Computer networking

Basics of the Network Lab

Student Lab Manual

Contents

Basics

1.1 Resources used in the labs

Objective

To briefly introduce students with functions of resources used in the labs.

Routers

A router is a network device that forwards network traffic along optimized paths. Router uses networks protocols (set of network rules and algorithms) to connect different network segments. A router allows users in a network to share a single connection to the Internet or a WAN.
A router can also be viewed as a specialized computer that is designed to forward packets very efficiently. Like a computer, a typical router consists of the following: CPU, Memory, System Bus, and network interfaces (Figure 1). These components are described below.

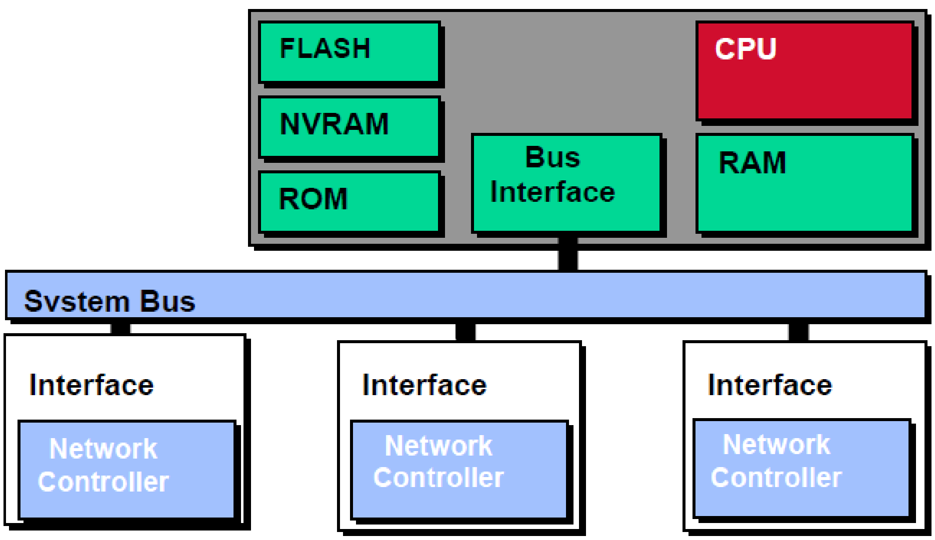


Figure 1. Hardware Components of a Router.

(a) CPU – The Central Processing Unit performs the computation and logical operations.

(b) Interfaces – These are the network connections through which packets transverse the router. The console and auxiliary ports are examples of the router interfaces. The console port is an asynchronous data port for the direct terminal access to the router. Remote router access can be provided by a modem connection to the aux port. The aux port can also be used for WAN connection.

(c) Memory – Routers have four types of memory:
1) ROM (Read Only Memory) – ROM contains power-on diagnostics, the bootstrap program, and the operating system software loader.

2) RAM (Random Access Memory) – RAM is for storing routing tables, the ARP cache, fast-switching caches, and packet queuing and buffering. This memory provides temporary (or running) memory for the router's configurations while the router is powered on. When the router is powered off, all the data in the RAM, including the running configuration and routing tables, will be cleared.

3) NVRAM (Nonvolatile RAM) – This is where the router's configurations are saved. As this would suggest, the NVRAM content is retained when you power down or reboot the router.

4) Flash (Erasable, Programmable ROM) – Flash memory holds the operating system image (IOS Software) and macrocodes. Using flash memory allows you to update software without removing or replacing chips on the processor. Flash contents are retained when you power down or reboot the router.

Switches

Switches are link-layer devices that forward frames (link layer packets) based on LAN destination addresses. When a frame comes into a switch interface, the switch examines the link layer destination address of the frame and attempts to forward it on the interface that leads to the destination.
A typical switch consists of all the hardware components that are explained above for a router.

Cables

Three different types of cables will be used for the labs. They are straight-through cable, console (rollover) cable and crossover cable. They differ from one another as to how the component wires of the cable are inserted into the pins of the adapters at the two ends of the cable (see Figure 2). In the figure, the numbers refer to pins in the adapters.

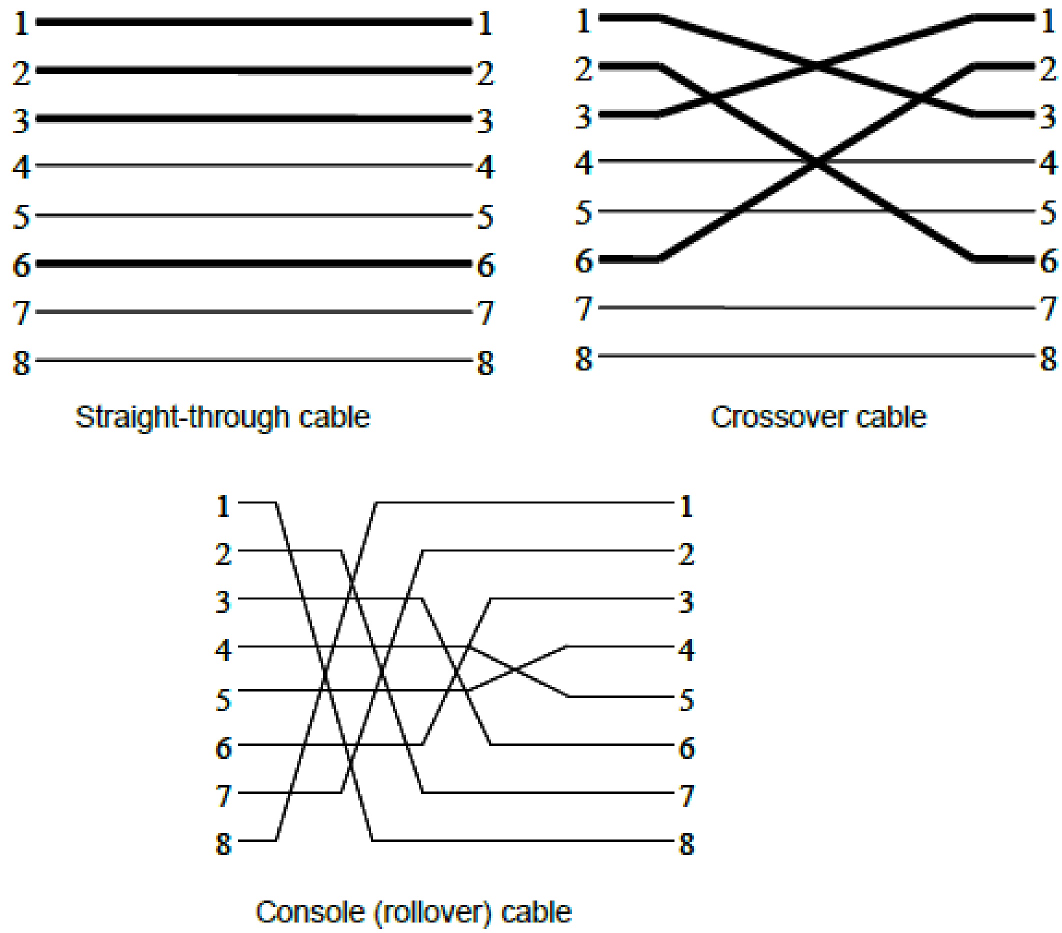


Figure 2. Types of cables

Straight-through cable (only four wires are used):
Host to switch or hub

Router to switch or hub

Crossover cable (only four wires are used):
Switch to switch

Hub to hub

Host to host

Hub to switch

Router direct to host

Rollover/Rolled/Console cable (also, not all wires are used):

Connects router to host via serial communication (COMX) port (using HyperTerminal!)

Find out which wires are used in the rolled cable

1.2 Establishing a Console Session with HyperTerminal

Objective

To re-introduce students to configure router using the putty software.

Introduction

Switches and Routers are the network processors that will be used throughout the network labs. Cisco and Huawei switches and routers that are provided for the practical labs. They all apply very similar installation procedures and commands. Therefore, we will explain the steps to interact with a router. Students should use similar concepts to interact with the other devices in the later labs.

HyperTerminal is a simple Windows-based terminal emulation program that can be used to connect to the console port on the router. Establishing a Console session with a HyperTerminal is the most basic way to access a router for checking or changing its configuration. This will provide the router with a keyboard and monitor.

Preparation

The following resources are required:
Workstation
Router
Console (rollover) cable
Putty software on the desktop

Diagram

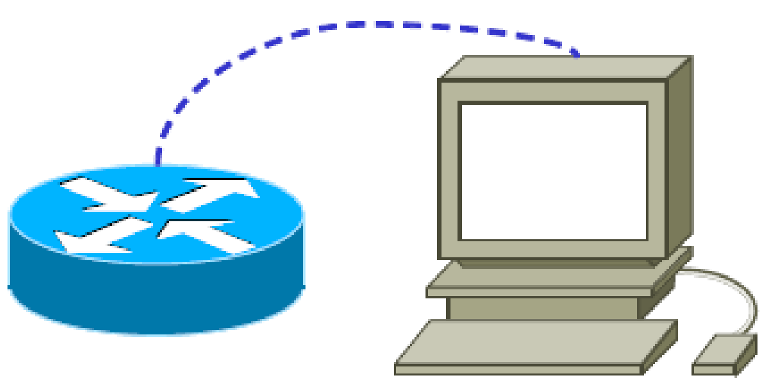


Figure 3. A router connected to a workstation using a console cable.

Experiment

1. The router should be turned off. Connect a console (rollover) cable to the console port on the router and the other end to the PC with a DB-9 adapter to the COM1 port.

double click to putty software
2. select COM port:

3. Plug in the power cord of the router and turn on the router. Or if the router is already on, press the **Enter** key. Now, there should be a response from the router.

4. After a moment, when the command "press RETURN to get started" appears press **Enter**. You will finally see the command prompt: **Router>**

5. To close the console session, type **Exit**.

1.3 Common Commands

Objective

To familiarize students with common commands used to interact with switches and routers.

Introduction

To connect to the router we execute Internetworking Operating System (IOS) commands. IOS is software that runs on all routers and allows the user to manage and configure the processes that occur on the router. IOS is command-line interface (CLI) software which accepts user commands and displays router output.
As a security feature, Cisco IOS provides separate commands into two different access level modes; user EXEC level and privileged EXEC level.
User EXEC level: allows a person to access only a limited number of basic monitoring commands. In this mode, the router or switch prompt is displayed as: **hostname>**

The right arrow (>) in the prompt indicates that the router or switch is at the user EXEC mode.

Privileged EXEC level: allows a person to access all router commands (including configuration and management) and can be password protected to allow only authorized people to access the router. In this mode the symbol "**#** " is displayed as the prompt. **hostname#**

There is also a sublevel of the Privileged Exec level, the configuration level. From privileged mode, you can monitor devices, view the status of interfaces, or run debugging. However, if you want to change the configuration of the router, you must enter configuration mode.
In this section you will be introduced to basic router commands that will run either in the user exec or privileged level. You are required to familiarize yourself by using the commands as instructed and looking at the outputs.

Preparation

The following resources are required:

Workstation
Router
Console (rollover) cable

Diagram

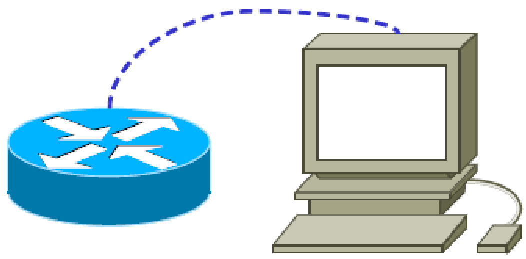


Figure 4. A router connected to a workstation using a console cable.

Experiment

1. Start a putty session.

2. Now you should be prompted with **Router >** which shows that you are working in the ***user exec*** level. Use the Help command **?** to see the list of available commands in the ***user exec*** level.
Router > **?**

3. When the word “more” appears, press the space bar to display the next page of information.

4. Practice the frequently used user exec commands from table 1 by typing the commands and pressing **Enter**.

Command	Purpose
Router > show	Show running system information
Router > where	List active connections
Router > sh?	List all commands that begin with "sh". Note that there is no space before **?** Try also arbitrary letters other than "sh".
Router > show ?	List all available arguments that match with some command (eg. show) Note: there is space before **?** Try also valid command words other than "show".

Table 1. Few frequently used commands in the user Exec level.

Commands are often abbreviated to the minimum number of letters that identifies a unique selection. The CLI is smart enough to recognize abbreviated commands. For example "sh" would be enough instead of "show" to issue the command: **Router**> **show ?** because "show" is the only valid command that begins with "sh". In addition, if you enter the first few letters of a command and hit Tab, it will display the remainder of the command.

5. Press the up arrow to see or reuse the last entered command. Press it again to go to the command before that. Press the down arrow to go back through the list.

6. Enter the **Privileged EXEC** level.

Router > **enable [Enter]**
Enter the password given to you by the lab administrator when prompted.

7. Use the Help command **?** to see the list of available commands in the ***privileged*** level.
Router # ?

Practice the frequently used privileged commands from table 2.

Command	purpose
Router# dir	List files on a file system
r1# show ip interface	Learn about the status of the interfaces of this router
Router# show run	View the configuration of the router
Router# show running-config	View the Running Configuration. (There are two different configurations stored on the router; the Running Configuration and the Start-Up Configuration. The Running Configuration is your current, working configuration. It is stored in the RAM memory of the router.)
r1# show startup-config	View the Start-Up configuration. It is the configuration that is loaded when the router initializes its boot sequence and it is stored in the NVRAM of the router.
Router# show version	Find the version and system information about your router
r1# show memory	Find memory information about the router

Table 2. Few frequently used commands in the privileged level.

8. Enter the **Configuration** level.
Router# configure terminal [Enter]
Practice the frequently used configuration commands from table 3. Use also the help command "**?**" to see available commands.

Command	purpose
	Eg. Router> no ip address 192.168.13.1 255.255.255.0 To delete the statement ip address 192.168.13.1 255.255.255.0
Router(config)# hostname r1	Change the router name from "Router" to "r1". The command prompt will look now **r1(config)#**
Router(config-if)#no *statement*	Delete a configuration statement line. Eg. to reverse the result of the router name change: **r1(config)# no hostname r1**
Router(config)# <CTRL>+Z	Switch from configuration to privileged mode

Table 3. Few frequently used commands in the configuration level.

9. To exit the **Privileged EXEC** level use the command:
Router # exit [Enter]

10. At the end of the practical lesson, close the HyperTerminal and shut down the router.

1.4 Controlling User Access to the Router

Objective

To familiarize students with controlling access to a router using passwords, and performing password recovery.

Introduction

Securing the router with a password was introduced in 1.3. In fact, there are 5 passwords used to secure the router. The *enable password* and *enable secret* are used to secure the privileged EXEC mode. The *enable secret* is the newer encrypted version and overrides the *enable password* if set. The remaining three are used to secure the user EXEC mode. They secure the *console* **(con)** port, the auxiliary **(aux)** port (can be used as console), and the telnet **(vty)** ports for remote access to the router.

Preparation
The following resources are required:
Workstation
Router
Console (rollover) cable
Diagram

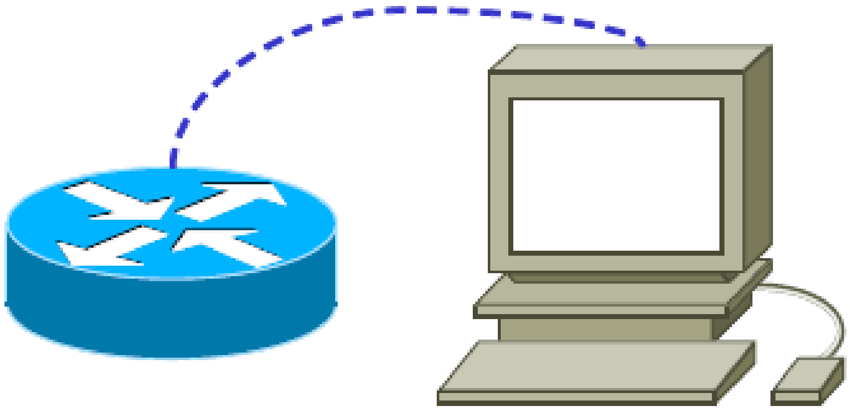


Figure 5. A router connected to a workstation using a console cable.

Experiment
Securing the router's privileged EXEC mode:
1. Enter the privileged mode:

Router> enable [ENTER]
2. Enter configuration mode:

Router# config t [ENTER]
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
3. Set the secret password to "cisco":

Router(config)# enable **secret cisco [ENTER]**
Securing the router's user EXEC mode:
4. Enter the **console line** and set the password

Router(config)# line con 0 [ENTER]
Router(config-line)# password conpassword [ENTER]
Router(config-line)# login
The **login** command ensures that the router prompts for authentication. It has to be used only *after* setting a password.
Router(config-line)# exit [ENTER]
5. Enter the **aux line** and set the password

Router(config)# line aux 0 [ENTER]
Router(config-line)# password auxpassword [ENTER]
Router(config-line)# login
Router(config-line)# exit [ENTER]
6. Enter the **vty lines** and enter the password:

Router(config)# line vty 0 4 [ENTER]
Router(config-line)# password vtypassword [ENTER]
Router(config-line)# login
Router(config-line)# exit [ENTER]

7. Exit the config mode, save the configuration and check that passwords have been set:
Router(config)# exit [ENTER]
Router# copy run start
Router# sh run [ENTER]
!
hostname Router
!
enable secret 5 1FWX0$hlzpT92by9EgO78nOxobD0
!
ip subnet-zero
!
!
line con 0
password conpassword
login
line aux 0
password auxpassword
login
line vty 0 4
password vtypassword
login
!
end

8. The output shows the encrypted secret password, and the unencrypted user EXEC passwords. Exit the HyperTerminal session, and restart it again. Now both the router's user EXEC and privileged EXEC mode should ask you for a password (let's assume you remember them).

Password Recovery:
Upon booting, the router loads the IOS program from flash memory. The IOS then finds a configuration (**startup-config)** file in NVRAM. This is then copied into RAM and called (**running-config)** and used to run the router.
NVRAM has a software register, the value of which controls the router's boot sequence. The passwords were saved into NVRAM with the

command **copy run start**. Changing the router's boot sequence (by changing the register value) to avoid the NVRAM will therefore bypass the passwords, and allow the router to be reset.

9. Check the value of the config register with:
Router# sh ver [ENTER]

10. Restart (switch **off** … *5second delay*… and **on**) the router, interrupt the boot sequence by pressing **Cntrl + Break**. The router goes into ROM monitor (**rommon 1>**) mode.

11. Change the value of the configuration register –
!!!! IT IS EXTREMELY CRITICAL THAT YOU ENTER THE CORRECT REGISTER VALUE !!!!!
rommon 1 > confreg 0x2142 [ENTER]
You must reset or power cycle for new config to take effect

12. You now enter (**rommon 2 >**) mode, in which you now reset the router:
rommon 2 > reset [ENTER]
The router reboots and avoids the saved configuration with passwords

13. Answer **no** to the setup question, or press **Cntrl + C**:
--- *System Configuration Dialog* ---
Would you like to enter the initial configuration dialog? [yes/no]: ***n***
Press RETURN to get started!

14. You can now enter the router without passwords
Router> enable [ENTER]
Router# copy start run [ENTER]
Destination filename [running-config] ? **[ENTER]**
This puts the configuration in RAM

15. Check the running configuration, you can view (thereby recover) the user EXEC mode passwords, but *only view* the encrypted privileged EXEC mode secret. You would thus have to set a new privileged EXEC mode secret.
Router# sh run [ENTER]

16. For this lab, you will remove all the passwords by entering the configuration mode:
Router# config t [ENTER]
Router(config)# no enable secret [ENTER]

Remove the console port password:
Router(config)# line con 0 [ENTER]
Router(config-line)# no password [ENTER]
Router(config-line)# exit [ENTER]
Remove the auxiliary port password:
Router(config)# line aux 0 [ENTER]
Router(config-line)# no password [ENTER]
Router(config-line)# exit [ENTER]
Remove the telnet password:
Router(config)# line vty 0 4 [ENTER]
Router(config-line)# no password [ENTER]
Router(config-line)# exit [ENTER]

17. Change the register value to **0x2102** to boot from NVRAM (**startup-config**), and leave the configuration mode:

!!!! IT IS EXTREMELY CRITICAL THAT YOU ENTER THE CORRECT REGISTER VALUE !!!!!
Router(config)# config-register 0x2102 [ENTER]
Router(config)# exit [ENTER]
18. Save the new configuration and confirm changes:

Router# copy run start [ENTER]
Router# sh run [ENTER]

***Notice the changes? ***
19. Reboot the router and check that it does not prompt you for passwords.

1.5 Static Routing

Objective

To establish connectivity between two Local Area Networks (LANS) on a Wide Area Network (WAN) link using static routing.

Introduction

IP routing is automatically enabled on Cisco routers. If it has been previously disabled on your router, you turn it back on in configuration mode with the command **ip routing**.
Router(config)#ip routing
There are two main ways a router knows where to send packets. The administrator can assign **static routes**, or the router can learn routes by employing a **dynamic routing protocol.** These days static routes are generally used in very simple networks or in particular cases that necessitate their use. To create a static route, the administrator tells the router operating system that any
network traffic destined for a specified network layer address should be forwarded to a similarly specified network layer address. In the Cisco IOS this is done with the **ip route** command. Static routes can be configured by specifying the next-hop ip address of the adjacent router or by specifying the outgoing interface. The syntax is as follows:
Router(config)#**ip route** [destination network] [subnet mask] [next-hop ip address]
Or
Router(config)#**ip route** [destination network] [subnet mask] [outgoing interface]
For example
Router(config)# **ip route** 192.168.3.0 255.255.255.0 172.16.7.1
Or
Router(config)# **ip route** 192.168.3.0 255.255.255.0 serial 0/0
Two things need to be said about this example. First, the packet destination address must include the subnet mask for that destination network. Second, the address it is to be forwarded to is the specified address of the next router along the path to the destination or the outgoing interface.

Preparation

The following resources are required:
Two PCs with 10/100 NICs

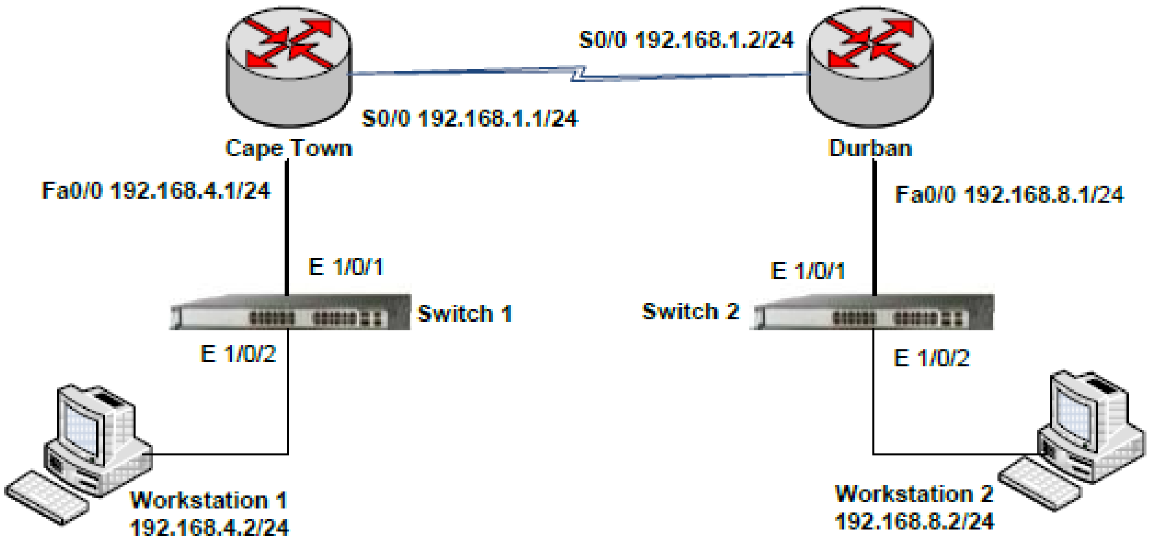
Two Routers (Cisco 2600 series)

Two Switches (Quidway S3900 series)

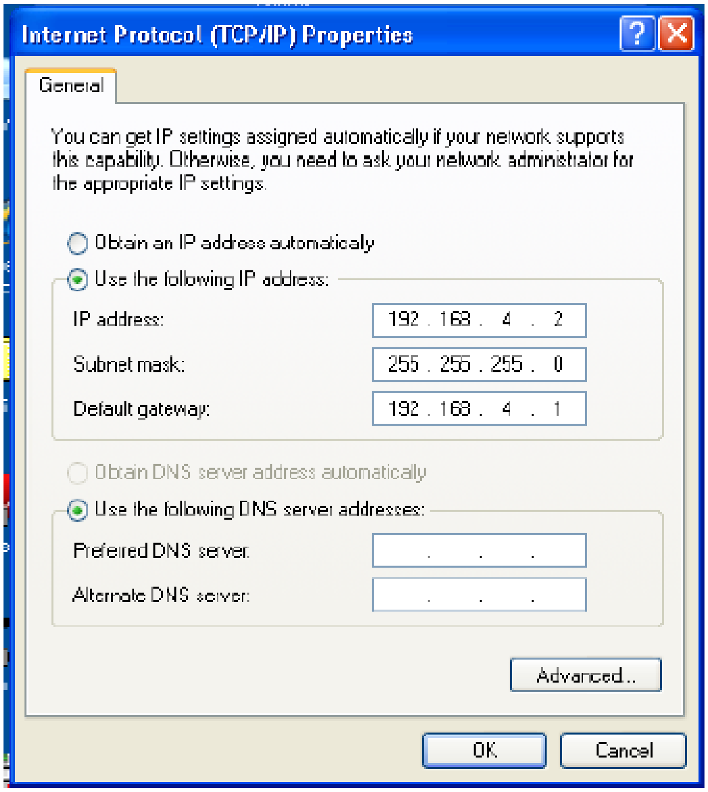
Four straight through cables

Two Console Cables
1 serial cable

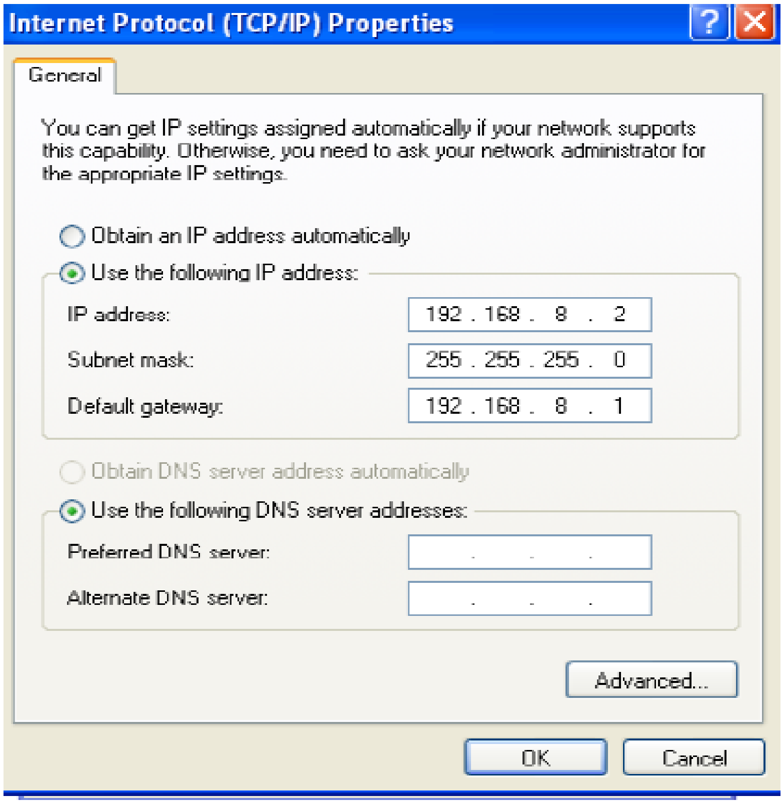
Diagram



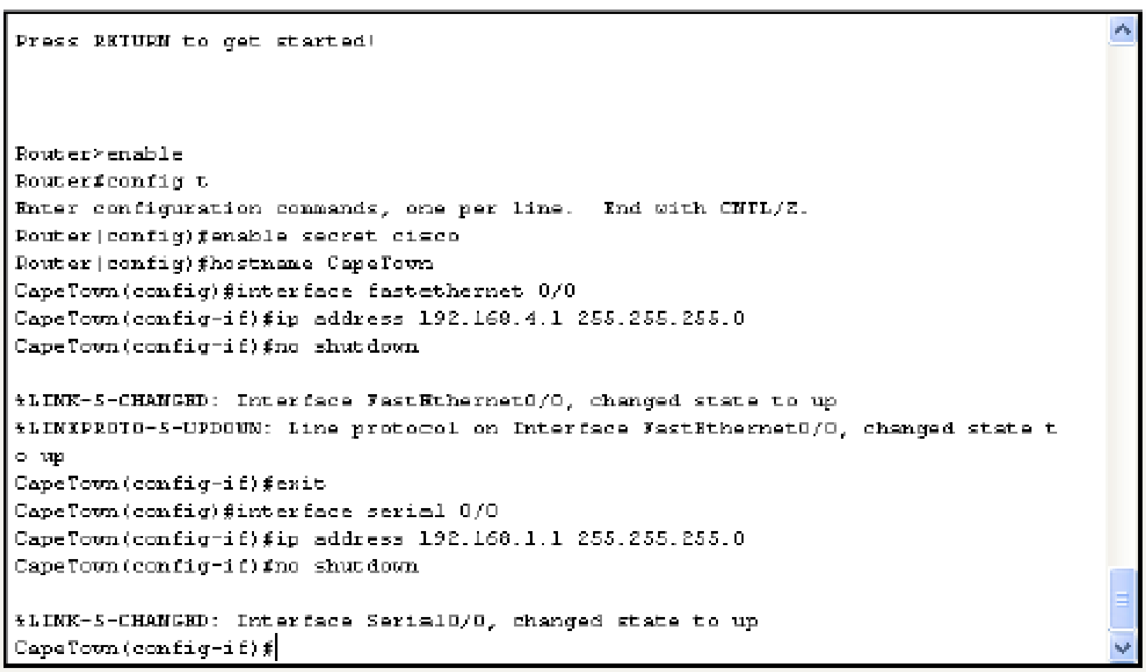
Experiment
Step 1:
Set up the network as shown in the diagram.
Step 2:
Establish Hyper Terminal sessions with both routers
Step 3:
Configure static IP addresses for the two workstations as shown below:
WORKSTATION 1 ACTIVITY



WORKSTATION 2 ACTIVITY



WORKSTATION 1 ACTIVITY



```
Press RETURN to get started!



Router>enable
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#enable secret cisco
Router(config)#hostname CapeTown
CapeTown(config)#interface fastethernet 0/0
CapeTown(config-if)#ip address 192.168.4.1 255.255.255.0
CapeTown(config-if)#no shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state t
o up
CapeTown(config-if)#exit
CapeTown(config)#interface serial 0/0
CapeTown(config-if)#ip address 192.168.1.1 255.255.255.0
CapeTown(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/0, changed state to up
CapeTown(config-if)#
```

Step 4:
Enter configuration mode on the router
Router> **enable** // Enter privileged mode
Router# **Config t** // Enter configuration mode
Router(config)#
Step 5:
Set the enable password to "cisco"
Router(config)# **enable secret** cisco
Step 6:
Change the name of the router to CapeTown
Router(config)# **hostname** CapeTown
Step 7:
Configure the FastEthernet interface fa0/0 on the CapeTown router
CapeTown(config)# **interface fastethernet 0/0**
CapeTown(config-if)# **ip address** 192.168.4.1 255.255.255.0
CapeTown(config-if)# **no shutdown** // Turn on the interface
CapeTown(config-if)# **exit**
CapeTown(config)#

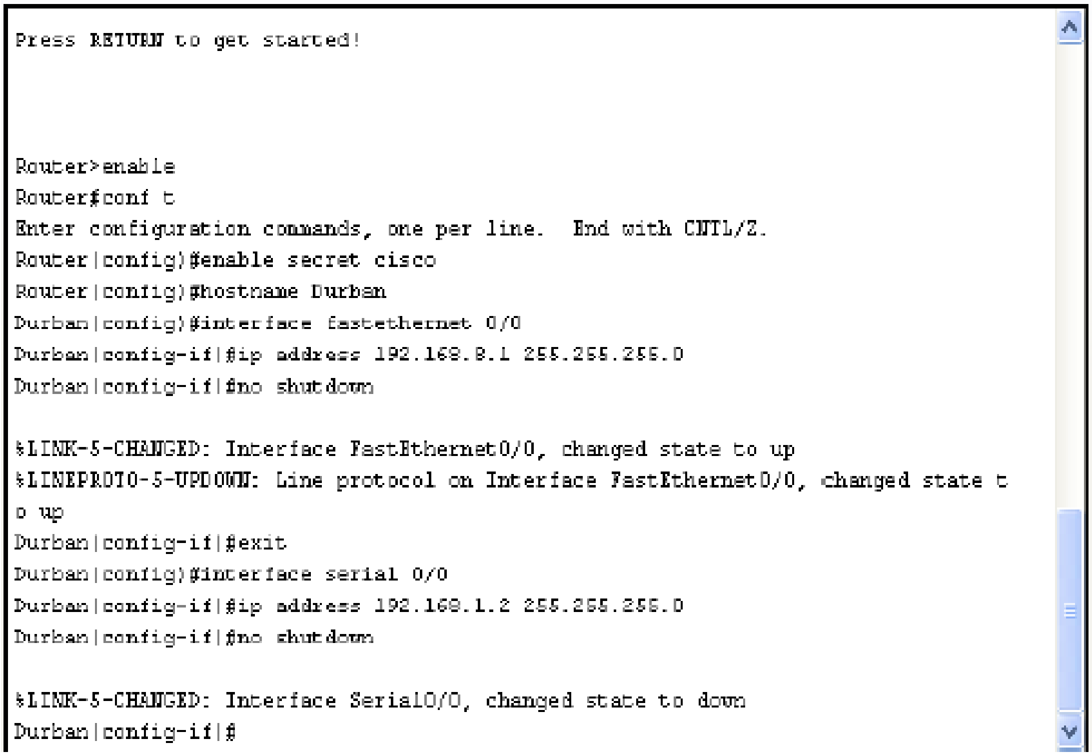
Step 8:
Configure the serial interface s0/0 on the CapeTown router
CapeTown(config) **interface serial 0/0**
CapeTown(config-if) **ip address** 192.168.1.1 255.255.255.0
CapeTown(config-if) **no shutdown**
Configure clocking on the serial interface that will act as the DCE. Serial interfaces require a clock signal to control the timing of the communications. In most environments, a DCE device such as a CSU will provide the clock. By default, Cisco routers are DTE devices but they can be configured as DCE devices.
First determine if the serial interface has a DTE or DCE cable attached to it using the **show controllers** command.
CapeTown#**show controllers serial 0/0**
If the output says **DCE V.35** then configure clock rate on that interface. If the output says **DTE V.35** then do not configure clock rate on that interface.
CapeTown(config) **interface serial 0/0**
CapeTown(config-if) **clock rate 56000**

```
CapeTown#show controllers serial 0/0
Interface Serial0/0
Hardware is PowerQUICC MPC860
DCE V.35, no clock
idb at 0x81081AC4, driver data structure at 0x81084AC0
SCC Registers:
General [GSMR]=0x2:0x00000000, Protocol-specific [PSMR]=0x8
Events [SCCE]=0x0000, Mask [SCCM]=0x0000, Status [SCCS]=0x00
Transmit on Demand [TODR]=0x0, Data Sync [DSR]=0x7E7E
Interrupt Registers:
Config [CICR]=0x00367F80, Pending [CIPR]=0x0000C000
Mask   [CIMR]=0x00200000, In-srv  [CISR]=0x00000000
Command register [CR]=0x580
Port A [PADIR]=0x1030, [PAPAR]=0xFFFF
       [PAODR]=0x0010, [PADAT]=0xCBFF
Port B [PBDIR]=0x09C0F, [PBPAR]=0x0800E
       [PBODR]=0x00000, [PBDAT]=0x3FFFD
Port C [PCDIR]=0x00C, [PCPAR]=0x200
       [PCSO]=0xC20,  [PCDAT]=0xDF2, [PCINT]=0x00F
Receive Ring
        rmd(68012830): status 9000 length 60C address 3B6DAC4
        rmd(68012838): status B000 length 60C address 3B6D444
Transmit Ring
```

```
Durban#show controllers serial 0/0
Interface Serial0/0
Hardware is PowerQUICC MPC860
DTE V.35 clocks stopped.
idb at 0x81081AC4, driver data structure at 0x81084AC0
SCC Registers:
General [GSMR]=0x2:0x00000000, Protocol-specific [PSMR]=0x8
Events [SCCE]=0x0000, Mask [SCCM]=0x0000, Status [SCCS]=0x00
Transmit on Demand [TODR]=0x0, Data Sync [DSR]=0x7E7E
Interrupt Registers:
Config [CICR]=0x00367F80, Pending [CIPR]=0x0000C000
Mask   [CIMR]=0x00200000, In-srv  [CISR]=0x00000000
Command register [CR]=0x580
Port A [PADIR]=0x1030, [PAPAR]=0xFFFF
       [PAODR]=0x0010, [PADAT]=0xCBFF
Port B [PBDIR]=0x09C0F, [PBPAR]=0x0800E
       [PBODR]=0x00000, [PBDAT]=0x3FFFD
Port C [PCDIR]=0x00C, [PCPAR]=0x200
       [PCSO]=0xC20,  [PCDAT]=0xDF2, [PCINT]=0x00F
Receive Ring
        rmd(68012830): status 9000 length 60C address 3B6DAC4
        rmd(68012838): status B000 length 60C address 3B6D444
Transmit Ring
```

- Save your configuration using the following command:
  CapeTown# **copy run start**.

WORKSTATION 2 ACTIVITY


```
Press RETURN to get started!



Router>enable
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#enable secret cisco
Router(config)#hostname Durban
Durban(config)#interface fastethernet 0/0
Durban(config-if)#ip address 192.168.8.1 255.255.255.0
Durban(config-if)#no shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state t
o up
Durban(config-if)#exit
Durban(config)#interface serial 0/0
Durban(config-if)#ip address 192.168.1.2 255.255.255.0
Durban(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/0, changed state to down
Durban(config-if)#
```

Step 9:
Enter configuration mode on the router
Router> **enable** // Enter privileged mode
Router# **Config t** // Enter configuration mode
Router(config)#
Step 10:
Set the enable password to “cisco”
Router(config)# **enable secret** cisco
Step 11:
Change the name of the router to Durban
Router(config)# **hostname** Durban

Step 12:
Configure the FastEthernet interface fa0/0 on the Durban router
Durban(config)# **interface fastethernet 0/0**
Durban(config-if)# **ip address** 192.168.8.1 255.255.255.0
Durban(config-if)# **no shutdown** // Turn on the interface
Durban(config-if)# **exit**
Durban(config)#
Step 13:
Configure the serial interface s0/0 on the Durban router
Durban(config) **interface serial 0/0**
Durban(config-if) **ip address** 192.168.1.2 255.255.255.0
Durban(config-if) **no shutdown**

Configure clocking on the serial interface that will act as the DCE. Serial interfaces require a clock signal to control the timing of the communications. In most environments, a DCE device such as a CSU will provide the clock. By default, Cisco routers are DTE devices but they can be configured as DCE devices.
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Durban(config) **interface serial 0/0**
Durban(config-if) **clock rate 56000**

```
CapeTown#show controllers serial 0/0
Interface Serial0/0
Hardware is PowerQUICC MPC860
DCE V.35, no clock
idb at 0x81081AC4, driver data structure at 0x81084AC0
SCC Registers:
General [GSMR]=0x2:0x00000000, Protocol-specific [PSMR]=0x8
Events [SCCE]=0x0000, Mask [SCCM]=0x0000, Status [SCCS]=0x00
Transmit on Demand [TODR]=0x0, Data Sync [DSR]=0x7E7E
Interrupt Registers:
Config [CICR]=0x00367F80, Pending [CIPR]=0x0000C000
Mask   [CIMR]=0x00200000, In-srv  [CISR]=0x00000000
Command register [CR]=0x580
Port A [PADIR]=0x1030, [PAPAR]=0xFFFF
       [PAODR]=0x0010, [PADAT]=0xCBFF
Port B [PBDIR]=0x09C0F, [PBPAR]=0x0800E
       [PBODR]=0x00000, [PBDAT]=0x3FFFD
Port C [PCDIR]=0x00C, [PCPAR]=0x200
       [PCSO]=0xC20,  [PCDAT]=0xDF2, [PCINT]=0x00F
Receive Ring
        rmd(68012830): status 9000 length 60C address 3B6DAC4
        rmd(68012838): status B000 length 60C address 3B6D444
Transmit Ring
```

```
Durban#show controllers serial 0/0
Interface Serial0/0
Hardware is PowerQUICC MPC860
DTE V.35 clocks stopped.
idb at 0x81081AC4, driver data structure at 0x81084AC0
SCC Registers:
General [GSMR]=0x2:0x00000000, Protocol-specific [PSMR]=0x8
Events [SCCE]=0x0000, Mask [SCCM]=0x0000, Status [SCCS]=0x00
Transmit on Demand [TODR]=0x0, Data Sync [DSR]=0x7E7E
Interrupt Registers:
Config [CICR]=0x00367F80, Pending [CIPR]=0x0000C000
Mask   [CIMR]=0x00200000, In-srv  [CISR]=0x00000000
Command register [CR]=0x580
Port A [PADIR]=0x1030, [PAPAR]=0xFFFF
       [PAODR]=0x0010, [PADAT]=0xCBFF
Port B [PBDIR]=0x09C0F, [PBPAR]=0x0800E
       [PBODR]=0x00000, [PBDAT]=0x3FFFD
Port C [PCDIR]=0x00C, [PCPAR]=0x200
       [PCSO]=0xC20,  [PCDAT]=0xDF2, [PCINT]=0x00F
Receive Ring
        rmd(68012830): status 9000 length 60C address 3B6DAC4
        rmd(68012838): status B000 length 60C address 3B6D444
Transmit Ring
```

- Save your configuration using the following command
  Durban# **copy run start**

WORKSTATION 1 ACTIVITY

Step 14:

Display the ip routing table on the Cape Town router. The networks that are directly connected to the router are denoted by C. If a route is not in the routers to which the host is connected, the host cannot reach the destination host. CapeTown# **show ip route**

```
CapeTown>en
Password:
CapeTown#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, Serial0/0
C    192.168.4.0/24 is directly connected, FastEthernet0/0
CapeTown#
```

WORKSTATION 2 ACTIVITY

Step 15:

Display the routing table of the Durban router. The networks that are directly connected to the router are denoted by C. If a route is not in the routers to which the host is connected, the host cannot reach the destination host.

Durban# **show ip route**

```
Durban>en
Password:
Durban#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, Serial0/0
C    192.168.8.0/24 is directly connected, FastEthernet0/0
Durban#
```

Ping Command

The **ping** utility is used to test network connectivity. The **ping** command sends a packet to the destination host and then waits for a reply from that host. Results from the **ping** command can help to evaluate path-to-host reliability, delays over the path and whether the host is reachable or is functioning. The **ping** output displays minimum, maximum and average times it takes for a ping packet to find a specified host and return. The **ping** command uses internet control message protocol (ICMP) and is a basic testing mechanism for network connectivity. Exclamation marks (**!**) indicate each successful echo. One or more periods (**.**) indicates a timeout while waiting for a packet from the ping target.

Example

To ping a host with the ip address of 172.16.8.1 simply type:

Ping 172.16.8.1

WORKSTATION 1 ACTIVITY

Step 16:

Q: From workstation 1, use the command prompt to ping the Fast Ethernet interface of the Cape Town router at 192.168.4.1. Was the ping successful?

Successful

Q: From workstation1, use the command prompt to ping workstation 2 at 192.168.8.2. Was the ping successful? Why?

Success full

~~This is because the connectivity has been established successfully and indicate that communication~~ between workstation 2 and the router (Durban) is excellent.

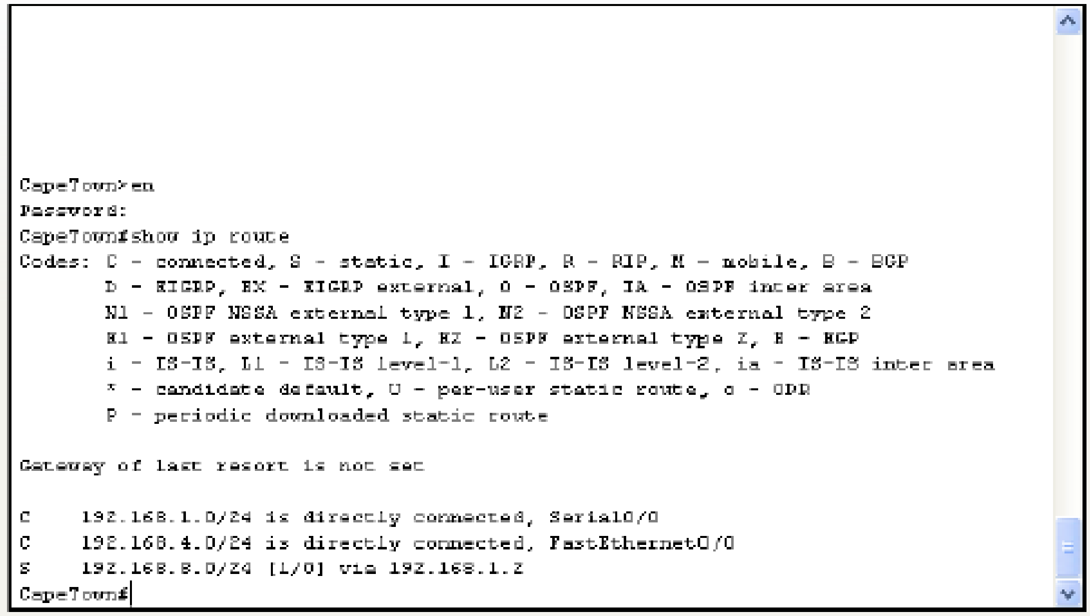
Step 17:

Configure static routes to the network 192.168.8.0 on the CapeTown router.

CapeTown(config)**ip route** 192.168.8.0 255.255.255.0 192.168.1.2

Display the ip routing table on the CapeTown router. The network denoted by S is the static route that was configured.

CapeTown#**show ip route**



```
CapeTown>en
Password:
CapeTown#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, Serial0/0
C    192.168.4.0/24 is directly connected, FastEthernet0/0
S    192.168.8.0/24 [1/0] via 192.168.1.2
CapeTown#
```

WORKSTATION 2 ACTIVITY

Step 18:

Configure static routes to the network 192.168.4.0 on the Durban router.

Durban(config)**ip route** 192.168.4.0 255.255.255.0 192.168.1.1

Display the ip routing table on the Durban router. The network denoted by S is the static route that was configured.

Workstation 1 activity: Q2. Response:

The ping command was success due to the following reasons:

Connectivity Exists: There is network connectivity between Workstation1 and Workstation2. They are either on the same local network (subnet) or reachable through a router or other network devices.

No Firewall Blocking ICMP: The ping command uses the ICMP (Internet Control Message Protocol) to test the connection. For the ping to succeed, both workstations (and any routers in between) must allow ICMP packets. The success suggests that no firewalls or security policies are blocking ICMP requests and responses.

Correct IP Configuration: Both Workstation1 and Workstation2 likely have correct IP configurations, including the right subnet mask, default gateway (if they are on different subnets), and possibly DNS settings.

Network Devices Functioning: All intermediate network devices (e.g., switches, routers) between the two workstations are functioning properly, forwarding packets as expected.

This successful ping shows that the two machines can communicate with each other over the network, meaning the network is properly set up, and there are no immediate issues with routing, IP addressing, or firewall rules that would prevent basic communication.

Durban (config)#**show ip route**

```
Durban>en
Password:
Durban#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, Serial0/0
S    192.168.4.0/24 [1/0] via 192.168.1.1
C    192.168.8.0/24 is directly connected, FastEthernet0/0
Durban#
```

WORKSTATION 1 ACTIVITY

Step 19:

Q: From workstation1, use the command prompt to ping workstation 2 at 192.168.8.2. Was the ping successful? Why?

When pinging the workstation 2 i.e. Ip address: 192.168.8.2, The ping was successful due to success internet connection established well.

Also response similar to Workstation 1 activity, Q2 Response.

Q: Why is a static route needed on both routers?

The static route is needed on both routers since data or communication will be from workstation 1 to workstation 2 and vice-versa. When there's no route to every router there might not be a communication between those workstations.

A static route is needed on both routers in certain network setups to ensure proper bidirectional communication between different networks. Here's why:

1. Routing of Traffic in Both Directions:

Routers only know about networks they are directly connected to, or networks that are learned through routing protocols or static routes. If you have two routers connecting different networks, both routers need to know how to reach the other network for communication to flow smoothly. A static route is needed on each router for the following reasons:

Router CapeTown to Router Durban: If Router CapeTown needs to send traffic to a network behind Router Durban, a static route on Router A is necessary to tell it where to forward packets for that specific network.

Router Durban to Router CapeTown: Likewise, if Router Durban needs to send traffic back to the network behind Router CapeTown, it also needs a static route that tells it where to forward packets for Router A's network.

Without static routes on both routers, communication would be unidirectional (only one-way) because one router would not know how to route return traffic to the source network.