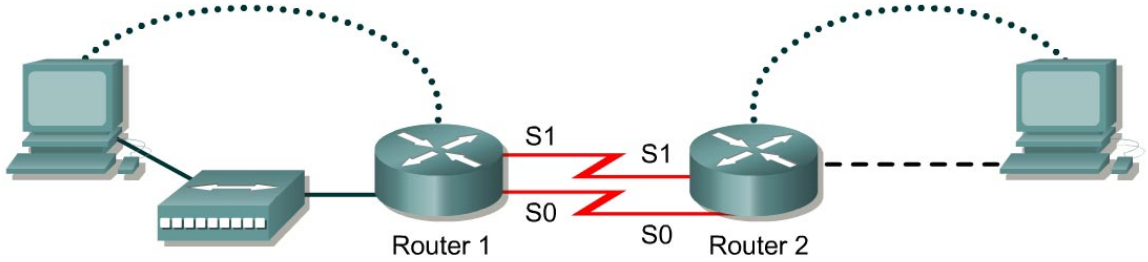
Lab 7.3.8 Unequal Cost Load Balancing with IGRP – Instructor Version 2500



Router designation	Router Name	Enable secret password	Enable/VTY/ and Console passwords	Routing protocol	RIP network statements		
Router 1	MAD	class	cisco	IGRP	192.168.41.0	192.168.50.0	192.168.52.0
Router 2	MIL	class	cisco	IGRP	192.168.50.0	192.168.52.0	192.168.33.0

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	MIL	192.168.41.1	DCE	192.168.50.1	DCE	192.168.52.1	255.255.255.0
Router 2	MAD	192.168.33.1	DTE	192.168.50.2	DTE	192.168.52.2	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

- Observe unequal-cost load balancing.
- Tune IGRP networks by using advanced debug commands.

Background/Preparation

Cable a network similar to the one in the diagram. Any router that meets the interface requirements displayed on the above diagram, such as 800, 1600, 1700, 2500, 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.

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 according to the chart. If there are problems doing this, refer to the Configuring Host Tables lab. Finally configure IGRP routing on the routers using the Autonomous System (AS) of 34. If there are problems doing this, refer to the Configuring IGRP lab. Make sure to copy the **running-config** to the **startup-config** on each router.

Step 2 Configure bandwidth on the MAD router interfaces

a. In order to make unequal cost load balancing to work, it is necessary need to establish different metrics for the IGRP routes. This is done with the bandwidth command. The serial 0 interface will be set to a bandwidth of 56K and the serial 1 interface will be set to a value of 384K. The route-cache must also be turned off for load balancing. 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 info to route packets to the same destination. Enter the following statements on the MAD router:

```
MAD(config)#interface serial 0/0
MAD(config-if)#bandwidth 56
MAD(config-if)#no ip route-cache
MAD(config-if)#interface serial 0/1
MAD(config-if)#bandwidth 384
MAD(config-if)#no ip route-cache
```

b. Because the IGRP metric includes bandwidth in its calculation, bandwidth must be manually configured on the serial interfaces in order to ensure accuracy. For the purposes of this lab, the alternative paths to network 192.168.41.0 from the MAD router are not of unequal cost until the appropriate bandwidths are set.

c. Use the **show interface** command output to verify the correct bandwidth settings and the **show ip interface** command to ensure that fast switching is disabled.

```
MAD#show interfaces serial 0
Serial0 is up, line protocol is up
  Hardware is HD64570

  Internet address is 192.168.50.1/24
  MTU 1500 bytes, BW 56 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  <…output omitted …>


MAD#show interfaces serial 1
Serial1 is up, line protocol is up
  Hardware is HD64570
  Internet address is 192.168.52.1/24
  MTU 1500 bytes, BW 384 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
       <…output omitted …>

MAD#show ip interface serial 0
Serial0 is up, line protocol is up
  Internet address is 192.168.50.1/24
```



```
  Broadcast address is 255.255.255.255
                <…output omitted …>
  IP fast switching is disabled
  IP fast switching on the same interface is disabled
                <…output omitted …>

MAD#show ip interface serial 1
Serial1 is up, line protocol is up
  Internet address is 192.168.52.1/24
  Broadcast address is 255.255.255.255
                    <…output omitted …>
  IP fast switching is disabled

  IP fast switching on the same interface is disabled
                    <…output omitted …>
```

d. Can the bandwidth of Ethernet interfaces be set manually? Yes

Step 3 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 4 Use the variance command to configure unequal-cost load balancing

a. The variance value determines whether IGRP will accept unequal-cost routes. An IGRP router will only accept routes equal to the local best metric for the destination multiplied by the variance value. So if the local best metric of an IGRP router for a network is 10476, and the variance is 3, the router will accept unequal-cost routes with any metric up to 31428 or 10,476 x 3. This is as long as the advertising router is closer to the destination. An IGRP router accepts only up to four paths to the same network.

Note: An alternate route is added to the route table only if the next-hop router in that path is closer to the destination (has a lower metric value) than the current route.

b. By default, IGRP variance is set to 1, which means that only routes that are exactly 1 times the local best metric are installed. Therefore, a variance of 1 disables unequal-cost load balancing.

```
MAD#show ip protocols
Routing Protocol is "igrp 34"
  Sending updates every 90 seconds, next due in 4 seconds
  Invalid after 270 seconds, hold down 280, flushed after 630
  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
  IGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  IGRP maximum hopcount 100
  IGRP maximum metric variance 1
  Redistributing: igrp 34
  Routing for Networks:
    192.168.41.0
    192.168.50.0
    192.168.52.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.50.2         100      00:00:48
    192.168.52.2         100      00:00:48
  Distance: (default is 100)
```



```
MAD#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    192.168.41.0/24 is directly connected, Ethernet0
C    192.168.52.0/24 is directly connected, Serial1
C    192.168.50.0/24 is directly connected, Serial0
I    192.168.33.0/24 [100/28141] via 192.168.52.2, 00:00:09, Serial1
```

c. Configure the MAD router to enable unequal-cost load balancing using the following commands:

```
MAD(config)#router igrp 34
MAD(config-router)#variance 10
```

d. According to the help feature, what is the maximum variance value? 128

e. Check the MAD routing table. It should have two routes to network 192.168.33.0 with unequal metrics.

```
MAD#show ip protocols
Routing Protocol is "igrp 34"
  Sending updates every 90 seconds, next due in 21 seconds
  Invalid after 270 seconds, hold down 280, flushed after 630
  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
  IGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  IGRP maximum hopcount 100
  IGRP maximum metric variance 10
  Redistributing: igrp 34
  Routing for Networks:
    192.168.41.0
    192.168.50.0
    192.168.52.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.50.2         100      00:00:47
    192.168.52.2         100      00:00:47
  Distance: (default is 100)

MAD#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    192.168.41.0/24 is directly connected, Ethernet0
C    192.168.52.0/24 is directly connected, Serial1
C    192.168.50.0/24 is directly connected, Serial0
I    192.168.33.0/24 [100/180671] via 192.168.50.2, 00:00:10, Serial0
                     [100/28141] via 192.168.52.2, 00:00:10, Serial1
```

These answers will vary.

f. What is the IGRP metric for the route to 192.168.33.0 through serial 0? 180671

g. What is the IGRP metric for the route to 192.168.33.0 through serial 1? 28141

Step 5 Check Basic Routing Configuration

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

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

MAD

Route connected	IP address	Through Network / Interface
Connected	192.168.41.0	Connected
IGRP	192.168.33.0	192.168.50.2 192.168.52.2
Connected	192.168.50.0	Connected
Connected	192.168.52.0	Connected

MIL

Route connected	IP address	Through Network / Interface
Connected	192.168.33.0	Connected
IGRP	192.168.41.0	192.168.50.1 192.168.52.1
Connected	192.168.50.0	Connected
Connected	192.168.52.0	Connected

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

Step 6 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 MAD router.

c. Send a 30 ping packets across the network from the host attached to MIL router to the host attached to the MAD router. This can be done with the with the **ping 192.168.41.2 – n 30** command on the host. As the pings are responded to, the router outputs IP packet information. Stop the debug after the pings by using the command **undebug all**.

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.

```
03:37:00: IP: s=192.168.33.2 (Ethernet0), d=192.168.41.2 (Serial1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial1), d=192.168.33.2 (Ethernet0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (Ethernet0), d=192.168.41.2 (Serial1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial1), d=192.168.33.2 (Ethernet0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (Ethernet0), d=192.168.41.2 (Serial1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial1), d=192.168.33.2 (Ethernet0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (Ethernet0), d=192.168.41.2 (Serial1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial1), d=192.168.33.2 (Ethernet0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (Ethernet0), d=192.168.41.2 (Serial1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial1), d=192.168.33.2 (Ethernet0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (Ethernet0), d=192.168.41.2 (Serial1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial1), d=192.168.33.2 (Ethernet0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (Ethernet0), d=192.168.41.2 (Serial0), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial0), d=192.168.33.2 (Ethernet0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (Ethernet0), d=192.168.41.2 (Serial1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial1), d=192.168.33.2 (Ethernet0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (Ethernet0), d=192.168.41.2 (Serial1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial1), d=192.168.33.2 (Ethernet0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (Ethernet0), d=192.168.41.2 (Serial1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial1), d=192.168.33.2 (Ethernet0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (Ethernet0), d=192.168.41.2 (Serial1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial1), d=192.168.33.2 (Ethernet0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (Ethernet0), d=192.168.41.2 (Serial1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial1), d=192.168.33.2 (Ethernet0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (Ethernet0), d=192.168.41.2 (Serial0), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial0), d=192.168.33.2 (Ethernet0), len 100, rcvd 3

<…output omitted …>
```

Note:The load balancing is UNEQUAL. Serial 0 is used for every sixth packet.

Step 7 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 **`ip route-cache`** on both serial interfaces of the MAD router.

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

d. Is fast switching enabled? Yes

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.

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

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

g. Examine and record part of the debug output.

h. 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.

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(config)#reloadRouter#reload
```

The responding line prompt will be:

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

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

The responding line prompt will be:

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

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

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

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

The responding line prompt will be:

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

Press **Enter**.

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

Router Interface Summary					
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2	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.					


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

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname MAD
!
enable secret 5 $1$hNjs$/e9x2AlV23Pk/xAVkTtrZ0
!
!
ip subnet-zero
ip host MIL 192.168.33.1 192.168.50.2 192.168.52.2
!
interface Ethernet0
 ip address 192.168.41.1 255.255.255.0
 no ip directed-broadcast
!
interface Serial0
 bandwidth 56
 ip address 192.168.50.1 255.255.255.0
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
 no fair-queue
 clockrate 56000
!
interface Serial1
 bandwidth 384
 ip address 192.168.52.1 255.255.255.0
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
 no fair-queue
 clockrate 56000
!
router igrp 34
 variance 10
 network 192.168.41.0
 network 192.168.50.0
 network 192.168.52.0
!
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
```

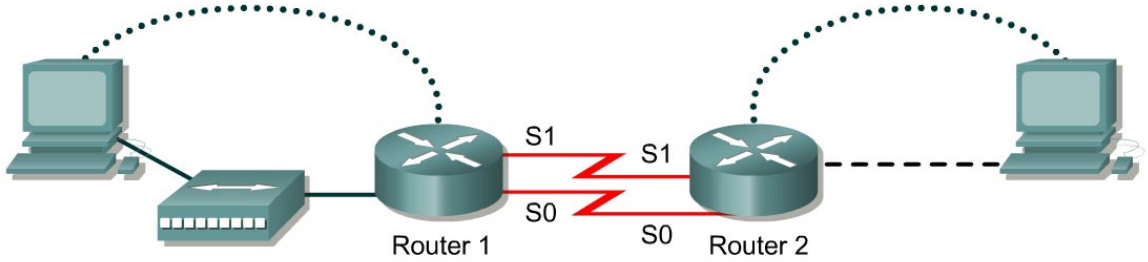


```
 login
!
end


MIL#show running-config
Building configuration...

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname MIL
!
enable secret 5 $1$/MqF$GHyjCJ9EWThZyJyXkss5c1
!
ip subnet-zero
ip host MAD 192.168.41.1 192.168.50.1 192.168.52.1
!
interface Ethernet0
 ip address 192.168.33.1 255.255.255.0
 no ip directed-broadcast
 no keepalive
!
interface Serial0
 ip address 192.168.50.2 255.255.255.0
 no ip directed-broadcast
 no ip mroute-cache
 no fair-queue
!
interface Serial1
 ip address 192.168.52.2 255.255.255.0
 no ip directed-broadcast
 no fair-queue
!
!
router igrp 34
 network 192.168.33.0
 network 192.168.50.0
 network 192.168.52.0
!
no ip classless
no ip http server
!
line con 0
 exec-timeout 0 0
 password cisco
 login
 transport input none
line aux 0
line vty 0 4
 password cisco
 login
!
end
```


Lab 7.3.8 Unequal Cost Load Balancing with IGRP – Instructor Version 2600



Router designation	Router Name	Enable secret password	Enable/VTY/ and Console passwords	Routing protocol	RIP network statements		
Router 1	MAD	class	cisco	IGRP	192.168.41.0	192.168.50.0	192.168.52.0
Router 2	MIL	class	cisco	IGRP	192.168.50.0	192.168.52.0	192.168.33.0

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	MIL	192.168.41.1	DCE	192.168.50.1	DCE	192.168.52.1	255.255.255.0
Router 2	MAD	192.168.33.1	DTE	192.168.50.2	DTE	192.168.52.2	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

- Observe unequal-cost load balancing.
- Tune IGRP networks by using advanced debug commands.

Background/Preparation

Cable a network similar to the one in the diagram. Any router that meets the interface requirements displayed on the above diagram, such as 800, 1600, 1700, 2500, 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.

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 according to the chart. If there are problems doing this, refer to the Configuring Host Tables lab. Finally configure IGRP routing on the routers using the Autonomous System (AS) of 34. If there are problems doing this, refer to the Configuring IGRP lab. Make sure to copy the **`running-config`** to the **`startup-config`** on each router.

Step 2 Configure bandwidth on the MAD router interfaces

a. In order to make unequal cost load balancing to work, it is necessary need to establish different metrics for the IGRP routes. This is done with the bandwidth command. The serial 0 interface will be set to a bandwidth of 56K and the serial 1 interface will be set to a value of 384K. The route-cache must also be turned off for load balancing. 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 info to route packets to the same destination. Enter the following statements on the MAD router:

```
MAD(config)#interface serial 0/0
MAD(config-if)#bandwidth 56
MAD(config-if)#no ip route-cache
MAD(config-if)#interface serial 0/1
MAD(config-if)#bandwidth 384
MAD(config-if)#no ip route-cache
```

b. Because the IGRP metric includes bandwidth in its calculation, bandwidth must be manually configured on the serial interfaces in order to ensure accuracy. For the purposes of this lab, the alternative paths to network 192.168.41.0 from the MAD router are not of unequal cost until the appropriate bandwidths are set.

c. Use the **`show interface`** command output to verify the correct bandwidth settings and the **`show ip interface`** command to ensure that fast switching is disabled.

```
MAD#show interfaces serial 0/0
Serial0/0 is up, line protocol is up
  Hardware is HD64570

  Internet address is 192.168.50.1/24
  MTU 1500 bytes, BW 56 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  <…output omitted …>

MAD#show interfaces serial 0/1
Serial0/1 is up, line protocol is up
  Hardware is HD64570
  Internet address is 192.168.52.1/24
  MTU 1500 bytes, BW 384 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
       <…output omitted …>


MAD#show ip interface serial 0/0
Serial0/0 is up, line protocol is up
  Internet address is 192.168.50.1/24
```



```
  Broadcast address is 255.255.255.255
                <…output omitted …>
  IP fast switching is disabled
  IP fast switching on the same interface is disabled
                <…output omitted …>

MAD#show ip interface serial 0/1
Serial0/1 is up, line protocol is up
  Internet address is 192.168.52.1/24
  Broadcast address is 255.255.255.255
                    <…output omitted …>
  IP fast switching is disabled

  IP fast switching on the same interface is disabled

  <…output omitted …>
```

d. Can the bandwidth of Ethernet interfaces be set manually? Yes

Step 3 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 4 Use the variance command to configure unequal-cost load balancing

a. The variance value determines whether IGRP will accept unequal-cost routes. An IGRP router will only accept routes equal to the local best metric for the destination multiplied by the variance value. So if the local best metric of an IGRP router for a network is 10476, and the variance is 3, the router will accept unequal-cost routes with any metric up to 31428 or 10,476 x 3. This is as long as the advertising router is closer to the destination. An IGRP router accepts only up to four paths to the same network.

Note: An alternate route is added to the route table only if the next-hop router in that path is closer to the destination (has a lower metric value) than the current route.

b. By default, IGRP variance is set to 1, which means that only routes that are exactly 1 times the local best metric are installed. Therefore, a variance of 1 disables unequal-cost load balancing.

```
MAD#show ip protocols
Routing Protocol is "igrp 34"
  Sending updates every 90 seconds, next due in 4 seconds
  Invalid after 270 seconds, hold down 280, flushed after 630
  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
  IGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  IGRP maximum hopcount 100
  IGRP maximum metric variance 1
  Redistributing: igrp 34
  Routing for Networks:
    192.168.41.0
    192.168.50.0
    192.168.52.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.50.2         100      00:00:48
    192.168.52.2         100      00:00:48
  Distance: (default is 100)
```



```
MAD#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    192.168.41.0/24 is directly connected, FastEthernet0/0
C    192.168.52.0/24 is directly connected, Serial0/1
C    192.168.50.0/24 is directly connected, Serial0/0
I    192.168.33.0/24 [100/28141] via 192.168.52.2, 00:00:09, Serial0/1
```

c. Configure the MAD router to enable unequal-cost load balancing using the following commands:

```
MAD(config)#router igrp 34
MAD(config-router)#variance 10
```

d. According to the help feature, what is the maximum variance value? 128

e. Check the MAD routing table. It should have two routes to network 192.168.33.0 with unequal metrics.

```
MAD#show ip protocols
Routing Protocol is "igrp 34"
  Sending updates every 90 seconds, next due in 21 seconds
  Invalid after 270 seconds, hold down 280, flushed after 630
  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
  IGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  IGRP maximum hopcount 100
  IGRP maximum metric variance 10
  Redistributing: igrp 34
  Routing for Networks:
    192.168.41.0
    192.168.50.0
    192.168.52.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.50.2         100      00:00:47
    192.168.52.2         100      00:00:47
  Distance: (default is 100)

MAD#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    192.168.41.0/24 is directly connected, FastEthernet0/0
C    192.168.52.0/24 is directly connected, Serial0/1
C    192.168.50.0/24 is directly connected, Serial0/0
I    192.168.33.0/24 [100/180671] via 192.168.50.2, 00:00:10, Serial0/0
                     [100/28141] via 192.168.52.2, 00:00:10, Serial0/1
```

These answers will vary.

f. What is the IGRP metric for the route to 192.168.33.0 through serial 0? 180671

g. What is the IGRP metric for the route to 192.168.33.0 through serial 1? 28141

Step 5 Check Basic Routing Configuration

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

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

MAD

Route connected	IP address	Through Network / Interface
Connected	192.168.41.0	Connected
IGRP	192.168.33.0	192.168.50.2 192.168.52.2
Connected	192.168.50.0	Connected
Connected	192.168.52.0	Connected

MIL

Route connected	IP address	Through Network / Interface
Connected	192.168.33.0	Connected
IGRP	192.168.41.0	192.168.50.1 192.168.52.1
Connected	192.168.50.0	Connected
Connected	192.168.52.0	Connected

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

Step 6 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 MAD router.

c. Send a 30 ping packets across the network from the host attached to MIL router to the host attached to the MAD router. This can be done with the with the **ping 192.168.41.2 – n 30** command on the host. As the pings are responded to, the router outputs IP packet information. Stop the debug after the pings by using the command **undebug all**.

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.

```
03:37:00: IP: s=192.168.33.2 (FastEthernet0/0), d=192.168.41.2
(Serial0/1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial0/1), d=192.168.33.2
(FastEthernet0/0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (FastEthernet0/0), d=192.168.41.2
(Serial0/1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial0/1), d=192.168.33.2
(FastEthernet0/0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (FastEthernet0/0), d=192.168.41.2
(Serial0/1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial0/1), d=192.168.33.2
(FastEthernet0/0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (FastEthernet0/0), d=192.168.41.2
(Serial0/1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial0/1), d=192.168.33.2
(FastEthernet0/0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (FastEthernet0/0), d=192.168.41.2
(Serial0/1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial0/1), d=192.168.33.2
(FastEthernet0/0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (FastEthernet0/0), d=192.168.41.2
(Serial0/1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial0/1), d=192.168.33.2
(FastEthernet0/0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (FastEthernet0/0), d=192.168.41.2
(Serial0/0), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial0/0), d=192.168.33.2
(FastEthernet0/0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (FastEthernet0/0), d=192.168.41.2
(Serial0/1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial0/1), d=192.168.33.2
(FastEthernet0/0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (FastEthernet0/0), d=192.168.41.2
(Serial0/1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial0/1), d=192.168.33.2
(FastEthernet0/0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (FastEthernet0/0), d=192.168.41.2
(Serial0/1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial01), d=192.168.33.2
(FastEthernet0/0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (FastEthernet0/0), d=192.168.41.2
(Serial0/1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial0/1), d=192.168.33.2
(FastEthernet0/0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (FastEthernet0/0), d=192.168.41.2
(Serial0/1), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial0/1), d=192.168.33.2
(FastEthernet0/0), len 100, rcvd 3
03:37:00: IP: s=192.168.33.2 (FastEthernet0/0), d=192.168.41.2
(Serial0/0), len 100, sending
03:37:00: IP: s=192.168.41.2 (Serial0/0), d=192.168.33.2
(FastEthernet0/0), len 100, rcvd 3
```

<…output omitted …>

Note: The load balancing is UNEQUAL. Serial 0/0 is used for every sixth packet.

Step 7 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 **`ip route-cache`** on both serial interfaces of the MAD router.

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

d. Is fast switching enabled? Yes

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.

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

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

g. Examine and record part of the debug output.

h. 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.

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(config)#reloadRouter#reload
```

The responding line prompt will be:

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

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

The responding line prompt will be:

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

Press **Enter** to confirm.

In the first line of the response will be:

```
Reload requested by console.
```

After the router has reloaded the line prompt will be:

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

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

The responding line prompt will be:

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

Press **Enter**.

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

Router Interface Summary					
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2	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.					

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

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname MAD
!
enable secret 5 $1$hNjs$/e9x2AlV23Pk/xAVkTtrZ0
!
!
ip subnet-zero
ip host MIL 192.168.33.1 192.168.50.2 192.168.52.2
!
interface FastEthernet0/0
 ip address 192.168.41.1 255.255.255.0
 no ip directed-broadcast
!
interface Serial0/0
 bandwidth 56
 ip address 192.168.50.1 255.255.255.0
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
 no fair-queue
 clockrate 56000
!
interface Serial0/1
 bandwidth 384
 ip address 192.168.52.1 255.255.255.0
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
 no fair-queue
 clockrate 56000
!
router igrp 34
 variance 10
 network 192.168.41.0
 network 192.168.50.0
 network 192.168.52.0
!
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
```

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

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname MIL
!
enable secret 5 $1$/MqF$GHyjCJ9EWThZyJyXkss5c1
!
ip subnet-zero
ip host MAD 192.168.41.1 192.168.50.1 192.168.52.1
!
interface FastEthernet0/0
 ip address 192.168.33.1 255.255.255.0
 no ip directed-broadcast
 no keepalive
!
interface Serial0/0
 ip address 192.168.50.2 255.255.255.0
 no ip directed-broadcast
 no ip mroute-cache
 no fair-queue
!
interface Serial0/1
 ip address 192.168.52.2 255.255.255.0
 no ip directed-broadcast
 no fair-queue
!
!
router igrp 34
 network 192.168.33.0
 network 192.168.50.0
 network 192.168.52.0
!
no ip classless
no ip http server
!
line con 0
 exec-timeout 0 0
 password cisco
 login
 transport input none
line aux 0
line vty 0 4
 password cisco
 login
!
end
```

