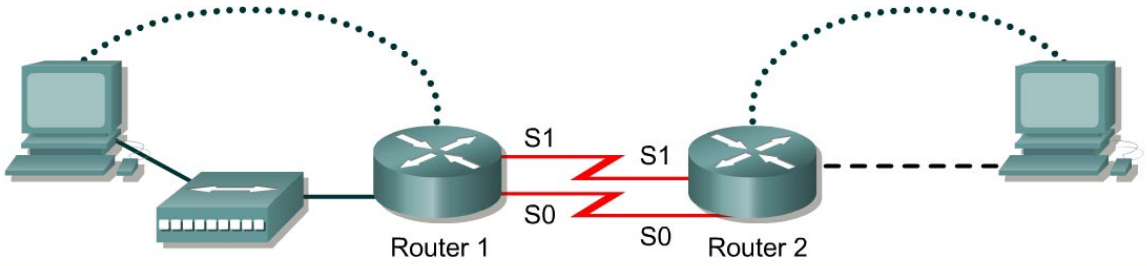
Lab 7.2.9 Load Balancing Across Multiple Paths – Instructor Version 2500



Router designation	Router Name	Enable secret password	Enable/VTY/ and Console passwords	Routing protocol	RIP network statements		
Router 1	GAD	class	cisco	RIP	192.168.14.0	192.168.15.0	192.168.13.0
Router 2	BHM	class	cisco	RIP	192.168.15.0	192.168.16.0	192.168.13.0

Router designation	IP Host Table Entry	Fast Ethernet 0 address	Interface type Serial 0	Serial 0 address	Interface type Serial 1	Serial 1 address	Subnet mask all addresses
Router 1	BHM	192.168.14.1	DCE	192.168.15.1	DCE	192.168.13.1	255.255.255.0
Router 2	GAD	192.168.16.1	DTE	192.168.15.2	DTE	192.168.13.2	255.255.255.0

Note: The IP Host Table Entry column contents indicate the name(s) of the other router(s) in the IP host table.

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

Objective

- Configure Load balance across multiple paths.
- Observe the load balancing process.

Background/Preparation

Cable a network similar to the one in the diagram. Any router that meets the interface requirements displayed in the above diagram, such as 800, 1600, 1700, 2500, and 2600 routers, or a combination, may be used. Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce a slightly different output. The following steps are intended to be executed on each router unless specifically instructed otherwise.

Start a HyperTerminal session as performed in the Establishing a HyperTerminal session lab.

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

 Copyright © 2003, Cisco Systems, Inc.

Step 1 Configure the hostname and passwords on the routers

a. On the routers, enter the global configuration mode and configure the hostname as shown in the chart. Then configure the console, virtual terminal, and enable passwords. If there are problems doing this, refer to the Configuring Router Passwords lab. Next configure the interfaces and routing according to the chart. If there are problems doing this, refer to the Configuring Host Tables lab and the Configuring RIP lab. Make sure to copy the **`running-config`** to the **`startup-config`** on each router so the configuration will not be lost if the router is power-cycled.

Step 2 Configure the hosts with the proper IP address, subnet mask and default gateway

a. Test the configuration by pinging all interfaces from each host. If the pinging is not successful troubleshoot the configuration.

Step 3 Check Basic Routing Configuration

a. Enter **`show ip protocol`** command on each router.

b. In the configuration, is "Routing protocol is RIP" displayed? Yes

c. Enter the command **`show ip route`** `on both routers.` List how the route is connected (directly, RIP), the IP address and via through what network. There should be four routes in each table.

GAD

Route connected	IP address	Through Network / Interface
Connected	192.168.13.0	Connected
RIP	192.168.16.0	192.168.13.2
		192.168.15.2
Connected	192.168.14.0	Connected
Connected	192.168.15.0	Connected

BHM

Route connected	IP address	Through Network / Interface
Connected	192.168.13.0	Connected
RIP	192.168.14.0	192.168.13.1
		192.168.15.1
Connected	192.168.15.0	Connected
Connected	192.168.16.0	Connected

d. Circle the evidence of load balancing in the above output.

Step 4 Make sure that the router load balance is on a per-packet basis

a. Configure the router to load balance on a per-packet basis. Both serial interfaces must use process switching. Process switching forces the router to look in the routing table for the destination network of each routed packet. In contrast, fast-switching, which is the default, stores the initial table lookup in a high-speed cache and uses the information to route packets to the same destination.

b. Enable process switching on both serial interfaces:

```
GAD(config-if)#no ip route-cache
BHM(config-if)#no ip route-cache
```

c. Verify that fast switching is disabled by using the **`show ip interface`** command.

d. Was fast switching disabled? Yes

 Copyright © 2003, Cisco Systems, Inc.

Step 5 Verify per-packet load balancing

a. Because there are two routes to the destination network, half the packets will be sent along one path, and half will travel over the other. The path selection alternates with each packet received.

b. Observe this process by using the **debug ip packet** command on the GAD.

c. Send 30 ping packets across the network from the host attached to BHM router to the host attached to the GAD router. This can be done with the **ping 192.168.16.2 – n 30** command on the host. As the pings are responded to the router generates IP packet information. Stop the debug by using the command **undebug all** on the GAD router.

d. Examine and record part of the debug output.

e. What is the evidence of load balancing in the output? The packets are being sent through serial 0 and serial 1.

Step 6 Verify per-destination load balancing

a. After verifying per-packet load balancing, configure the router to use per-destination load balancing. Both serial interfaces must use fast switching so that the route-cache can be used after the initial table lookup.

b. Use the command `GAD(config-if)#`**ip route-cache**.

c. Use the **show ip interface** to verify that fast switching is enabled.

d. Is fast switching enabled? Yes

e. The routing table is consulted only once per destination, therefore, packets that are part of a packet train to a specific host will all follow the same path. Only when a second destination forces another table lookup or when the cached entry expires will the alternate path be used.

Use the **debug ip packet** command and **ping** across the network. Note which serial interface the packet was sent out on.

f. Examine and record part of the debug output. Which serial interface was the packet sent out on?

Serial 0

Upon completion of the previous steps, log off by typing **exit** and turn the router off.

 Copyright © 2003, Cisco Systems, Inc.

Erasing and reloading the router

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

If prompted for a password, enter **class**. If “class” does not work, ask the instructor for assistance.

```
Router>enable
```

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

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

The responding line prompt will be:

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

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged exec mode enter the command **reload**.

```
Router#reload
```

The responding line prompt will be:

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

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

The responding line prompt will be:

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

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

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

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

The responding line prompt will be:

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

Press **Enter**.

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

 Copyright © 2003, Cisco Systems, Inc.

Router Interface Summary					
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2	Interface #5
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)			
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)	
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)	
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)	
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)	
In order to find out exactly how the router is configured, look at the interfaces. This will identify the type of router as well as how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in IOS command to represent the interface.					

 Copyright © 2003, Cisco Systems, Inc.

Router Output

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

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname BHM
!
enable secret 5 $1$aSAZ$tA5JwOOhP8chL0s3LJYMi.
!
ip subnet-zero
!
interface Ethernet0
 ip address 192.168.16.1 255.255.255.0
 no ip directed-broadcast
!
interface Serial0
 ip address 192.168.15.2 255.255.255.0
 no ip directed-broadcast
 no ip route-cache
!
interface Serial1
ip address 192.168.13.2 255.255.255.0
no ip directed-broadcast
no ip route-cache
!
router rip
 network 192.168.13.0
 network 192.168.15.0
 network 192.168.16.0
!
no 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
```

 Copyright © 2003, Cisco Systems, Inc.

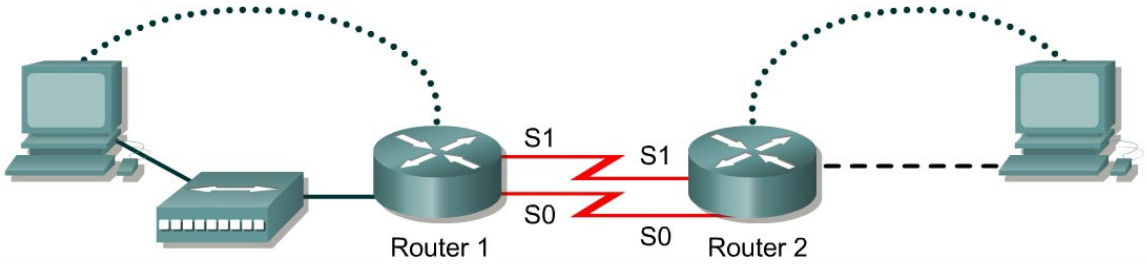
```
GAD#show running-config
Building configuration...

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname GAD
!
enable secret 5 $1$yOU1$wXUASjW8rYzUxoAqRDmg8.
!
ip subnet-zero
!
interface Ethernet0
 ip address 192.168.14.1 255.255.255.0
 no ip directed-broadcast
!
interface Serial0
 ip address 192.168.15.1 255.255.255.0
 no ip directed-broadcast
 no ip route-cache
 clockrate 56000
!
interface Serial1
 ip address 192.168.13.1 255.255.255.0
 no ip directed-broadcast
 no ip route-cache
 clockrate 56000
!
router rip
 network 192.168.13.0
 network 192.168.14.0
 network 192.168.15.0
!
no ip classless
ip http server
!
line con 0
 exec-timeout 0 0
 password cisco
 login
 transport input none
line aux 0
 password cisco
 login
line vty 0 4
 password cisco
 login
!
end
```

 Copyright © 2003, Cisco Systems, Inc.

```
GAD#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    192.168.13.0/24 is directly connected, Serial1
C    192.168.14.0/24 is directly connected, Ethernet0
C    192.168.15.0/24 is directly connected, Serial0
R    192.168.16.0/24 [120/1] via 192.168.15.2, 00:00:05, Serial0
                     [120/1] via 192.168.13.2, 00:00:05, Serial1


BHM#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    192.168.13.0/24 is directly connected, Serial1
R    192.168.14.0/24 [120/1] via 192.168.13.1, 00:00:12, Serial1
                     [120/1] via 192.168.15.1, 00:00:12, Serial0
C    192.168.15.0/24 is directly connected, Serial0
C    192.168.16.0/24 is directly connected, Ethernet0

BHM#
```

 Copyright © 2003, Cisco Systems, Inc.

Lab 7.2.9 Load Balancing Across Multiple Paths – Instructor Version 2600



Router designation	Router Name	Enable secret password	Enable/VTY/ and Console passwords	Routing protocol	RIP network statements		
Router 1	GAD	class	cisco	RIP	192.168.14.0	192.168.15.0	192.168.13.0
Router 2	BHM	class	cisco	RIP	192.168.15.0	192.168.16.0	192.168.13.0

Router designation	IP Host Table Entry	Fast Ethernet 0 address	Interface type Serial 0	Serial 0 address	Interface type Serial 1	Serial 1 address	Subnet mask all addresses
Router 1	BHM	192.168.14.1	DCE	192.168.15.1	DCE	192.168.13.1	255.255.255.0
Router 2	GAD	192.168.16.1	DTE	192.168.15.2	DTE	192.168.13.2	255.255.255.0

Note: The IP Host Table Entry column contents indicate the name(s) of the other router(s) in the IP host table.

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

Objective

- Configure Load balance across multiple paths.
- Observe the load balancing process.

Background/Preparation

Cable a network similar to the one in the diagram. Any router that meets the interface requirements displayed in the above diagram, such as 800, 1600, 1700, 2500, and 2600 routers, or a combination, may be used. Please refer to the chart at the end of the lab to correctly identify the interface identifiers to be used based on the equipment in the lab. The configuration output used in this lab is produced from 1721 series routers. Any other router used may produce a slightly different output. The following steps are intended to be executed on each router unless specifically instructed otherwise.

Start a HyperTerminal session as performed in the Establishing a HyperTerminal session lab.

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

 Copyright © 2003, Cisco Systems, Inc.

Step 1 Configure the hostname and passwords on the routers

a. On the routers, enter the global configuration mode and configure the hostname as shown in the chart. Then configure the console, virtual terminal, and enable passwords. If there are problems doing this, refer to the Configuring Router Passwords lab. Next configure the interfaces and routing according to the chart. If there are problems doing this, refer to the Configuring Host Tables lab and the Configuring RIP lab. Make sure to copy the **`running-config`** to the **`startup-config`** on each router so the configuration will not be lost if the router is power-cycled.

Step 2 Configure the hosts with the proper IP address, subnet mask and default gateway

a. Test the configuration by pinging all interfaces from each host. If the pinging is not successful troubleshoot the configuration.

Step 3 Check Basic Routing Configuration

a. Enter **`show ip protocol`** command on each router.

b. In the configuration, is "Routing protocol is RIP" displayed? Yes

c. Enter the command **`show ip route`** `on both routers.` List how the route is connected (directly, RIP), the IP address and via through what network. There should be four routes in each table.

GAD

Route connected	IP address	Through Network / Interface
Connected	192.168.13.0	Connected
RIP	192.168.16.0	192.168.13.2
		192.168.15.2
Connected	192.168.14.0	Connected
Connected	192.168.15.0	Connected

BHM

Route connected	IP address	Through Network / Interface
Connected	192.168.13.0	Connected
RIP	192.168.14.0	192.168.13.1
		192.168.15.1
Connected	192.168.15.0	Connected
Connected	192.168.16.0	Connected

d. Circle the evidence of load balancing in the above output.

Step 4 Make sure that the router load balance is on a per-packet basis

a. Configure the router to load balance on a per-packet basis. Both serial interfaces must use process switching. Process switching forces the router to look in the routing table for the destination network of each routed packet. In contrast, fast-switching, which is the default, stores the initial table lookup in a high-speed cache and uses the information to route packets to the same destination.

b. Enable process switching on both serial interfaces:

```
GAD(config-if)# no ip route-cache
BHM(config-if)# no ip route-cache
```

c. Verify that fast switching is disabled by using the **`show ip interface`** command.

d. Was fast switching disabled? Yes

 Copyright © 2003, Cisco Systems, Inc.

Step 5 Verify per-packet load balancing

a. Because there are two routes to the destination network, half the packets will be sent along one path, and half will travel over the other. The path selection alternates with each packet received.

b. Observe this process by using the **`debug ip packet`** command on the GAD.

c. Send 30 ping packets across the network from the host attached to BHM router to the host attached to the GAD router. This can be done with the **`ping 192.168.16.2 – n 30`** command on the host. As the pings are responded to the router generates IP packet information. Stop the debug by using the command **`undebug all`** on the GAD router.

d. Examine and record part of the debug output.

e. What is the evidence of load balancing in the output?

The packets are being sent through serial 0/0 and serial 0/1.

Step 6 Verify per-destination load balancing

a. After verifying per-packet load balancing, configure the router to use per-destination load balancing. Both serial interfaces must use fast switching so that the route-cache can be used after the initial table lookup.

b. Use the command `GAD(config-if)#`**`ip route-cache`**.

c. Use the **`show ip interface`** to verify that fast switching is enabled.

d. Is fast switching enabled? Yes

e. The routing table is consulted only once per destination, therefore, packets that are part of a packet train to a specific host will all follow the same path. Only when a second destination forces another table lookup or when the cached entry expires will the alternate path be used.

Use the **`debug ip packet`** command and **`ping`** across the network. Note which serial interface the packet was sent out on.

f. Examine and record part of the debug output. Which serial interface was the packet sent out on?

Serial 0/0

Upon completion of the previous steps, log off by typing **exit** and turn the router off.

 Copyright © 2003, Cisco Systems, Inc.

Erasing and reloading the router

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

If prompted for a password, enter **class**. If “class” does not work, ask the instructor for assistance.

```
Router>enable
```

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

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

The responding line prompt will be:

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

Press **Enter** to confirm.

The response should be:

```
Erase of nvram: complete
```

Now at the privileged exec mode enter the command **reload**.

```
Router#reload
```

The responding line prompt will be:

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

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

The responding line prompt will be:

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

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

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

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

The responding line prompt will be:

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

Press **Enter**.

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

 Copyright © 2003, Cisco Systems, Inc.

Router Interface Summary					
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2	Interface #5
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)			
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)	
1700	FastEthernet 0 (FA0)	FastEthernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)	
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)	
2600	FastEthernet 0/0 (FA0/0)	FastEthernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)	
In order to find out exactly how the router is configured, look at the interfaces. This will identify the type of router as well as how many interfaces the router has. There is no way to effectively list all of the combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in IOS command to represent the interface.					

 Copyright © 2003, Cisco Systems, Inc.

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

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname GAD
!
enable secret 5 $1$yOU1$wXUASjW8rYzUxoAqRDmg8.
!
ip subnet-zero
!
interface FastEthernet0/0
 ip address 192.168.14.1 255.255.255.0
 no ip directed-broadcast
!
interface Serial0/0
 ip address 192.168.15.1 255.255.255.0
 no ip directed-broadcast
 no ip route-cache
 clockrate 56000
!
interface Serial0/1
 ip address 192.168.13.1 255.255.255.0
 no ip directed-broadcast
 no ip route-cache
 clockrate 56000
!
router rip
 network 192.168.13.0
 network 192.168.14.0
 network 192.168.15.0
!
no ip classless
ip http server
!
line con 0
 exec-timeout 0 0
 password cisco
 login
 transport input none
line aux 0
 password cisco
 login
line vty 0 4
 password cisco
 login
!
end
```

 Copyright © 2003, Cisco Systems, Inc.

```
GAD#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    192.168.13.0/24 is directly connected, Serial0/1
C    192.168.14.0/24 is directly connected, FastEthernet0/0
C    192.168.15.0/24 is directly connected, Serial0/0
R    192.168.16.0/24 [120/1] via 192.168.15.2, 00:00:05, Serial0/0
                     [120/1] via 192.168.13.2, 00:00:05, Serial0/1


BHM#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    192.168.13.0/24 is directly connected, Serial0/1
R    192.168.14.0/24 [120/1] via 192.168.13.1, 00:00:12, Serial0/1
                     [120/1] via 192.168.15.1, 00:00:12, Serial0/0
C    192.168.15.0/24 is directly connected, Serial0/0
C    192.168.16.0/24 is directly connected, Ethernet0/0

BHM#
```

 Copyright © 2003, Cisco Systems, Inc.