

CISCO SYSTEMS



Cisco Networking Academy Program

**CCNA**  
Semester 2  
v 1.0



## **Optional CCNA 2-Router Exercises Student Version**

**For use with 800, 1600, 1700,  
2500, and 2600 series routers.**

**Created as part of the Instructional  
Excellence Initiative.**



## Lab 1 Router Topology

### Objective

This lab will focus on your ability to design a two router network topology with two workstations.

### Lab Tasks

In this lab you will work with a partner to design a two router network topology and an IP addressing scheme. Diagram the network using Cisco ConfigMaker/Cisco Network Designer 3.0 (CND) or similar software. Use creative freedom in designing the network with what is available.

### Web Links

[Download Cisco ConfigMaker](#)

[ConfigMaker Getting Started Guide](#)

### Step 1

- a. Use Cisco ConfigMaker/Cisco Network Designer (CND) to create a network diagram.
- b. Be sure the following items are included in your diagram:
  - Name two routers – RouterA and RouterB
  - Name two workstations – WorkstationA and WorkstationB
  - Set up three networks using class C addressing
  - Apply hostnames, IP Addresses and other relevant information.

### Notes:

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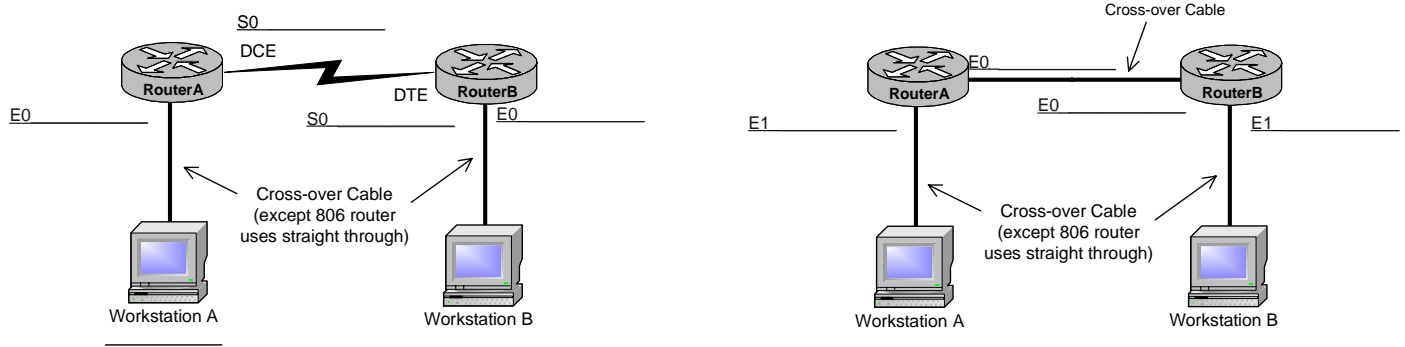
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## Lab 2 Setting Up Routers



### Objective

Cable and configure workstations and routers. Setup IP addressing scheme using class C networks.

### Lab Tasks

Cable a network similar to one of the diagrams above. Be sure to have at least three separate networks and two computers. Any router that meets the interface requirements displayed on the above diagram (i.e. 800, 1600, 1700, 2500 and 2600 routers or a combination) may be used. The configuration output used in this lab is produced from 2500 series routers. Any other router used may produce slightly different output. The following steps are intended to be executed on each router unless specifically instructed otherwise.

## General Information

- Using the question mark (?) and arrow keys help to enter commands.
- Each command mode restricts you to a set of available commands. If there is difficulty entering a command, check the prompt and then enter the question mark (?) for a list of available commands. The problem might be a wrong command mode or using the wrong syntax.
- To disable a feature, enter the keyword **no** before the command; for example, **no ip routing**.
- Save the configuration changes to NVRAM so that the changes are not lost if there is a system reload or power outage.

Command Modes			
Command Mode	Access Method	Router Prompt Displayed	Exit Method
User EXEC	Log in.	Router>	To <b>logout</b> command.
Privileged EXEC	From user EXEC mode, enter the <b>enable</b> command.	Router#	To exit to user EXEC mode, use the <b>disable</b> , <b>exit</b> , or <b>logout</b> command.
Global configuration	From the privileged EXEC mode, enter the <b>configure terminal</b> command.	Router(config)#	To exit to privileged EXEC mode, use the <b>exit</b> or <b>end</b> command, or press <b>Ctrl-z</b> .
Interface configuration	From the global configuration mode, enter the <b>interface type number</b> command, such as <b>interface serial 0</b> .	Router(config-if)#	To exit to global configuration mode, use the <b>exit</b> command.

## Web Links

[General information on routers](#)

[Terms and acronyms](#)

[IP routing protocol IOS command summary](#)

[Cisco 800 Router Configuration Guide](#)

## Step 1

Using any class C IP addresses, design and document the network. It should contain 3 separate networks and 2 workstations. Each workstation should belong to a different network. Label the diagram above. Include interface type and number, IP address, subnet mask, and cable type.

- a. What is the gateway address of Workstation A? Workstation B?
- 

## Step 2

Turn on all your devices. Start the HyperTerminal program and create a new connection.

- Name – Cisco Lab Router
- Specify COM port – COM 1 or COM 2 (typically COM1)
- 9600 bps
- 8 Data bits
- Parity None
- 1 Stop bit
- No flow control

Press the **Enter** key a few times until the user EXEC mode prompt is displayed. If prompted to enter the initial configuration dialog, type **no**. This will reach the command-line interface (CLI). If you have entered auto configuration (setup) mode by accident, type **CTRL-C** to terminate and return to the Router> prompt.

Type **enable** to enter privilege EXEC mode. If prompted for a password type **cisco** or **class**. If not prompted for a password, then no enable password has been set.

```
Router>enable
Router#
```

The router may contain configurations from a previous student. Erase the startup configuration and reload the router to remove any residual configurations.

```
Router#erase startup-config
Erasing the nvram filesystem will remove all files! Continue?
[confirm]
[OK]
Erase of nvram: complete
Router#reload
Proceed with reload? [confirm]
```

### Step 3

Once the router has restarted and prompted to enter the initial configuration dialog, type **no**. The initial configuration dialog is a set of questions that could guide the basic setup process of a router. While this is an easy way to setup a router, the intricate underlying IOS language will be hidden. Do not use this since it is critical to learn how to configure a router using the IOS commands. Knowledge of these commands is necessary for modification of an existing configuration, troubleshooting and advanced router configuration.

Enter global configuration mode. Global configuration mode is used to modify the routers configuration. Set the host name of your router to RouterA (or RouterB).

```
Router#configure terminal  
Enter configuration commands, one per line. End with CNTL/Z.  
Router(config)#hostname RouterA  
RouterA(config)#
```

Notice the prompt changed to reflect the new name.

## Step 4

It is important to set passwords to prevent unauthorized access to view and modify the configuration of the routers. There are three levels of passwords: user mode, privilege mode and telnet access. The passwords selected for these labs are used for purposes of ease of learning and are not recommended for actual business use. Secure passwords should contain combinations of letters and numbers with no actual meaning.

Set the privilege EXEC mode password to **cisco**.

```
RouterA(config)#enable password cisco
```

To specify an additional layer of security over the enable password command, use the **enable secret** global configuration command. The **enable secret** command provides better security by storing the enable secret password using a non-reversible cryptographic function. If the same password is used for the enable password and enable secret commands, an error message will appear warning that this practice is not recommended. However despite the warning, the password will be accepted. Using the same password will undermine the additional security the **enable secret** command provides. Set the enable secret password to **class**.

```
RouterA(config)#enable secret class
```

Enable password checking at virtual terminal session login and set the telnet password to **cisco**. The first command changes to line configuration mode. The command **line vty 0 4** identifies that the virtual terminal (or telnet) password for five lines. The command **login** enables access. To disable access use the **no** form of the command.

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

The terminal used to locally configure the router is attached to the console port. To configure line parameters for the console, type **line console 0** from global configuration mode. Set the user EXEC password to **cisco** and enable password checking at console session login.

```
RouterA(config)#line console 0
RouterA(config-line)#password cisco
RouterA(config-line)#login
RouterA(config-line)#exit
```

## Step 5

Configure IP addresses for each router interface. From global configuration mode, type **interface** followed by the type of interface to be configured followed by the port number ( i.e. **interface Ethernet 0**). This will enter the interface configuration mode. Set the IP address and subnet mask. When typing the commands below, replace **XXX.XXX.XXX.XXX** with the appropriate IP address for each interface. Be sure to type **no shutdown** to activate the interface.

```
RouterA(config)#interface Ethernet 0
RouterA(config-if)#ip address XXX.XXX.XXX.XXX 255.255.255.0
RouterA(config-if)#no shutdown
00:50:25: %LINK-3-UPDOWN: Interface Ethernet0, changed state to up
```

When configuring synchronous serial interfaces a clock rate needs to be set on the DCE interface.

```
RouterA(config)#interface Serial 0
RouterA(config-if)#ip address XXX.XXX.XXX.XXX 255.255.255.0
RouterA(config-if)#clock rate 56000
RouterA(config-if)#no shutdown
00:50:25: %LINK-3-UPDOWN: Interface Serial0, changed state to up
```

## Step 6

Save the running configuration to the startup configuration file.

```
RouterA#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
```

- a. Why is the running configuration saved to the startup configuration?

---

---

---

## Step 7

View the running configuration.

```
RouterA#show running-config
```

Using the **show ip interface brief** command, check the status of each interface.

```
RouterA#show ip interface brief
Interface  IP-Address      OK? Method Status  Protocol
Ethernet0  192.168.2.1     YES manual up      up
Ethernet1  192.168.1.1     YES manual up      up
Serial0    unassigned     YES unset  administratively down down
Serial1    unassigned     YES unset  administratively down down
```

At this point your routers should be able to ping directly connected devices.

```
RouterA#ping 192.168.2.2
```

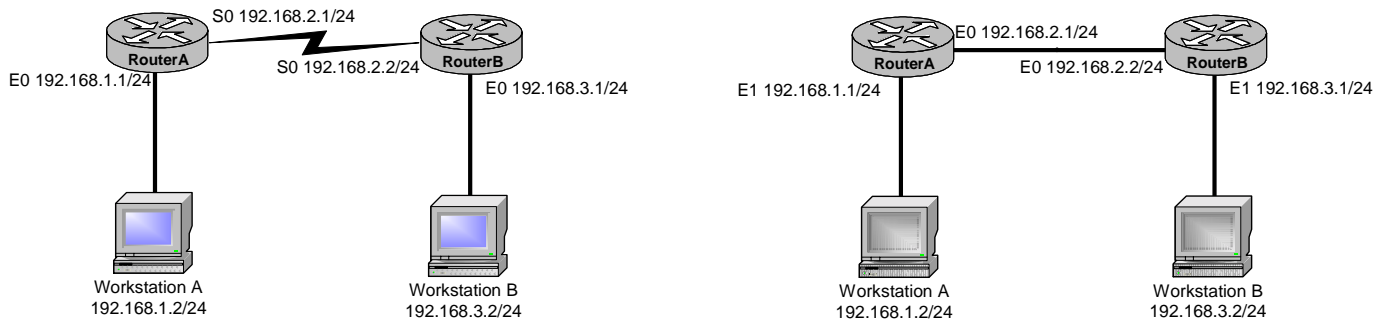
Type escape sequence to abort.

```
Sending 5, 100-byte ICMP Echos to 192.168.2.2, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/32/36
ms
```

Each workstation should be able to ping the attached router. Troubleshoot as necessary. Hint: Did you remember to assign a specific IP address and default gateway to the workstation? If you are running Windows 98, check using **START>RUN>winipcfg**. If you are running Windows 2000, check using **START>RUN>cmd>ipconfig**.

At this point the workstations will not be able to communicate with each other. The following labs will demonstrate the process required to get communication working.

## Lab 3 Static Routes



### Objective

Configure static routes between each router.

### Lab Tasks

Build a network similar to one of the networks above. Be sure you have at least three separate networks and two computers. You may use any router that meets the interface requirements displayed on the above diagram (i.e. 800, 1600, 1700, 2500 and 2600 routers or a combination). The configuration output used in this lab is produced from 2500 series routers. Any other router used may produce slightly different output.

Configure all IP addresses, host names and passwords. Confirm basic connectivity by performing pings between directly connected devices. All pings should be successful. Troubleshoot as necessary. Refer to previous labs for assistance in setting up routers. All commands below are intended to be executed on each router unless specifically instructed otherwise.

### Step 1

- You should now have your network cabled together and IP addresses in place. Run a ping command from one of your workstations to the other. Are you successful?

```
C:\>ping 192.168.3.2
```

---

## Step 2

- a. Why did the ping fail?

---

Check the interfaces on both routers with the command `show ip interface brief`.

RouterA#`show ip interface brief`

- b. Are all the required interfaces up?

---

Using the command `show ip route`, view the IP routing table.

RouterA#`show ip route`

- c. Are all the routes to each network in the routing table?

---

- d. Which network(s) are missing?

---

- e. How can you remedy this situation so that WorkstationA has access to WorkstationB?

---

### Step 3

Add static routes to each router.

In global configuration mode, add a static route on RouterA to network 192.168.3.0.

```
RouterA(config)#ip route 192.168.3.0 255.255.255.0 192.168.2.2
```

Notice the addition to the IP routing table.

```
RouterA#show ip route
```

```
Gateway of last resort is not set
```

```
C    192.168.1.0/24 is directly connected, Ethernet1
```

```
C    192.168.2.0/24 is directly connected, Ethernet0
```

```
S    192.168.3.0/24 [1/0] via 192.168.2.2
```

- a. Ping WorkstationB from RouterA. Are you successful?

---

- b. Ping WorkstationB from WorkstationA. Are you successful?

```
C:\>ping 192.168.3.2
```

---

- c. Why did the ping fail?

---

---

---

## Step 4

Add the missing route on RouterB

On RouterB add a route to network 192.168.1.0.

```
RouterB(config)#ip route 192.168.1.0 255.255.255.0 192.168.2.1
```

Verify the route was properly added to RouterB.

```
RouterB#show ip route
```

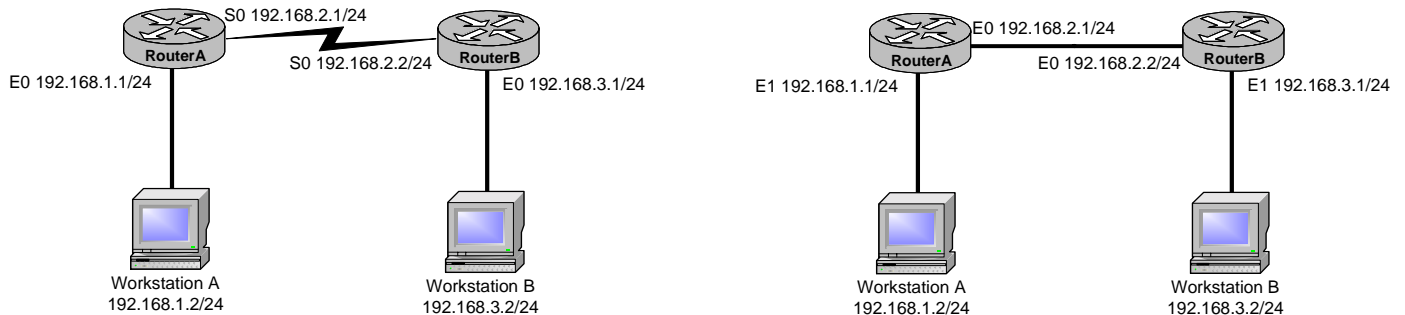
```
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B -  
       BGP  
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2  
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP  
       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
```

```
S    192.168.1.0/24 [1/0] via 192.168.2.1  
C    192.168.2.0/24 is directly connected, Ethernet0  
C    192.168.3.0/24 is directly connected, Ethernet1
```

- a. Ping WorkstationB from WorkstationA. Ping Workstation B from WorksationA. Are you successful?
-

## Lab 4 RIP



### Objective

Setup dynamic routing between networks using RIP (Routing Information Protocol)

### Lab Tasks

Build a network similar to one of the networks above. Be sure you have at least three separate networks and two computers. You may use any router that meets the interface requirements displayed on the above diagram (i.e. 800, 1600, 1700, 2500 and 2600 routers or a combination). The configuration output used in this lab is produced from 2500 series routers. Any other router used may produce slightly different output.

Configure all IP addresses, host names and passwords. Confirm basic connectivity by performing pings between directly connected devices. All pings should be successful. Troubleshoot as necessary. Be sure to set the default gateway on your workstations to the IP address of the router to which it is connected.

If the routers are still configured with static routes from the previous lab (Lab 3), ensure that you erase the starting configuration and reload.

## General RIP Information

- 2 versions of RIP, RIP version 1 and RIP version 2
- RIPv1 is a classful and RIPv2 is classless
- RIP uses a distance vector algorithm which uses hop counts to determine routing metrics
- Administrative distance is 120
- Maximum hop count is 15
- Routing updates between directly connected neighbors are broadcast (255.255.255.255) every 30 seconds by default
- Default invalid time is 180 seconds and default flush time is 240 seconds
- More information on RIP and RIPv2 can be found in RFC 1058 and RFC 1723.

## Web Links

[RFC 1058](#)

[RFC 1723](#)

[Information on RIP @ CCO](#)

## Step 1

- a. The network should be cabled together and IP addresses configured. Run a ping command from one of your workstations to the other. Are you successful?

```
C:\> ping 192.168.3.2
```

- b. Is the IP address and default gateway properly set on both workstations?

- c. Are all the necessary interfaces 'UP' on both routers?

```
Router A#show ip interface brief
```

Interface	IP-Address	OK?	Method	Status	Protocol
Ethernet0	192.168.2.1	YES	manual	up	up
Ethernet1	192.168.1.1	YES	manual	up	up
Serial0	unassigned	YES	unset	administratively down	down
Serial1	unassigned	YES	unset	administratively down	down

```
Router B#show ip interface brief
```

Interface	IP-Address	OK?	Method	Status	Protocol
Ethernet0	192.168.2.2	YES	manual	up	up
Ethernet1	192.168.3.1	YES	manual	up	up
Serial0	unassigned	YES	unset	administratively down	down
Serial1	unassigned	YES	unset	administratively down	down

View the routing table on each router.

```
RouterA#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
```

```
C   192.168.1.0/24 is directly connected, Ethernet1
C   192.168.2.0/24 is directly connected, Ethernet0
```

```
RouterB#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   192.168.2.0/24 is directly connected, Ethernet0
C   192.168.3.0/24 is directly connected, Ethernet1
```

- d. Is anything missing in the routing table?
- 
- 

## Step 2

A manually entered static route was one way of adding a missing route to each router. A second method is to configure a routing protocol. Routing protocols exchange routing information between routers and choose the best path to a network if multiple paths exist. Enable RIP as the routing protocol on RouterA. The first step is to enable the RIP process from global configuration mode. Then add the networks that to advertise to other routers with the **network** command. RouterA would usually advertise all directly connected networks.

Now configure RIP on RouterB.

```
RouterA(config)#router rip
RouterA(config-router)#network 192.168.1.0
RouterA(config-router)#network 192.168.2.0
```

## Step 3

Using the **show ip protocols** command, verify that RIP is setup properly.

```
RouterA#show ip protocols
```

```
Routing Protocol is "rip"
  Sending updates every 30 seconds, next due in 12 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Redistributing: rip
  Default version control: send version 1, receive any version
    Interface        Send  Recv  Key-chain
  Ethernet0          1    1 2
  Ethernet1          1    1 2
  Routing for Networks:
    192.168.2.0
    192.168.1.0
  Routing Information Sources:
    Gateway         Distance    Last Update
  192.168.2.2       120        00:00:19
  Distance: (default is 120)
```

```
RouterB#show ip protocol
```

```
Routing Protocol is "rip"
  Sending updates every 30 seconds, next due in 14 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Outgoing update filter list for all interfaces is
  Incoming update filter list for all interfaces is
  Redistributing: rip
  Default version control: send version 1, receive any version
    Interface        Send  Recv  Triggered RIP  Key-chain
  Ethernet0          1    1 2
  Ethernet1          1    1 2
  Routing for Networks:
    192.168.2.0
    192.168.3.0
  Routing Information Sources:
    Gateway         Distance    Last Update
  192.168.2.1       120        00:00:11
  Distance: (default is 120)
```

## View the IP routing table entries.

```
RouterA#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
```

```
C    192.168.1.0/24 is directly connected, Ethernet1
C    192.168.2.0/24 is directly connected, Ethernet0
R    192.168.3.0/24 [120/1] via 192.168.2.2, 00:00:26, Ethernet0
```

Network      Administrative      Metric      Learned from      Update Time      Interface

Distance

```
RouterB#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
```

```
R    192.168.1.0/24 [120/1] via 192.168.2.1, 00:00:06, Ethernet0
C    192.168.2.0/24 is directly connected, Ethernet0
C    192.168.3.0/24 is directly connected, Ethernet1
```

## Step 4

View the RIP update process. Turn on debug for RIP events and clear the routing table to initiate the routing update process.

```
RouterB#debug ip rip
RouterB#clear ip route *
4d04h: RIP: sending request on Ethernet0 to 255.255.255.255
4d04h: RIP: sending request on Ethernet1 to 255.255.255.255
4d04h: RIP: received v1 update from 192.168.2.1 on Ethernet0
4d04h:     192.168.1.0 in 1 hops
4d04h: RIP: sending v1 update to 255.255.255.255 via Ethernet0 (192.168.2.2)
4d04h: RIP: build update entries
4d04h:   network 192.168.3.0 metric 1
4d04h: RIP: sending v1 update to 255.255.255.255 via Ethernet1 (192.168.3.1)
4d04h: RIP: build update entries
4d04h:   network 192.168.1.0 metric 2
4d04h:   network 192.168.2.0 metric 1
4d04h: RIP: sending v1 flash update to 255.255.255.255 via Ethernet0 (192.168.2.2)
4d04h: RIP: build flash update entries
4d04h:   network 192.168.3.0 metric 1
4d04h: RIP: sending v1 flash update to 255.255.255.255 via Ethernet1 (192.168.3.1)
4d04h: RIP: build flash update entries
4d04h:   network 192.168.1.0 metric 2
4d04h:   network 192.168.2.0 metric 1
4d04h: RIP: received v1 update from 192.168.2.1 on Ethernet0
4d04h:     192.168.1.0 in 1 hops
```

```
RouterA#debug ip rip
RouterA#clear ip route *

04:54:34: RIP: sending general request on Ethernet0 to 255.255.255.255
04:54:34: RIP: sending general request on Ethernet0 to 224.0.0.9
04:54:34: RIP: sending general request on Ethernet1 to 255.255.255.255
04:54:34: RIP: sending general request on Ethernet1 to 224.0.0.9
04:54:43: RIP: received v1 update from 192.168.2.2 on Ethernet0
04:54:43:     192.168.3.0 in 1 hops
04:54:43: RIP: sending v1 update to 255.255.255.255 via Ethernet0 (192.168.2.1)
         network 192.168.1.0, metric 1
04:54:43: RIP: sending v1 update to 255.255.255.255 via Ethernet1 (192.168.1.1)
         network 192.168.2.0, metric 1
         network 192.168.3.0, metric 2
04:54:48: RIP: received v1 update from 192.168.2.2 on Ethernet0
         192.168.3.0 in 1 hops
04:54:48: RIP: sending v1 update to 255.255.255.255 via Ethernet0 (192.168.2.1)
         network 192.168.1.0, metric 1
04:54:48: RIP: sending v1 update to 255.255.255.255 via Ethernet1 (192.168.1.1)
         network 192.168.2.0, metric 1
         network 192.168.3.0, metric 2
```

- a. What is the command to turn off all debug output?
-

## Step 5

- a. Test connectivity with ping between RouterA and WorkstationB and between RouterB and WorkstationA. Are the pings successful?
- 

```
RouterA#ping 192.168.3.2
```

```
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 192.168.3.2, timeout is 2 seconds:  
!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 40/44/60 ms
```

```
RouterB#ping 192.168.1.2
```

```
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:  
!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/32/32 ms
```

- b. Now, test connectivity between both workstations. Is it successful?
- 

```
C:\>ping 192.168.3.2
```

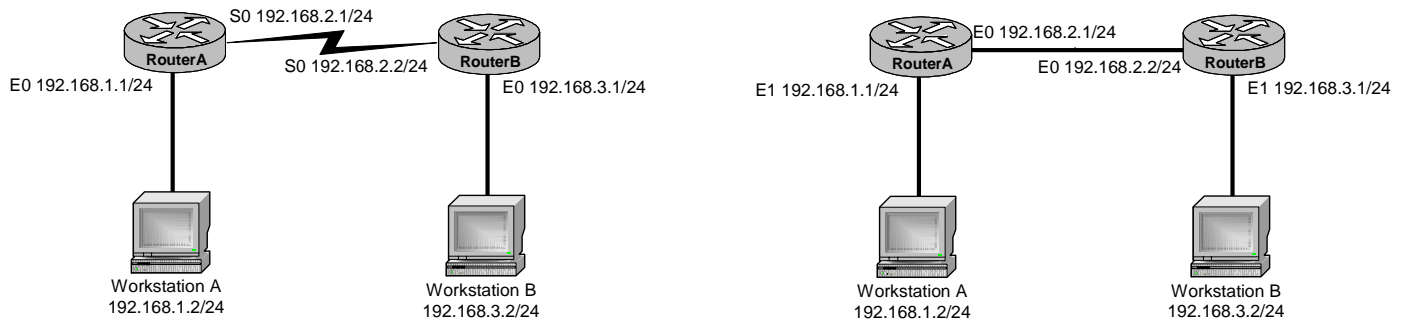
```
Pinging 192.168.3.2 with 32 bytes of data:  
  
Reply from 192.168.3.2: bytes=32 time<10ms TTL=128  
Reply from 192.168.3.2: bytes=32 time<10ms TTL=128  
Reply from 192.168.3.2: bytes=32 time<10ms TTL=128  
Reply from 192.168.3.2: bytes=32 time<10ms TTL=128  
  
Ping statistics for 192.168.3.2:  
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),  
Approximate round trip times in milli-seconds:  
Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

## Step 6

- a. What improvements can be implemented on this network?
- 

- b. What are the benefits of the suggested improvements?
-

## Lab 5 Housekeeping



### Objective

Implement basic configuration settings on routers.

### Lab Tasks

Build a network similar to one of the networks above. Be sure you have at least three separate networks and two computers. You may use any router that meets the interface requirements displayed on the above diagram (e.g., 800, 1600, 1700, 2500 and 2600 routers or a combination). The configuration output displayed in this lab may differ from your experiences. The configuration output used in this lab is from 2500 series routers.

Configure all IP addresses, host names and passwords. Connect to each router via Hyperterminal. The following troubleshooting commands are intended to be executed on each router unless specifically instructed otherwise.

### Step 1

Set the clock and time zone on your router.

```
RouterA#configure terminal
RouterA(config)#clock timezone HST -10
RouterA(config)#exit
RouterA#clock set 14:45:00 12 February 2002
```

To view the time and date use the command `show clock`.

```
RouterA#show clock
14:48:34.063 HST Tue Feb 12 2002
```

- Why would setting the system time on the routers be useful?
-

## Step 2

Set a description on all active interfaces. The **description** command is used in interface configuration mode to add an explanation or to remark on an interface. This command can eliminate confusion in large network with many connections.

```
RouterA(config-if)#description Connection to RouterB
```

View the running configuration to see the description line.

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

Current configuration : 1100 bytes
!
! Last configuration change at 14:57:44 HST Fri Feb 15 2002
!
version 12.1
no service password-encryption
!
hostname RouterA
!
enable password cisco
!
clock timezone HST -10
ip subnet-zero
!
interface Ethernet0
  description Connection to RouterB
  ip address 192.168.2.1 255.255.255.0
!
interface Ethernet1
  ip address 192.168.1.1 255.255.255.0
!
interface Serial0
  no ip address
  shutdown
!
interface Serial1
  no ip address
  shutdown
!
ip classless
no ip http server
!
line con 0
  password cisco
  login
  transport input none
line aux 0
line vty 0 4
  password cisco
  login
!
end
```

### Step 3

Specify a message-of-the-day (MOTD) banner. Use the **banner motd** global configuration command. Follow the command with one or more blank spaces and a delimiting character of your choice. Then enter one or more lines of text, terminating the message with the second occurrence of the delimiting character.

```
RouterA(config)#banner motd #
Enter TEXT message. End with the character '*'.
The power will be out on Friday, February 15, 2001 from 8:00 AM to
9:00 AM.
#
```

When a MOTD banner is set, it is displayed when a user connects via the console port or a telnet connection. The maximum size of the banner is 400 characters or 20 lines.

Logoff your router with the **exit** command and login to see the change.

```
RouterA con0 is now available

Press RETURN to get started.
```

```
The power will be out on Friday, February 15, 2001 from 8:00 AM to
9:00 AM.
```

```
User Access Verification
```

```
Password:
RouterA>
```

### Step 4

Add security to your router passwords. To encrypt passwords, use the **service password-encryption** global configuration command. The actual encryption process occurs when the current configuration is written or when a password is configured. Password encryption can be applied to both the privileged command password and to console and virtual terminal line access passwords.

```
RouterA(config)#service password-encryption
RouterA#copy running-config startup-config
```

Use the **show running-config** command to verify that all password are encrypted.

## Step 5

By default, IP Domain Name System-based host-name-to-address translation is enabled. To disable this feature, use **no ip domain-lookup** global configuration command. If domain name lookup is initiated and no valid name servers are specified, the router may take about 30 secs to timeout. This feature is not required in a lab environment without a DNS server. It will also prevent the router from starting a DNS lookup on any unintentional mistyped one word command.

Misspell a command in privilege mode. Notice the time it takes before you have control of the CLI.

```
RouterA#sdow
Translating "sdow"...domain server (255.255.255.255)
Translating "sdow"...domain server (255.255.255.255)
(255.255.255.255)Translating "sdow"...domain server
(255.255.255.255)
% Unknown command or computer name, or unable to find computer
address
```

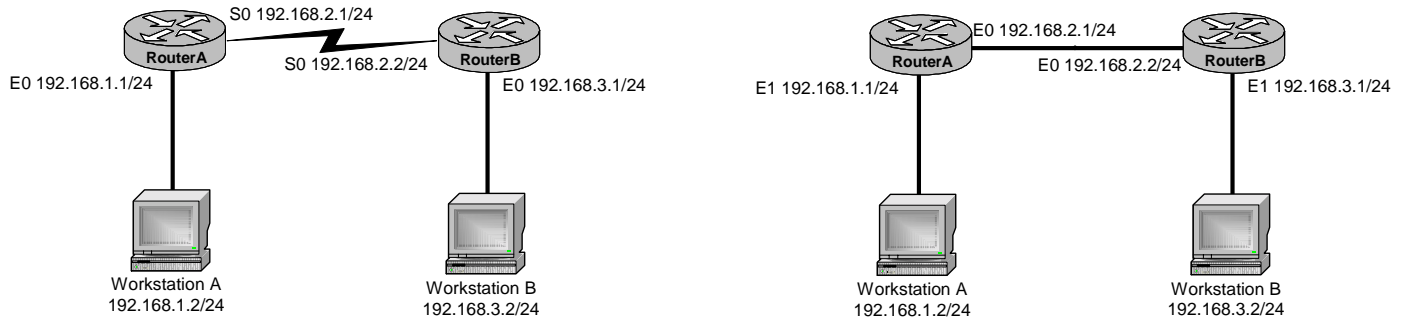
Enter configuration mode and enter the command **no ip domain-lookup**.

```
RouterA#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
RouterA(config)#no ip domain-lookup
RouterA(config)#end
```

Now, misspell a command in privilege mode. Notice you immediately have control of the CLI.

```
RouterA#laskdjf
Translating "laskdjf"
Translating "laskdjf"
% Unknown command or computer name, or unable to find computer
address
RouterA#
```

## Lab 6 Address Resolution Protocol (ARP)



### Objective

Understand the ARP process.

### Lab Tasks

Build a network similar to one of the networks above. Be sure you have at least three separate networks and two computers. You may use any router that meets the interface requirements displayed on the above diagram (e.g., 800, 1600, 1700, 2500 and 2600 routers or a combination). The configuration output displayed in this lab may differ from your experiences. The configuration output used in this lab is from 2500 series routers.

Configure all IP addresses, host names and passwords and use static routing. Confirm basic connectivity by performing pings between devices. All pings should be successful. Troubleshoot as necessary. Refer to previous labs for assistance in setting up routers.

### General Information

Address Resolution Protocol (ARP) is a protocol for mapping an IP address to a physical device address in a local area network. When an incoming packet destined for a host machine on a particular local area network arrives at a gateway, the gateway asks the ARP program to find a physical host or MAC address that matches the IP address. The ARP program looks in the ARP cache and, if it finds the address, provides it so that the packet can be converted to the right packet length and format and sent to the machine. If no entry is found for the IP address, ARP broadcasts a request (ARP Request) packet in a special format to all the machines on the LAN to see if one machine knows that it has that IP address associated with it. A machine that recognizes the IP address as its own returns a reply (ARP Reply). ARP updates the ARP cache for future reference and then sends the packet to the MAC address that replied.

## Step 1

A router's serial interface does not have a MAC address associated with. However, Ethernet interfaces do. Use the **show interfaces** command to display the MAC address of each router.

```
RouterA#show interfaces ethernet 1
```

```
Ethernet0 is up, line protocol is up
  Hardware is Lance, address is 0010.7b81.8598 (bia 0010.7b81.8598)
  Internet address is 192.168.1.1/24
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:09, output 00:00:07, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    26 packets input, 4781 bytes, 0 no buffer
    Received 14 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
    0 input packets with dribble condition detected
    66 packets output, 8090 bytes, 0 underruns
    0 output errors, 0 collisions, 1 interface resets
    0 babbles, 0 late collision, 0 deferred
    0 lost carrier, 0 no carrier
    0 output buffer failures, 0 output buffers swapped out
```

Modifiable  
MAC Address

Burned in MAC  
Address

Default ARP  
timeout set to 4  
hours

```
RouterA#show interfaces ethernet 0
```

```
Ethernet1 is up, line protocol is up
  Hardware is Lance, address is 0010.7b81.8599 (bia 0010.7b81.8599)
  Internet address is 192.168.2.1/24
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:15, output 00:00:03, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    11 packets input, 2921 bytes, 0 no buffer
    Received 7 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
    0 input packets with dribble condition detected
    58 packets output, 7530 bytes, 0 underruns
    0 output errors, 0 collisions, 1 interface resets
    0 babbles, 0 late collision, 0 deferred
    0 lost carrier, 0 no carrier
    0 output buffer failures, 0 output buffers swapped out
```

Notice here each interface has two MAC addresses. The first MAC address displayed is the configurable MAC address and the second address is the burned in MAC address. The default timeout value for ARP is set to four hours. You can specify the amount of time before ARP entries are aged and removed from the ARP table per interface with the interface configuration command **arp timeout <time>**.

Using the command **show arp**, view the ARP table. Notice that RouterA only contains two entries, one for each of its Ethernet interfaces.

```
RouterA#show arp
```

Protocol	Address	Age (min)	Hardware Addr	Type	Interface
Internet	192.168.1.1	-	0010.7b81.8598	ARPA	Ethernet1
Internet	192.168.2.1	0	0010.7b81.8599	ARPA	Ethernet0

## Step 2

Activate and deactivate all interfaces on each router to remove any residual ARP entries from the ARP table.

- a. Enable `debug arp` on RouterA. Run a `ping` from WorkstationA to RouterA (192.168.1.1). What does the debug output show?

```
00:01:34: IP ARP: rcvd req src 192.168.1.2 0002.1763.ad55, dst 192.168.1.1 Ethernet1
00:01:34: IP ARP: creating entry for IP address: 192.168.1.2, hw: 0002.1763.ad55
00:01:34: IP ARP: sent rep src 192.168.1.1 0010.7b81.8598,
          dst 192.168.1.2 0002.1763.ad55 Ethernet1
```

- b. Analyze the debug output and explain what is happening?

---

---

View the ARP table on RouterA and WorkstationA to view the new entries.

```
RouterA#show arp
Protocol Address          Age (min) Hardware Addr  Type   Interface
Internet 192.168.2.1          -         0010.7b81.8599 ARPA   Ethernet0
Internet 192.168.1.1          0         0010.7b81.8598 ARPA   Ethernet1
Internet 192.168.1.2          -         0002.1763.ad55 ARPA   Ethernet1
```

WorkstationA's ARP table

```
C:\>arp -a

Interface: 192.168.1.2 on Interface 0x3000004
Internet Address      Physical Address    Type
192.168.1.1           00-10-7b-81-85-98  dynamic
```

To communicate between RouterA and WorkstationA, both devices required each other's MAC address. In these examples you are using the `ping` command to initiate ARP request and replies. Keep in mind any communication between applications on different nodes requires knowledge by the source of the MAC address of the destination or gateway prior to successfully communicating.

## Step 3

Enable `debug arp` on RouterA and RouterB. Execute the `ping` command from WorkstationA to WorkstationB. Take note of the debug output as it is displayed.

- a. What are your observations?

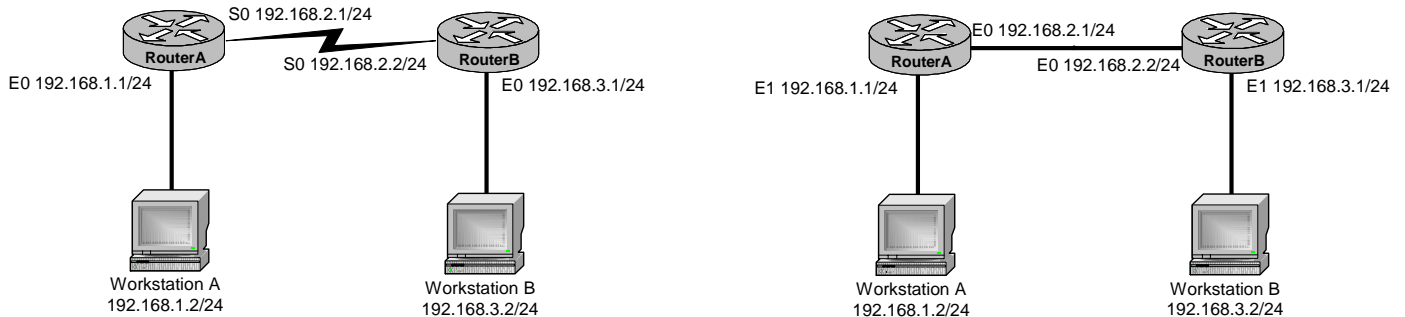
---

---

---

---

## Lab 7 On by Default



### Objective

Learn the default settings automatically configured on a router.

### Lab Tasks

Build a network similar to one of the networks above. Erase the running configuration and reload each router to remove any residual configuration. You may use any router that meets the interface requirements displayed on the above diagram (e.g., 800, 1600, 1700, 2500 and 2600 routers or a combination).

### Step 1

Take a look at the default settings in global configuration mode.

- What is the default name given to the router when you first log on? What command did you use to find this information?

---

- Is IP routing on or off by default? What command did you use to find this information?

---

- Is IPX routing on or off by default? What command did you use to find this information?

---

- What is the command to enable IPX routing?

---

## Step 2

Take a look at the default settings in interface configuration mode.

- a. What is the default encapsulation for serial interfaces?

---

- b. What are other encapsulation types supported by your router? (use the help command for more assistance)

---

- c. What is the default activation status of each interface?

---

- d. What is the command to activate and deactivate an interface?

---

## Step 3

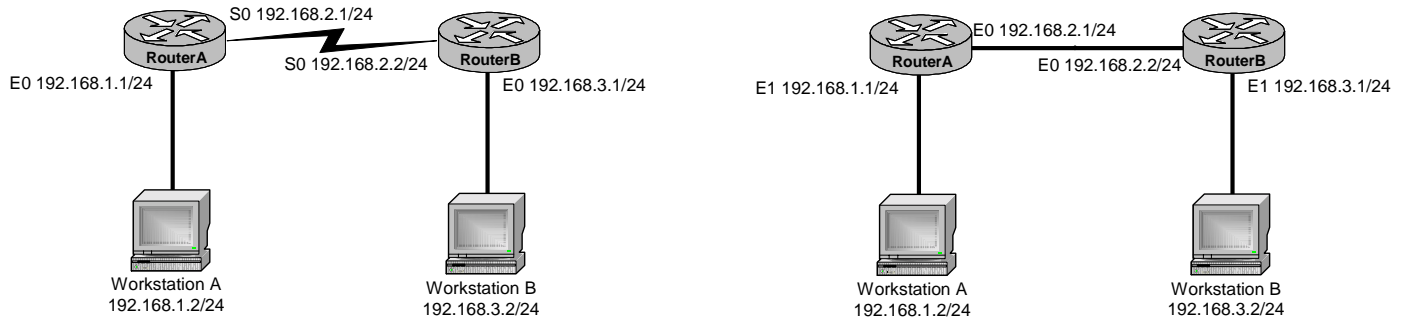
- a. Find and list three more default settings.

---

---

---

## Lab 8 Enhanced Interior Gateway Routing Protocol (EIGRP)



### Objective

Set up dynamic routing between networks using EIGRP.

### Lab Tasks

Build a network similar to one of the networks above. Be sure to have at least three separate networks and two computers. You may use any router that meets the interface requirements displayed on the above diagram (i.e. 800, 1600, 1700, 2500, 2600 routers, or any combination of these routers). The configuration output displayed in this lab may differ from what is shown. The examples shown are from 2500 series routers.

Configure all IP address, host names and passwords. Confirm basic connectivity by performing pings between directly connected devices. All pings should be successful. Troubleshoot as necessary.

### General EIGRP Information

- Integrates the capabilities of link-state protocols into distance vector protocols.
- EIGRP uses the Diffusing Update Algorithm (DUAL) developed at SRI International by Dr. J.J. Garcia-Luna-Aceves.
- Support for variable-length subnet masking (VLSM)
- EIGRP sends partial updates when the metric for a route changes rather than regular periodic updates.
- EIGRP includes support for AppleTalk, IP, and Novell NetWare networks.

### Web Links

[Information on EIGRP @ CCO](#)

### Step 1

Enable EIGRP as the routing protocol on Router A. Then add the networks needed to be advertised to other routers with the `network` command. Repeat this process on Router B.

```
RouterA(config)#router eigrp 1
RouterA(config-router)#network 192.168.1.0
RouterA(config-router)#network 192.168.2.0
```

### Step 2

Verify EIGRP is setup properly.

```
RouterA#show ip protocols
```

View the IP routing table entries.

```
RouterA#show ip route
```

### Step 3

- a. Test connectivity with ping between RouterA and WorkstationB. Is the ping successful?

---

```
RouterA#ping 192.168.3.2
```

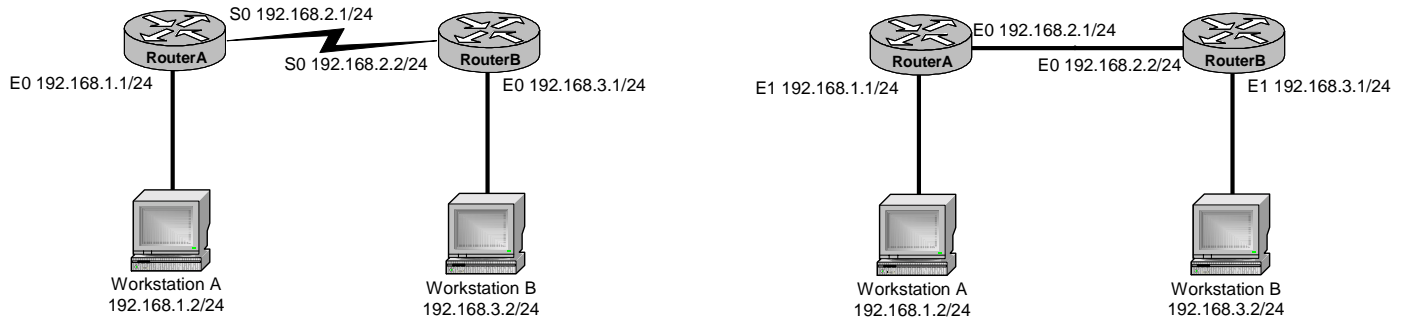
```
RouterB#ping 192.168.1.2
```

- b. Now test connectivity between both workstations. Is this successful?

---

```
C:\>ping 192.168.3.2
```

## Lab 9 Administrative Distance



### Objective

Analyze the effects of using two routing protocols.

### Lab Tasks

Build a network similar to one of the networks above. Be sure to have at least three separate networks and two computers. You may use any router that meets the interface requirements displayed on the above diagram (i.e. 800, 1600, 1700, 2500, 2600 routers, or any combination of these routers). The configuration output displayed in this lab may differ from what is shown. The examples shown are from 2500 series routers.

Configure IP addresses, hostnames and use RIP as the routing protocol. Confirm basic connectivity by performing pings between all devices. All pings should be successful. Troubleshoot as necessary.

## Step 1

Using the **show ip protocols** command, verify RIP is configured properly.

```
RouterA#show ip protocols
Routing Protocol is "rip"
  Sending updates every 30 seconds, next due in 9 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Outgoing update filter list for all interfaces is
  Incoming update filter list for all interfaces is
  Redistributing: rip
  Default version control: send version 1, receive any version
  Interface          Send  Recv  Triggered RIP  Key-chain
  Ethernet0          1     1 2
  Ethernet1          1     1 2
Routing for Networks:
  192.168.1.0
  192.168.2.0
Routing Information Sources:
  Gateway            Distance    Last Update
  192.168.2.2        120        00:00:13
Distance: (default is 120)
```

- a. What is RIP's administrative distance?

---

- b. What would happen if both EIGRP and RIP were used? Why does this happen?

---

---

## Step 2

Add EIGRP to both routers using AS 1.

```
RouterA(config)#router eigrp 1
RouterA(config-router)#network 192.168.1.0
RouterA(config-router)#network 192.168.2.0

RouterB(config)#router eigrp 1
RouterB(config-router)#network 192.168.2.0
RouterB(config-router)#network 192.168.3.0
```

Using the command `show ip protocols`, check if EIGRP is correctly configured on both routers.

```
RouterA#show ip protocols
```

```
Routing Protocol is "eigrp 1"
  Outgoing update filter list for all interfaces is
  Incoming update filter list for all interfaces is
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  EIGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  EIGRP maximum hopcount 100
  EIGRP maximum metric variance 1
  Redistributing: eigrp 1
  Automatic network summarization is not in effect
  Routing for Networks:
    192.168.1.0
    192.168.2.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.2.2      90            00:04:26
  Distance: internal 90 external 170
```

```
Routing Protocol is "rip"
```

```
  Sending updates every 30 seconds, next due in 0 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Outgoing update filter list for all interfaces is
  Incoming update filter list for all interfaces is
  Redistributing: rip
  Default version control: send version 1, receive any version
  Interface          Send  Recv  Triggered RIP  Key-chain
  FastEthernet0      1    1 2
  Serial0            1    1 2
  Automatic network summarization is in effect
  Routing for Networks:
    192.168.1.0
    192.168.2.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.2.2      120           00:00:26
  Distance: (default is 120)
```

### Step 3

- a. View the routing table. Which routing protocol's routes were placed in the routing table?
- 

```
RouterA#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, FastEthernet0
C    192.168.2.0/24 is directly connected, Serial0
D    192.168.3.0/24 [90/20537600] via 192.168.2.2, 00:08:03, Serial0
```

- b. Test connectivity between both workstations. Is the test successful?
- 

```
C:\>ping 192.168.3.2
```

```
Pinging 192.168.3.2 with 32 bytes of data:
```

```
Reply from 192.168.3.2: bytes=32 time<10ms TTL=128
Reply from 192.168.3.2: bytes=32 time<10ms TTL=128
Reply from 192.168.3.2: bytes=32 time<10ms TTL=128
Reply from 192.168.3.2: bytes=32 time<10ms TTL=128
```

```
Ping statistics for 192.168.3.2:
```

```
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

**Step 4**

- a. What are the default administrative distances for the following protocols?

RIP

---

IGRP

---

EIGRP

---

BGP – External

---

BGP - Internal

---

OSPF

---

Static Route

---

## Step 5

Due to network migration reasons, RouterA needs to use and advertise RIP routes as the preferred routing protocol.

Modify RIP on RouterA to have an administrative distance of 75.

```
RouterA(config-router)#distance 75
RouterA(config-router)#end
RouterA#clear ip route *
```

View the routing table and notice the changes.

```
RouterA#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, FastEthernet0
C    192.168.2.0/24 is directly connected, Serial0
R    192.168.3.0/24 [75/1] via 192.168.2.2, 00:00:08, Serial0
```

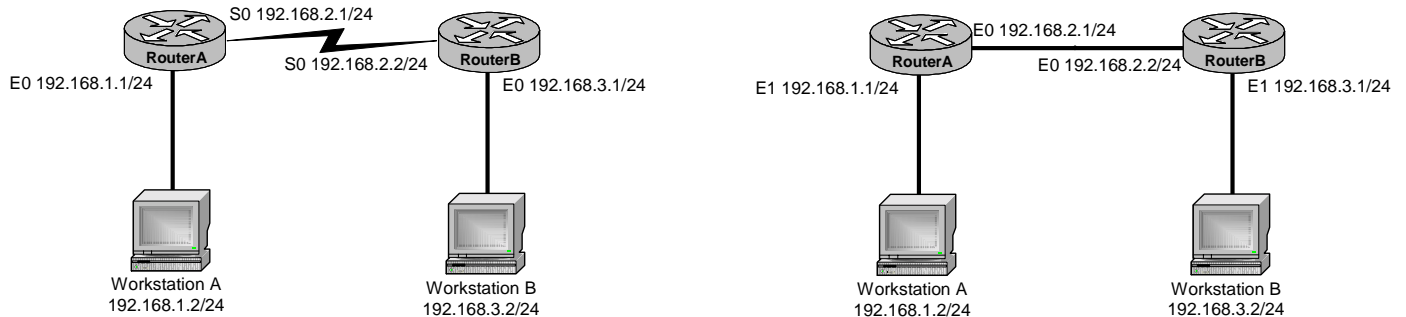
- a. Why did the RIP route replace the EIGRP route in the routing table?

---

- b. List two ways to prove the RIP administrative distance change is in effect.

---

## Lab 10 Understanding Basic Error Messages and Introduction to Debug Commands



### Objective

Understand when to use basic troubleshooting commands.

### Lab Tasks

Build a network similar to one of the networks above. Be sure to have at least three separate networks and two computers. You may use any router that meets the interface requirements displayed on the above diagram (i.e. 800, 1600, 1700, 2500, 2600 routers, or any combination of these routers). The configuration output displayed in this lab may differ from what is shown. The examples shown are from 2500 series routers.

Configure all IP addresses, host names and passwords. Use RIP as your routing protocol. Confirm basic connectivity by performing pings between devices. All pings should be successful. Troubleshoot as necessary. Refer to previous labs for instructions on configuring routers.

## Step 1

Sometimes the router may return error messages when entering commands. Understanding general CLI error messages is important quality to a proficient technician.

- a. Enter the command **show con** in global configuration mode. What is the error message? What does it mean?

---

---

- b. What method is used when this type of error message appears?

---

---

- c. Enter the command **show configuration** to display the programmed router commands.

---

- d. Enter the command **show routers** in privilege mode. What is the error message? What does it mean?

---

---

- e. What method is used when this type of error message appears?

---

---

- f. In global configuration mode, enter the command **router**. What is the error message? What does it mean?

---

- g. What method is used when this type of error message appears?

---

---

## Step 2

Debug commands allow troubleshooting configuration problems that may occur on a network. Debug commands provide extensive, informative displays to help interpret problems.

- a. In privilege mode, enter the command `debug ip rip`. What output is displayed on the console?

---

---

- b. What does this information mean?

---

---

- c. What other debug commands are useful?

---

---

---

Use the `undebug all` command to disable all debug output.

To use debug command during a telnet session with a router, enter the `terminal monitor` command.