CISCO SYSTEMS

CISCO NETWORKING ACADEMY PROGRAM

CCNA 4:
WAN Technologies v3.1.1
Student Lab Manual

Lab 1.1.4a Configuring NAT

Router Designation	Router Name	FastEthernet 0 Address /Subnet Mask	Interface Type	Serial 0 Address /Subnet Mask	Loopback 0 Address / Subnet Mask	Enable Secret Password	Enable/VTY/Console Passwords
Router 1	Gateway	10.10.10.1/24	DTE	200.2.2.18/30	NA	class	cisco
Router 2	ISP	NA	DCE	200.2.2.17/30	172.16.1.1/32	class	cisco

Objective

- Configure a router to use network address translation (NAT) to convert internal IP addresses, typically private addresses, into outside public addresses.

Background/Preparation

An ISP has allocated a company the public classless interdomain routing (CIDR) IP address 199.99.9.32/27. This is equivalent to 30 public IP addresses. Since the company has an internal requirement for more than 30 addresses, the IT manager has decided to implement NAT. The addresses 199.99.9.33 – 199.99.9.39 for static allocation and 199.99.9.40 – 199.99.9.62 for dynamic allocation. Routing will be done between the ISP and the gateway router used by the company. A static route will be used between the ISP and gateway routers and a default route will be used between the gateway router and the ISP. The ISP connection to the Internet will be represented by a loopback address on the ISP router.

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers

- 1600 series routers

- 1700 series routers

- 2500 series routers

- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure all of the following according to the chart:

- The hostname

- The console password

- The virtual terminal password

- The enable secret password

- The interfaces

If problems occur during this configuration, refer to the configuration reference sheet at the end of this lab for help.

Step 2 Save the configuration

At the privileged EXEC mode prompt, on both routers, type the command `copy running-config startup-config`.

Step 3 Configure the hosts with the proper IP address, subnet mask, and default gateway

Each workstation should be able to ping the attached router. If the ping was not successful, troubleshoot as necessary. Check and verify that the workstation has been assigned a specific IP address and default gateway. If running Windows 98, check using **Start** > **Run** > **winipcfg**. If running Windows 2000 or higher, check using `ipconfig` in a DOS window.

Step 4 Verify that the network is functioning

a. From the attached hosts, ping the FastEthernet interface of the default gateway router.

b. Was the ping from the first host successful? _____

c. Was the ping from the second host successful? _____

d. If the answer is no for either question, troubleshoot the router and host configurations to find the error. Ping again until they are both successful.

Step 5 Create a static route

a. Create a static route from the ISP to the Gateway router. Addresses 199.99.9.32/27 have been allocated for Internet access outside of the company. Use the `ip route` command to create the static route.

```
ISP(config)#ip route 199.99.9.32 255.255.255.224 200.2.2.18
```

b. Is the static route in the routing table? _____

c. What command checks the routing table contents? _____

d. If the route was not in the routing table, give one reason why this might be so?

_____

Step 6 Create a default route

a. From the Gateway router to the ISP router, create a static route to network 0.0.0.0 0.0.0.0, using the `ip route` command. This will forward any unknown destination address traffic to the ISP by setting a Gateway of Last Resort on the Gateway router.

```
Gateway(config)#ip route 0.0.0.0 0.0.0.0 200.2.2.17
```

b. Is the static route in the routing table? _____

c. Try to ping from one of the workstations to the ISP serial interface IP address.

d. Was the ping successful? _____

e. Why? _____

Step 7 Define the pool of usable public IP addresses

To define the pool of public addresses, use the `ip nat pool` command:

```
Gateway(config)#ip nat pool public-access 199.99.9.40 199.99.9.62
netmask 255.255.255.224
```

Step 8 Define an access list that will match the inside private IP addresses

To define the access list to match the inside private addresses, use the `access-list` command:

```
Gateway(config)#access-list 1 permit 10.10.10.0 0.0.0.255
```

Step 9 Define the NAT translation from inside list to outside pool

To define the NAT translation, use the `ip nat inside source` command:

```
Gateway(config)#ip nat inside source list 1 pool public-access
```

Step 10 Specify the interfaces

The active interfaces on the router need to be specified as either inside or outside interfaces with respect to NAT. To do this, use the `ip nat inside` or `ip nat outside` command:

```
Gateway(config)#interface fastethernet 0
Gateway(config-if)#ip nat inside
Gateway(config-if)#interface serial 0
Gateway(config-if)#ip nat outside
```

Step 11 Testing the configuration

a. Configure one of the PCs on the LAN with the IP address 10.10.10.10/24 and a default gateway address of 10.10.10.1. From the PC, ping 172.16.1.1. If successful, look at the NAT translation on the Gateway router, using the command `show ip nat translations`.

b. What is the translation of the inside local host addresses?

_____ = _____ _____ = _____

c. The inside global address is assigned by? _____

d. The inside local address is assigned by? _____

Upon completion of the previous steps, finish the lab by doing the following:

- Logoff by typing **exit**

- Turn the router off

- Remove and store the cables and adapter

Configuration reference sheet

This sheet contains the basic configuration commands for the ISP and Gateway routers:

ISP
```
Router#configure terminal
Router(config)#hostname ISP
ISP(config)#enable password cisco
ISP(config)#enable secret class
ISP(config)#line console 0
ISP(config-line)#password cisco
ISP(config-line)#login
ISP(config-line)#exit
ISP(config)#line vty 0 4
ISP(config-line)#password cisco
ISP(config-line)#login
ISP(config-line)#exit
ISP(config)#interface loopback 0
ISP(config-if)#ip add 172.16.1.1 255.255.255.255
ISP(config-if)#no shutdown
ISP(config-if)#exit
ISP(config)#interface serial 0
ISP(config-if)#ip add 200.2.2.17 255.255.255.252
ISP(config-if)#clock rate 64000
ISP(config-if)#no shutdown
ISP(config)#exit
ISP(config)#ip route 199.99.9.32 255.255.255.224 200.2.2.18
ISP(config)#end
ISP#copy running-config startup-config
Destination filename [startup-config]?[Enter]
```

Gateway
```
Router#configure terminal
Router(config)#hostname Gateway
Gateway(config)#enable password cisco
Gateway(config)#enable secret class
Gateway(config)#line console 0
Gateway(config-line)#password cisco
Gateway(config-line)#login
Gateway(config-line)#exit
Gateway(config)#line vty 0 4
Gateway(config-line)#password cisco
Gateway(config-line)#login
Gateway(config-line)#exit
Gateway(config)#interface fastethernet 0
Gateway(config-if)#ip add 10.10.10.1 255.255.255.0
Gateway(config-if)#no shutdown
Gateway(config-if)#exit
Gateway(config)#interface serial 0
Gateway(config-if)#ip add 200.2.2.18 255.255.255.252
Gateway(config-if)#no shutdown

Gateway(config)#ip route 0.0.0.0 0.0.0.0 200.2.2.17
```

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```

Press **Enter**.

Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)

In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.

Lab 1.1.4b Configuring PAT

Router Designation	Router Name	FastEthernet 0 Address /Subnet Mask	Interface Type	Serial 0 Address /Subnet Mask	Loopback 0 Address / Subnet Mask	Enable Secret Password	Enable/VTY/Console Passwords
Router 1	Gateway	10.10.10.1/24	DTE	200.2.2.18/30	NA	class	cisco
Router 2	ISP	NA	DCE	200.2.2.17/30	172.16.1.1/32	class	cisco

Straight-through cable	————————
Serial cable	————————
Console (rollover)	••••••••••••••••••••
Crossover cable	– – – – – – – – – –

Objective

- Configure a router to use Port Address Translation (PAT) to convert internal IP addresses, typically private addresses, into an outside public address.

Background/Preparation

Aidan McDonald has just received a DSL line Internet connection to a local ISP in his home. The ISP has allocated only one IP address to be used on the serial port of his remote access device. Thus all PCs on Aidan's LAN, each with its own private IP address, will share one public IP address on the router using PAT. Routing from the home or gateway router to the ISP will be done by using a default route to Serial 0 of the Gateway router. The ISP connection to the Internet will be represented by a loopback address on the ISP router.

Cable a network similar to the one in the diagram. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers

- 1600 series routers

- 1700 series routers

- 2500 series routers

- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in this lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure all of the following according to the chart:

- The hostname
- The console password
- The virtual terminal password
- The enable secret password
- The interfaces

If problems occur during this configuration, refer to Lab 1.1.4a Configuring NAT.

Step 2 Save the configuration

At the privileged EXEC mode prompt, on both routers, type the command `copy running-config startup-config`.

Step 3 Configure the hosts with the proper IP address, subnet mask, and default gateway

Each workstation should be able to ping the attached router. If the ping was not successful, troubleshoot as necessary. Check and verify that the workstation has been assigned a specific IP address and default gateway. If running Windows 98, check using **Start** > **Run** > **winipcfg**. If running Windows 2000 or higher, check using `ipconfig` in a DOS window.

Step 4 Verify that the network is functioning

a. From the attached hosts, ping the FastEthernet interface of the default gateway router.

b. Was the ping from the first host successful? _____

c. Was the ping from the second host successful? _____

d. If the answer is no for either question, troubleshoot the router and host configurations to find the error. Then ping again until they both are successful.

Step 5 Create a default route

a. Add a default route to the serial 0 interface of the gateway router. This will forward any unknown destination address traffic to the ISP. Use the `ip route` command to create the default route:

```
Gateway(config)#ip route 0.0.0.0 0.0.0.0 serial 0
```

b. Is the route in the routing table? _____

c. Try to ping from one of the workstations to the ISP serial interface IP address.

d. Was the ping successful? _____

e. Why? _____

f. What command checks the routing table contents? _____

Step 6 Define an access list that will match the inside private IP addresses

To define the access list to match the inside private addresses, use the `access-list` command:

```
Gateway(config)#access-list 1 permit 10.10.10.0 0.0.0.255
```

Step 7 Define the PAT translation from inside list to outside address

To define the PAT translation, use the `ip nat inside source` command. This command, with the overload option, will create port address translation using the serial 0 IP address as the base:

```
Gateway(config)#ip nat inside source list 1 interface serial 0 overload
```

Step 8 Specify the interfaces

The active interfaces on the router need to be specified as either inside or outside interfaces with respect to PAT. To do this, use the `ip nat inside` or `ip nat outside` command:

```
Gateway(config)#interface fastethernet 0
Gateway(config-if)#ip nat inside
Gateway(config-if)#interface serial 0
Gateway(config-if)#ip nat outside
```

Step 9 Testing the configuration

a. Configure a PC on the internal LAN with the IP address 10.10.10.10/24 and a default gateway 10.10.10.1. From the PCs, ping the Internet address 172.16.1.1. If successful, Telnet to the same IP address. Then look at the PAT translation on the gateway router, using the command `show ip nat translations`.

b. What is the translation of the inside local host addresses?

_____ = _____ _____ = _____

c. What does the number after the colon represent? _____

d. Why do all of the commands for PAT say NAT? _____

Upon completion of the previous steps, finish the lab by doing the following:

•   Logoff by typing `exit`

•   Turn the router off

•   Remove and store the cables and adapter

Configuration reference sheet

This sheet contains the basic configuration commands for the ISP and Gateway routers:

```
ISP
Router#configure terminal
Router(config)#hostname ISP
ISP(config)#enable password cisco
ISP(config)#enable secret class
ISP(config)#line console 0
ISP(config-line)#password cisco
ISP(config-line)#login
ISP(config-line)#exit
ISP(config)#line vty 0 4
ISP(config-line)#password cisco
ISP(config-line)#login
ISP(config-line)#exit
ISP(config)#interface loopback 0
ISP(config-if)#ip address 172.16.1.1 255.255.255.255
ISP(config-if)#exit
ISP(config)#interface serial 0
ISP(config-if)#ip address 200.2.2.17 255.255.255.252
ISP(config-if)#no shutdown
ISP(config-if)#clock rate 64000
ISP(config)#ip route 199.99.9.32 255.255.255.224 200.2.2.18
ISP(config)#end
ISP#copy running-config startup-config

Gateway
Router#configure terminal
Router(config)#hostname Gateway
Gateway(config)#enable password cisco
Gateway(config)#enable secret class
Gateway(config)#line console 0
Gateway(config-line)#password cisco
Gateway(config-line)#login
Gateway(config-line)#exit
Gateway(config)#line vty 0 4
Gateway(config-line)#password cisco
Gateway(config-line)#login
Gateway(config-line)#exit
Gateway(config)#interface fastethernet 0
Gateway(config-if)#ip address 10.10.10.1 255.255.255.0
Gateway(config-if)#no shutdown
Gateway(config-if)#exit
Gateway(config)#interface serial 0
Gateway(config-if)#ip address 200.2.2.18 255.255.255.252
Gateway(config-if)#no shutdown
Gateway(config)#ip route 0.0.0.0 0.0.0.0 200.2.2.17
```

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```

Press **Enter**.

Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	**Ethernet Interface #1**	**Ethernet Interface #2**	**Serial Interface #1**	**Serial Interface #2**
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)
In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.				

Lab 1.1.4c Configuring Static NAT Addresses

Router Designation	Router Name	FastEthernet 0 Address /Subnet Mask	Interface Type	Serial 0 Address /Subnet Mask	Loopback 0 Address / Subnet Mask	Enable Secret Password	Enable/VTY/Console Passwords
Router 1	Gateway	10.10.10.1/24	DTE	200.2.2.18/30	NA	class	cisco
Router 2	ISP	NA	DCE	200.2.2.17/30	172.16.1.1/32	class	cisco

Straight-through cable	——————————
Serial cable	——————⟍——
Console (rollover)	••••••••••••••••••••
Crossover cable	— — — — — — — — —

Objective

- Configure a router to use network address translation (NAT) to convert internal IP addresses, typically private addresses, into outside public addresses.

- Configure static IP mapping to allow outside access to an internal PC.

Background/Preparation

The ISP has allocated a company the public classless interdomain routing (CIDR) IP address 199.99.9.32/27. This is equivalent to 30 public IP addresses. Since the company has an internal requirement for more than 30 addresses, the IT manager has decided to use NAT. Addresses 199.99.9.33 – 199.99.9.39 will be reserved for static allocation and 199.99.9.40 – 199.99.9.62 for dynamic allocation. Routing between the ISP and the gateway router will be done using a static route between the ISP and the gateway, and a default route between the gateway and the ISP. The ISP connection to the Internet will be represented by a loopback address on the ISP router.

Cable a network similar to the one in the diagram. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers

- 1600 series routers

- 1700 series routers

- 2500 series routers

- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in this lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure all of the following according to the chart:

- The hostname
- The console password
- The virtual terminal password
- The enable secret password
- The interfaces

If problems occur during this configuration, refer to the configuration reference sheet at the end of this lab for help.

Step 2 Save the configuration

At the privileged EXEC mode prompt, on both routers, type the command `copy running-config startup-config`.

Step 3 Configure the hosts with the proper IP address, subnet mask, and default gateway

Each workstation should be able to ping the attached router. If the ping was not successful, troubleshoot as necessary. Check and verify that the workstation has been assigned a specific IP address and default gateway. If running Windows 98, check using **Start** > **Run** > **winipcfg**. If running Windows 2000 or higher, check using `ipconfig` in a DOS window.

Step 4 Verify that the network is functioning

a. From the attached hosts, ping the FastEthernet interface of the default gateway router.

b. Was the ping from the first host successful? _____

c. Was the ping from the second host successful? _____

d. If the answer is no for either question, troubleshoot the router and host configurations to find the error. Then ping again until they both are successful.

Step 5 Create a static route

a. Create a static route from the ISP to the Gateway router. Addresses 199.99.9.32/27 have been allocated for Internet access outside of the company. Use the `ip route` command to create the static route:

```
ISP(config)#ip route 199.99.9.32 255.255.255.224 200.2.2.18
```

b. Is the route in the routing table? _____

c. What command checks the routing table contents? _____

d. If the route was not in the routing table, give one reason why this might be so?

_____

Step 6 Create a default route

a. Add a default route from the Gateway router to the ISP router using the ip route command. This will forward any unknown destination address traffic to the ISP:

```
Gateway(config)#ip route 0.0.0.0 0.0.0.0 200.2.2.17
```

b. Is the route in the routing table? _____

c. Try to ping from one of the workstations to the ISP serial interface IP address.

d. Was the ping successful? _____

e. Why? _____

Step 7 Define the pool of usable public IP addresses

To define the pool of public addresses, use the `ip nat pool` command:

```
Gateway(config)#ip nat pool public_access 199.99.9.40 199.99.9.62
netmask 255.255.255.224
```

Step 8 Define an access list that will match the inside private IP addresses

To define the access list to match the inside private addresses, use the `access-list` command:

```
Gateway(config)#access-list 1 permit 10.10.10.0 0.0.0.255
```

Step 9 Define the NAT translation from inside list to outside pool

To define the NAT translation, use the `ip nat inside source` command:

```
Gateway(config)#ip nat inside source list 1 pool public_access
```

Step 10 Specify the interfaces

The active interfaces on the router need to be identified as either inside or outside interfaces with respect to NAT. To do this, use the `ip nat inside` or `ip nat outside` command.

```
Gateway(config)#interface fastethernet 0
Gateway(config-if)#ip nat inside
Gateway(config-if)#interface serial 0
Gateway(config-if)#ip nat outside
```

Step 11 Configuring Static Mapping

a. Workstation #1, 10.10.10.10/24, will be designated as the public WWW server. Thus, it needs a permanent public IP address. This mapping is defined using a static NAT mapping.

b. Configure one of the PCs on the LAN with the IP address 10.10.10.10/24 and a default gateway address of 10.10.10.1. To configure a static IP NAT mapping, use the `ip nat inside source static` command at the privileged EXEC mode prompt:

```
Gateway(config)#ip nat inside source static 10.10.10.10 199.99.9.33
```

This permanently maps 199.99.9.33 to the inside address 10.10.10.10.

c. Look at the translation table:

```
Gateway#show ip nat translations
```

Does the mapping appear in the output of the `show` command? _____

Step 12 Testing the configuration

a. From the 10.10.10.10 workstation, verify it can ping 172.16.1.1

b. Is the ping successful? _____

c. Why? _____

d. From the ISP router, ping the host with the static NAT translation by typing **ping 10.10.10.10**.

e. What were the results of the ping, was it successful? _____

f. Why? _____

g. From the ISP router, ping 199.99.9.33. If successful, look at the NAT translation on the Gateway router, using the command `show ip nat translations`.

h. What is the translation of the inside local host addresses?

_____ = _____ _____ = _____

Upon completion of the previous steps, finish the lab by doing the following:

• Logoff by typing **exit**

• Turn the router off

• Remove and store the cables and adapter

Configuration reference sheet

This sheet contains the basic configuration commands for the ISP and Gateway routers:

```
ISP
Router#configure terminal
Router(config)#hostname ISP
ISP(config)#enable password cisco
ISP(config)#enable secret class
ISP(config)#line console 0
ISP(config-line)#password cisco
ISP(config-line)#login
ISP(config-line)#exit
ISP(config)#line vty 0 4
ISP(config-line)#password cisco
ISP(config-line)#login
ISP(config-line)#exit
ISP(config)#interface loopback 0
ISP(config-if)#ip address 172.16.1.1 255.255.255.255
ISP(config-if)#exit
ISP(config)#interface serial 0
ISP(config-if)#ip address 200.2.2.17 255.255.255.252
ISP(config-if)#clock rate 64000
ISP(config)#ip route 199.99.9.32 255.255.255.224 200.2.2.18
ISP(config)#end
ISP#copy running-config startup-config

Gateway
Router#configure terminal
Router(config)#hostname Gateway
Gateway(config)#enable password cisco
Gateway(config)#enable secret class
Gateway(config)#line console 0
Gateway(config-line)#password cisco
Gateway(config-line)#login
Gateway(config-line)#exit
Gateway(config)#line vty 0 4
Gateway(config-line)#password cisco
Gateway(config-line)#login
Gateway(config-line)#exit
Gateway(config)#interface fastethernet 0
Gateway(config-if)#ip address 10.10.10.1 255.255.255.0
Gateway(config-if)#no shutdown
Gateway(config-if)#exit
Gateway(config)#interface serial 0
Gateway(config-if)#ip address 200.2.2.18 255.255.255.252
Gateway(config-if)#no shutdown
Gateway(config)#ip route 0.0.0.0 0.0.0.0 200.2.2.17
```

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.
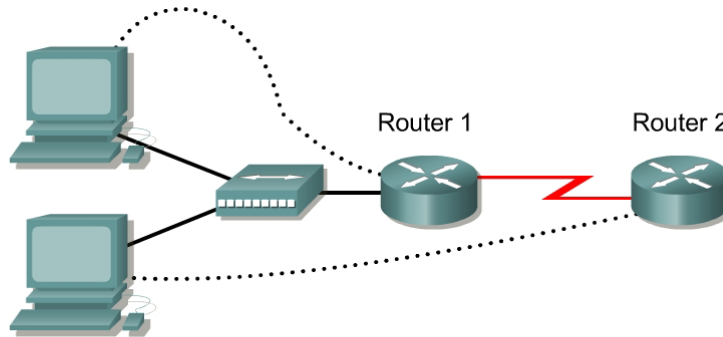
The responding line prompt will be:

```
Press RETURN to get started!
```
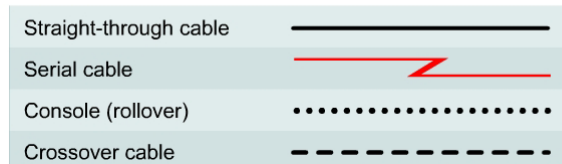
Press **Enter**.

Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)

In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.

Lab 1.1.5 Verifying NAT and PAT Configuration

Router Designation	Router Name	FastEthernet 0 Address /Subnet Mask	Interface Type	Serial 0 Address /Subnet Mask	Loopback 0 Address / Subnet Mask	Enable Secret Password	Enable/VTY/Console Passwords
Router 1	Gateway	10.10.10.1/24	DTE	200.2.2.18/30	NA	class	cisco
Router 2	ISP	NA	DCE	200.2.2.17/30	172.16.1.1/32	class	cisco

Straight-through cable	————————
Serial cable	—⚡—
Console (rollover)	••••••••••••••••••••
Crossover cable	– – – – – – – – –

Objective

- Configure a router for Network Address Translation (NAT) and Port Address Translation (PAT)

- Test the configuration and verify NAT/PAT statistics

Background/Preparation

The ISP has allocated a company the public CIDR IP address 199.99.9.32/30. This CIDR mask will yield four IP address with only two of the IP addresses usable for host address. Since the company has an internal requirement for more than 30 addresses, the IT manager has decided to use NAT with PAT. Routing between the ISP and the gateway router is done using a static route between the ISP and the gateway, and a default route between the gateway and the ISP. The ISP connection to the Internet will be represented by a loopback address on the ISP router.

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers

- 1600 series routers

- 1700 series routers

- 2500 series routers

- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure all of the following according to the chart:

- The hostname

- The console password

- The virtual terminal password

- The enable secret password

- The interfaces

If problems occur during this configuration, refer to Lab 1.1.4a Configuring NAT.

Step 2 Save the configuration

At the privileged EXEC mode prompt, on both routers, type the command `copy running-config startup-config`.

Step 3 Configure the hosts with the proper IP address, subnet mask, and default gateway

Each workstation should be able to ping the attached router. If the ping was not successful, troubleshoot as necessary. Check and verify that the workstation has been assigned a specific IP address and default gateway. If running Windows 98, check using **Start** > **Run** > **winipcfg**. If running Windows 2000 or higher, check using `ipconfig` in a DOS window.

Step 4 Verify that the network is functioning

a. From the attached hosts, ping the FastEthernet interface of the default gateway router.

b. Was the ping from the first host successful? _____

c. Was the ping from the second host successful? _____

d. If the answer is no for either question, troubleshoot the router and host configurations to find the error. Then ping again until they both are successful.

Step 5 Create a static route

a. Create a static route from the ISP to the Gateway router. Addresses 199.99.9.32/30 have been allocated for Internet access outside of the company. Use the `ip route` command to create the static route.

```
ISP(config)#ip route 199.99.9.32 255.255.255.252 200.2.2.18
```

b. Is the static route in the routing table? _____

c. What command checks the routing table contents? _____

d. If the route was not in the routing table, give one reason why this might be so?

Step 6 Create a default route

a. Add a default route from the Gateway router to the ISP router using the `ip route` command. This will forward any unknown destination address traffic to the ISP:

```
Gateway(config)#ip route 0.0.0.0 0.0.0.0 200.2.2.17
```

b. Is the static route in the routing table? _____

c. Try to ping from one of the workstations to the ISP serial interface IP address.

d. Was the ping successful? _____

e. Why? _____

Step 7 Define the pool of usable public IP addresses

To define the pool of public addresses, use the `ip nat pool` command:

```
Gateway(config)#ip nat pool public-access 199.99.9.32 199.99.9.35
netmask 255.255.255.252
```

Step 8 Define an access list that will match the inside private IP addresses

To define the access list to match the inside private addresses, use the `access-list` command:

```
Gateway(config)#access-list 1 permit 10.10.10.0 0.0.0.255
```

Step 9 Define the NAT translation from inside list to outside pool

To define the NAT translation, use the `ip nat inside source` command:

```
Gateway(config)#ip nat inside source list 1 pool public-access overload
```

Step 10 Specify the interfaces

The active interfaces on the router need to be identified as either inside or outside interfaces with respect to NAT. To do this, use the `ip nat inside` or `ip nat outside` command:

```
Gateway(config)#interface fastethernet 0
Gateway(config-if)#ip nat inside
Gateway(config-if)#interface serial 0
Gateway(config-if)#ip nat outside
```

Step 11 Testing the configuration

a. From the workstations, ping 172.16.1.1. Open multiple DOS windows on each workstation and Telnet to the 172.16.1.1 address. Next, view the NAT translations on the Gateway router, with the command `show ip nat translations`.

b. What is the translation of the inside local host addresses?

_____ = _____ _____ = _____

Step 12 Verify NAT and PAT Statistics

a. To view the NAT and PAT statistics type the `show ip nat statistics` command at the privileged EXEC mode prompt.

b. How many active translations have taken place? _____

c. How many addresses are in the pool? _____

d. How many addresses have been allocated so far? _____

Upon completion of the previous steps, finish the lab by doing the following:

• Logoff by typing `exit`

• Turn the router off

• Remove and store the cables and adapter

Configuration reference sheet

This sheet contains the basic configuration commands for the ISP and Gateway routers:

```
ISP
Router#configure terminal
Router(config)#hostname ISP
ISP(config)#enable password cisco
ISP(config)#enable secret class
ISP(config)#line console 0
ISP(config-line)#password cisco
ISP(config-line)#login
ISP(config-line)#exit
ISP(config)#line vty 0 4
ISP(config-line)#password cisco
ISP(config-line)#login
ISP(config-line)#exit
ISP(config)#interface loopback 0
ISP(config-if)#ip address 172.16.1.1 255.255.255.255
ISP(config-if)#exit
ISP(config)#interface serial 0
ISP(config-if)#ip address 200.2.2.17 255.255.255.252
ISP(config-if)#no shutdown
ISP(config-if)#clock rate 64000
ISP(config)#ip route 199.99.9.32 255.255.255.252 200.2.2.18
ISP(config)#end
ISP#copy running-config startup-config

Gateway
Router#configure terminal
Router(config)#hostname Gateway
Gateway(config)#enable password cisco
Gateway(config)#enable secret class
Gateway(config)#line console 0
Gateway(config-line)#password cisco
Gateway(config-line)#login
Gateway(config-line)#exit
Gateway(config)#line vty 0 4
Gateway(config-line)#password cisco
Gateway(config-line)#login
Gateway(config-line)#exit
Gateway(config)#interface fastethernet 0
Gateway(config-if)#ip address 10.10.10.1 255.255.255.0
Gateway(config-if)#no shutdown
Gateway(config-if)#exit
Gateway(config)#interface serial 0
Gateway(config-if)#ip address 200.2.2.18 255.255.255.252
Gateway(config-if)#no shutdown
Gateway(config)#ip route 0.0.0.0 0.0.0.0 200.2.2.17
```

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router(config)#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.
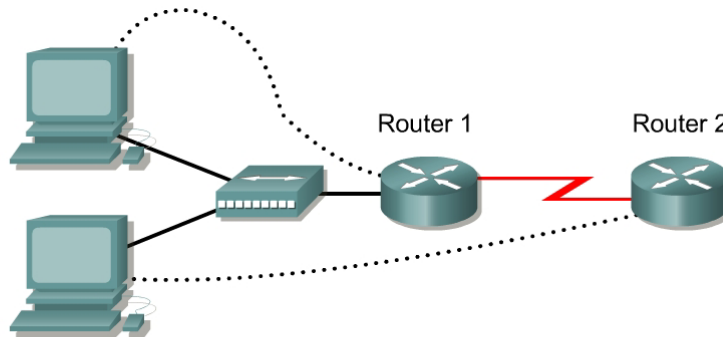
The responding line prompt will be:

```
Press RETURN to get started!
```
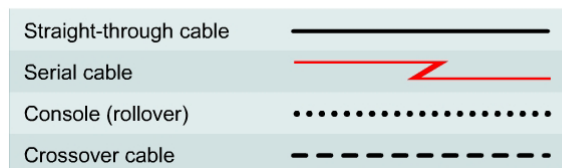
Press **Enter**.

Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)
In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.				

Lab 1.1.6 Troubleshooting NAT and PAT

Router Designation	Router Name	FastEthernet 0 Address /Subnet Mask	Interface Type	Serial 0 Address /Subnet Mask	Loopback 0 Address / Subnet Mask	Enable Secret Password	Enable/VTY/Console Passwords
Router 1	Gateway	10.10.10.1/24	DTE	200.2.2.18/30	NA	class	cisco
Router 2	ISP	NA	DCE	200.2.2.17/30	172.16.1.1/32	class	cisco

Straight-through cable	————————
Serial cable	——————Z——
Console (rollover)	••••••••••••••••••••
Crossover cable	– – – – – – – – – – –

Objective

- Configure a router for Network Address Translation (NAT) and Port Address Translation (PAT)
- Troubleshoot NAT and PAT using `debug`

Background/Preparation

The ISP has allocated a company the public CIDR IP address 199.99.9.32/30. This is equivalent to four public IP addresses. Since the company has an internal requirement for more than 30 addresses, the IT manager has decided to use NAT with PAT. Routing between the ISP and the gateway router is done using a static route between the ISP and the gateway, and a default route between the gateway and the ISP. The ISP connection to the Internet will be represented by a loopback address on the ISP router.

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers
- 1600 series routers
- 1700 series routers
- 2500 series routers

- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure all of the following according to the chart:

- The hostname
- The console password
- The virtual terminal password
- The enable secret password
- The interfaces

If problems occur during this configuration, refer to Lab 1.1.4a Configuring NAT.

Step 2 Save the configuration

At the privileged EXEC mode prompt, on both routers, type the command `copy running-config startup-config`.

Step 3 Configure the hosts with the proper IP address, subnet mask, and default gateway

Each workstation should be able to ping the attached router. If the ping was not successful, troubleshoot as necessary. Check and verify that the workstation has been assigned a specific IP address and default gateway. If running Windows 98, check using **Start** > **Run** > **winipcfg**. If running Windows 2000 or higher, check using `ipconfig` in a DOS window.

Step 4 Verify that the network is functioning

a. From the attached hosts, ping the FastEthernet interface of the default gateway router.

b. Was the ping from the first host successful? _____

c. Was the ping from the second host successful? _____

d. If the answer is no for either question, troubleshoot the router and host configurations to find the error. Then ping again until they both are successful.

Step 5 Create a static route

a. Create a static route from the ISP to the Gateway router. Addresses 199.99.9.32/30 have been allocated for Internet access outside of the company. Use the `ip route` command to create the static route:

```
ISP(config)#ip route 199.99.9.32 255.255.255.252 200.2.2.18
```

b. Is the static route in the routing table? _____

c. What command checks the routing table contents? _____

d. If the route was not in the routing table, give one reason why this might be so?

_____

Step 6 Create a default route

a. Add a default route, using the `ip route` command, from the Gateway router to the ISP router. This will forward any unknown destination address traffic to the ISP:

```
Gateway(config)#ip route 0.0.0.0 0.0.0.0 200.2.2.17
```

b. Is the static route in the routing table? _____

c. Try to ping from one of the workstations to the ISP serial interface IP address.

d. Was the ping successful? _____

e. Why? _____

Step 7 Define the pool of usable public IP addresses

To define the pool of public addresses, use the `ip nat pool` command:

```
Gateway(config)#ip nat pool public-access 199.99.9.32 199.99.9.35
netmask 255.255.255.252
```

Step 8 Define an access list that will match the inside private IP addresses

To define the access list to match the inside private addresses, use the `access-list` command:

```
Gateway(config)#access-list 1 permit 10.10.10.0 0.0.0.255
```

Step 9 Define the NAT translation from inside list to outside pool

To define the NAT translation, use the `ip nat inside source` command:

```
Gateway(config)#ip nat inside source list 1 pool public-access overload
```

Step 10 Specify the interfaces

On the active interfaces on the router, it needs to be specified as either inside or outside interfaces with respect to NAT. To do this, use the `ip nat inside` command:

```
Gateway(config)#interface fastethernet 0
Gateway(config-if)#ip nat inside
```

Step 11 Testing the configuration

a. Turn on debugging for the NAT process by typing `debug ip nat` at the privileged EXEC mode prompt.

b. Does the `debug` command show any output? _____

c. If translation were taking place there would be output from the **debug** command. While reviewing the running configuration of the gateway router, it is seen that the **ip nat outside** statement has not been entered on the serial 0 interface. To configure this enter the following:

```
Gateway(config)#interface serial 0
Gateway(config-if)#ip nat outside
```

From the workstations, ping 172.16.1.1

If the **ip nat outside** statement was entered correctly, there should be output from the **debug ip nat** command.

d. What does the line NAT*: S=10.10.10.? -> 199.99.9.33 mean?

_____

e. To stop the debug output, type **undebug all** at the privileged EXEC mode prompt.

Upon completion of the previous steps, finish the lab by doing the following:

- Logoff by typing **exit**

- Turn the router off

- Remove and store the cables and adapter

Configuration reference sheet

This sheet contains the basic configuration commands for the ISP and Gateway routers:

```
ISP
Router#configure terminal
Router(config)#hostname ISP
ISP(config)#enable password cisco
ISP(config)#enable secret class
ISP(config)#line console 0
ISP(config-line)#password cisco
ISP(config-line)#login
ISP(config-line)#exit
ISP(config)#line vty 0 4
ISP(config-line)#password cisco
ISP(config-line)#login
ISP(config-line)#exit
ISP(config)#interface loopback 0
ISP(config-if)#ip add 172.16.1.1 255.255.255.255
ISP(config-if)#exit
ISP(config)#interface serial 0
ISP(config-if)#ip add 200.2.2.17 255.255.255.252
ISP(config-if)#no shutdown
ISP(config-if)#clock rate 64000
ISP(config)#ip route 199.99.9.32 255.255.255.252 200.2.2.18
ISP(config)#end
ISP#copy running-config startup-config
Destination filename [startup-config]?[Enter]

Gateway
Router#configure terminal
Router(config)#hostname Gateway
Gateway(config)#enable password cisco
Gateway(config)#enable secret class
Gateway(config)#line console 0
Gateway(config-line)#password cisco
Gateway(config-line)#login
Gateway(config-line)#exit
Gateway(config)#line vty 0 4
Gateway(config-line)#password cisco
Gateway(config-line)#login
Gateway(config-line)#exit
Gateway(config)#interface fastethernet 0
Gateway(config-if)#ip add 10.10.10.1 255.255.255.0
Gateway(config-if)#no shutdown
Gateway(config-if)#exit
Gateway(config)#interface serial 0
Gateway(config-if)#ip add 200.2.2.18 255.255.255.252
Gateway(config-if)#no shutdown

Gateway(config)#ip route 0.0.0.0 0.0.0.0 200.2.2.17
```

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router(config)#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```

Press **Enter**.

Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	**Ethernet Interface #1**	**Ethernet Interface #2**	**Serial Interface #1**	**Serial Interface #2**
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)
In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.				

Lab 1.2.6 Configuring DHCP
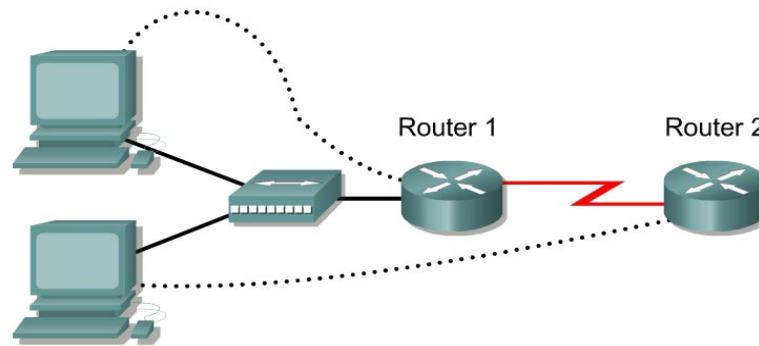
Router Designation	Router Name	FastEthernet 0 Address/ Subnet Mask	Interface Type	Serial 0 Address/ Subnet Mask	Loopback 0 Address/ Subnet Mask	Enable Secret Password	Enable/VTY/ Console Passwords
Router 1	Campus	172.16.12.1/24	DTE	172.16.1.6/30	NA	class	cisco
Router 2	ISP	NA	DCE	172.16.1.5/30	172.16.13.1/32	class	cisco

Straight-through cable	————
Serial cable	—— Z ——
Console (rollover)	••••••••••••••
Crossover cable	— — — — —

Objective

- Configure a router for Dynamic Host Configuration Protocol (DHCP) to dynamically assign addresses to attached hosts.

Background/Preparation

Routing from the ISP router to the campus router uses a static route. A default route is used to route from the campus router to the ISP router. The ISP connection to the Internet is simulated by a loopback address on the ISP router.

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers
- 1600 series routers
- 1700 series routers
- 2500 series routers
- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure all of the following according to the chart:

- The hostname

- The console password

- The virtual terminal password

- The enable secret password

- The interfaces

If problems occur during this configuration, refer to Lab 1.1.4a Configuring NAT.

Step 2 Save the configuration

At the privileged EXEC mode prompt, on both routers, type the command `copy running-config startup-config`.

Step 3 Create a static route

a. Addresses 172.16.12.0/24 have been allocated for Internet access outside of the company. Use the `ip route` command to create the static route:

```
ISP(config)#ip route 172.16.12.0 255.255.255.0 172.16.1.6
```

b. Is the static route in the routing table? _____

Step 4 Create a default route

a. Use the `ip route` command to add a default route from the campus router to the ISP router. This will provide the mechanism to forward any unknown destination address traffic to the ISP:

```
campus(config)#ip route 0.0.0.0 0.0.0.0 172.16.1.5
```

b. Is the static route in the routing table? _____

Step 5 Create the DHCP address pool

To configure the campus LAN pool, use the following commands:

```
campus(config)#ip dhcp pool campus
campus(dhcp-config)#network 172.16.12.0 255.255.255.0
campus(dhcp-config)#default-router 172.16.12.1
campus(dhcp-config)#dns-server 172.16.1.2
campus(dhcp-config)#domain-name foo.com
campus(dhcp-config)#netbios-name-server 172.16.1.10
```

Step 6 Excluding addresses from pool

To exclude addresses from the pool, use the following commands:

```
campus(config)#ip dhcp excluded-address 172.16.12.1 172.16.12.11
```

Step 7 Verifying DHCP Operation
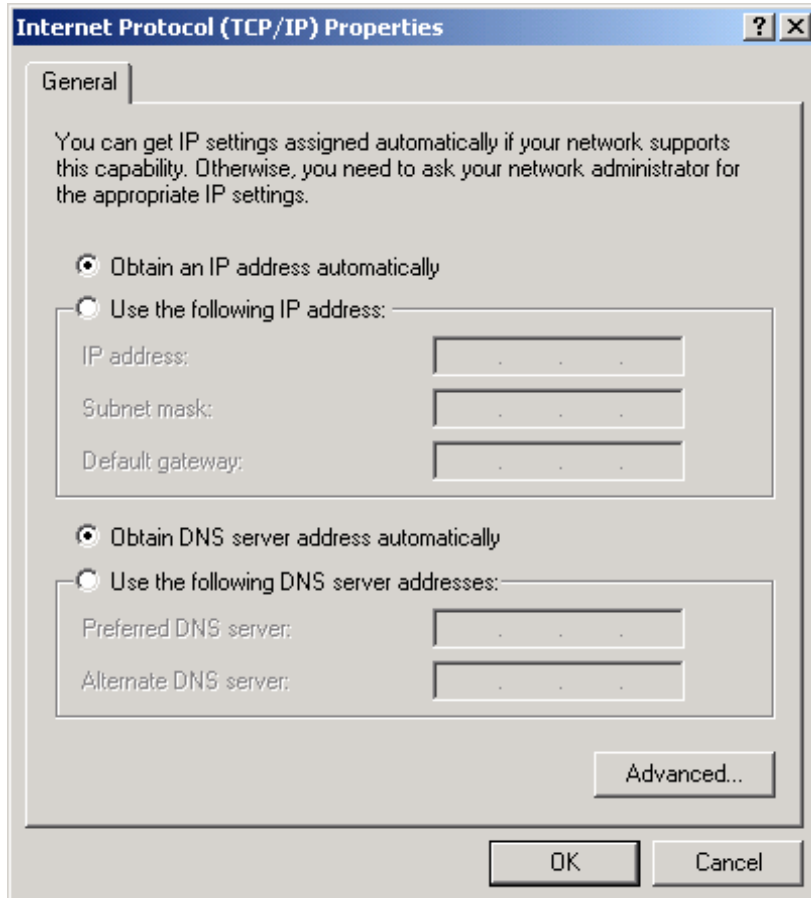
a. At each workstation on the directly connected subnet configure the TCP/IP properties so the workstation will obtain an IP address and Domain Name System (DNS) server address from the DHCP server. After changing and saving the configuration, reboot the workstation.

b. To confirm the TCP/IP configuration information on each host use **Start** > **Run** > **winipcfg /all**. If running Windows 2000, check using **ipconfig /all** in a DOS window.

c. What IP address was assigned to the workstation? _____

d. What other information was automatically assigned?

_____ _____ _____

e. When was the lease obtained? _____

f. When will the lease expire? _____

Step 8 View DHCP bindings

    a. From the campus router, the bindings for the hosts can be seen. To see the bindings, use the command `show ip dhcp binding` at the privileged EXEC mode prompt.

    b. What were the IP addresses assigned? _____

    c. What are the three other fields listed in the output?

_____ _____ _____

Upon completion of the previous steps, finish the lab by doing the following:

- Logoff by typing `exit`

- Turn the router off

- Remove and store the cables and adapter

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```

Press **Enter**.

Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)

In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.

Lab 1.2.8 Configuring DHCP Relay
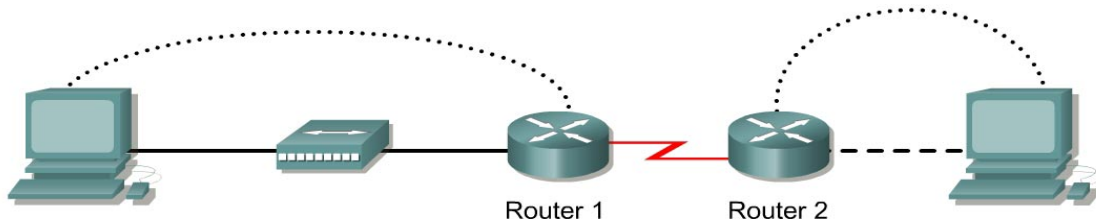
Router Designation	Router Name	FastEthernet 0 Address/ Subnet Mask	Interface Type	Serial 0 Address/Subnet Mask	Enable Secret Password	Enable/VTY/ Console Passwords
Router 1	Campus	172.16.12.1/24	DCE	172.16.1.1/30	class	cisco
Router 2	Remote	172.16.13.1/24	DTE	172.16.1.2/30	class	cisco

Straight-through cable	
Serial cable	
Console (rollover)	
Crossover cable	

Objective

- A router will be configured for Dynamic Host Configuration Protocol (DHCP).

- The ability for workstations to remotely obtain DHCP addresses will be added.

- Addresses will be dynamically assigned to the attached hosts.

Background/Preparation

A DHCP client uses IP broadcasts to find the DHCP server. However, these broadcasts are not forwarded by routers, so in the case of the remote LAN, the workstations will not be able to locate the DHCP server. The router must be configured with the `ip helper-address` command to enable forwarding of these broadcasts, as unicast packets, to the specific server.

Routing between the remote router and the campus router is done using a static route between the remote router and gateway router, and a default route between the gateway router and remote router.

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers

- 1600 series routers

- 1700 series routers

- 2500 series routers

- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure all of the following according to the chart:

- The hostname

- The console password

- The virtual terminal password

- The enable secret password

- The interfaces

Step 2 Configure routing on the remote router

Use Open Shortest Path First (OSPF) as the routing protocol. Set up the network as area 0 and the process ID as 1:

```
remote(config)#router ospf 1
remote(config-router)#network 172.16.1.0 0.0.0.3 area 0
remote(config-router)#network 172.16.13.0 0.0.0.255 area 0
```

Step 3 Configure routing on the campus router

a. Use OSPF as the routing protocol. Set up the network as area 0 and the process ID as 1:

```
campus(config)#router ospf 1
campus(config-router)#network 172.16.12.0 0.0.0.3 area 0
campus(config-router)#network 172.16.12.0 0.0.0.255 area 0
```

b. Are there OSPF routes in the routing table? _____

Step 4 Save the configurations

At the privileged EXEC mode prompt on both routers, type the command **copy running-config startup-config**.

Step 5 Create the campus DHCP address pool on the campus router

To configure the campus LAN pool, use the following commands:

```
campus(config)#ip dhcp pool campus
campus(dhcp-config)#network 172.16.12.0 255.255.255.0
campus(dhcp-config)#default-router 172.16.12.1
campus(dhcp-config)#dns-server 172.16.12.2
campus(dhcp-config)#domain-name foo.com
campus(dhcp-config)#netbios-name-server 172.16.12.10
```

Step 6 Create the remote DHCP address pool on the campus router

To configure the remote LAN pool, use the following commands:

```
campus(dhcp-config)#ip dhcp pool remote
campus(dhcp-config)#network 172.16.13.0 255.255.255.0
campus(dhcp-config)#default-router 172.16.13.1
campus(dhcp-config)#dns-server 172.16.12.2
campus(dhcp-config)#domain-name foo.com
campus(dhcp-config)#netbios-name-server 172.16.12.10
```

Step 7 Exclude addresses from pool

a.   To exclude addresses from the pool, use the following commands:

```
campus(config)#ip dhcp excluded-address 172.16.12.1 172.16.12.11
campus(config)#ip dhcp excluded-address 172.16.13.1 172.16.13.11
```

This defines the address range to be excluded from dynamic issue by the DHCP server.

b.   Why would addresses be excluded? _____

Step 8 Verify DHCP operation on the campus router
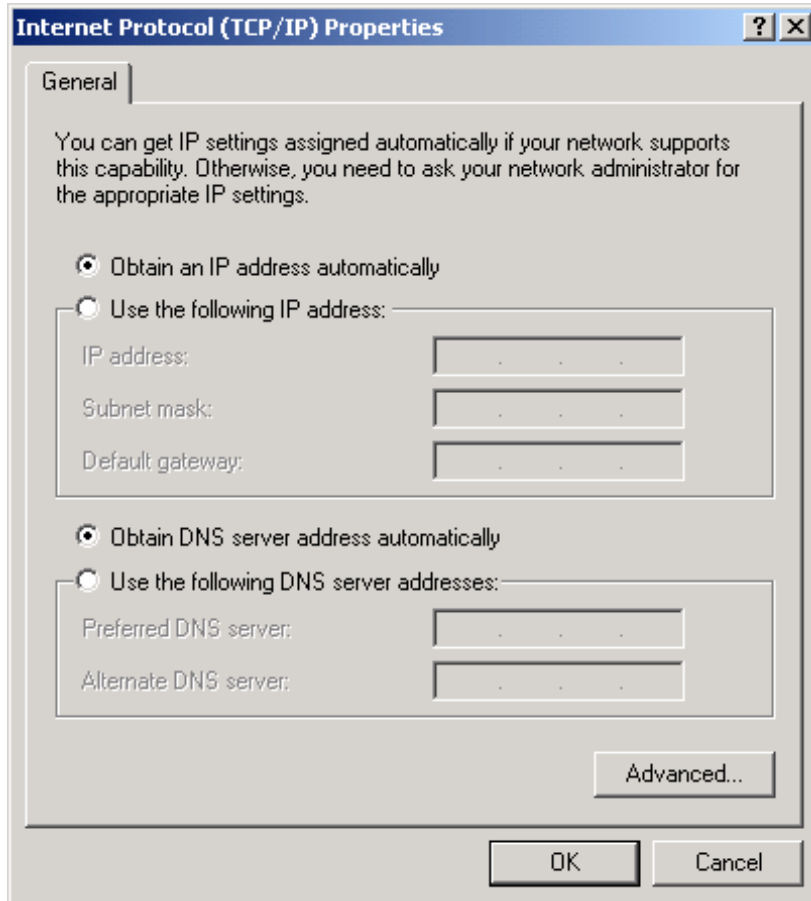
a. From the workstation directly connected to the campus router configure the TCP/IP properties for the workstation to obtain its IP properties automatically from DHCP. These properties include the IP address and the Domain Name System (DNS) server address.

b. After changing the configuration, reboot the workstation. View the TCP/IP configuration information on each host. If running Windows 98, go to **Start** > **Run** > **winipcfg /all**. With Windows 2000 or higher, use **ipconfig /all** in a DOS command prompt window.

c. What IP address was assigned to the workstation? _____

Step 9 Configuring DHCP relay

Configure the remote router with the `ip helper-address` command to enable forwarding of broadcasts, as unicast packets, to the specific server. This command must to be configured on the LAN interface of the remote router for DHCP to function:

```
remote(config)#interface fastethernet 0
remote(config-if)#ip helper-address 172.16.1.1
```


Step 10 Verify DHCP operation on the remote router

a. Reboot the workstation attached to the remote router.

b. Is there a valid address assigned from the DHCP pool? _____

c. What IP address was assigned to the workstation? _____

    d. If there is no IP address, troubleshoot the workstation and router configurations and repeat Step 11.

Step 11 View DHCP bindings

    a. From the campus router, the bindings for the hosts can be seen. To see the bindings, use the command `show ip dhcp binding` at the privileged EXEC mode prompt.

    b. What are the IP addresses assigned to the hosts?

_____   _____

Upon completion of the previous steps, finish the lab by doing the following:

- Logoff by typing `exit`

- Turn the router off

- Remove and store the cables and adapter

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor) .

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router(config)#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```
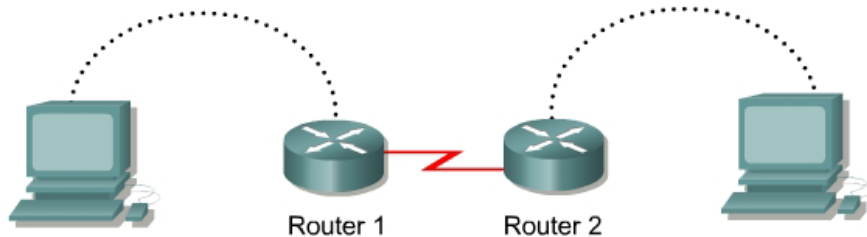
Press **Enter**.

Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)

In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.

Lab 3.1.7 Troubleshooting a Serial Interface

Router 1   Router 2

Router Designation	Router Name	Interface Type	Serial 0 Address	Subnet Mask	Enable Secret Password	Enable/VTY/ Console Passwords
Router 1	London	DCE	192.168.15.1	255.255.255.0	class	cisco
Router 2	Paris	DTE	192.168.15.2	255.255.255.0	class	cisco

Straight-through cable	————————
Serial cable	—————Z———
Console (rollover)	••••••••••••••••••••
Crossover cable	— — — — — — — — ·

Objective

- Configure a serial interface on two routers.

- Use `show` commands to troubleshoot connectivity issues.

Background/Preparation

Configure the appropriate serial interfaces to allow connectivity between the two routers.

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers

- 1600 series routers

- 1700 series routers

- 2500 series routers

- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure all of the following according to the chart:

- The hostname

- The console password

- The virtual terminal password

- The enable secret password

If problems occur during this configuration, refer to Lab 1.1.4a Configuring NAT.

Step 2 Configure the Paris interface as shown

Configure the Paris router serial interface as follows:

```
Paris(config)#interface serial 0
Paris(config-if)#ip address 192.168.15.2 255.255.255.0
Paris(config-if)#clock rate 56000
Paris(config-if)#no shutdown
Paris(config-if)#exit
Paris(config)#exit
```

Step 3 Configure the London interface as shown

Configure the London router serial interface as follows:

```
London(config)#interface serial 0
London(config-if)#ip address 192.168.15.1 255.255.255.0
London(config-if)#no shutdown
London(config-if)#exit
London(config)#exit
```

Step 4 Save the configuration

```
London#copy running-config startup-config
```

```
Paris#copy running-config startup-config
```

Step 5 Enter the command `show interface serial 0` (refer to interface chart) on London

```
London#show interface serial 0
```

This will show the details of interface serial 0.

Answer the following questions:

a. Serial 0 is _____, line protocol is _____.

b. What type of problem is indicated in the last statement?

_____

c. Internet address is _____.

d. Encapsulation _____

Step 6 Enter the command `show interface serial 0` (refer to interface chart) on Paris

```
Paris#show interface serial 0
```

This will show the details of interface serial 0.

Answer the following questions:

a. Serial 0 is _____ , line protocol is_____ .

b. Internet address is _____ .

c. Encapsulation _____

d. To what OSI layer is the "Encapsulation" referring? _____

e. Why is the interface down?

_____

Step 7 Correct the clock location

The clock rate statement has been placed on the wrong interface. It is currently placed on the Paris router, but the London router is the Data Communications Equipment (DCE). Remove the clock rate statement from the Paris router using the **no** version of the command and then add it to the London router configuration.

Step 8 Enter the command `show interface serial 0` on Paris

```
Paris#show interface serial 0
```

a. Serial 0 is _____ , line protocol is_____ .

b. What is the difference in the Line and Protocol status recorded on Paris earlier? Why?

_____

Step 9 Verify that the serial connection is functioning by pinging the serial interface of the other router

```
London#ping 192.168.15.2
```

```
Paris#ping 192.168.15.1
```

a. Can the serial interface on the Paris router be pinged from London? _____

b. Can the serial interface on the London router be pinged from Paris? _____

c. If the answer is no for either question, troubleshoot the router configurations to find the error. Then do the pings again until the answer to both questions is yes.

Upon completion of the previous steps, finish the lab by doing the following:

•   Logoff by typing **exit**

•   Turn the router off

•   Remove and store the cables and adapter

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```

Press **Enter**.

Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	**Ethernet Interface #1**	**Ethernet Interface #2**	**Serial Interface #1**	**Serial Interface #2**
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)
In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.				

Lab 3.3.2 Configuring PPP Encapsulation
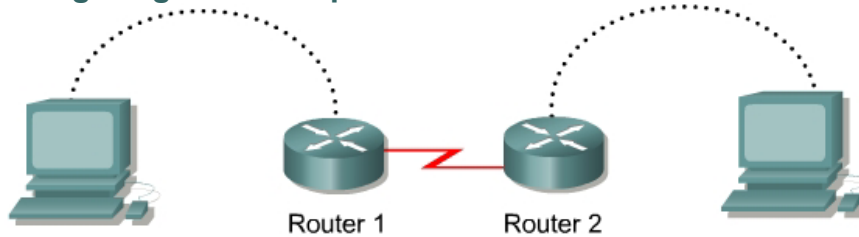
Router Designation	Router Name	Interface Type	Serial 0 Address	Subnet Mask	Enable Secret Password	Enable/VTY/ Console Passwords
Router 1	Washington	DCE	192.168.15.1	255.255.255.0	class	cisco
Router 2	Dublin	DTE	192.168.15.2	255.255.255.0	class	cisco

Straight-through cable	————————
Serial cable	———⌐————
Console (rollover)	••••••••••••••••••••
Crossover cable	– – – – – – – – – ·

Objective

- Configure the serial interfaces on two routers with the PPP protocol.
- Test the link for connectivity.

Background/Preparation

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers
- 1600 series routers
- 1700 series routers
- 2500 series routers
- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions sheet. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure all of the following according to the chart:

- The hostname
- The console password
- The virtual terminal password
- The enable secret password

If problems occur during this configuration, refer to Lab 1.1.4a Configuring NAT.

Step 2 Configure the Dublin interface as shown

Configure the Dublin router serial interface as follows:

```
Dublin(config)#interface serial 0
Dublin(config-if)#ip address 192.168.15.2 255.255.255.0
Dublin(config-if)#no shutdown
Dublin(config-if)#exit
Dublin(config)#exit
```

Step 3 Configure the Washington interface as shown

Configure the Washington router serial interface as follows:

```
Washington(config)#interface serial 0
Washington(config-if)#ip address 192.168.15.1 255.255.255.0
Washington(config-if)#clock rate 64000
Washington(config-if)#no shutdown
Washington(config-if)#exit
Washington(config)#exit
```

Step 4 Save the configuration

```
Washington#copy running-config startup-config

Dublin#copy running-config startup-config
```

Step 5 Enter the command `show interface serial 0` (refer to interface chart) on Washington

```
Washington#show interface serial 0
```

a. This will show the details of interface serial 0.

b. Serial 0 is _____, line protocol is_____.

c. Internet address is _____.

d. Encapsulation _____

Step 6 Enter the command `show interface serial 0` (refer to interface chart) on Dublin

```
Dublin#show interface serial 0
```

a. This will show the details of interface serial 0.

b. Serial 0 is _____, line protocol is_____.

c. Internet address is _____.

d. Encapsulation _____

Step 7 Change the encapsulation type

Change the encapsulation type to PPP by typing `encapsulation ppp` at the interface serial 0 configuration mode prompt on both routers.

```
Washington(config-if)#encapsulation ppp
```

```
Dublin(config-if)#encapsulation ppp
```

Step 8 Enter the command `show interface serial 0` on Washington

```
Washington#show interface serial 0
```

Encapsulation _____

Step 9 Enter the command `show interface serial 0` on Dublin

```
Dublin#show interface serial 0
```

Encapsulation _____

Step 10 Verify that the serial connection is functioning by pinging the serial interface of the other router

```
Washington#ping 192.168.15.2
```

```
Dublin#ping 192.168.15.1
```

a. Can the serial interface on the Dublin router be pinged from Washington? _____

b. Can the serial interface on the Washington router be pinged from Dublin? _____

c. If the answer is no for either question, troubleshoot the router configurations to find the error. Then do the pings again until the answer to both questions is yes.

Upon completion of the previous steps, finish the lab by doing the following:

• Logoff by typing `exit`

• Turn the router off

• Remove and store the cables and adapter

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router(config)#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```

Press **Enter**.

Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)
In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface				

Lab 3.3.3 Configuring PPP Authentication
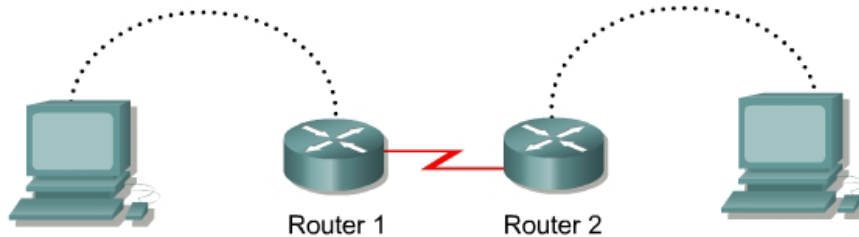
Router 1   Router 2

Router Designation	Router Name	Interface Type	Serial 0 Address	Subnet Mask	Enable Secret Password	Enable/VTY/ Console Passwords
Router 1	Madrid	DCE	192.168.15.1	255.255.255.0	class	cisco
Router 2	Tokyo	DTE	192.168.15.2	255.255.255.0	class	cisco

Straight-through cable ————
Serial cable ————
Console (rollover) ••••••••••••••
Crossover cable – – – – – –
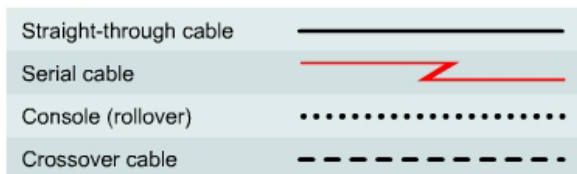
Objective

- Configure PPP authentication using CHAP on two routers.

Background/Preparation

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers
- 1600 series routers
- 1700 series routers
- 2500 series routers
- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure all of the following according to the chart:

- The hostname
- The console password
- The virtual terminal password
- The enable secret password

If problems occur during this configuration, refer to Lab 1.1.4a Configuring NAT.

Step 2 Configure the Tokyo interface as shown

Configure the Tokyo router serial interface as follows:

```
Tokyo(config)#interface serial 0
Tokyo(config-if)#ip address 192.168.15.2 255.255.255.0
Tokyo(config-if)#encapsulation ppp
Tokyo(config-if)#no shutdown
Tokyo(config-if)#exit
Tokyo(config)#exit
```

Step 3 Configure the Madrid interface as shown

Configure the Madrid router serial interface as follows:

```
Madrid(config)#interface serial 0
Madrid(config-if)#ip address 192.168.15.1 255.255.255.0
Madrid(config-if)#clock rate 64000
Madrid(config-if)#encapsulation ppp
Madrid(config-if)#no shutdown
Madrid(config-if)#exit
Madrid(config)#exit
```

Step 4 Save the configuration

```
Madrid#copy running-config startup-config

Tokyo#copy running-config startup-config
```

Step 5 Enter the command `show interface serial 0` on Madrid

```
Madrid#show interface serial 0
```

Encapsulation _____

Step 6 Enter the command `show interface serial 0` on Tokyo

```
Tokyo#show interface serial 0
```

Encapsulation _____

Step 7 Verify that the serial connection is functioning by pinging the serial interface of the other router

```
Madrid#ping 192.168.15.2

Tokyo#ping 192.168.15.1
```

If the pings are unsuccessful, troubleshoot the router configurations to find the error. Then do the pings again until both pings are successful.

Step 8 Configure PPP authentication

Configure the username and password on the Madrid router. The passwords must be the same on both routers. The username must reflect the other routers hostname exactly. The password and user names are case sensitive:

```
Madrid(config)#username Tokyo password cisco
Madrid(config)#interface serial 0
Madrid(config-if)#ppp authentication chap
```

Step 9 Verify that the serial connection is functioning

a. Verify that the serial connection is functioning by pinging the serial interface of the other router:

```
Madrid#ping 192.168.15.2
```

b. Is the ping successful? _____

c. Why? _____

Step 10 Configure PPP authentication

Configure the username and password on the Tokyo router. The passwords must be the same on both routers. The username must reflect the other routers hostname exactly. The password and user names are case sensitive:

```
Tokyo(config)#username Madrid password cisco
Tokyo(config)#interface serial 0
Tokyo(config-if)#ppp authentication chap
```

Step 11 Verify that the serial connection is functioning

a. Verify that the serial connection is functioning by pinging the serial interface of the other router:

```
Tokyo#ping 192.168.15.1
```

b. Is the ping successful? _____

c. Why? _____

Upon completion of the previous steps, finish the lab by doing the following:

- Logoff by typing `exit`

- Turn the router off

- Remove and store the cables and adapter

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router(config)#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```

Press **Enter**.

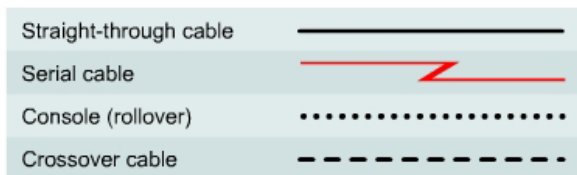Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)

In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.

Lab 3.3.4 Verifying PPP Configuration
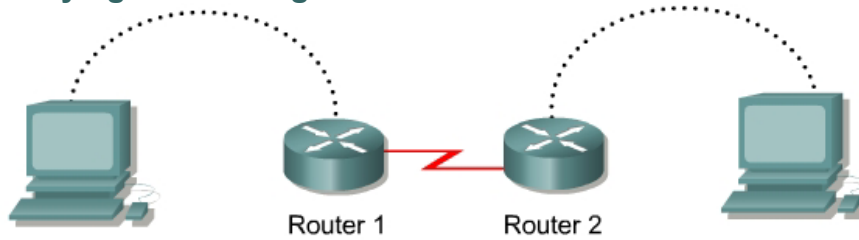
Router Designation	Router Name	Interface Type	Serial 0 Address	Subnet Mask	Enable Secret Password	Enable/VTY/ Console Passwords
Router 1	Brasilia	DCE	192.168.15.1	255.255.255.0	class	cisco
Router 2	Warsaw	DTE	192.168.15.2	255.255.255.0	class	cisco

Straight-through cable	———————
Serial cable	—————⚡———
Console (rollover)	••••••••••••••••••••
Crossover cable	– – – – – – – – – •

Objective

- Configure a serial interface on two routers with the PPP protocol.
- Verify and test the link for connectivity.

Background/Preparation

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers
- 1600 series routers
- 1700 series routers
- 2500 series routers
- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure all of the following according to the chart:

- The hostname

- The console password

- The virtual terminal password

- The enable secret password

If problems occur during this configuration, refer to Lab 1.1.4a Configuring NAT.

Step 2 Configure the Warsaw interface as shown

Configure the Warsaw router serial interface as follows:

```
Warsaw(config)#interface serial 0
Warsaw(config-if)#ip address 192.168.15.2 255.255.255.0
Warsaw(config-if)#no shutdown
Warsaw(config-if)#exit
Warsaw(config)#exit
```

Step 3 Configure the Brasilia interface as shown

Configure the Brasilia router serial interface as follows:

```
Brasilia(config)#interface serial 0
Brasilia(config-if)#ip address 192.168.15.1 255.255.255.0
Brasilia(config-if)#clock rate 64000
Brasilia(config-if)#no shutdown
Brasilia(config-if)#exit
Brasilia(config)#exit
```

Step 4 Save the configuration

```
Brasilia#copy running-config startup-config
```

```
Warsaw#copy running-config startup-config
```

Step 5 Enter the command `show interface serial 0` (refer to interface chart) on Brasilia

```
Brasilia#show interface serial 0
```

This will show the details of interface serial 0.

Encapsulation _____

Step 6 Enter the command `show interface serial 0` (refer to interface chart) on Warsaw

```
Warsaw#show interface serial 0
```

This will show the details of interface serial 0.

Encapsulation _____

Step 7 Turn on PPP debugging

Turn on the PPP debug function on both routers by typing `debug ppp tasks` at the privileged EXEC mode prompt.

Step 8 Change the encapsulation type

a. Change the encapsulation type to PPP by typing `encapsulation ppp` at the interface serial 0 configuration mode prompt on both routers.

```
Brasilia(config-if)#encapsulation ppp

Warsaw(config-if)#encapsulation ppp
```

b. What did the debug function report when the PPP encapsulation was applied to each router?

_____

c. Turn off the debug function by typing `undebug all` at the privileged EXEC mode prompt.

Step 9 Enter the command `show interface serial 0` on Brasilia

```
Brasilia#show interface serial 0
```

Encapsulation _____

Step 10 Enter the command `show interface serial 0` on Warsaw

```
Warsaw#show interface serial 0
```

Encapsulation _____

Step 11 Verify that the serial connection is functioning

a. Ping the other router to verify that there is connectivity between the two routers.

```
Brasilia#ping 192.168.15.2

Warsaw#ping 192.168.15.1
```

b. Can the serial interface on the Warsaw router be pinged from Brasilia? _____

c. Can the serial interface on the Brasilia router be pinged from Warsaw? _____

d. If the answer is no for either question, troubleshoot the router configurations to find the error. Then do the pings again until the answer to both questions is yes.

Upon completion of the previous steps, finish the lab by doing the following:

*   Logoff by typing `exit`

*   Turn the router off

*   Remove and store the cables and adapter

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router(config)#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```

Press **Enter**.

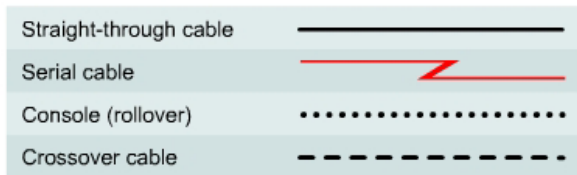Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)

In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in IOS command to represent the interface.

Lab 3.3.5 Troubleshooting PPP Configuration
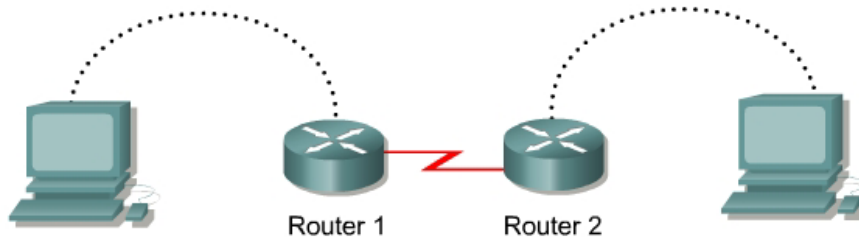
Router Designation	Router Name	Interface Type	Serial 0 Address	Subnet Mask	Enable Secret Password	Enable/VTY/ Console Passwords
Router 1	London	DCE	192.168.15.1	255.255.255.0	class	cisco
Router 2	Paris	DTE	192.168.15.2	255.255.255.0	class	cisco

Straight-through cable	———————
Serial cable	——————Z———
Console (rollover)	••••••••••••••••••••
Crossover cable	– – – – – – – – – •

Objective

- Configure PPP on the serial interfaces of two routers.
- Use `show` and `debug` commands to troubleshoot connectivity issues.

Background/Preparation

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers
- 1600 series routers
- 1700 series routers
- 2500 series routers
- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure all of the following according to the chart:

- The hostname

- The console password

- The virtual terminal password

- The enable secret password

If problems occur during this configuration, refer to Lab 1.1.4a Configuring NAT.

Step 2 Configure the Paris interface as shown

Configure the Paris router serial interface as follows:

```
Paris(config)#interface serial 0
Paris(config-if)#ip address 192.168.15.2 255.255.255.0
Paris(config-if)#clock rate 56000
Paris(config-if)#exit
Paris(config)#exit
```

Step 3 Configure the London interface as shown

Configure the London router serial interface as follows:

```
London(config)#interface serial 0
London(config-if)#ip address 192.168.15.1 255.255.255.0
London(config-if)#encapsulation ppp
London(config-if)#no shutdown
London(config-if)#exit
London(config)#exit
```

Step 4 Save the configuration

```
London#copy running-config startup-config
```

```
Paris#copy running-config startup-config
```

Step 5 Enter the command `show interface serial 0` (refer to interface chart) on London

```
London#show interface serial 0
```

This will show the details of interface serial 0.

a. List the following information discovered from issuing this command.

b. Serial 0 is _____, line protocol is_____.

c. What type of problem is indicated in the last statement? _____

_____

d. Internet address is _____.

e. Encapsulation _____

Step 6 Enter the command `show interface serial 0` (refer to interface chart) on Paris

```
Paris#show interface serial 0
```

This will show the details of interface serial 0.

a. List the following information discovered from issuing this command.

b. Serial 0 is _____ , line protocol is_____ .

c. Internet address is _____ .

d. Encapsulation _____

e. To what OSI layer is the "Encapsulation" referring? _____

f. If the Serial interface was configured, why did the **`show interface serial 0`** output show that the interface is down?

_____

Step 7 Correct the clock location

The clock rate statement has been placed on the wrong interface. It is currently placed on the Paris router, but the London router is the Data Communications Equipment (DCE). Remove the clock rate statement from the Paris router using the **`no`** version of the command and then add it to the London routers configuration.

Step 8 Enter the command `show cdp neighbors` on London

a. Is there any output from the command? _____

b. Should there be output? _____

Step 9 Enter the command `debug ppp negotiation` on London

a. It may take 60 seconds or more before output occurs.

b. Is there output? _____

c. What is the output saying? _____

d. Is there a problem with PPP encapsulation on the London router or the Paris router?

_____

e. Why? _____

f. What were the encapsulations listed for the interfaces?

London? _____ Paris? _____

g. Is there an issue with the above statement? _____

h. What is the issue? _____

Step 10 Enter the command `debug ppp negotiation` on the Paris router

a. Enter the command **`debug ppp negotiation`** on the Paris router at the privileged EXEC mode prompt.

b. Is there any output from the **`debug`** command? _____

Step 11 Correct the encapsulation type

a.   Convert the encapsulation to PPP on the Paris router.

b.   Is there any output from the `debug` command? _____

c.   Does it confirm link establishment? _____

Step 12 Enter the command `show interface serial 0` on Paris

```
Paris#show interface serial 0
```

a.   Serial 0 is _____, line protocol is _____.

b.   Encapsulation _____

c.   What is the difference in the Line and Protocol status recorded on Paris earlier? Why?

_____

Step 13 Verify that the serial connection is functioning by pinging the serial interface of the other router

```
London#ping 192.168.15.2

Paris#ping 192.168.15.1
```

a.   From London, can the serial interface ping the Paris router? _____

b.   From Paris, can the serial interface ping the London router? _____

c.   If the answer is no for either question, troubleshoot the router configurations to find the error. Then do the pings again until the answer to both questions is yes.

Upon completion of the previous steps, finish the lab by doing the following:

*   Logoff by typing `exit`

*   Turn the router off

*   Remove and store the cables and adapter

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router(config)#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```

Press **Enter**.

Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	**Ethernet Interface #1**	**Ethernet Interface #2**	**Serial Interface #1**	**Serial Interface #2**
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)
In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.				

Lab 4.2.1 Configuring ISDN BRI (U-Interface)
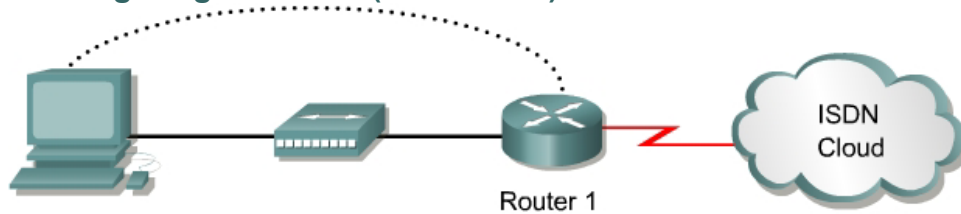
Router 1

Router Designation	Router Name	Enable Secret Password	Passwords	FastEthernet 0 Address/ Subnet Mask	BRI 0 Address	Adtran Connection
Router 1	Ottawa	class	cisco	192.168.14.1/24	NA	BRI 1

Straight-through cable	———————
Serial cable	———————
Console (rollover)	··················
Crossover cable	– – – – – – – – ·

Objective

• Configure an ISDN router to make a successful connection to a local ISDN switch.

Background/Preparation

This lab assumes that a router with an ISDN BRI U interface is available. An Adtran Atlas550 ISDN emulator is used to simulate the ISDN switch and cloud. If an ISDN router is not available, review the lab and perform as many noninterface commands as possible.

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

• 800 series routers

• 1600 series routers

• 1700 series routers

• 2500 series routers

• 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure all of the following according to the chart:

- The hostname
- The console password
- The virtual terminal password
- The enable secret password

Step 2 Verifying the ISDN BRI switch type

a. Not all ISDN switch types are the same worldwide and the first step is to configure the following:

- The ISDN TE1 device
- The router
- What ISDN switch type is in use

This information will be provided by the ISDN telco provider. In this case, the ISDN Switch type, supported by the Adtran simulator, is National ISDN-1, North America. It is configured, on the router, using the keyword `basic-ni`. To check the ISDN BRI status, issue the following command before issuing any configuration commands:

```
Ottawa#show isdn status
```

b. What is the Layer 1 status?

_____

c. What is the ISDN switch type? _____

Step 3 Specifying the switch type

a. To specify the ISDN switch type use the `isdn switch-type` command at the global configuration mode prompt. The different switch types available may be reviewed using the `isdn switch-type ?` command:

```
Ottawa#configure terminal
Ottawa(config)#isdn switch-type ?
```

b. How many different switch types are available? _____

c. To configure the router to communicate with a National ISDN-1 switch type:

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

Step 4 Verifying switch status

a. Check the state of the ISDN Interface again.

```
Ottawa#show isdn status
```

b. What is the Layer 1 status?

_____

---

c. What is the ISDN switch type? _____

Step 5 Activate the BRI connection

Activate the ISDN BRI using the `no shutdown` command at the interface configuration prompt.

```
Ottawa#configure terminal
Ottawa(config)#interface bri 0
Ottawa(config-if)#no shutdown
```

Step 6 Review switch status

a. At this stage the ISDN BRI should be physically active and one TEI should have been negotiated.

```
Ottawa#show isdn status
```

a. What is the Layer 1 status?

_____

b. What is the ISDN switch type? _____

c. Has the Layer 2 status changed? _____

Step 7 Configuring ISDN SPIDs

Depending on region, ISDN service profile identifiers (SPIDs) may have to be specified for the ISDN Switch to respond to the ISDN TE1 correctly. The SPIDs, supported by the Adtran simulator, are specified as `isdn spid1` and `isdn spid2`. To configure the SPIDs issue the following commands:

```
Ottawa(config)#interface bri 0
Ottawa(config-if)#isdn spid1 51055510000001 5551000
Ottawa(config-if)#isdn spid2 51055510010001 5551001
```

Step 8 Review switch status

a. Check the state of the ISDN Interface again:

```
Ottawa#show isdn status
```

b. What does the output specify about spid1? _____

c. What does the output specify about spid2? _____

d. Careful examination of this output shows that the assigned SPID values have not been sent to the ISDN switch and verified. The reason for this is that they were specified after the ISDN interface was enabled. To send the SPID values the interface must be reset.

Step 9 Resetting the interface

a. To manually reset the ISDN BRI interface issue the command `clear interface bri 0.` This will cause all ISDN parameters to be renegotiated. Issue the clear command on the router and then check the ISDN interface status. SPID1 and SPID2 will now be sent and validated:

```
Ottawa#clear interface bri 0
```

```
        Ottawa#show isdn status
```

b. Have SPID1 and SPID2 been sent and verified?

_____

Step 10 Save the configuration and reboot

a. Save the configuration and reboot the router. This time, verify that the ISDN Interface has correctly negotiated with the ISDN switch. Review activity on the ISDN Interface using the **show isdn active** command:

```
        Ottawa#copy running-config startup-config
        Ottawa#reload
        Ottawa#show isdn active
```

b. The history table has a maximum of how many entries?

_____

c. History table data is retained for how long?

_____

Upon completion of the previous steps, finish the lab by doing the following:

• Logoff by typing **exit**

• Turn the router off

• Remove and store the cables and adapter

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router(config)#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```

Press **Enter**.

Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)

In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.

Lab 4.3.2 Configuring Legacy DDR
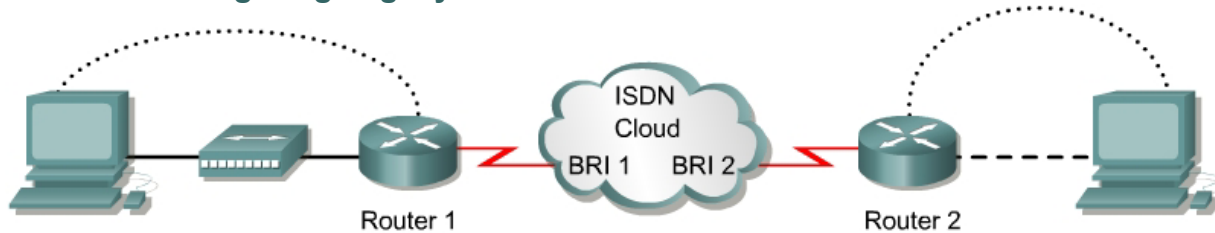
Router Designation	Router Name	Enable Secret Password	Passwords	FastEthernet 0 Address/Subnet Mask
Router 1	Tokyo	class	cisco	192.168.1.1/24
Router 2	Moscow	class	cisco	192.168.2.1/24

Router Designation	Router Name	SPID Numbers	Phone Numbers	Adtran Connection
Router 1	Tokyo	51055510000001 51055510010001	5551000 5551001	BRI 1
Router 2	Moscow	51055520000001 51055520010001	5552000 5552001	BRI 2

Straight-through cable	————————
Serial cable	———⚡———
Console (rollover)	•••••••••••••••••••••
Crossover cable	– – – – – – – – –

Objective

- Configure an ISDN router to make a legacy dial-on-demand routing (DDR) call to another ISDN capable router.

- When the DDR connection is successfully made, augment the configuration to specify that only http traffic will bring up the link.

Background/Preparation

In this lab, 2 ISDN routers are required. If ISDN routers are not available, review the lab to become familiar with the process. An Adtran Atlas550 ISDN emulator is used to simulate the switch/ISDN cloud.

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers

- 1600 series routers

- 1700 series routers

- 2500 series routers

- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure all of the following according to the chart:

- The hostname

- The console password

- The virtual terminal password

- The enable secret password

Step 2 Define switch type and spid numbers

The switch type and spid numbers need to be specified on the routers.

```
Router(config)#hostname Tokyo
Tokyo(config)#enable secret class
Tokyo(config)#isdn switch-type basic-ni
Tokyo(config)#interface fastethernet 0
Tokyo(config-if)#ip address 192.168.1.1 255.255.255.0
Tokyo(config-if)#no shutdown
Tokyo(config-if)#exit
Tokyo(config)#interface bri 0
Tokyo(config-if)#isdn spid1 51055510000001 5551000
Tokyo(config-if)#isdn spid2 51055510010001 5551001
Tokyo(config-if)#no shutdown

Router(config)#hostname Moscow
Moscow(config)#enable secret class
Moscow(config)#isdn switch-type basic-ni
Moscow(config)#interface fastethernet 0
Moscow(config-if)#ip address 192.168.2.1 255.255.255.0
Moscow(config-if)#no shutdown
Moscow(config-if)#exit
Moscow(config)#interface bri 0
Moscow(config-if)#isdn spid1 51055520000001 5552000
Moscow(config-if)#isdn spid2 51055520010001 5552001
Moscow(config-if)#no shutdown
```

Step 3 Defining static routes for DDR

a. Use static and default routes instead of dynamic routing, in order to reduce the cost of the dialup connection. To configure a static route, the network address of the network to be reached must be known. The IP address of the next router on the path to this destination must be known as well.

```
Moscow#configure terminal
Moscow(config)#ip route 192.168.1.0 255.255.255.0 192.168.3.1

Tokyo#configure terminal
Tokyo(config)#ip route 0.0.0.0 0.0.0.0 192.168.3.2
```

b. Perform a show IP route to verify routes exist.

Step 4 Specifying interesting traffic for DDR

Specify the traffic that will cause the DDR interface to dialup the remote router. For the moment, declare that all IP traffic is interesting. This is done using the `dialer-list` command:

```
Tokyo#configure terminal
Tokyo(config)#dialer-list 1 protocol ip permit
Tokyo(config)#interface bri 0
Tokyo(config-if)#dialer-group 1
Tokyo(config-if)#end
```

Step 5 Configuring DDR dialer information

a. Configure the correct dialer information so that the dialer profile and dialer interface function correctly. This includes all of the following:

- IP address information

- PPP configuration

- Name

- Passwords

- Dial number

```
Tokyo#configure terminal
Tokyo(config)#interface bri 0
Tokyo(config-if)#ip address 192.168.3.1 255.255.255.0
```

b. Configure the PPP information:

```
Tokyo#configure terminal
Tokyo(config)#username Moscow password class
Tokyo(config)#interface bri 0
Tokyo(config-if)#encapsulation ppp
Tokyo(config-if)#ppp authentication chap
```

c. Configure the dial information:

```
Tokyo#configure terminal
Tokyo(config)#interface bri 0
Tokyo(config-if)#dialer idle-timeout 120
Tokyo(config-if)#dialer map ip 192.168.3.2 name Moscow 5552000
```

Step 6 Configuring DDR Dialer Information

```
Moscow#configure terminal
Moscow(config)#dialer-list 1 protocol ip permit
Moscow(config)#username Tokyo password class
Moscow(config)#interface bri 0
Moscow(config-if)#ip address 192.168.3.2 255.255.255.0
Moscow(config-if)#dialer-group 1
Moscow(config-if)#encapsulation ppp
```

```
Moscow(config-if)#ppp authentication chap
Moscow(config-if)#dialer idle-timeout 120
Moscow(config-if)#dialer map ip 192.168.3.1 name Tokyo 5551000
```

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router(config)#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```

Press **Enter**.

Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)

In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.

Lab 4.3.7 Configuring Dialer Profiles
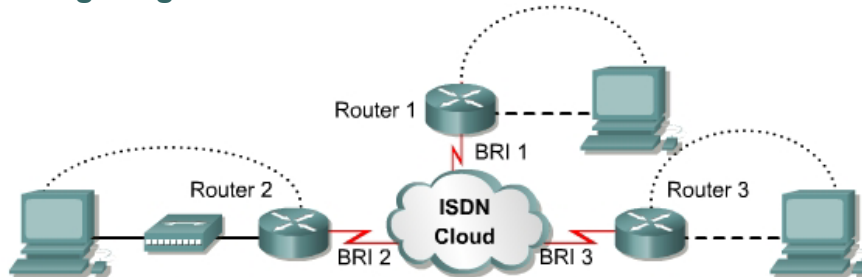
Router Designation	Router Name	Enable Secret Password	Passwords	FastEthernet 0 Address/Subnet Mask
Router 1	Tokyo	class	cisco	192.168.1.1/24
Router 2	Moscow	class	cisco	192.168.2.1/24
Router 3	Sydney	class	cisco	192.168.3.1/24

Router Designation	Router Name	SPID Numbers	Phone Numbers	Adtran Connection
Router 1	Tokyo	51055510000001 51055510010001	5551000 5551001	BRI 1
Router 2	Moscow	51055520000001 51055520010001	5552000 5552001	BRI 2
Router 3	Sydney	51055530000001 51055530010001	5553000 5553001	BRI 3

Straight-through cable —————— Console (rollover) ••••••••••••••••••••

Serial cable Crossover cable – – – – – – – – – •

Objective

- Configure ISDN Dialer Profiles on the routers enabling a dial-on-demand routing (DDR) call to be made from two remote routers simultaneously into a central ISDN BRI router.

Background/Preparation

In this lab, 3 ISDN routers are required. If ISDN routers are not available, review the lab to become familiar with the process. An Adtran Atlas550 ISDN emulator is used to simulate the switch/ISDN cloud.

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers

- 1600 series routers

- 1700 series routers

- 2500 series routers

- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the router

Configure the following according to the chart:

- The hostname

- The console password

- The virtual terminal password

- The enable secret password

If problems occur during this configuration, refer to Lab 1.1.4a Configuring NAT.

Step 2 Define switch type and spid numbers

To configure the switch type and spid numbers use the following commands.

```
Router(config)#hostname Tokyo
Tokyo(config)#enable secret class
Tokyo(config)#isdn switch-type basic-ni
Tokyo(config)#interface fastethernet 0
Tokyo(config-if)#ip address 192.168.1.1 255.255.255.0
Tokyo(config-if)#no shutdown
Tokyo(config-if)#exit
Tokyo(config)#interface bri 0
Tokyo(config-if)#isdn spid1 51055510000001 5551000
Tokyo(config-if)#isdn spid2 51055510010001 5551001
Tokyo(config-if)#no shutdown

Router(config)#hostname Moscow
Moscow(config)#enable secret class
Moscow(config)#isdn switch-type basic-ni
Moscow(config)#interface fastethernet 0
Moscow(config-if)#ip address 192.168.2.1 255.255.255.0
Moscow(config-if)#no shutdown
Moscow(config-if)#exit
Moscow(config)#interface bri 0
Moscow(config-if)#isdn spid1 51055520000001 5552000
Moscow(config-if)#isdn spid2 51055520010001 5552001
Moscow(config-if)#no shutdown

Router(config)#hostname Sydney
Sydney(config)#enable secret class
Sydney(config)#isdn switch-type basic-ni
Sydney(config)#interface fastethernet 0
Sydney(config-if)#ip address 192.168.3.1 255.255.255.0
Sydney(config-if)#no shutdown
Sydney(config-if)#exit
Sydney(config)#interface bri 0
Sydney(config-if)#isdn spid1 51055530000001 5553000
Sydney(config-if)#isdn spid2 51055530010001 5553001
Sydney(config-if)#no shutdown
```

Step 3 Defining static routes for DDR

Use static and default routes instead of dynamic routing, in order to reduce the cost of the dialup connection. To configure a static route, the network address of the network that is going to be reached must be known. The IP address of the next router on the path to this destination must be known as well.

```
Moscow#configure terminal
Moscow(config)#ip route 0.0.0.0 0.0.0.0 192.168.253.1

Sydney#configure terminal
Sydney(config)#ip route 0.0.0.0 0.0.0.0 192.168.254.1

Tokyo#configure terminal
Tokyo(config)#ip route 192.168.2.0 255.255.255.0 192.168.253.2
Tokyo(config)#ip route 192.168.3.0 255.255.255.0 192.168.254.2
```

Step 4 Specifying interesting traffic for DDR

Traffic must be defined as 'interesting' to cause the DDR interface to dialup the remote router. For the moment, declare that all IP traffic is interesting using the `dialer-list` command.

```
Moscow(config)#dialer-list 1 protocol ip permit
Moscow(config)#interface dialer 0
Moscow(config-if)#dialer-group 1

Sydney(config)#dialer-list 1 protocol ip permit
Sydney(config)#interface dialer 0
Sydney(config-if)#dialer-group 1

Tokyo#configure terminal
Tokyo(config)#dialer-list 1 protocol ip permit
Tokyo(config)#interface dialer 1
Tokyo(config-if)#description The Profile for the Moscow router
Tokyo(config-if)#dialer-group 1
Tokyo(config-if)#interface dialer 2
Tokyo(config-if)#description The Profile for the Sydney router
Tokyo(config-if)#dialer-group 1
```

Step 5 Configuring DDR dialer information

Configure the correct dialer information so that the dialer profile and dialer interface function correctly. This includes all of the following:

- IP address information

- PPP configuration

- Name

- Passwords

- Dial number

```
Tokyo(config)#interface dialer 1
Tokyo(config-if)#ip address 192.168.253.1 255.255.255.0
Tokyo(config-if)#interface dialer 2
Tokyo(config-if)#ip address 192.168.254.1 255.255.255.0
Tokyo(config-if)#interface bri 0
Tokyo(config-if)#encapsulation ppp
Tokyo(config-if)#ppp authentication chap
Tokyo(config-if)#interface dialer 1
Tokyo(config-if)#encapsulation ppp
Tokyo(config-if)#ppp authentication chap
Tokyo(config-if)#interface dialer 2
Tokyo(config-if)#encapsulation ppp
Tokyo(config-if)#ppp authentication chap
Tokyo(config-if)#exit
Tokyo(config)#username Moscow password class
Tokyo(config)#username Sydney password class

Moscow(config)#interface dialer 0
Moscow(config-if)#ip address 192.168.253.2 255.255.255.0
Moscow(config-if)#interface bri 0
Moscow(config-if)#encapsulation ppp
Moscow(config-if)#ppp authentication chap
Moscow(config-if)#interface dialer 0
Moscow(config-if)#encapsulation ppp
Moscow(config-if)#ppp authentication chap
Moscow(config-if)#no shutdown
Moscow(config-if)#exit
Moscow(config)#username Tokyo password class

Sydney(config)#interface dialer 0
Sydney(config-if)#ip address 192.168.254.2 255.255.255.0
Sydney(config-if)#interface bri 0
Sydney(config-if)#encapsulation ppp
Sydney(config-if)#ppp authentication chap
Sydney(config-if)#interface dialer 0
Sydney(config-if)#encapsulation ppp
Sydney(config-if)#ppp authentication chap
Sydney(config-if)#no shutdown
Sydney(config-if)#exit
Sydney(config)#username Tokyo password class
```

Step 6 Configure dialer information

a. Next, the dial information must be configured to specify the remote name of the remote router in the Dialer Profile. The dial string, or phone number to use to contact this remote device must also be specified. Use the following commands to do this:

```
Tokyo(config)#interface dialer 1
Tokyo(config-if)#dialer remote-name Moscow
Tokyo(config-if)#dialer string 5552000
Tokyo(config-if)#dialer string 5552001
Tokyo(config-if)#interface dialer 2
Tokyo(config-if)#dialer remote-name Sydney
Tokyo(config-if)#dialer string 5553000
Tokyo(config-if)#dialer string 5553001
```

b. To configure the dial information on Moscow, use the following:

```
Moscow(config-if)#interface dialer 0
Moscow(config-if)#dialer remote-name Tokyo
Moscow(config-if)#dialer string 5551000
Moscow(config-if)#dialer string 5551001
```

c. To configure the dial information on Sydney, use the following:

```
Sydney(config-if)#interface dialer 0
Sydney(config-if)#dialer remote-name Tokyo
Sydney(config-if)#dialer string 5551000
Sydney(config-if)#dialer string 5551001
```

Step 7 Associate dialer profiles

a. Finally, associate the Dialer Profiles with the Dialer Interfaces that will be used, when needed. Create a Dialer Pool, and put the interfaces and the associated Dialer Profiles in a common pool. The commands for doing this are as follows:

```
Tokyo(config-if)#interface bri 0
Tokyo(config-if)#dialer pool-member 1
Tokyo(config-if)#interface dialer 1
Tokyo(config-if)#dialer pool 1
Tokyo(config-if)#interface dialer 2
Tokyo(config-if)#dialer pool 1
```

b. On Moscow, the commands issued would be as follows:

```
Moscow(config-if)#interface bri 0
Moscow(config-if)#dialer pool-member 1
Moscow(config-if)#interface dialer 0
Moscow(config-if)#dialer pool 1
```

c. Use the same commands to configure the Sydney router.

Step 8 Configure dialer timeouts

a. Configure a `dialer idle-timeout` of 60 seconds for each of the dialer interfaces:

```
Tokyo(config)#interface dialer 1
Tokyo(config-if)#dialer idle-timeout 60
Tokyo(config-if)#interface dialer 2
Tokyo(config-if)#dialer idle-timeout 60
```

b. Repeat these commands on Moscow and Sydney.

Step 9 View the Tokyo router configuration

a. To view the configuration, use the `show running-config` command:

   Tokyo#`show running-config`

b. How many username statements are there?

   _____

c. What authentication type is being used for PPP?

   _____

d. Which sections of the configuration list the authentication type?

   _____

e. What are the dialer strings on the Tokyo router?

   _____

Step 10 Verifying the DDR Configuration

a. Now, generate some interesting traffic across the DDR link from Moscow and Sydney to verify that connections are made correctly and the dialer profiles are functioning:

   Moscow#`ping 192.168.1.1`

b. Were the pings successful?

   _____

c. If not troubleshoot the router configurations.

d. What other information was displayed when the ping was issued?

   _____

   Sydney#`ping 192.168.1.1`

e. Were the pings successful?

   _____

f. If the pings were not successful troubleshoot the router configurations.

g. Use the `show dialer` command to see the reason for the call. This information is shown for each channel:

   Tokyo#`show dialer`

h. Which dialer strings are associated with Dialer1?_____

i. What is the last status for dial string 5553000 in the Dialer2 readout? _____

j. Use the `show interface` command and note that the output shows that the interface is spoofing. This provides a mechanism for the interface to simulate an active state for internal processes, such as routing, on the router. The `show interface` command can also be used to display information about the B channel:

```
Tokyo#show interface bri 0
```

Upon completion of the previous steps, finish the lab by doing the following:

- Logoff by typing `exit`

- Turn the router off

- Remove and store the cables and adapter

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router(config)#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```

Press **Enter**.

Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)
In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.				

Lab 5.2.1 Configuring Frame Relay
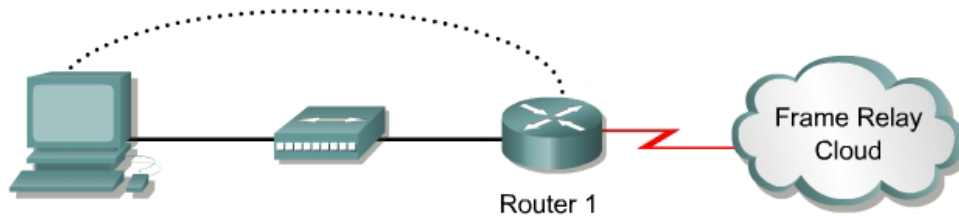
Router 1

Router Designation	Router Name	Enable Secret Password	Passwords	FastEthernet 0 Address/ Subnet Mask	Serial 0 Address	Adtran Connection
Router 1	Cork	class	cisco	192.168.14.1/24	NA	1/1

Straight-through cable	———————
Serial cable	—————⚡———
Console (rollover)	··················
Crossover cable	– – – – – – – ·

Objective

Configure a router to establish a connection to a local Frame Relay switch/cloud.

Background/Preparation

An Adtran Atlas550 Frame Relay emulator is used to simulate the Frame Relay switch/cloud.

The Cork Wholesale Food Company has just had a Frame Relay circuit installed to its local central office (CO) by the telco carrier. The network administrator must confirm that the router and Frame Relay switch are able to successfully communicate.

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers

- 1600 series routers

- 1700 series routers

- 2500 series routers

- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure the following according to the chart:

- The hostname
- The console password
- The virtual terminal password
- The enable secret password

If problems occur during this configuration, refer to Lab 1.1.4a Configuring NAT.

Step 2 Configuring the serial interface

a. In Frame Relay, the customer router is considered the DTE device. In order to configure the serial interface, the Layer 2 Frame Relay frame type must be defined. To configure the frame type, use the following commands:

```
Cork#configure terminal
Cork(config)#interface serial 0
Cork(config-if)#encapsulation frame-relay ietf
```

b. Next the format of the Frame Relay management protocol must be configured. To configure the Local Management Interface (LMI) type, use the following commands:

```
Cork(config-if)#frame-relay lmi-type ansi
Cork(config-if)#no shutdown
Cork(config-if)#end
```

Step 3 Verifying the Frame Relay configuration

a. To verify the configuration, use the `show interfaces` commands, related to Frame Relay. To view the serial interface configuration use the following command:

```
Cork#show interfaces serial 0
```

b. What is the state of the interface? Serial 0 is _____, line protocol is _____.

c. What is the encapsulation type?

_____

d. What state is the DTE LMI in?

_____

e. What is the LMI type?

_____

Step 4 Reviewing switch assignments

a. To verify that the data-link connection identifiers (DLCIs) are defined on the switch use `show frame-relay pvc`. The DLCIs are learned by the router via LMI, and can be viewed with the following command:

```
Cork#show frame-relay pvc
```

b. What DLCI numbers are available on the switch?

_____

c. What is the PVC status of the first DLCI?

_____

Step 5 Check the Frame Relay map

```
Cork#show frame-relay map
```

This output shows that none of the DLCIs, defined on the switch, are in use. The permanent virtual circuit (PVC) is inactive and there is no current mapping between the Layer 2 DLCI and Layer 3 IP address as seen in the `show frame-relay map` command.

Upon completion of the previous steps, finish the lab by doing the following:

- Logoff by typing **exit**
- Turn the router off
- Remove and store the cables and adapter

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:
```
Erase of nvram: complete
```
Now at the privileged EXEC mode, enter the command **reload**

```
Router#reload
```

The responding line prompt will be:
```
System configuration has been modified. Save? [yes/no]:
```
Type **n** and then press **Enter**.

The responding line prompt will be:
```
Proceed with reload? [confirm]
```
Press **Enter** to confirm.

In the first line of the response will be:
```
Reload requested by console.
```
After the router has reloaded the line prompt will be:
```
Would you like to enter the initial configuration dialog? [yes/no]:
```
Type **n** and then press **Enter**.

The responding line prompt will be:
```
Press RETURN to get started!
```
Press **Enter**.

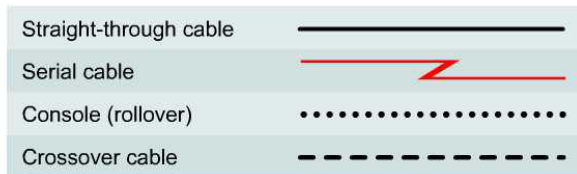Now the router is ready for the assigned lab to be performed.

| Router Interface Summary | | | | |
|---|---|---|---|---|
| Router Model | Ethernet Interface #1 | Ethernet Interface #2 | Serial Interface #1 | Serial Interface #2 |
| 800 (806) | Ethernet 0 (E0) | Ethernet 1 (E1) | | |
| 1600 | Ethernet 0 (E0) | Ethernet 1 (E1) | Serial 0 (S0) | Serial 1 (S1) |
| 1700 | FastEthernet 0 (FA0) | FastEthernet 1 (FA1) | Serial 0 (S0) | Serial 1 (S1) |
| 2500 | Ethernet 0 (E0) | Ethernet 1 (E1) | Serial 0 (S0) | Serial 1 (S1) |
| 2600 | FastEthernet 0/0 (FA0/0) | FastEthernet 0/1 (FA0/1) | Serial 0/0 (S0/0) | Serial 0/1 (S0/1) |

In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.

## Lab 5.2.2 Configuring Frame Relay PVC
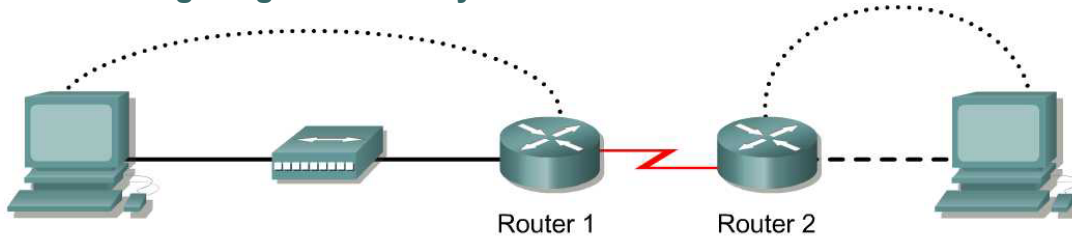


Router 1    Router 2

| Router Designation | Router Name | Interface Type | Serial 0 Address | FastEthernet 0 Address/Subnet Mask | DLCI Number | Enable Secret Password | Enable/VTY/ Console Passwords |
|---|---|---|---|---|---|---|---|
| Router 1 | Washington | DCE | 192.168.1.1/24 | 192.168.3.1/24 | 102 | class | cisco |
| Router 2 | Dublin | DTE | 192.168.1.2/24 | 192.168.2.1/24 | 102 | class | cisco |

| | |
|---|---|
| Straight-through cable | |
| Serial cable | |
| Console (rollover) | |
| Crossover cable | |

### Objective

- Configure two routers back-to-back as a Frame Relay permanent virtual circuit (PVC). This will be done manually, in the absence of a Frame Relay switch, and therefore there will be no Local Management Interface (LMI).

### Background/Preparation

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers

- 1600 series routers

- 1700 series routers

- 2500 series routers

- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

**Note:** Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

## Step 1 Configure the routers

Configure the following according to the chart:

- The hostname

- The console password

- The virtual terminal password

- The enable secret password

- The Fast Ethernet interface

If problems occur during this configuration, refer to Lab 1.1.4a Configuring NAT.

## Step 2 Configuring the Washington serial interface

First, define the Frame Relay frame type to be used on this link. To configure the encapsulation type, use the command **encapsulation frame-relay ietf**. Disable keepalive messages since there is no Frame Relay switch in this configuration and consequently no Frame Relay DCE:

```
Washington#configure terminal
Washington(config-if)#interface serial 0
Washington(config-if)#encapsulation frame-relay ietf
Washington(config-if)#no keepalive
Washington(config-if)#ip address 192.168.1.1 255.255.255.0
Washington(config-if)#no shutdown
```

Step 3 Configure the Frame Relay map on Washington

a. When sending an Ethernet frame to a remote IP address, the remote MAC address must be discovered, so that the correct frame type can be constructed. Frame Relay needs a similar mapping.

b. The remote IP address needs to be mapped to the local DLCI (Layer 2 address), so the correctly addressed frame can be created locally for this PVC. Since there is no way of mapping the DLCI automatically with LMI disabled, this map must be created manually, using the **frame-relay map** command. The **broadcast** parameter also allows for IP broadcasts to use the same mapping for crossing this PVC:

```
Washington(config-if)#frame-relay map ip 192.168.1.2 201 ietf broadcast
```

Step 4 Configure the DCE on Washington

In this configuration, when DCE cables are used, a clock signal is necessary. The **bandwidth** command is optional, but wise to use to verify bandwidth transmission. Another option is to title the connection using the **description** command. It is very useful to record information in the description about the PVC, such as remote contact person and the leased line circuit identifier:

```
Washington(config-if)#clock rate 64000
Washington(config-if)#bandwidth 64
Washington(config-if)#description PVC to Dublin, DLCI 201, Circuit
#DASS465875, Contact John Tobin (061-8886745)
```

Step 5 Configure Dublin router

Configure the Dublin router using the following commands.

```
Dublin#configure terminal
Dublin(config-if)#interface serial 0
Dublin(config-if)#encapsulation frame-relay ietf
Dublin(config-if)#no keepalive
Dublin(config-if)#no shutdown
Dublin(config-if)#ip address 192.168.1.2 255.255.255.0
Dublin(config-if)#frame-relay map ip 192.168.1.1 201 ietf broadcast
Dublin(config-if)#bandwidth 64
Dublin(config-if)#description PVC to Washington, DLCI 201, Circuit
#DASS465866 Contact Pat White (091-6543211)
```

Step 6 Verifying Frame Relay PVC

a. On the Washington router, type the command `show frame-relay pvc`:

```
Washington#show frame-relay pvc
```

b. What is the DLCI number reported?

_____

c. What is the PVC status?

_____

d. What is the value of the DLCI USAGE?

_____

Step 7 Showing Frame Relay map

a. To view the Layer 2 to Layer 3 mapping, use the `show frame-relay map` command at the privileged EXEC mode prompt:

```
Washington#show frame-relay map
```

b. What is the IP address shown?

_____

c. What state is interface serial 0 in?

_____

Step 8 Verify Frame Relay connectivity

a. From the Washington router, ping the Dublin router serial interface.

b. Was the ping successful?

_____

c. If the ping was not successful, troubleshoot the router configurations.

Upon completion of the previous steps, finish the lab by doing the following:

- Logoff by typing `exit`

- Turn the router off

- Remove and store the cables and adapter

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```

Press **Enter**.

Now the router is ready for the assigned lab to be performed.

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)
In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.				

Lab 5.2.5 Configuring Frame Relay Subinterfaces
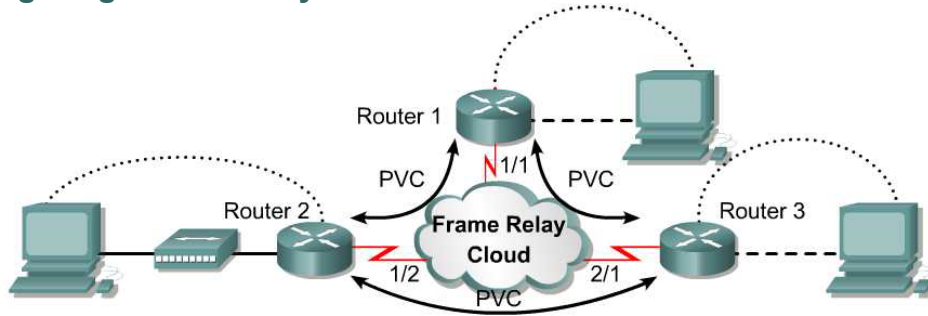
Router Designation	Router Name	Interface Type	Serial 0 Address	DLCI Number	FastEthernet 0 Address/Subnet Mask	Routing Protocol	Enable Secret Password	Enable/ VTY/ Console Passwords
Router 1	Amsterdam	DTE	192.168.4.1/24 192.168.5.1/24	102 103	192.168.1.1/24	IGRP 100	class	cisco
Router 2	Paris	DTE	192.168.4.2/24 192.168.6.1/24	201 203	192.168.2.1/24	IGRP 100	class	cisco
Router 3	Berlin	DTE	192.168.5.2/24 192.168.6.2/24	301 302	192.168.3.1/24	IGRP 100	class	cisco

Straight-through cable	———————
Serial cable	———Z———
Console (rollover)	••••••••••••••••••
Crossover cable	– – – – – – – – •

Objective

- Configure three routers in a full-mesh Frame Relay network.

Background/Preparation

An Adtran Atlas550 Frame Relay emulator is used to simulate the Frame Relay switch/cloud.

Cable a network similar to the one in the diagram above. Any router that meets the interface requirements displayed on the above diagram may be used. This includes the following and any of their possible combinations:

- 800 series routers

- 1600 series routers

- 1700 series routers

- 2500 series routers

- 2600 series routers

Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce slightly different output. Conduct the following steps on each router unless specifically instructed otherwise.

Start a HyperTerminal session.

Note: Refer to the erase and reload instructions at the end of this lab. Perform those steps on all routers in this lab assignment before continuing.

Step 1 Configure the routers

Configure the following according to the chart:

- The hostname

- The console password

- The virtual terminal password

- The enable secret password

- The Fast Ethernet interface according to the chart

If problems occur during this configuration, refer to Lab 1.1.4a Configuring NAT.

Step 2 Configure the Serial 0 Interfaces

a. First, the Frame Relay encapsulation type to be used on this link must be defined using the following commands:

```
Amsterdam#configure terminal
Amsterdam(config)#interface serial 0
Amsterdam(config-if)#encapsulation frame-relay ietf
Amsterdam(config-if)#frame-relay lmi-type ansi
```

b. Use a description field to store relevant information, such as the circuit number in case a line fault has to be reported:

```
Amsterdam(config-if)#description Circuit #KPN465555
Amsterdam(config-if)#no shutdown
```

c. The same commands are used to configure the Berlin and Paris routers:

```
Paris(config)#interface serial 0
Paris(config-if)#encapsulation frame-relay ietf
Paris(config-if)#frame-relay lmi-type ansi
Paris(config-if)#description Circuit #FRT372826
Paris(config-if)#no shutdown

Berlin(config)#interface serial 0
Berlin(config-if)#encapsulation frame-relay ietf
Berlin(config-if)#frame-relay lmi-type ansi
Berlin(config-if)#description Circuit #DTK465866
Berlin(config-if)#no shutdown
```

Step 3 Create subinterfaces on the Amsterdam router

For each of the permanent virtual circuits (PVCs), create a subinterface on the serial port. This subinterface will be a point-to-point configuration. For consistency and future troubleshooting, use the data-link connection identifier (DLCI) number as the subinterface number. The commands to create a subinterface are as follows:

```
Amsterdam(config-if)#interface serial 0.102 point-to-point
Amsterdam(config-if)#description PVC to Paris, DLCI 102, Contact Rick
Voight(+33-1-5534-2234) Circuit #FRT372826
Amsterdam(config-if)#ip address 192.168.4.1 255.255.255.0
Amsterdam(config-if)#frame-relay interface-dlci 102
Amsterdam(config-if)#interface serial 0.103 point-to-point
Amsterdam(config-if)#description PVC to Berlin, DLCI 103, Contact P
Wills(+49- 61 03 / 7 65 72 00) Circuit #DTK465866
Amsterdam(config-if)#ip address 192.168.5.1 255.255.255.0
Amsterdam(config-if)#frame-relay interface-dlci 103
```

Step 4 Create subinterfaces on the Paris router

To configure the subinterfaces on the Paris router, use the following commands:

```
Paris(config-if)#interface Serial 0.201 point-to-point
Paris(config-if)#description PVC to Amsterdam, DLCI 201, Contact Peter
Muller (+31 20 623 32 67) Circuit #KPN465555
Paris(config-if)#ip address 192.168.4.2 255.255.255.0
Paris(config-if)#frame-relay interface-dlci 201
Paris(config-if)#interface Serial 0.203 point-to-point
Paris(config-if)#description PVC to Berlin, DLCI 203, Contact Peter Willis
(+49- 61 03 / 7 66 72 00) Circuit #DTK465866
Paris(config-if)#ip address 192.168.6.1 255.255.255.0
Paris(config-if)#frame-relay interface-dlci 203
```

Step 5 Create subinterfaces on the Berlin router

To configure the subinterfaces on the Berlin router, use the following commands:

```
Berlin(config-if)#interface Serial 0.301 point-to-point
Berlin(config-if)#description PVC to Amsterdam, DLCI 301, Contact Peter
Muller (+31 20 623 32 67) Circuit #KPN465555
Berlin(config-if)#ip address 192.168.5.2 255.255.255.0
Berlin(config-if)#frame-relay interface-dlci 301
Berlin(config-if)#interface Serial 0.302 point-to-point
Berlin(config-if)#description PVC to Paris, DLCI 302, Contact Rick Voight
(+33-1-5534-2234) Circuit #FRT372826
Berlin(config-if)#ip address 192.168.6.2 255.255.255.0
Berlin(config-if)#frame-relay interface-dlci 302
```

Step 6 Configure IGRP routing

To configure the routing protocol Interior Gateway Routing Protocol (IGRP) 100, use the following configuration syntax:

```
Amsterdam(config-if)#router igrp 100
Amsterdam(config-router)#network 192.168.1.0
Amsterdam(config-router)#network 192.168.4.0
Amsterdam(config-router)#network 192.168.5.0

Paris(config-if)#router igrp 100
Paris(config-router)#network 192.168.2.0
Paris(config-router)#network 192.168.4.0
Paris(config-router)#network 192.168.6.0

Berlin(config-if)#router igrp 100
Berlin(config-router)#network 192.168.3.0
Berlin(config-router)#network 192.168.5.0
Berlin(config-router)#network 192.168.6.0
```

Step 7 Verifying Frame Relay PVC

a. On the Amsterdam router, issue the command **show frame-relay pvc**:

```
Amsterdam#show frame-relay pvc
```

b. How many active local PVCs are there? _____

c. What is the interface value? _____

d. What is the PVC status? _____

e. Which DLCI # is inactive? _____

f. From this it can be seen that there are three DLCIs defined on this Frame Relay circuit, and only two of them are in use. This is the way the Adtran 550 emulator has been configured. It is useful output, as it shows what would be seen if a DLCI is defined on the Frame Relay switch, but not configured on the router. The other DLCIs, 102 and 103, are ACTIVE and associated with their respective subinterfaces. It also shows that some packets have actually passed across the PVC.

Step 8 Show the Frame Relay maps

a. Look at the frame relay maps by typing the command **show frame-relay map** at the privileged EXEC mode prompt:

```
Amsterdam#show frame-relay map
```

b. What is the status of the links? _____

c. The DLCIs are defined as what type? _____

d. Are the DLCIs the same on the Paris router? _____

Step 9 Show LMIs

a. Look at the Local Management Interface (LMI) statistics using the `show frame-relay lmi` command:

```
Amsterdam#show frame-relay lmi
```

b. Which fields have non-zero counter values? _____

c. What is the LMI type? _____

Step 10 Check routing protocol

a. Use the `show ip route` command to verify that the PVCs are up and active:

```
Amsterdam#show ip route
```

b. Is the routing protocol working? _____

c. If not, troubleshoot the routers configurations.

d. List the IGRP routes _____ _____ _____

Step 11 Verify connectivity

a. Ping the fastethernet interfaces.

b. Were the pings successful? _____

c. If the pings were not successful, troubleshoot the router configurations and repeat this step.

Upon completion of the previous steps, finish the lab by doing the following:

• Logoff by typing `exit`

• Turn the router off

• Remove and store the cables and adapter

Erasing and reloading the router

Enter into the privileged EXEC mode by typing **enable**.

If prompted for a password, enter **class** (if that does not work, ask the instructor).

```
Router>enable
```

At the privileged EXEC mode, enter the command **erase startup-config**.

```
Router#erase startup-config
```

The responding line prompt will be:

```
Erasing the nvram filesystem will remove all files! Continue? [confirm]
```

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged EXEC mode, enter the command **reload**.

```
Router#reload
```

The responding line prompt will be:

```
System configuration has been modified. Save? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Proceed with reload? [confirm]
```

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

```
Would you like to enter the initial configuration dialog? [yes/no]:
```

Type **n** and then press **Enter**.

The responding line prompt will be:

```
Press RETURN to get started!
```

Press **Enter**.

Now the router is ready for the assigned lab to be performed.

		Router Interface Summary		
Router Model	**Ethernet Interface #1**	**Ethernet Interface #2**	**Serial Interface #1**	**Serial Interface #2**
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)

In order to find out exactly how the router is configured, look at the interfaces. This will identify what type and how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in an IOS command to represent the interface.