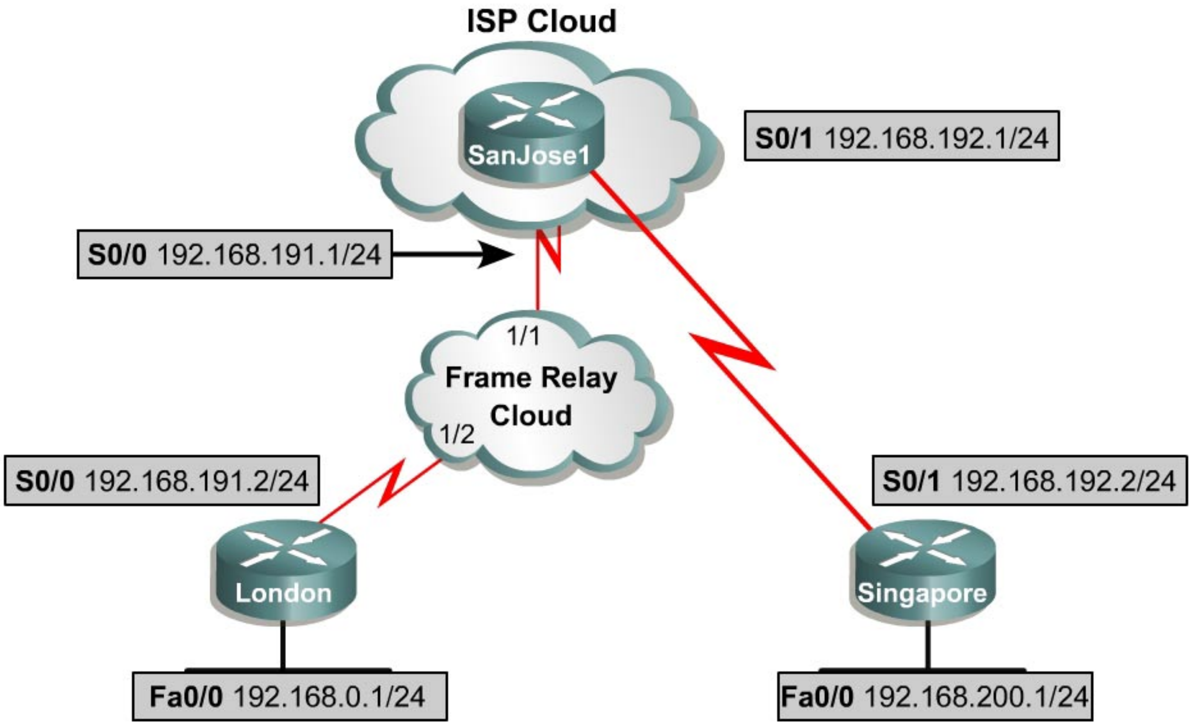
   ____

Exit the console session on SanJose1 and log back in again. Eventually, there will be a prompt for a username. Enter the username **admin**. When prompted for a password, enter the password of **aaacisco**. This authentication attempt will return an error, because there is no local username/password database. Remember, an error is not the same as an authentication failure. A failure occurs when the authentication method is operational, but the username/password combination is found to be invalid.

There is a third method of authentication defined by the `aaa authentication` command. This specifies that the enable password, or secret, if it exists, should be used in the event the first two authentication methods return an error.

The router can be accessed by using the enable password, **cisco**.

Lab 13.8.1 Configuring a Site-to-Site IPSec VPN Using Pre-Shared Keys



Objective

Plan and configure VPN connections between two sites using IKE and IPSEC.

Scenario

The International Travel Agency (ITS) has decided that communications between the London and Singapore branch offices require a method of insuring that sensitive corporate data is not being intercepted. ITA has decided to implement a site-to-site VPN solution. The solution that will be implemented will enable a site-to-site IPSec based VPN to ensure confidentiality, integrity, and authentication. In this scenario, the SanJose1 site will act as the Internet Service Provider (ISP).

Step 1

Before beginning this lab, it is recommended that each router be reloaded after erasing its startup configuration. This prevents problems that may be caused by residual configurations. Cable the network according to the diagram. This lab assumes an Adtran Atlas 550 will be used to emulate the Frame Relay cloud. Be sure to connect the serial interfaces on the router to the port as labeled in the diagram. On each router, configure their respective hostname and FastEthernet address.

On the SanJose1 router, configure the following:

```
SanJose1(config)#int s 0/0
SanJose1(config-if)#ip address 192.168.191.1 255.255.255.0
SanJose1(config-if)#encapsulation frame-relay
SanJose1(config-if)#frame-relay lmi-type ansi
```



```
SanJose1(config-if)#no shut

SanJose1(config)#int s 0/1
SanJose1(config-if)#ip address 192.168.192.1 255.255.255.0
SanJose1(config-if)#no shut
SanJose1(config-if)#exit

SanJose1(config)#ip route 192.168.0.0 255.255.255.0 192.168.191.2
SanJose1(config)#ip route 192.168.200.0 255.255.255.0 192.168.192.2
```

On the London and Singapore routers, configure their serial interfaces and default routes as follows:

```
London(config)#int s0/0
London(config-if)#ip add 192.168.191.2 255.255.255.0
London(config-if)#encapsulation frame-relay
London(config-if)#frame-relay lmi-type ansi
London(config-if)#no shut
London(config-if)#exit
London(config)#ip route 0.0.0.0 0.0.0.0 192.168.191.1

Singapore(config)#int s0/1
Singapore(config-if)#ip add 192.168.192.2 255.255.255.0
Singapore(config-if)#clock rate 56000
Singapore(config-if)#no shut
Singapore(config-if)#exit
Singapore(config)#ip route 0.0.0.0 0.0.0.0 192.168.192.1
```

Verify connectivity between the FastEthernet LANs on London and Singapore with an extended ping.

Step 2

Plan the parameters for IKE.

Parameter	Singapore Site	London Office
Key distribution method—manual or **isakmp**	isakmp	isakmp
Encryption algorithm—**DES** or 3DES	DES	DES
Hash algorithm—MD5 or **SHA-1**	SHA-1	SHA-1
Authentication method—Pre-share or **RSA**	pre-share	pre-share
Key exchange—D-H **Group 1** or 2	Group 1	Group 1
IKE SA Lifetime—**86400** seconds or less	86400	86400

Note: The default values are in bold.

Enable IKE on the Singapore router. Create an IKE policy with a priority of 100 using pre-shared keys as the method of authentication. Configure a pre-shared key of **cisco1234** and use the Serial interface IP address on the London router as the peer's address.

```
Singapore(config)#crypto isakmp policy 100
Singapore(config-isakmp)#authentication pre-share
Singapore(config-isakmp)#crypto isakmp key cisco1234 address 192.168.191.2
```

A given pre-shared key is a private key shared between two peers. As a given peer, the same key could be specified to share with multiple remote peers. However, a more secure approach is to specify different keys to share between different pairs of peers.

Verify the IKE policy for the Singapore router, as follows:

```
Singapore#show crypto isakmp policy
```

The configuration output should look similar to the following:

```
Protection suite of priority 100
        encryption algorithm:   DES - Data Encryption Standard (56 bit
        keys).
        hash algorithm:         Secure Hash Standard
        authentication method:  Pre-Shared Key
        Diffie-Hellman group:   #1 (768 bit)
        lifetime:               86400 seconds, no volume limit
Default protection suite
        encryption algorithm:   DES - Data Encryption Standard (56 bit
        keys).
        hash algorithm:         Secure Hash Standard
        authentication method:  Rivest-Shamir-Adleman Signature
        Diffie-Hellman group:   #1 (768 bit)
        lifetime:               86400 seconds, no volume limit
```

Step 3

Enable IKE on the London router. Create an IKE policy with a priority of 100 using pre-shared keys as the method of authentication. Configure a pre-shared key of **cisco1234** and use the Serial interface IP address on the Singapore router as the peer's address.

```
London(config)#crypto isakmp policy 100
London(config-isakmp)#authentication pre-share
London(config-isakmp)#crypto isakmp key cisco1234 address 192.168.192.2
```

Verify the IKE policy for the London router, as follows:

```
London#show crypto isakmp policy
```

The configuration output should look similar to Singapore's output

Step 4

Plan and configure IPSec policies on the Singapore and London routers.

Policy	Singapore	London
Transform set	esp-des	esp-des
Traffic type to be encrypted	IP	IP
SA establishment	ipsec-isakmp	ipsec-isakmp

An access list needs to be configured on each router to specify which traffic is to be encrypted. In this lab, only the LAN traffic between sites is to be protected. On the Singapore router, configure an extended access list 120 that will define this traffic going to the London router as follows:

```
Singapore(config)#access-list 120 permit ip 192.168.200.0 0.0.0.255
192.168.0.0 0.0.0.255
```


Now, configure an IPSec transform set called MYSET and specify that ESP with DES will be used.

```
Singapore(config)#crypto ipsec transform-set MYSET esp-des
```

Note: Up to three transform sets can be in a set. Sets are limited to one AH and up to two ESP transforms.

Configure an IPSec crypto map using a map name of MYMAP and a sequence number of **110**. This crypto map is to use **`ipsec-isakmp`**.

```
Singapore(config)#crypto map MYMAP 110 ipsec-isakmp
```

Configure the crypto map to match the access list 120, set the transform set MYSET upon the match condition, and set the peer address as the Serial Interface IP address on the London router.

```
Singapore(config-crypto-map)#match address 120
Singapore(config-crypto-map)#set transform-set MYSET
Singapore(config-crypto-map)#set peer 192.168.191.2
```

Finally, apply crypto map MYMAP to the serial interface on the Singapore router.

```
Singapore(config)#int s0/1
Singapore(config-if)#crypto map MYMAP
```

Use the **`show crypto ipsec sa`** command and verify the configuration settings.

```
Singapore#show crypto ipsec sa

interface: Serial0/1
    Crypto map tag: MYMAP, local addr. 192.168.192.2

   local  ident (addr/mask/prot/port): (192.168.200.0/255.255.255.0/0/0)
   remote ident (addr/mask/prot/port): (192.168.0.0/255.255.255.0/0/0)
   current_peer: 192.168.191.2
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 0, #pkts encrypt: 0, #pkts digest 0
    #pkts decaps: 0, #pkts decrypt: 0, #pkts verify 0
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0, #pkts decompress
failed: 0
    #send errors 0, #recv errors 0

     local crypto endpt.: 192.168.192.2, remote crypto endpt.:
192.168.191.2
     path mtu 1500, media mtu 1500
     current outbound spi: 0
<Output omitted>
```

Record the number of packets encrypted ______________ and the number of packets decrypted ______________

Apply the similar settings to the London router as follows:

```
London(config)#access-list 120 permit ip 192.168.0.0 0.0.0.255
192.168.200.0 0.0.0.255
London(config)#crypto ipsec transform-set MYSET esp-des
London(config)#crypto map MYMAP 110 ipsec-isakmp
London(config-crypto-map)#match address 120
```



```
London(config-crypto-map)#set transform-set MYSET
London(config-crypto-map)#set peer 192.168.192.2
```

Finally, apply crypto map MYMAP to the serial interface on the London router.

```
London(config)#int s0/0
London(config-if)#crypto map MYMAP
```

Use the **show crypto ipsec sa** command and verify the configuration settings. The output should be similar to that of the Singapore router.

Step 5

Test and verify the VPN operation. From the Singapore router enable debugging to observe the ISAKMP and IPSec negotiation and security association creation as follows:

```
Singapore#debug crypto ipsec
Crypto IPSEC debugging is on
Singapore#debug crypto isakmp
Crypto ISAKMP debugging is on
```

Since the encryption is performed between LAN interfaces, an extended ping must be used. From the Singapore router, do an extended ping to the London router LAN interface IP address from the LAN interface IP address of the Singapore router.

Was any debug information seen? _____________

Now verify the security associations by using the **show crypto ipsec sa** and **show crypto isakmp sa** commands. Output should be similar to the following:

```
Singapore#show crypto ipsec sa

interface: Serial0/1
    Crypto map tag: MYMAP, local addr. 192.168.192.2

   local  ident (addr/mask/prot/port): (192.168.200.0/255.255.255.0/0/0)
   remote ident (addr/mask/prot/port): (192.168.0.0/255.255.255.0/0/0)
   current_peer: 192.168.191.2
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 4, #pkts encrypt: 4, #pkts digest 0
    #pkts decaps: 4, #pkts decrypt: 4, #pkts verify 0
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0, #pkts decompress
failed: 0
    #send errors 1, #recv errors 0

     local crypto endpt.: 192.168.192.2, remote crypto endpt.:
192.168.191.2
     path mtu 1500, media mtu 1500
     current outbound spi: E1F92A37

     inbound esp sas:
      spi: 0xAA42D3DF(2856506335)
        transform: esp-des ,
        in use settings ={Tunnel, }
        slot: 0, conn id: 2000, flow_id: 1, crypto map: MYMAP
        sa timing: remaining key lifetime (k/sec): (4607999/3441)
        IV size: 8 bytes
        replay detection support: N
```


Complete the following information from the **show** commands:

Packets encrypted _____________ Packets decrypted _____________

To observe the process again, clear the SAs by using the **clear crypto sa** and the **clear crypto isakmp** commands. Then generate interesting traffic by doing additional extended pings between routers.

