E1 Basic Router Configuration

1.1 Learning Objectives

Upon completion of this lab, you will be able to:

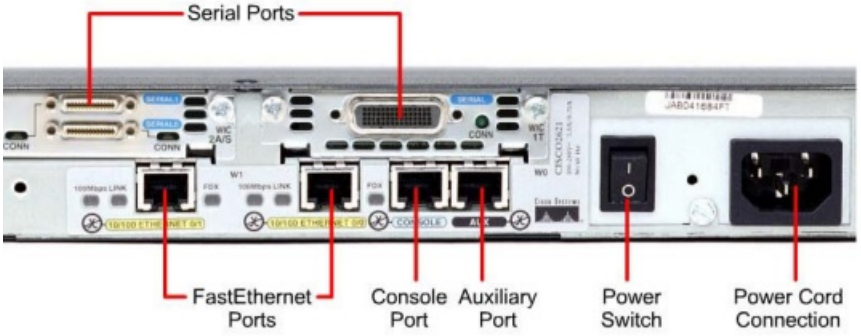
- Learn about the router components and connections.
- Learn how to access a router directly or remotely.
- Cable a network consisting of routers, switches and attached PCs.
- Configure Cisco router global configuration settings.
- Configure Cisco router password access and configure interfaces.
- Configure static routing on Cisco routers.
- Test the network and verify LAN connectivity.

1.2 Router internal components

A router is typically like a computer which operates with two main components:

- **Hardware (Router physical components)**
  - Power Supply
  - CPU
  - Memory (RAM, NVRAM, ROM, Flash)
  - System bus
  - Interfaces
- **Software**
  - **Internetworking operating system (IOS)** the operating system that manages the hardware platform.
  - **Configuration file** a program file that contains commands that reflects how the router will react (stored in the NVRAM).

1.3 Router External Connections

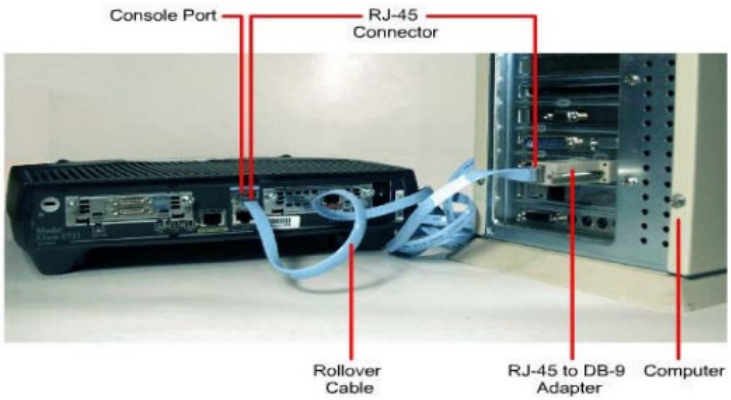


1. **Port:** normally means one of the management ports used for administrative access (e.g. console port, auxiliary port).
2. **Interface:** normally refers to interfaces that are capable of sending and receiving user traffic (e.g. serial WAN interfaces, Ethernet interfaces, FastEthernet interfaces).

However, these terms are often used interchangeably in the industry.

1.3.1 Management Ports

- Console Port
  - Is the most common of the management ports.
  - Used to connect the router to a PC running terminal emulator software as hyperterminal, for direct router configuration.



- Auxiliary (AUX) port
  - Not all routers have auxiliary ports.
  - Can also be used to attach a modem for remote router configuration.

1.4 Router Access Methods

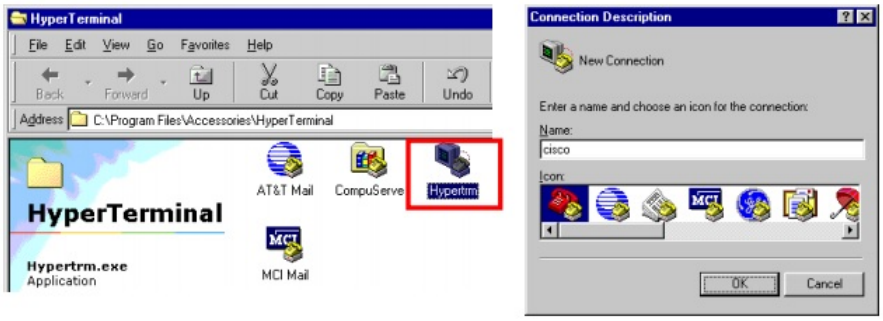
1. **Directly using the console port**
   The router is accessed by connecting the router to PC running terminal emulator software as HyperTerminal for direct router configuration, and establishing a CLI (Command Line Interface) session. No initial configuration is needed on the router before connecting to the console port. The console port must be used during initial configuration of the router, and disaster recovery procedures and troubleshooting where remote access is not possible.

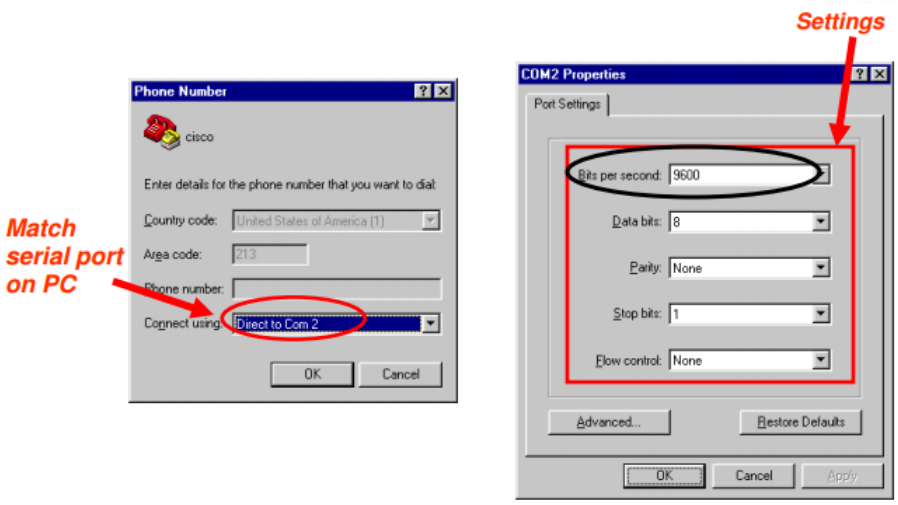
2. **Remotely using the auxiliary port**
   The router is accessed by establishing a CLI (Command Line Interface) session remotely via a telephone dialup connection using a modem connected to the router's AUX port.

3. **Remotely using Telnet or SSH**
   The router is accessed by using the Telnet or SSH (Secure Shell) protocols to remotely connect to a router on a TCP/IP network and establish a remote CLI session. The router is remotely accessed by opening one of its virtual terminals (VTYs). Network configuration is needed on both ends (IP address, subnet mask, etc.). Also basic configuration is needed on the remote router before Telnetting it, as the Telnet password.

4. **Web access**
   The router is accessed remotely by typing its IP address into a web browser. This supports GUI configuration, but does not include all configurations that can be done in a CLI session.

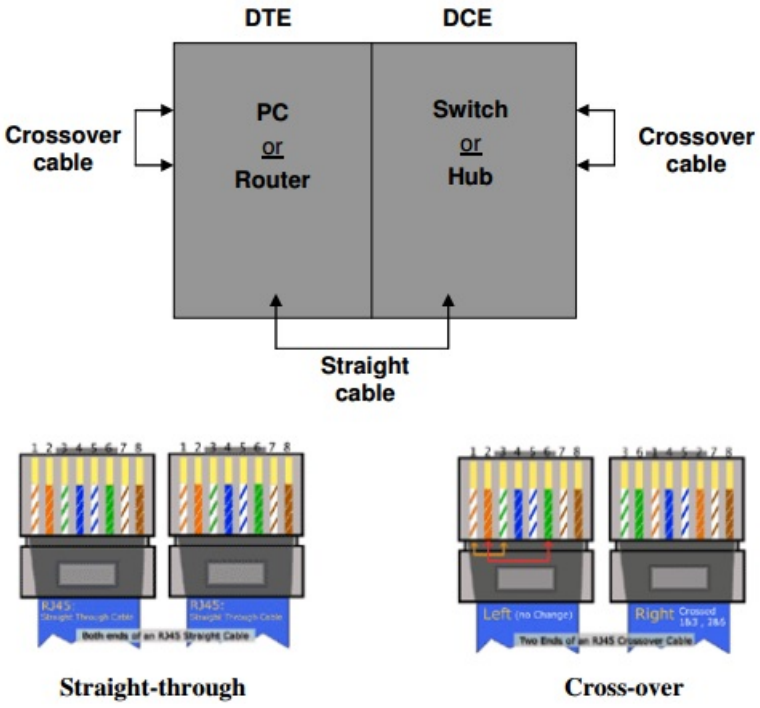
Using HyperTerminal to establish a CLI session through the console port



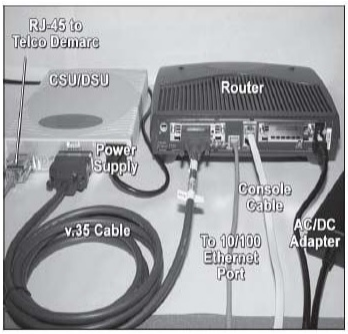


1.5 Router Interfaces

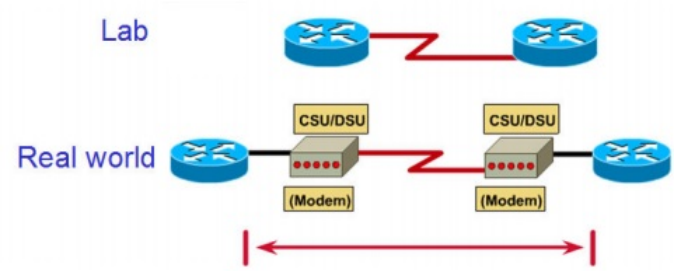
- Interface on Cisco routers refers to a physical connector on the router whose main purpose is to receive and forward packets.
- Routers have multiple interfaces used to connect to multiple networks with different types of media and connectors.
- **Every interface on the router belongs to a different IP network.**
- **Cisco IOS will not allow two active interfaces on the same router to belong to the same network.**
- Routers have **LAN interfaces** like Ethernet interfaces and Fast Ethernet interfaces and Gigabit Ethernet interfaces (Typically RJ-45 jack (UTP)) for connections to LANs. Each interface should have a layer 2 MAC address and a layer 3 IP address. Router-to-switch connections and switch-to-PC connections are ***straight-through*** cables. Router-to-router connections and router's Ethernet interface to a PC's NIC and switch-to-switch connections are ***crossover cables***.



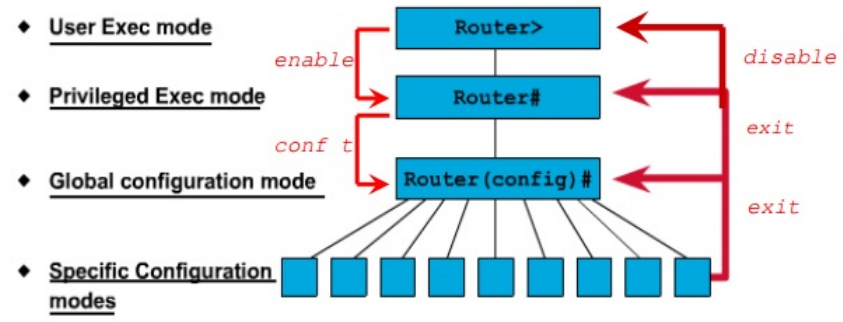
- Routers have **WAN interfaces** used to connect to external networks, usually over a larger geographical distance. They have a variety of serial links, including T1, ATM and Frame Relay. Each interface should have a layer 3 IP address and a layer 2 address (not MAC address but a layer 2 address depending on the technology used).
- For the lab routers, WAN interfaces are **smart serial connectors**. The router is typically a DTE device. The DTE cable is connected to the serial interface on the router to a CSU/DSU device (DCE). This cable is called **V.35** cable.



- In the lab we use serial DTE/DCE cables (no CSU/DSU) with a DTE cable connected to one router and a DCE cable connected to the other router. This is called **null modem** or connecting the routers **back-to-back**.
- The router acting as the DCE is the master (connected to the female part of the V.35 cable) and the DTE router is the slave (connected to the male part of the V.35 cable). **The master (DCE) must specify the clock rate so that the 2 routers can talk to each other.**



1.6 CLI First Look



Configuration Mode	Prompt
Interface	`Router(config-if)#`
Subinterface	`Router(config-subif)#`
Line	`Router(config-line)#`
Router	`Router(config-router)#`

1. **Setup Mode**
   - The *setup mode* is a Y/N configuration dialogue.

- The router will enter *setup mode* when the contents of NVRAM have been erased with the *"erase startup-config"* command (i.e. the startup configuration have been deleted), or when the router is "out of the box" and has not been initially configured.
- Typing n for *no* or pressing Ctrl+C skips the *setup mode* and enters the *User EXEC* mode.

2. **User EXEC Mode**

   - The *user EXEC mode* allows only a limited number of **basic monitoring commands**. It does not allow any commands that might change the configuration of the router.
   - This mode is often referred to as a view only mode.
   - The *user EXEC mode* can be identified by the > prompt.
   - Typing the command ***enable*** (or ***en***) enters the *privileged EXEC mode*.

3. **Privileged EXEC Mode (enable mode) (administrator mode)**

   - The *privileged EXEC mode* allows advanced monitoring and troubleshooting commands (e.g. show commands, ping, traceroute, telnet). This mode can be configured to require a password.
   - Configuration and management commands require that the network administrator be at the *privileged EXEC mode*.
   - The *privileged EXEC mode* can be identified by the # prompt.
   - Typing the command ***disable*** returns to the *User EXEC mode*.
   - Typing the command ***configure terminal***(or ***conf t***) enters the global configuration mode.

4. **Global configuration mode**

   - The *global configuration mode* allows **configuration commands that affect the entire device** (as changing the router's hostname or enabling a routing protocol on the router or encrypting the router's passwords).
   - The *global configuration mode* can be identified by the (config)# prompt.
   - Typing the command ***exit*** returns to the *privileged EXEC mode*.

5. **Sub-configuration mode**

   - The *sub-configuration mode* allows **configuration commands that affect a specific interface or line**.
   - The command "**Router(config)#interface *interface-type interface-number***" goes from the global configuration mode to a specific interface's sub-configuration mode (e.g. **Router(config)#interface *serial 0/1/0***)
   - The command "**Router(config)#line *line-type line-number***" goes from the global configuration mode to a specific port's sub-configuration mode(e.g. **Router(config)#line *console 0*** or **Router(config)#line *vty 0***).

1.6.1 Using CLI help

Context Sensitive Help

Example of a sequence of commands using the CLI context sensitive help

```
Cisco#cl?
clear  clock
Cisco#clock ?
  set  Set the time and date
Cisco#clock set
% Incomplete command.
Cisco#clock set ?
  hh:mm:ss  Current Time
Cisco#clock set 19:50:00
% Incomplete command.
```

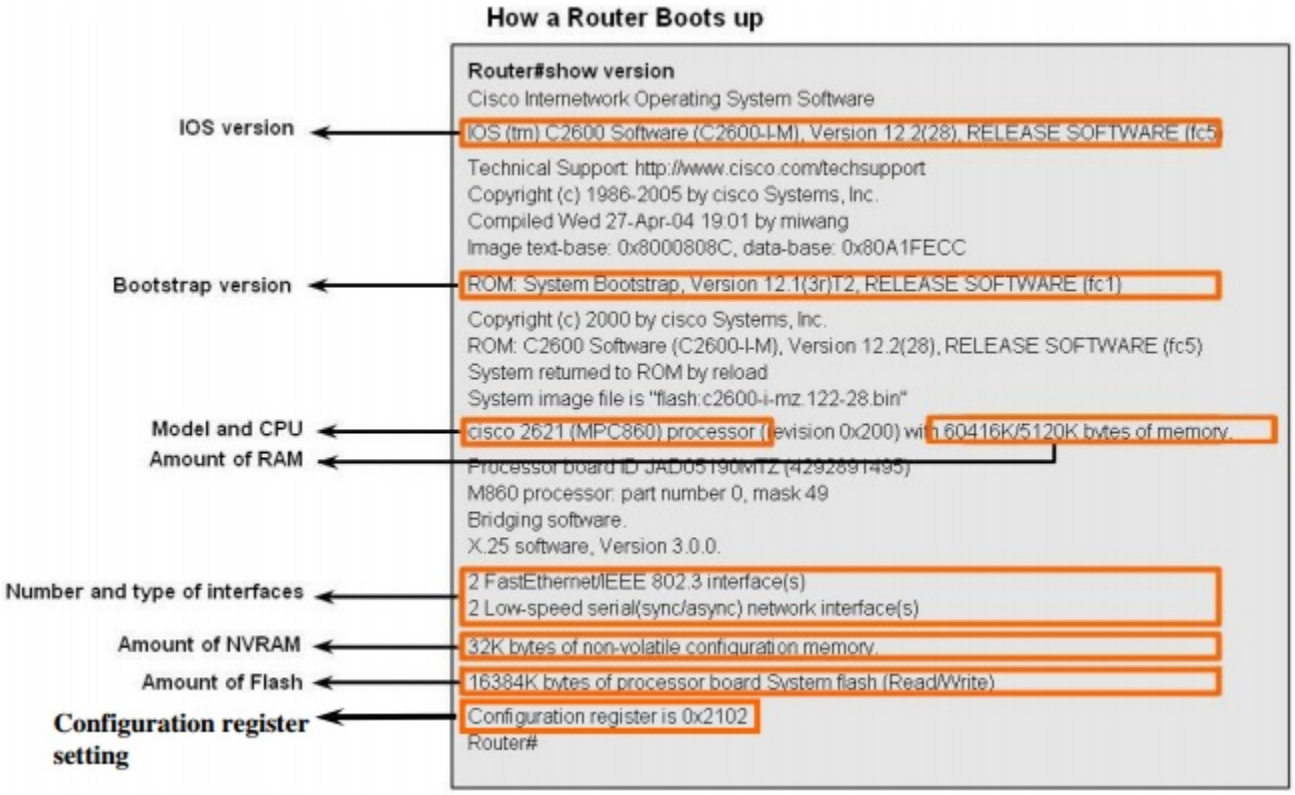
```
Cisco#clock set 19:50:00 ?
  <1-31>  Day of the month
  MONTH   Month of the year
Cisco#clock set 19:50:00 25 6
                           ^
Invalid input detected at '^' marker.
Cisco#clock set 19:50:00 25 June
% Incomplete command.
Cisco#clock set 19:50:00 25 June ?
  <1993-2035>  Year
Cisco#clock set 19:50:00 25 June 2007
Cisco#
```

Error Message	Meaning	Examples	How to Get Help
`% Ambiguous command: 'command'`	not enough characters entered for the IOS to recognize the command	`Switch#c` `% Ambiguous command:'c'`	Reenter the command followed by a question mark (?) with no space between the command and the question mark. The possible keywords that you can enter with the command are displayed.
`% Incomplete command.`	not all of the required keywords or arguments were entered	`Switch#clock set` `% Incomplete command.`	Reenter the command followed by a question mark (?) with a space after last word. The required keywords or arguments are displayed.

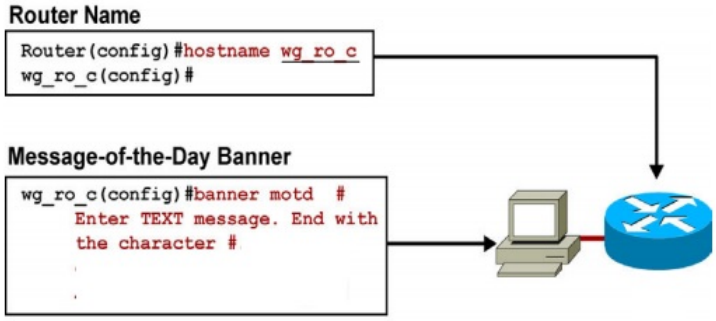
`% Invalid input detected at '^' marker`	command was entered incorrectly. The error occurred where the caret mark (^) appears.	`Switch#clock set`
		`19:50:00 25 6`
		`^`
		`% Invalid input detected at '^' marker.`
			Reenter the command followed by a question mark (?) in a place pointed by '^' mark. It can be also needed to delete last keyword(s) or argument(s).

1.7 Basic Router Configuration Commands

1. ***show version* Command**



2. **Naming a router and Configuring a Message-of-the-day banner**



3. **Viewing, Saving and Erasing the Configurations**

   (a) **show startup-config command**

   - The startup-config file is the saved configuration in NVRAM.
   - If there is a startup-config file in NVRAM when the router boots up, this file will be copied into running-config.
   - The running-config is what the router will use.
   - This command is a privileged user mode command.

   (b) **show running-config Command**

   - The running-config file is the configuration in RAM memory.
   - All changes are made to the running-config file.
   - This is the configuration that the router is currently using.
   - The running-config is lost when the router loses power or reloads.
   - This command is a privileged user mode command.

```
Router#show running-config

Current configuration : 542 bytes
!
version 12.2
!
interface FastEthernet0/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0
 no ip address
 shutdown
!
line con 0
line aux 0
line vty 0 4
!
end
Router#
```

   (c) **copy running-config startup-config Command**
   This command should be issued every now and then while working on the router to save the running configuration from the volatile RAM to the NVRAM (non volatile RAM).

```
Router#copy running-config startup-config     (or copy run start)
Destination filename [startup-config]?  <Press Enter>
Building configuration...
[OK]
```

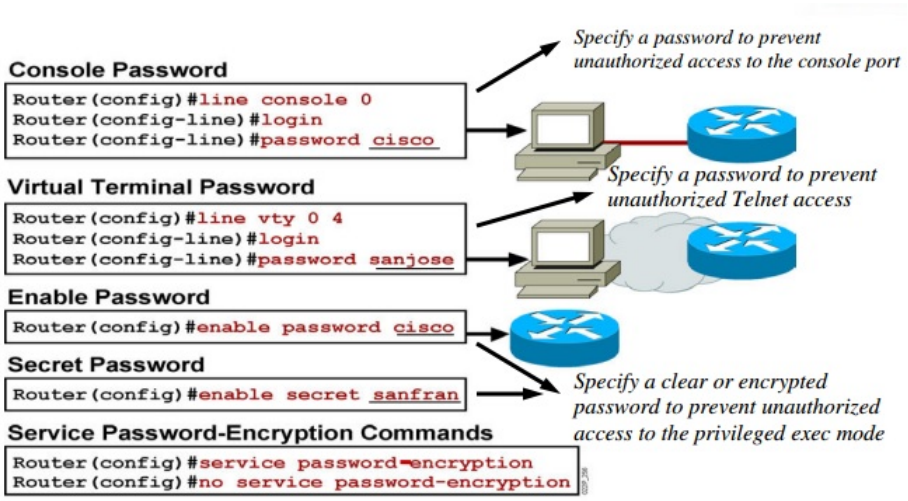
(d) **Return the Device to Its original configuration**
Erase the startup configuration file by using erase startup-config or erase start at the privileged EXEC mode prompt: **Router#erase startup-config**. Then reload the router using the command **reload**

```
Router#erase startup-config
Erasing the nvram filesystem will remove all files! Continue?
[confirm]  <Press Enter>
[OK]
Erase of nvram: complete
Router# reload
System configuration has been modified. Save? [yes/no]: n
Proceed with reload? [confirm]
```

4. **Managing the Console input**

- **Router(config)#line console 0**.
- **Router(config-line)#logging synchronous**.
  synchronizes unsolicited messages and debug output with solicited IOS software output
- **Router(config-line)#exec-timeout 0 0**.
  used to set the interval in minutes and seconds that the EXEC command interpreter waits until user input is detected. If no input is detected during the interval, the current connection is resumed. The exec-timeout 0 0 command is used to specify no timeout.
- **Router(config)#no ip domain-lookup**
  When a command is mistyped on a router, the router attempts to resolve it via DNS. The router sends a broadcast in an attempt to resolve this unknown command through a remote DNS server. The DNS lookup attempt must time out before the configuration can continue. With "no ip domain-lookup" configured, the router doesn't attempt to find a remote DNS server. It immediately sends a message to the console that the command is unknown.

5. **Setting passwords**



6. **Connecting two routers**

To configure an interface:
Router(config)# interface interface-type interface-number
Router(config-if)# description description
Router(config-if)# ip address ip-addresssubnet-mask
Router(config-if)# clock rate rate-in-bps ***(required for DCE only)***
Router(config-if)# no shutdown
Router(config-if)#

How to tell which cable end is the DTE and which end is the DCE:

- Look at the label on the cable.
- Look at the connecter between the two cables - The DTE cable will always be male and the DCE cable will always be female.
- Issue the command "**show controllers serial** *interface-number*" to show the cable type.

```
Router#show controller serial 0/0
HD unit 0, idb = 0x121C04, driver structure at 0x127078
buffer size 1524  HD unit 0, V.35 DTE cable
  .
  .
  .
```

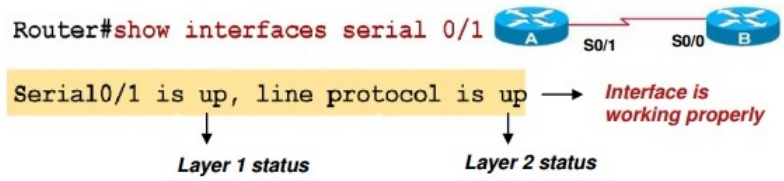

```
To know which interface is the DCE:
RouterA# show controllers s0/0
      |
      |
V.35 DCE cable
      |
      |
Router#conf t
RouterA(config)# interface serial 0/0
RouterA(config-if)# ip address 192.168.1.1 255.255.255.252
RouterA(config-if)# no shutdown
RouterA(config-if)# clock rate 64000    (required for serial DCE only)
RouterA(config-if)# exit

RouterB(config)# interface serial 0/1
RouterB(config-if)# ip address 192.168.1.2 255.255.255.252
RouterB(config-if)# no shutdown
RouterB(config-if)# exit
RouterB(config)# exit
Router#
```

7. **Verifying the configuration**

```
Router#show ip interface brief
Interface              IP-Address      OK?  Method   Status                Protocol
FastEthernet0/0        unassigned      YES  unset    administratively down    down
FastEthernet0/1        unassigned      YES  unset    administratively down    down
Serial0/0              192.168.1.1     YES  unset    up                          up
Serial0/1              unassigned      YES  unset    administratively down    down
Router#
```

Interpreting the interface status



- **Serial0/1 is up, line protocol is up**.
  Both layer 1 and layer 2 are working properly on interface serial 0/1
- **Serial0/1 is administratively down , line protocol is down**.
  This means that the interface is shut down.
- **Serial0/1 is down, line protocol is down**.
  This means that there is interface or cable H/W failure (failure in layer 1).
- **Serial0/1 is up, line protocol is down**.
  This means that there is different encapsulation type (PPP , HDLC , FR), or no clock rate on the DCE device (failure in layer 2).

8. **Testing the network**

   (a) **ping and traceroute Commands**

```
Router#ping 10.1.1.10

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/4 ms

Router#trace 192.168.101.101

Type escape sequence to abort.
Tracing the route to 192.168.101.101

   1 p1r1 (192.168.1.49) 20 msec 16 msec 16 msec
   2 p1r2 (192.168.1.18) 48 msec *  44 msec
Router#
```

   - The ping command moves from Layer 3 of the OSI model to Layer 2 and then Layer 1. Ping uses the ICMP protocol to check for connectivity.
   - A ping from the IOS will yield to one of several indications for each ICMP echo that was sent. The most common indicators are:
     - ! indicates receipt of an ICMP echo reply.
     - . indicates a timed out while waiting for a reply.

   (b) **TELNET**

Initiate a session

```
Denver>telnet paris
```

End a session

```
Paris>exit
```

Suspend a session

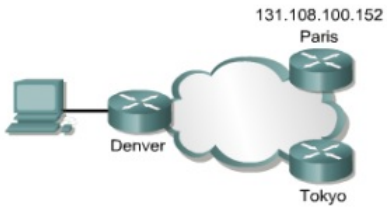
```
Paris><Ctrl><Shift><6><x>
Denver>
```

Resume a session

```
Denver><Enter>
```

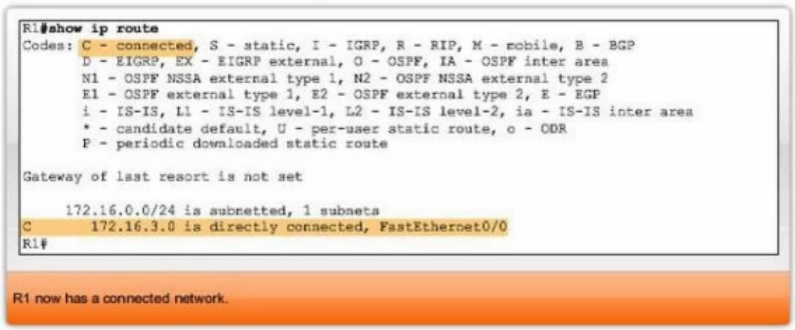
Disconnect a session

```
Denver>disconnect paris
```



9. **Making static routes to distant networks**

- When a router only has its interfaces configured & no other routing protocols are configured, its routing table contains only the directly connected networks, and only devices on the directly connected networks are reachable.

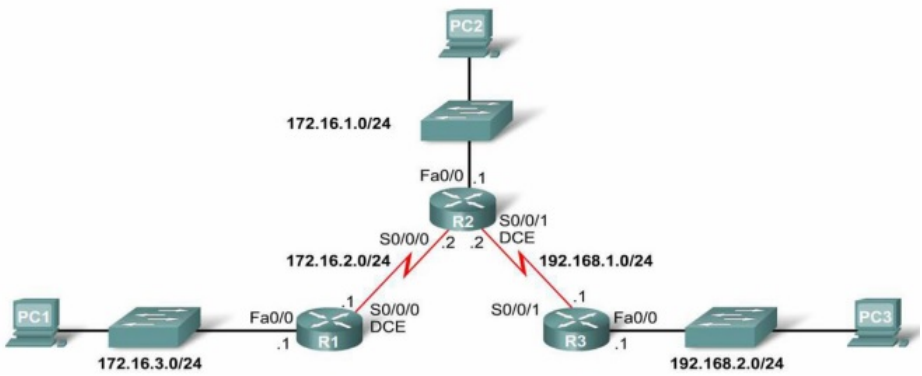


- A **static route** is a manually configured route used when routing from a network to another distant network.
- To configure a static route use the following command: **Router(config)# ip route** *network-address subnet-mask ip-address | exit-interface*

Router(config)# ip route *network-address subnet-mask*
{*ip-address* **|** *exit-interface* **}**
Note: {} means you must write one of the things in the braces

Parameter	Description
network-address	Destination network address of the remote network to be added to the routing table.
subnet-mask	Subnet mask of the remote network to be added to the routing table. The subnet mask can be modified to summarize a group of networks.
ip-address	Commonly referred to as the next-hop router's IP address.
exit-interface	Outgoing interface that is used to forward packets to the destination network.

- **Example: Configuring routes on R1 to the remote networks:**



R1(config)#ip route 172.16.1.0 255.255.255.0 172.16.2.2
(or R1(config)#ip route 172.16.1.0 255.255.255.0 S0/0/0)
R1(config)#ip route 192.168.1.0 255.255.255.0 172.16.2.2
R1(config)#ip route 192.168.2.0 255.255.255.0 172.16.2.2

10. **Abbreviating commands**

Router# en *is the same as* **Router# enable**

Router# conf t *is the same as* **Router# configure terminal**

Router# sh run *is the same as* **Router# show running-config**

Router# copy run start *is the same as* **Router# copy running-config startup-config**

Router# sh int *is the same as* **Router# show interfaces**

Router# sh con s 0/0 *is the same as* **Router# show controllers serial 0/0**

Router(config)# int s 0/1/0 *is the same as* **Router(config)# interface serial 0/1/0**

Router(config)# int f 0/0 *is the same as* **Router(config)# interface fastethernet 0/0**

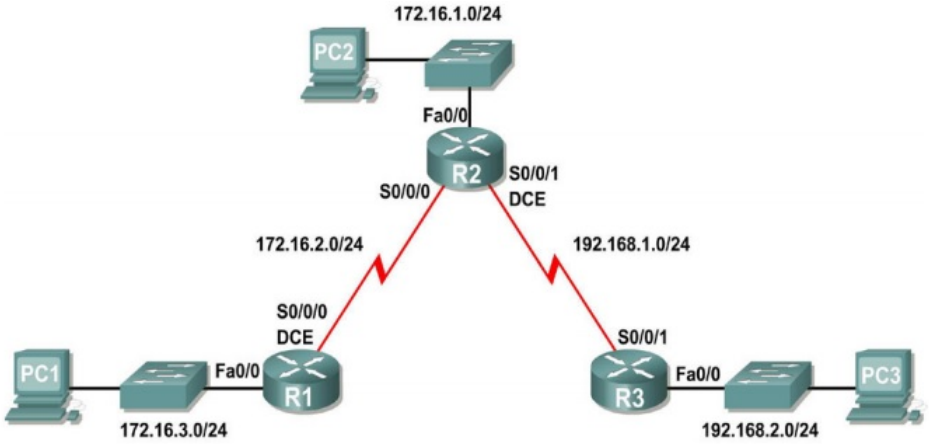
Router(config)# service pass *is the same as* **Router(config)# service password-encryption**

Router(config-if)# no sh *is the same as* **Router(config-if)# no shutdown**

and so on

1.8 Lab Work

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	**Fa0/0**	172.16.3.1	255.255.255.0	N/A
	S0/0/0	172.16.2.1	255.255.255.0	N/A
R2	**Fa0/0**	172.16.1.1	255.255.255.0	N/A
	S0/0/0	172.16.2.2	255.255.255.0	N/A
	S0/0/1	192.168.1.2	255.255.255.0	N/A
R3	**FA0/0**	192.168.2.1	255.255.255.0	N/A
	S0/0/1	192.168.1.1	255.255.255.0	N/A
PC1	**NIC**	172.16.3.10	255.255.255.0	172.16.3.1
PC2	**NIC**	172.16.1.10	255.255.255.0	172.16.1.1
PC3	**NIC**	192.168.2.10	255.255.255.0	192.168.2.1

1.8.1 Task 1 - Cable, Erase, and Reload the Routers

Step 1: Cable a network that is similar to the one in the Topology Diagram.

Step 2: Clear the configuration on each of the routers using the **erase startup-config** command and then **reload** the routers. Answer **no** if asked to save changes.

1.8.2 Task 2 - Perform Basic Router Configuration

Step 1: Use global configuration commands.
On the routers, enter global configuration mode and configure the basic global configuration commands: **hostname, banner motd, no ip domain-lookup, enable secret**.

Step 2: Configure the console and virtual terminal line passwords on each of the routers using the commands: **password** and **login**, and add the **logging synchronous** and **exec-timeout** commands.

1.8.3 Task 3 - Configure the router interfaces according to the addressing table

Example: For R1's interfaces:

R1#**configure terminal**
R1(config)#**interface fastethernet 0/0**
R1(config-if)#**ip address 172.16.3.1 255.255.255.0**

R1(config-if)#**no shutdown**

R1(config-if)#**interface Serial 0/0/0**
R1(config-if)#**ip address 172.16.2.1 255.255.255.0**
R1(config-if)#**clock rate 64000**
R1(config-if)#**no shutdown**
R1(config-if)#**exit**
R1(config)#**exit**
R1#**show ip route**

```
Codes: C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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

     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.2.0 is directly connected, Serial0/0/0
C       172.16.3.0 is directly connected, FastEthernet0/0
```

Now configure R2 and R3 Interfaces and configure the IP Address and default gateway on the Host PCs.

1.8.4 Task4 - Test and Verify the Configurations

Step 1: Test connectivity by pinging from each host PC to the default gateway that has been configured for that host. The pings should succeed.

Step 2: Use the **show ip interface brief** command to verify layer 1 and layer 2 configurations on the 3 routers. Use the **ping** command to test layer 3 connectivity between directly connected routers, i.e. between R1 and R2 and between R2 and R3. The pings should succeed.

Step 3: Use ping to check connectivity between devices that are not directly connected, such as between PC1 and PC2. The pings will fail because routers only know about directly connected networks. **Static routes are needed for routers to learn about distant networks**.

1.8.5 Task 5 - Configure Static Routes on the 3 routers to reach distant networks

Example: On the R3 router, configure a static route to the 172.16.1.0 network using the Serial 0/0/1 interface of R2 as the next-hop address.

R3(config)#**ip route 172.16.1.0 255.255.255.0 192.168.1.2**
(or R3(config)#**ip route 172.16.1.0 255.255.255.0 s0/0/1)**
R3(config)#**exit**
R3#**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, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 1 subnets
S       172.16.1.0 [1/0] via 192.168.1.2
C    192.168.1.0/24 is directly connected, Serial0/0/1
C    192.168.2.0/24 is directly connected, FastEthernet0/0
```

Use ping to check connectivity between the host PC3 and the host PC2.

This ping should fail. The ping request from PC3 will arrive at PC2. PC2 will send a ping reply back to PC3. However, the ping reply will be discarded at R2 because the R2 doesn't have a return route to the 192.168.2.0 network in its routing table.

Now continue configuring static routes.

On R3 configure another 2 static routes for the networks 172.16.2.0/24 and 172.16.3.0/24

On R2 configure 2 static routes for the networks 172.16.3.0/24 and 192.168.2.0/24

On R1 configure 3 static routes for the networks 172.16.1.0/24 and 192.168.1.0/24 and 192.168.2.0/24

View the routing tables of R1, R2 and R3 to verify the new static route entry.

Use ping to check connectivity between all host PCs. The pings should succeed.

1.8.6 Task 6 - Clean Up

Erase the configurations and reload the routers. Disconnect and store the cabling. For PC hosts that are normally connected to other networks (such as the college LAN or to the Internet), reconnect the appropriate cabling and restore the TCP/IP settings.