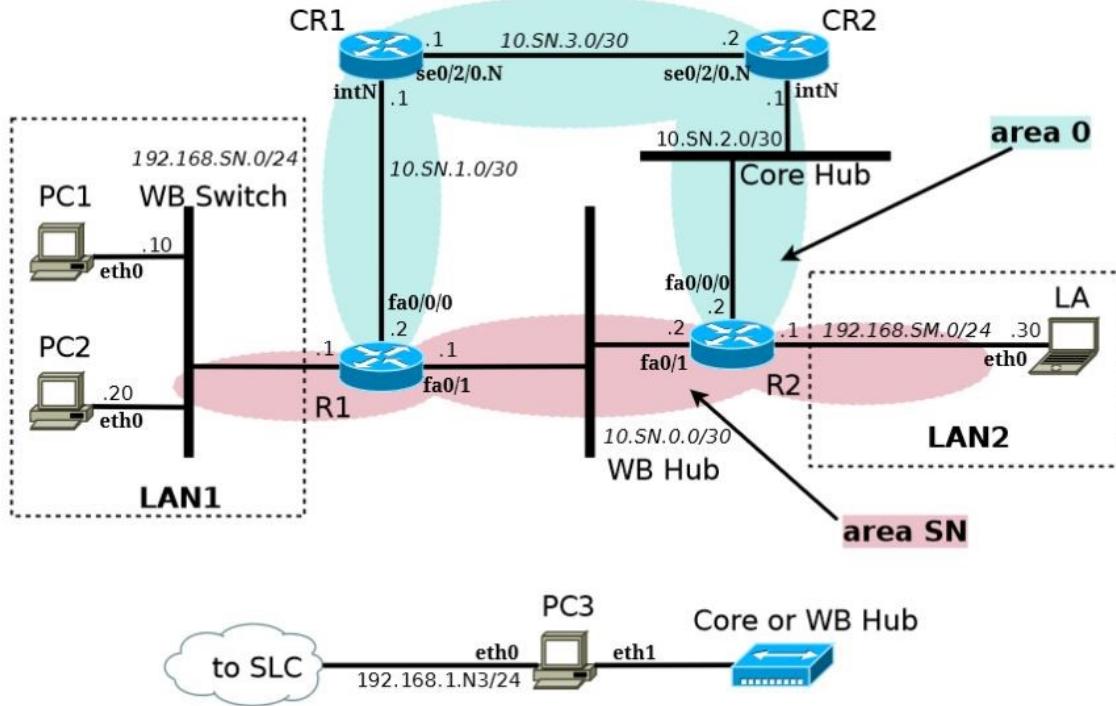


Lab 5: Intra-Domain Routing

Arun Kumar Rajendra Kumar
Mark Rutkowski

This lab deals with intra-domain routing protocols like RIP and OSPF by explaining its configuration, load balancing and topology. The equipment needed for the entire experiment is four cisco routers, four computers, two hub and two switches. The network topology is provided below



The connections are made as shown in the above diagram. Here we are considering workbench 3 so S=1 & M=7. The network address of LAN1 & LAN2 will be 192.168.34.0/24 and 192.168.38.0/24 respectively. The fast Ethernet face is used for the core routers and PC3 is used for monitoring.

Initially, RIP protocol is implemented by connecting eth1 of PC3 to the hub. Packets are captured by starting wireshark on it. Then each of the four routers are configured with RIP protocol in the Global configuration mode using the following commands,

```
router rip
version 2
no auto-summary
network <network address>
```

The last command may be used as many times as needed. In case, RIP packets are missed it can be rectified by using **no router rip** command. After the above commands are executed, trace route is done between two LANs and the routing table is displayed using **show ip route** command. **no ip split-horizon** makes the split horizon algorithm to disable. The captured packets are compared to the previous RIP packets and it is seen that R1 updates about LAN2 can be seen. Again split horizon is enabled. Next eth1 of PC3 is used to capture RIP messages in core router to router(2to2) link by pinging LAN1 & LAN2. Meanwhile, the two workbench routers are disconnected & change in routing table is noted. Then, they are reconnected to the hub and the same test is done. At last RIP on routers is disabled using **no router rip** command

Finally, OSPF is used and each workbench router is identified with a process id. Core routers uses 10 as the process id. PC3's eth1 is connected to the workbench hub and each of the routers needed to be configured for OSPF. The following commands are done in global configuration mode,

Interface for the workbench routers is done using **interface loopback0** command followed by

```
ip address 10.SN.99.X 255.255.255.255
router ospf <process id>
```

Then for all the routers **network <network address> <wildcard> area <area id>** command is executed for each interface.

In case, OSPF packets are missed, the entire process can be done again using **clear ip ospf <process id> process** in privileged EXEC mode. After the above commands are completed, LAN1 and LAN2 are pinged vice versa and the route is traced using **traceroute** followed by **show ip route**. Next,

```
show ip ospf
show ip ospf interface
show ip ospf neighbor
show ip ospf database
```

commands are executed in privileged EXEC mode. Only **summary LSA** type is observed and it is always known that RIP packets use UDP. Next, eth1 of PC3 is connected to the core hub and pinging is done between LAN1 & LAN2. The routing table is studied. Then, the WB routers are disconnected from the bench and routing

table is noted. It is to be seen that OSPF makes use of distinct metrics and not hop count. Default cost values are given which can be changed using the command below

ip ospf cost <interface cost>

Here, the interface fa0/1 cost of R1 is set to 1000 and the path is observed. Then the OSPF area number is changed from SN to 0 & again path is observed. This is done using traceroute command.

Thus, intra domain routing protocols are thoroughly studied here.

Section 4.1: Topology setup and address plan

```

team3@netlab-wb3pc3:~$ ssh -l team3 192.168.3.250
Password:
Welcome to the SecureInx Console Manager
Host number: SICL0
For a list of commands, type 'help'.
[agentaSwitch]> connect direct devicport RIM2
User 'team3' does not have permission to connect to Device Port 3.
Impersonating user 'team3' to connect to RIM2
Connecting to Device Port RIM2.
Connected to port 3. Escape sequence is ESC A
R1wB3>
R1wB3>configure terminal
% Invalid input detected at '^' marker.
R1wB3>enable
R1wB3>config t
Enter configuration commands, one per line. End with CNTL/Z.
R1wB3(config)#interface fastethernet 0/0
R1wB3(config-if)#ip address 192.168.13.1 255.255.255.0
R1wB3(config-if)#exit
R1wB3>#Feb 7 21:18:07.988: %SYS-5-CONFIG_I: Configured from console by console
R1wB3(config)#interface fastethernet 0/0/0
R1wB3(config-if)#ip address 10.13.0.1 255.255.255.0
% Invalid input detected at '^' marker.
R1wB3>config t
Enter configuration commands, one per line. End with CNTL/Z.
R1wB3(config)#interface fastethernet 0/0/0
R1wB3(config-if)#ip address 10.13.1.2 255.255.255.252
R1wB3(config-if)#exit
R1wB3>#Feb 7 21:18:53.584: %SYS-5-CONFIG_I: Configured from console by console
R1wB3>#Feb 7 21:18:53.584: %SYS-5-CONFIG_I: Configured from console by console
R1wB3(config)#interface fastethernet 0/0/0
R1wB3(config-if)#ip address 10.13.0.1 255.255.255.252
R1wB3(config-if)#exit
R1wB3>#Feb 7 21:19:25.616: %SYS-5-CONFIG_I: Configured from console by console
R1wB3>#show ip int br
Interface          IP-Address      OK? Method Status       Protocol
FastEthernet0/0     192.168.13.1   YES manual up        up
FastEthernet0/1     10.13.0.1     YES manual up        up
FastEthernet0/0/0   10.13.1.2     YES manual up        up
Loopback0           unassigned    YES NVRAM up        up
R1wB3>

```

This is the workbench router 1 setup. We have interface fa0/0 set to 192.168.13.1, interface fa0/1 set to 10.13.0.1 and interface fa0/0/0 set to 10.13.1.2.

```
team13@netlab-wb3pc3:~
```

File Edit View Terminal Tabs Help

R1WB3 con0 is now available

Press RETURN to get started.

R1WB3>

Returning to command line

Rebooting R1WB3 via direct deviceport R2M3

Connecting to Device port R2M3.

Connected to port 6. Escape sequence is ESC A

R2WB3>

R2WB3>conf t

% Invalid input detected at '^' marker.

R2WB3>enable

R2WB3>conf t

Enter configuration commands, one per line. End with CNTL/Z.

R2WB3>(config)#interface fast0/0/0

R2WB3>(config-if)#ip address 10.13.2.2 255.255.255.252

R2WB3>(config-if)#2

R2WB3#

R2WB3# 7 20:46:20.224: %SYS-5-CONFIG_I: Configured from console by console

R2WB3>conf t

Enter configuration commands, one per line. End with CNTL/Z.

R2WB3>(config)#interface fast0/0/0

R2WB3>(config-if)#ip address 192.168.17.1 255.255.255.0

R2WB3>(config-if)#2

R2WB3#

R2WB3# 7 20:47:12.092: %SYS-5-CONFIG_I: Configured from console by console

R2WB3>conf t

Enter configuration commands, one per line. End with CNTL/Z.

R2WB3>(config)#interface fast0/1

R2WB3>(config-if)#ip address 10.13.0.2 255.255.255.252

R2WB3#

R2WB3# 7 20:47:55.396: %SYS-5-CONFIG_I: Configured from console by console

Interface	IP-Address	OK?	Method	Status	Protocol
FastEthernet0/0	192.168.17.1	YES	manual	up	up
FastEthernet0/0/1	10.13.0.2	YES	manual	up	up
FastEthernet0/0/0	10.13.2.2	YES	manual	up	up
Loopback0	unassigned	YES	NVRAM	up	up

R2WB3#

This is the workbench router 2 setup. We have interface fa0/0 set to 192.168.17.1, interface fa0/1 set to 10.13.0.2 and interface fa0/0/0 set to 10.13.2.2.

```

File Edit View Terminal Tabs Help
Last clearing of "show interface" counters never
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: fifo
Output queue: 0/40 (size/max)
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
14 packets input, 5030 bytes
Received 14 broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
0 watchdog
0 input packets with dribble condition detected
2563285 packets output, 154514482 bytes, 0 underruns
0 output errors, 0 collisions, 0 interface resets
0 unknown protocol drops
0 babbles, 0 late collision, 0 deferred
0 lost carrier, 0 no carrier
0 output buffer failures, 0 output buffers swapped out
FastEthernet0/1 is up, line protocol is down

RIC#2
RIC#2
RIC#show int br
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    unassigned      YES NVRAM up           up
FastEthernet0/1    unassigned      YES NVRAM up           down
FastEthernet0/0/0   unassigned      YES NVRAM up           up
FastEthernet0/1/0   unassigned      YES NVRAM up           up
Serial0/2/0        unassigned      YES unset up          up
Serial0/2/0.1      unassigned      YES unset up          up
Serial0/2/0.2      unassigned      YES unset up          up
Serial0/2/0.3      10.13.3.1     YES manual up         up
Serial0/2/0.4      unassigned      YES unset up          up
Serial0/2/0.255    10.255.255.253 YES NVRAM up           up
Loopback0          10.99.99.1    YES NVRAM up           up
RIC#conf t
Enter configuration commands, one per line. End with CNTL/Z.
RIC(config)#interface fa0/0
RIC(config-if)#ip address 10.13.1.1 255.255.255.252
RIC(config-if)#2
RIC#show ip int br
%SYS-5-CONFIG_I: Configured from console/wt ip int br
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    unassigned      YES NVRAM up           up
FastEthernet0/1    unassigned      YES NVRAM up           down
FastEthernet0/0/0   10.13.1.1     YES manual up         up
FastEthernet0/1/0   unassigned      YES NVRAM up           up
Serial0/2/0        unassigned      YES unset up          up
Serial0/2/0.1      unassigned      YES unset up          up
Serial0/2/0.2      unassigned      YES unset up          up
Serial0/2/0.3      10.13.3.1     YES manual up         up
Serial0/2/0.4      unassigned      YES unset up          up
Serial0/2/0.255    10.255.255.253 YES NVRAM up           up
Loopback0          10.99.99.1    YES NVRAM up           up
RIC#
```

This is the core router 1 setup for our workbench. The fast Ethernet port on the core router was fa0/0/0 or R13C and it had the IP address 10.13.1.1. This also shows the sub-interfaces for the serial ports on the core routers. Interface se0/2/0.3 was set to the IP address 10.13.3.1.

```

team13@netlab-wb3pc3:~
```

Interface	IP-Address	OK?	Method	Status	Protocol
FastEthernet0/0	unassigned	YES	NVRAM	up	up
FastEthernet0/1	unassigned	YES	NVRAM	up	down
FastEthernet0/0/0	10.13.1.1	YES	manual	up	up
FastEthernet0/1/0	unassigned	YES	NVRAM	up	up
Serial0/2/0	unassigned	YES	NVRAM	up	up
Serial0/2/0.1	unassigned	YES	unset	up	up
Serial0/2/0.2	unassigned	YES	unset	up	up
Serial0/2/0.3	10.13.3.1	YES	manual	up	up
Serial0/2/0.4	unassigned	YES	unset	up	up
Serial0/2/0.255	10.255.255.253	YES	NVRAM	up	up
Loopback0	10.99.99.1	YES	NVRAM	up	up

```

R1C#
```

Returning to command line

[inputswitch] connect direct deviceport R2MC

Connecting to Device Port R2MC.

Connected to port 16. Escape sequence is ESC A

```

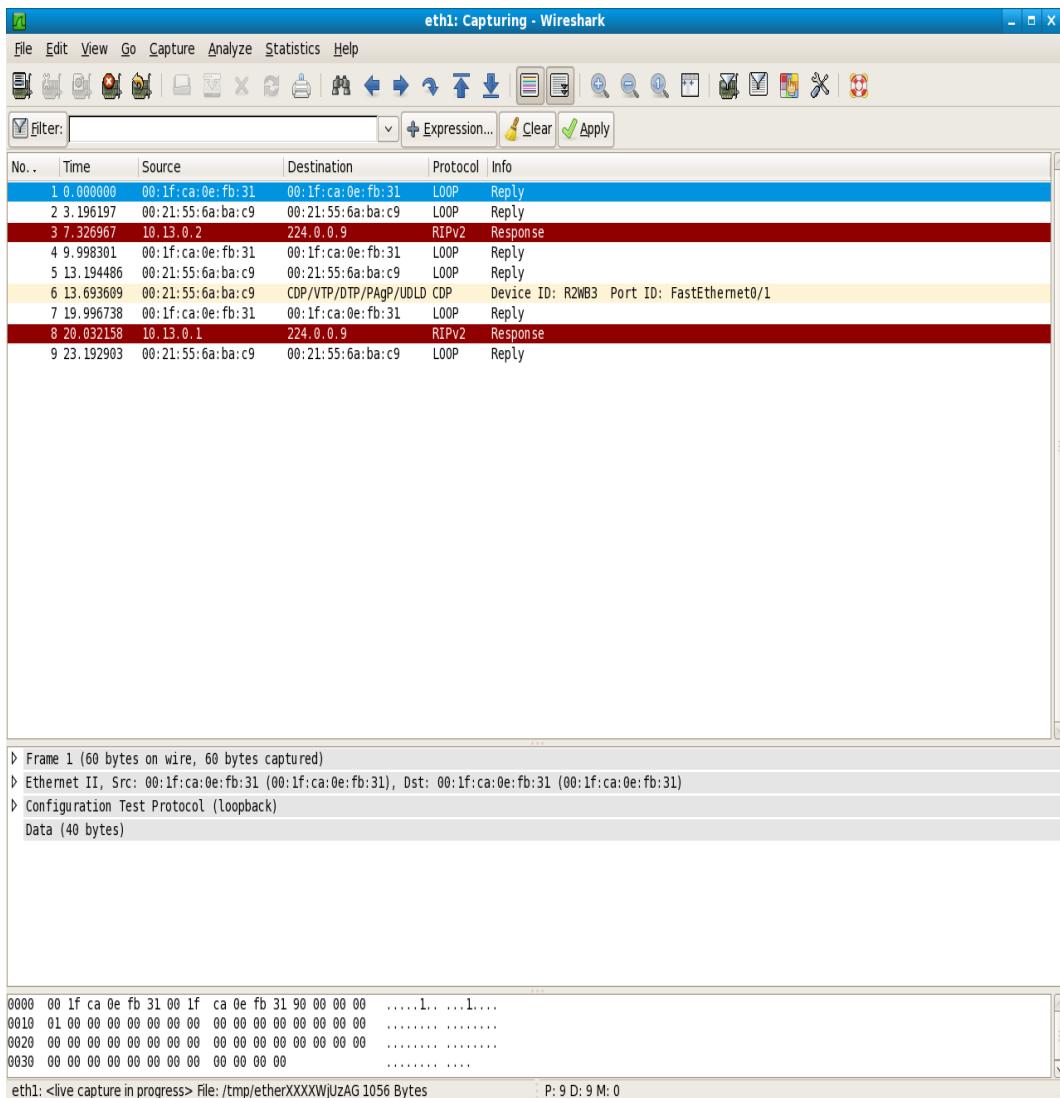
R2C>
R2C#
R2C>enable
R2C#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2C(config)#interface fa0/0/0
R2C(config-if)#ip address 10.13.2.1 255.255.255.252
R2C(config-if)#z
R2C#conf t
*Feb 7 21:30:31.554: %SYS-5-CONFIG_I: Configured from console by console
Enter configuration commands, one per line. End with CNTL/Z.
R2C(config)ip address 10.13.2.2 255.255.255.252
^
% Invalid input detected at '^' marker.

R2C(config)#interface se0/2/0.3
R2C(config-subif)#ip address 10.13.3.2 255.255.255.252
R2C(config-subif)#z
R2C#enable
*Feb 7 21:31:11.490: %SYS-5-CONFIG_I: Configured from console by c
R2C#
R2C#
R2C#sh ip int br
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    unassigned      YES NVRAM up           up
FastEthernet0/1    unassigned      YES NVRAM up           down
FastEthernet0/0/0   10.13.1.1     YES manual up          up
FastEthernet0/1/0   unassigned      YES NVRAM up          up
Serial0/2/0        unassigned      YES NVRAM up          up
Serial0/2/0.1      unassigned      YES unset up          up
Serial0/2/0.2      unassigned      YES unset up          up
Serial0/2/0.3      10.13.3.2     YES manual up          up
Serial0/2/0.4      unassigned      YES unset up          up
Serial0/2/0.255    10.255.255.254 YES NVRAM up          up
Loopback0          unassigned      YES NVRAM up          up
R2C#
```

This is the core router 2 setup for our workbench. The fast Ethernet port on the core router was fa0/0/0 or R23C and it had the IP address 10.13.2.1. This also shows the sub-interface for the serial ports on the core routers. Interface se0/2/0.3 was set to the IP address 10.13.3.2.

Section 4.2: RIP

The next step was to configure all four routers to use RIP. To do this we had to enable RIP, set the version number to 2, disable the automatic route summarization because we do not want the routers to advertise the wrong network prefixes, and enable RIP on the interfaces of each router. Using the network command we were able to set each router's interface to accept and send RIP packets, and its subnet will be advertised to other RIP routers. For example, in router 1 it will have three network addresses to add, 192.168.13.0, 10.13.1.0, and 10.13.0.0.



This shows the RIPv2 packets when eth1 of PC3 is connected to the workbench hub. RIPv2 packets include subnet information and in order to be compatible with RIPv1, it uses a maximum hop count of 15 hops. The destination address is 224.0.0.9 because it multicasts the entire routing table to all adjacent routers at that IP address.

```
team13@netlab-wb3pc2:~ - □ ×
File Edit View Terminal Tabs Help
[team13@netlab-wb3pc2 ~]$ traceroute 192.168.17.30
traceroute to 192.168.17.30 (192.168.17.30), 30 hops max, 40 byte packets
 1  (192.168.13.1)  1.056 ms  1.511 ms  1.829 ms
 2  (10.13.0.2)  1.404 ms  1.620 ms  1.864 ms
 3  (192.168.17.30)  0.955 ms  0.994 ms  0.985 ms
[team13@netlab-wb3pc2 ~]$ □
```

This is the traceroute result from PC2 with IP address 192.168.13.20/24 in LAN1 to laptop with IP address 192.68.17.30/24 in LAN2. The packet first leaves PC2 and goes to the interface fa0/1. The packet moves onto the workbench hub at 10.13.0.2 and then it is able to communicate with router 2 and deliver the packet to the laptop.

```

team3@netlab-wb3pc3:~
```

R 192.168.18.0/24 [120/2] via 10.13.2.1, 00:00:15, FastEthernet0/0/0

R2WB3#
R2WB3#
R2WB3#
R2WB3#
R2WB3#
R2WB3#^Z
R2WB3#

Returning to command line
[mgmtswitch]> connect direct deviceport RIM3
Connecting to Device Port RIM3.
Connected to port 5. Escape sequence is ESC A

R1WB3#
R1WB3#
R1WB3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
 D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
 N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
 E1 - OSPF external type 1, E2 - OSPF external type 2
 i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
 ia - IS-IS inter area, * - candidate default, U - per-user static route
 o - 0DR, P - periodic downloaded static route

Gateway of last resort is not set

C	192.168.13.0/24	is directly connected, FastEthernet0/0
R	192.168.14.0/24	[120/2] via 10.13.1.1, 00:00:14, FastEthernet0/0/0
R	192.168.15.0/24	[120/3] via 10.13.1.1, 00:00:14, FastEthernet0/0/0
	10.0.0.0/8	is variably subnetted, 14 subnets, 2 masks
R	10.11.1.0/30	[120/1] via 10.13.1.1, 00:00:14, FastEthernet0/0/0
R	10.11.0.0/30	[120/3] via 10.13.1.1, 00:00:14, FastEthernet0/0/0
R	10.11.3.0/30	[120/1] via 10.13.0.2, 00:00:17, FastEthernet0/1
R	10.11.2.0/30	[120/2] via 10.13.1.1, 00:00:17, FastEthernet0/0/0
R	10.14.0.0/30	[120/2] via 10.13.1.1, 00:00:15, FastEthernet0/0/0
R	10.13.3.0/30	[120/1] via 10.13.1.1, 00:00:15, FastEthernet0/0/0
R	10.14.1.0/30	[120/1] via 10.13.1.1, 00:00:16, FastEthernet0/0/0
R	10.13.2.0/30	[120/1] via 10.13.0.2, 00:00:18, FastEthernet0/1
R	10.14.2.0/30	[120/2] via 10.13.1.1, 00:00:16, FastEthernet0/0/0
	[120/2]	via 10.13.0.2, 00:00:19, FastEthernet0/1
C	10.13.1.0/30	is directly connected, FastEthernet0/0/0
R	10.14.3.0/30	[120/1] via 10.13.1.1, 00:00:17, FastEthernet0/0/0
C	10.13.0.0/30	is directly connected, FastEthernet0/0/0
R	10.13.1.1.0/30	[120/1] via 10.13.1.1, 00:00:18, FastEthernet0/0/0
R	10.255.255.252/30	[120/1] via 10.13.1.1, 00:00:18, FastEthernet0/0/0
R	192.168.17.0/24	[120/1] via 10.13.0.2, 00:00:21, FastEthernet0/1
R	192.168.18.0/24	[120/3] via 10.13.1.1, 00:00:19, FastEthernet0/0/0
	[120/3]	via 10.13.0.2, 00:00:21, FastEthernet0/1

R1WB3#
R1WB3#

This shows the ip route result for workbench router 1. It shows the RIP enabled interfaces added which includes 10.13.1.0, 10.13.0.0, 192.168.13.0.

```

team13@netlab-wb3pc3:~
File Edit View Terminal Tabs Help
% Invalid input detected at '^' marker.

R2WB3(config-router)#^Z
R2WB3#sh i
*Feb 21 21:20:08.231: %SYS-5-CONFIG_I: Configured from console by console
R2WB3#sh ip int br
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    192.168.17.1   YES manual up        up
FastEthernet0/1    10.13.0.2     YES manual up        up
FastEthernet0/0/0  10.13.2.2     YES manual up        up
Loopback0          unassigned    YES NVRAM up        up
R2WB3#
R2WB3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route
Gateway of last resort is not set

R  192.168.13.0/24 [120/1] via 10.13.0.1, 00:00:12, FastEthernet0/1
R  192.168.14.0/24 [120/3] via 10.13.2.1, 00:00:09, FastEthernet0/0/0
R  192.168.15.0/24 [120/2] via 10.13.2.1, 00:00:09, FastEthernet0/0/0
10.0.0.0/8 is variably subnetted, 14 subnets, 2 masks
R  10.11.1.0/30 [120/1] via 10.13.2.1, 00:00:09, FastEthernet0/0/0
R  10.11.0.0/30 [120/2] via 10.13.2.1, 00:00:09, FastEthernet0/0/0
R  10.11.3.0/30 [120/2] via 10.13.2.1, 00:00:10, FastEthernet0/0/0
R  10.11.1.0/30 [120/2] via 10.13.2.1, 00:00:10, FastEthernet0/0/0
R  10.11.2.0/30 [120/2] via 10.13.2.1, 00:00:13, FastEthernet0/0/1
R  10.14.0.0/30 [120/2] via 10.13.2.1, 00:00:10, FastEthernet0/0/0
R  10.13.3.0/30 [120/1] via 10.13.2.1, 00:00:10, FastEthernet0/0/0
R  10.14.1.0/30 [120/2] via 10.13.2.1, 00:00:10, FastEthernet0/0/0
C  10.13.2.0/30 is directly connected, FastEthernet0/1
R  10.14.2.0/30 [120/1] via 10.13.2.1, 00:00:13, FastEthernet0/0/0
R  10.13.1.0/30 [120/1] via 10.13.0.1, 00:00:17, FastEthernet0/1
R  10.14.3.0/30 [120/1] via 10.13.2.1, 00:00:14, FastEthernet0/0/0
C  10.13.0.0/30 is directly connected, FastEthernet0/0/0
R  10.99.1/32 [120/1] via 10.13.0.1, 00:00:14, FastEthernet0/0/0
[120/2] via 10.13.0.1, 00:00:18, FastEthernet0/1
R  10.255.255.252/30 [120/1] via 10.13.2.1, 00:00:14, FastEthernet0/0/0
C  192.168.17.0/24 is directly connected, FastEthernet0/0/0
R  192.168.18.0/24 [120/2] via 10.13.2.1, 00:00:15, FastEthernet0/0/0
R2WB3#
R2WB3#
R2WB3#
R2WB3#
R2WB3#^C

```

This shows the ip route result for workbench router 2. It shows the RIP enabled interfaces added which includes 10.13.0.0, 10.13.2.0, 192.168.17.0.

```

team13@netlab-wb3pc3:~
File Edit View Terminal Tabs Help
Connected to port 15. Escape sequence is ESC A

R1C#
R1C#
R1C#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route
Gateway of last resort is not set

R  192.168.13.0/24 [120/1] via 10.13.1.2, 00:00:05, FastEthernet0/0/0
R  192.168.14.0/24 [120/1] via 10.14.1.2, 00:00:24, FastEthernet0/1/0
R  192.168.15.0/24 [120/2] via 10.255.255.254, 00:00:18, Serial0/2/0.255
[120/2] via 10.14.3.2, 00:00:00, Serial0/2/0.4
[120/2] via 10.13.3.2, 00:00:04, Serial0/2/0.3
10.0.0.0/8 is variably subnetted, 14 subnets, 2 masks
C  10.11.1.0/30 is directly connected, FastEthernet0/0
R  10.11.0.0/30 [120/2] via 10.255.255.254, 00:00:19, Serial0/2/0.255
[120/2] via 10.14.3.2, 00:00:01, Serial0/2/0.4
[120/2] via 10.13.3.2, 00:00:05, Serial0/2/0.3
C  10.11.3.0/30 is directly connected, Serial0/2/0.1
R  10.11.2.0/30 [120/1] via 10.255.255.254, 00:00:19, Serial0/2/0.255
[120/1] via 10.14.3.2, 00:00:01, Serial0/2/0.4
[120/1] via 10.13.3.2, 00:00:05, Serial0/2/0.3
R  10.14.0.0/30 [120/1] via 10.14.1.2, 00:00:26, FastEthernet0/1/0
C  10.13.3.0/30 is directly connected, Serial0/2/0.3
C  10.14.1.0/30 is directly connected, FastEthernet0/1/0
R  10.13.2.0/30 [120/1] via 10.255.255.254, 00:00:21, Serial0/2/0.255
[120/1] via 10.14.3.2, 00:00:03, Serial0/2/0.4
[120/1] via 10.13.3.2, 00:00:07, Serial0/2/0.3
R  10.14.2.0/30 [120/1] via 10.255.255.254, 00:00:21, Serial0/2/0.255
[120/1] via 10.14.3.2, 00:00:03, Serial0/2/0.4
[120/1] via 10.13.3.2, 00:00:08, Serial0/2/0.3
C  10.13.1.0/30 is directly connected, FastEthernet0/0/0
C  10.14.3.0/30 is directly connected, Serial0/2/0.4
R  10.13.0.0/30 [120/1] via 10.13.1.2, 00:00:10, FastEthernet0/0/0
C  10.99.1/32 is directly connected, Loopback0
C  10.255.255.252/30 is directly connected, Serial0/2/0.255
R  192.168.17.0/24 [120/2] via 10.255.255.254, 00:00:23, Serial0/2/0.255
[120/2] via 10.14.3.2, 00:00:05, Serial0/2/0.4
[120/2] via 10.13.3.2, 00:00:10, Serial0/2/0.3
[120/2] via 10.13.1.2, 00:00:11, FastEthernet0/0/0
R  192.168.18.0/24 [120/2] via 10.255.255.254, 00:00:24, Serial0/2/0.255
[120/2] via 10.14.3.2, 00:00:06, Serial0/2/0.4
[120/2] via 10.14.1.2, 00:00:03, FastEthernet0/1/0
[120/2] via 10.13.3.2, 00:00:11, Serial0/2/0.3
R1C#
R1C#
R1C#^C

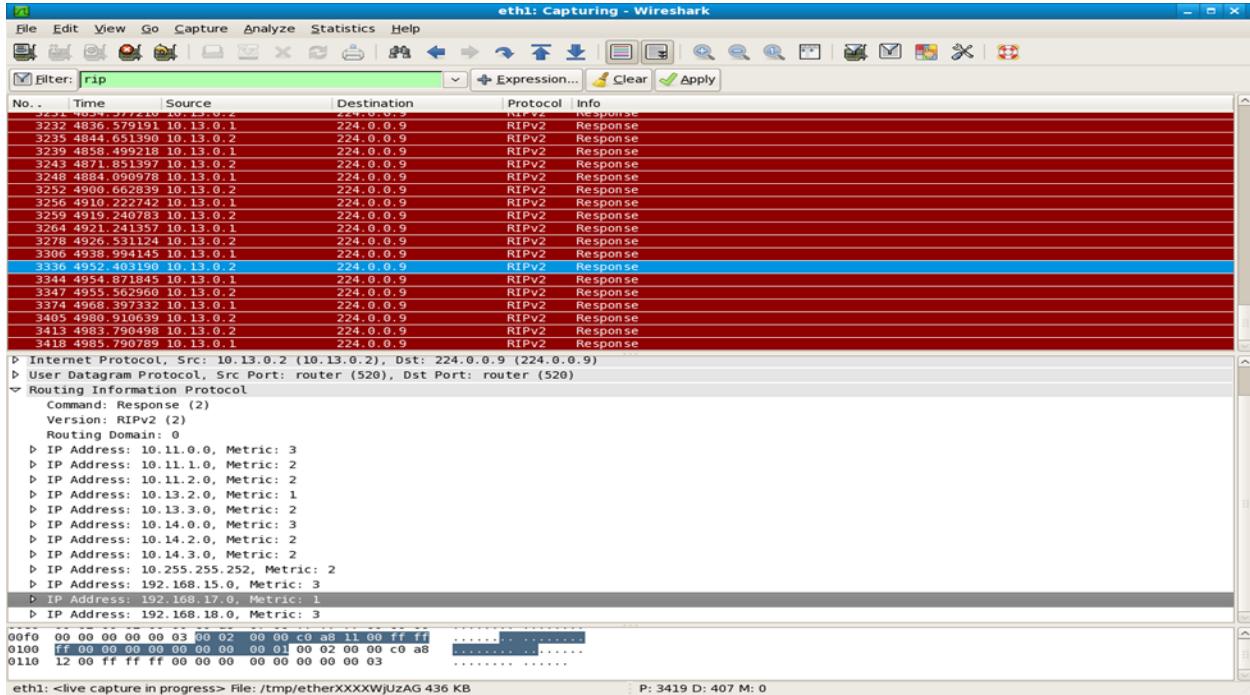
```

This is the show ip route result from the core router 1. It shows the RIP enabled interfaces of fa0/0/0 and the sub-interfaces of se0/2/0.3 which includes 10.13.1.0 and 10.13.3.0.

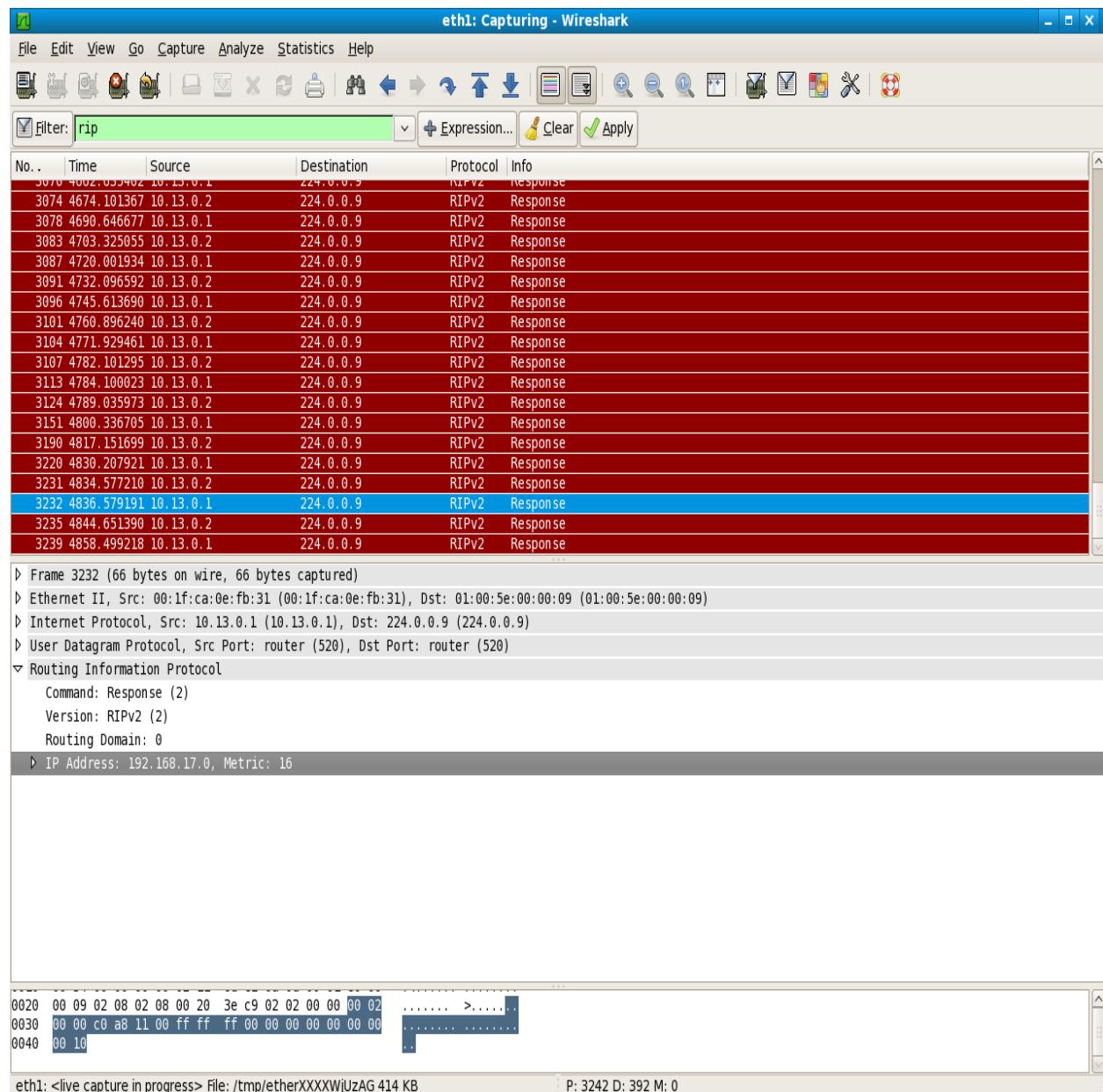
```
team13@netlab-wb3pc3:~
```

```
R2C#  
R2C# show ip route  
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP  
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2  
      E1 - OSPF external type 1, E2 - OSPF external type 2  
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  
      ia - IS-IS inter area, * - candidate default, U - per-user static route  
      o - ODR, P - periodic downloaded static route  
  
Gateway of last resort is not set  
  
R  192.168.13.0/24 [120/2] via 10.255.255.253, 00:00:22, Serial0/2/0.255  
    [120/2] via 10.13.3.1, 00:00:01, Serial0/2/0.4  
    [120/2] via 10.13.3.1, 00:00:05, Serial0/2/0.3  
    [120/2] via 10.13.2.2, 00:00:06, FastEthernet0/0/0  
R  192.168.14.0/24 [120/2] via 10.255.255.253, 00:00:22, Serial0/2/0.255  
    [120/2] via 10.13.3.1, 00:00:03, Serial0/2/0.4  
    [120/2] via 10.14.2.2, 00:00:07, FastEthernet0/1/0  
    [120/2] via 10.13.3.1, 00:00:06, Serial0/2/0.3  
R  192.168.15.0/24 [120/1] via 10.11.2.2, 00:00:12, FastEthernet0/0  
10.0.0.0/8 is variably subnetted, 14 subnets, 2 masks  
C  10.11.1.0/30 is directly connected, Serial0/2/0.1  
R  10.11.0.0/30 [120/1] via 10.11.2.2, 00:00:12, FastEthernet0/0  
R  10.11.3.0/30 [120/1] via 10.255.255.253, 00:00:23, Serial0/2/0.255  
    [120/1] via 10.14.3.1, 00:00:02, Serial0/2/0.4  
    [120/1] via 10.13.3.1, 00:00:06, Serial0/2/0.3  
C  10.11.2.0/30 is directly connected, FastEthernet0/0/0  
R  10.14.0.0/30 [120/1] via 10.14.2.2, 00:00:09, FastEthernet0/1/0  
C  10.13.3.0/30 is directly connected, Serial0/2/0.3  
R  10.14.1.0/30 [120/1] via 10.255.255.253, 00:00:23, Serial0/2/0.255  
    [120/1] via 10.13.3.1, 00:00:03, Serial0/2/0.4  
    [120/1] via 10.13.3.1, 00:00:07, Serial0/2/0.3  
C  10.13.2.0/30 is directly connected, FastEthernet0/0/0  
C  10.14.2.0/30 is directly connected, FastEthernet0/1/0  
R  10.13.1.0/30 [120/1] via 10.255.255.253, 00:00:24, Serial0/2/0.255  
    [120/1] via 10.14.3.1, 00:00:03, Serial0/2/0.4  
    [120/1] via 10.13.3.1, 00:00:08, Serial0/2/0.3  
C  10.14.3.0/30 is directly connected, Serial0/2/0.4  
R  10.13.0.0/30 [120/1] via 10.13.2.2, 00:00:10, FastEthernet0/0/0  
R  10.99.99.1/32 [120/1] via 10.255.255.253, 00:00:00, Serial0/2/0.255  
    [120/1] via 10.14.3.1, 00:00:05, Serial0/2/0.4  
    [120/1] via 10.13.3.1, 00:00:09, Serial0/2/0.3  
C  10.255.255.252/30 is directly connected, Serial0/2/0.255  
R  192.168.17.0/24 [120/1] via 10.13.2.2, 00:00:11, FastEthernet0/0/0  
R  192.168.18.0/24 [120/1] via 10.14.2.2, 00:00:12, FastEthernet0/1/0  
R2C#  
R2C#  
R2C#
```

This is the show ip route result from the core router 2. It shows the RIP enabled interfaces of fa0/0/0 and the sub-interfaces of se0/2/0.3 which includes 10.13.2.0 and 10.13.3.0.



This shows router 1's RIPv2 packets when the split horizon algorithm is enabled. This algorithm prevents a route from getting into a routing loop by not allowing a router to advertise a route back onto the interface where it just learned about the route. The metric is 1 here which means that it is one hop away from router 1.



This shows router 1's RIPv2 packets when the split horizon algorithm is disabled. The metric is now 16 which means that the distance from router 1 is considered unreachable because the maximum number of hops allowed in RIP is 15. This also demonstrates the “count to infinity” effect.

```
[team13@netlab-wb3pc2 ~]$ ping 192.168.17.30
PING 192.168.17.30 (192.168.17.30) 56(84) bytes of data.
64 bytes from 192.168.17.30: icmp_seq=1 ttl=62 time=0.461 ms
64 bytes from 192.168.17.30: icmp_seq=2 ttl=62 time=0.436 ms
64 bytes from 192.168.17.30: icmp_seq=3 ttl=62 time=0.448 ms
64 bytes from 192.168.17.30: icmp_seq=4 ttl=62 time=0.431 ms
64 bytes from 192.168.17.30: icmp_seq=5 ttl=62 time=0.436 ms
64 bytes from 192.168.17.30: icmp_seq=6 ttl=62 time=0.459 ms
64 bytes from 192.168.17.30: icmp_seq=7 ttl=62 time=0.466 ms
64 bytes from 192.168.17.30: icmp_seq=8 ttl=62 time=0.439 ms
64 bytes from 192.168.17.30: icmp_seq=9 ttl=62 time=0.427 ms
64 bytes from 192.168.17.30: icmp_seq=10 ttl=62 time=0.430 ms
64 bytes from 192.168.17.30: icmp_seq=11 ttl=62 time=0.429 ms
64 bytes from 192.168.17.30: icmp_seq=12 ttl=62 time=0.432 ms
64 bytes from 192.168.17.30: icmp_seq=13 ttl=62 time=0.430 ms
64 bytes from 192.168.17.30: icmp_seq=14 ttl=62 time=0.464 ms
64 bytes from 192.168.17.30: icmp_seq=15 ttl=62 time=0.426 ms
64 bytes from 192.168.17.30: icmp_seq=16 ttl=62 time=0.458 ms
64 bytes from 192.168.17.30: icmp_seq=17 ttl=62 time=0.426 ms
64 bytes from 192.168.17.30: icmp_seq=18 ttl=62 time=0.453 ms
64 bytes from 192.168.17.30: icmp_seq=19 ttl=62 time=0.429 ms
64 bytes from 192.168.17.30: icmp_seq=20 ttl=62 time=0.439 ms
From 192.168.13.1 icmp_seq=31 Destination Host Unreachable
From 192.168.13.1 icmp_seq=32 Destination Host Unreachable
From 192.168.13.1 icmp_seq=33 Destination Host Unreachable
From 192.168.13.1 icmp_seq=34 Destination Host Unreachable
From 192.168.13.1 icmp_seq=35 Destination Host Unreachable
From 192.168.13.1 icmp_seq=36 Destination Host Unreachable
From 192.168.13.1 icmp_seq=37 Destination Host Unreachable
From 192.168.13.1 icmp_seq=38 Destination Host Unreachable
From 192.168.13.1 icmp_seq=39 Destination Host Unreachable
From 192.168.13.1 icmp_seq=40 Destination Host Unreachable
From 192.168.13.1 icmp_seq=41 Destination Host Unreachable
64 bytes from 192.168.17.30: icmp_seq=42 ttl=60 time=24.6 ms
64 bytes from 192.168.17.30: icmp_seq=43 ttl=60 time=24.4 ms
64 bytes from 192.168.17.30: icmp_seq=44 ttl=60 time=24.5 ms
64 bytes from 192.168.17.30: icmp_seq=45 ttl=60 time=24.4 ms
64 bytes from 192.168.17.30: icmp_seq=46 ttl=60 time=24.3 ms
64 bytes from 192.168.17.30: icmp_seq=47 ttl=60 time=24.5 ms
64 bytes from 192.168.17.30: icmp_seq=48 ttl=60 time=24.5 ms
64 bytes from 192.168.17.30: icmp_seq=49 ttl=60 time=24.4 ms
64 bytes from 192.168.17.30: icmp_seq=50 ttl=60 time=24.5 ms
64 bytes from 192.168.17.30: icmp_seq=51 ttl=60 time=24.4 ms
64 bytes from 192.168.17.30: icmp_seq=52 ttl=60 time=24.4 ms
64 bytes from 192.168.17.30: icmp_seq=53 ttl=60 time=24.4 ms
```

This shows the timelapse when eth1 of PC3 was plugged into the core hub and this ping result is from PC2 with IP address of 192.168.13.20/24 to the laptop at 192.168.17.30/24. In this example it took 24.161 msec to resume normal operation after we unplugged the workbench routers from the hub.

```
team13@netlab-wb3pc2:~
```

File Edit View Terminal Tabs Help

```

a probe (default is 5.0). Non-integer (float
point) values allowed too
-q nqueries --queries=nqueries
    Set the number of probes per each hop. Default is
    3
-r
    Bypass the normal routing and send directly to a
    host on an attached network
-s src_addr --source=src_addr
    Use source src_addr for outgoing packets
-z sendwait --sendwait=sendwait
    Minimal time interval between probes (default 0).
    If the value is more than 10, then it specifies a
    number in milliseconds, else it is a number of
    seconds (float point values allowed too)
-A --as-path-lookups
    Perform AS path lookups in routing registries and
    print results directly after the corresponding
    addresses
-M name --module=name
    Use specified module (either builtin or external)
    for traceroute operations. Most methods have
    their shortcuts ('-I' means '-M icmp' etc.)
-O OPTS,... --options=OPTS,...
    Use module-specific option OPTS for the
    traceroute module. Several OPTS allowed,
    separated by comma. If OPTS is "help", print info
    about available options
--sport=num
    Use source port num for outgoing packets. Implies
    '-N 1'
-U --udp
    Use UDP to particular port for tracerouting
    (instead of increasing the port per each probe),
    default port is 53
-UL
    Use UDPLITE for tracerouting (default dest port
    is 53)
-P prot --protocol=prot
    Use raw packet of protocol prot for tracerouting
-V --version
    Print version info and exit
--help
    Read this help and exit

Arguments:
+ host      The host to traceroute to
packetlen   Specify an alternate probe packet length (default is 40).
            Useless for TCP SYN
[team13@netlab-wb3pc2 ~]$ traceroute 192.168.17.30
traceroute to 192.168.17.30 (192.168.17.30), 30 hops max, 40 byte packets
1 (192.168.13.1) 1.084 ms 1.425 ms 1.826 ms
2 (10.13.0.2) 1.475 ms 1.701 ms 1.934 ms
3 (192.168.17.30) 0.982 ms 1.019 ms 1.007 ms
[team13@netlab-wb3pc2 ~]$ traceroute 192.168.17.30
traceroute to 192.168.17.30 (192.168.17.30), 30 hops max, 40 byte packets
1 (192.168.13.1) 0.959 ms 1.207 ms 1.435 ms
2 (10.13.1.1) 1.608 ms 1.810 ms 2.008 ms
3 (10.255.255.254) 19.504 ms 28.797 ms 38.241 ms
4 (10.13.2.2) 47.775 ms 116.457 ms 108.510 ms
5 (192.168.17.30) 100.591 ms 87.642 ms 74.702 ms
[team13@netlab-wb3pc2 ~]$ 
[team13@netlab-wb3pc2 ~]$ 
```

This shows the routing path when the two workbench routers are connected to the workbench hub and when they are unplugged from the workbench hub. The traceroute is coming from PC2 in LAN1 with IP address 192.168.13.20/24 to the laptop in LAN2 with IP address 192.168.17.30/24. The first traceroute result shows the route path taken when the two routers are plugged into the workbench hub. It travels from PC2 to interface fa0/0 of router 1, through the hub to interface fa0/0 of router 2 and reaches its destination of the laptop. The second traceroute result shows the route it takes when the workbench routers are not plugged into the workbench hub as it goes from fa0/0 of router 1, up through the fast Ethernet interface of core router 1, through the sub-interfaces connection, through the core hub, reaching interface fa0/0/0 of router 2, and finally arriving at the destination of the laptop.

```

team13@netlab-wb3pc3:~
File Edit View Terminal Tabs Help
Feb 7 23:09:12.419: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R1WB3#config-if-if
*Feb 7 23:10:58.151: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
R1WB3#config-if-if
*Feb 7 23:13:52.423: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R1WB3#show ip route
% Invalid input detected at '^' marker.

R1WB3#config-if-if
*Feb 7 23:15:46.659: %SYS-5-CONFIG_I: Configured from console by console
R1WB3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C 192.168.13.0/24 is directly connected, FastEthernet0/0
R 192.168.14.0/24 [120/2] via 10.13.1.1, 00:00:18, FastEthernet0/0/0
R 192.168.15.0/24 [120/3] via 10.13.1.1, 00:00:19, FastEthernet0/0/0
R 192.168.11.0/24 [120/2] via 10.13.1.1, 00:00:18, FastEthernet0/0/1
R 10.0.0.0/8 is variably subnetted, 14 subnets, 2 masks
R 10.11.1.0/30 [120/1] via 10.13.1.1, 00:00:18, FastEthernet0/0/0
R 10.11.0.0/30 [120/3] via 10.13.0.2, 00:00:08, FastEthernet0/0/1
R 10.11.3.0/30 [120/2] via 10.13.1.1, 00:00:19, FastEthernet0/0/0
R 10.11.2.0/30 [120/1] via 10.13.1.1, 00:00:19, FastEthernet0/0/1
R 10.14.0.0/30 [120/1] via 10.13.1.1, 00:00:19, FastEthernet0/0/0
R 10.13.3.0/30 [120/1] via 10.13.1.1, 00:00:21, FastEthernet0/0/0
R 10.14.1.0/30 [120/1] via 10.13.1.1, 00:00:21, FastEthernet0/0/0
R 10.13.2.0/30 [120/2] via 10.13.1.1, 00:00:21, FastEthernet0/0/1
R 10.14.2.0/30 [120/2] via 10.13.1.1, 00:00:21, FastEthernet0/0/0
C 10.13.1.0/30 [120/1] via 10.13.1.1, 00:00:22, FastEthernet0/0/0
C 10.14.3.0/30 [120/1] via 10.13.1.1, 00:00:22, FastEthernet0/0/0
R 10.99.99.1/32 [120/1] via 10.13.1.1, 00:00:22, FastEthernet0/0/0
R 10.255.255.252/30 [120/1] via 10.13.1.1, 00:00:22, FastEthernet0/0/0
R 192.168.17.0/24 [120/1] via 10.13.0.2, 00:00:11, FastEthernet0/1
R 192.168.18.0/24 [120/3] via 10.13.1.1, 00:00:22, FastEthernet0/0/0
R 192.168.0.0/1 via 10.13.0.2, 00:00:11, FastEthernet0/0/1

R1WB3#
R1WB3#
R1WB3#
R1WB3#
R1WB3#

```

This shows the routing table of router 1 when both workbench routers are plugged in. It shows the RIP connection with the network address of the laptop 192.168.17.0/24.

```

team13@netlab-wb3pc3:~
File Edit View Terminal Tabs Help
Feb 7 23:16:08.151: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
R1WB3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

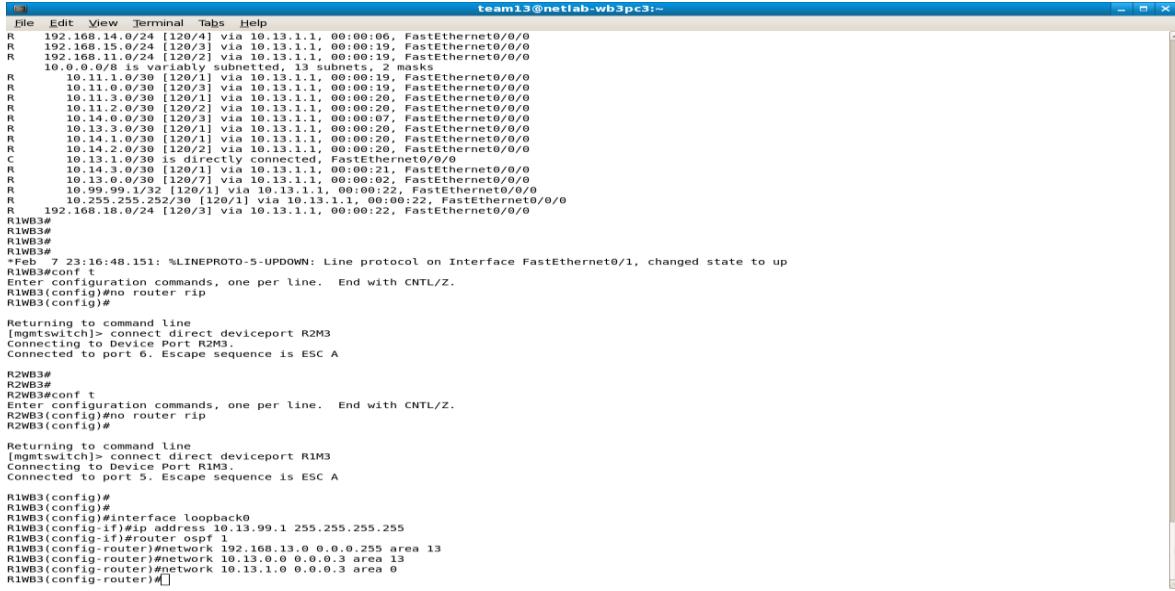
C 192.168.13.0/24 is directly connected, FastEthernet0/0
R 192.168.14.0/24 [120/4] via 10.13.1.1, 00:00:06, FastEthernet0/0/0
R 192.168.15.0/24 [120/3] via 10.13.1.1, 00:00:19, FastEthernet0/0/0
R 192.168.11.0/24 [120/2] via 10.13.1.1, 00:00:19, FastEthernet0/0/0
R 10.0.0.0/8 is variably subnetted, 14 subnets, 2 masks
R 10.11.1.0/30 [120/1] via 10.13.1.1, 00:00:19, FastEthernet0/0/0
R 10.11.0.0/30 [120/3] via 10.13.1.1, 00:00:20, FastEthernet0/0/0
R 10.11.2.0/30 [120/2] via 10.13.1.1, 00:00:20, FastEthernet0/0/0
R 10.14.0.0/30 [120/3] via 10.13.1.1, 00:00:07, FastEthernet0/0/0
R 10.13.3.0/30 [120/1] via 10.13.1.1, 00:00:20, FastEthernet0/0/0
R 10.14.1.0/30 [120/1] via 10.13.1.1, 00:00:20, FastEthernet0/0/0
R 10.14.2.0/30 [120/2] via 10.13.1.1, 00:00:20, FastEthernet0/0/0
C 10.13.1.0/30 [120/1] via 10.13.1.1, 00:00:21, FastEthernet0/0/0
R 10.14.3.0/30 [120/1] via 10.13.1.1, 00:00:02, FastEthernet0/0/0
R 10.99.99.1/32 [120/1] via 10.13.1.1, 00:00:22, FastEthernet0/0/0
R 10.255.255.252/30 [120/1] via 10.13.1.1, 00:00:22, FastEthernet0/0/0
R 192.168.17.0/24 [120/3] via 10.13.1.1, 00:00:22, FastEthernet0/0/0
R 192.168.18.0/24 [120/3] via 10.13.1.1, 00:00:22, FastEthernet0/0/0

R1WB3#
R1WB3#
R1WB3#
R1WB3#
R1WB3#

```

This shows the routing table of router 1 when the two workbench routers are not plugged in. In this case, the network address of LAN2 of 192.168.17.30 is not shown because RIP is not able to directly know that without knowing about router 2, when it is not connected to the hub.

Section 4.3: OSPF

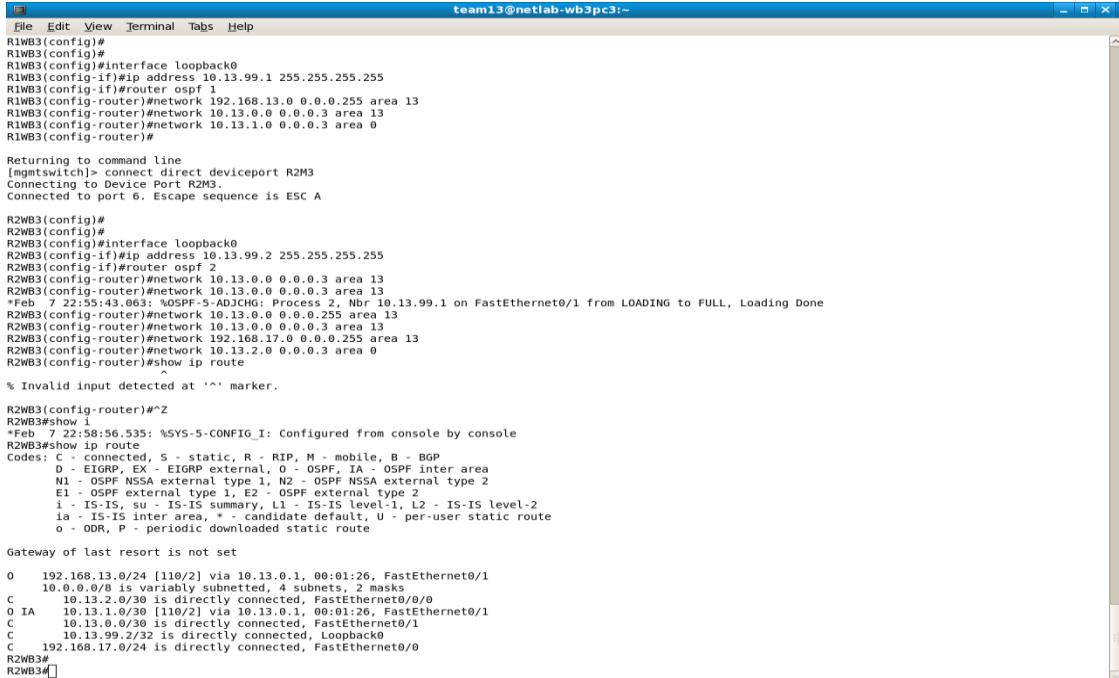


```

team13@netlab-wb3pc3:~ 
File Edit View Terminal Tabs Help
R 192.168.14.0/24 [120/4] via 10.13.1.1, 00:00:06, FastEthernet0/0/0
R 192.168.15.0/24 [120/3] via 10.13.1.1, 00:00:19, FastEthernet0/0/0
R 192.168.11.0/24 [120/2] via 10.13.1.1, 00:00:19, FastEthernet0/0/0
10.13.1.0/24 var 10.13.1.0/24 subnet mask 255.255.255.0
R 10.11.1.0/30 [120/1] via 10.13.1.1, 00:00:19, FastEthernet0/0/0
R 10.11.0.0/30 [120/3] via 10.13.1.1, 00:00:19, FastEthernet0/0/0
R 10.11.3.0/30 [120/1] via 10.13.1.1, 00:00:20, FastEthernet0/0/0
R 10.11.2.0/30 [120/2] via 10.13.1.1, 00:00:20, FastEthernet0/0/0
R 10.14.0.0/30 [120/3] via 10.13.1.1, 00:00:07, FastEthernet0/0/0
R 10.13.3.0/30 [120/1] via 10.13.1.1, 00:00:20, FastEthernet0/0/0
R 10.14.1.0/30 [120/2] via 10.13.1.1, 00:00:20, FastEthernet0/0/0
R 10.14.2.0/30 [120/3] via 10.13.1.1, 00:00:20, FastEthernet0/0/0
C 10.13.1.0/30 is directly connected, FastEthernet0/0/0
R 10.14.3.0/30 [120/1] via 10.13.1.1, 00:00:21, FastEthernet0/0/0
R 10.13.2.0/32 [120/1] via 10.13.1.1, 00:00:22, FastEthernet0/0/0
R 10.98.99.1/32 [120/1] via 10.13.1.1, 00:00:22, FastEthernet0/0/0
R 10.255.255.252/30 [120/1] via 10.13.1.1, 00:00:22, FastEthernet0/0/0
R 192.168.18.0/24 [120/3] via 10.13.1.1, 00:00:22, FastEthernet0/0/0
R1WBS3#
R1WBS3#
R1WBS3#
*Feb 7 23:16:48.151: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R1WBS3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1WBS3(config)#no router rip
R1WBS3(config)#
Returning to command line
[mgmtswitch] connect direct deviceport R2M3
Connecting to Device Port R2M3.
Connected to port 6. Escape sequence is ESC A
R2WBS3#
R2WBS3#
R2WBS3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2WBS3(config)#no router rip
R2WBS3(config)#
Returning to command line
[mgmtswitch] connect direct deviceport R1M3
Connecting to Device Port R1M3.
Connected to port 5. Escape sequence is ESC A
R1WBS3(config)#
R1WBS3(config)#interface loopback0
R1WBS3(config-if)#ip address 10.13.99.1 255.255.255.255
R1WBS3(config-if)#router ospf 1
R1WBS3(config-router)#network 192.168.13.0 0.0.0.255 area 13
R1WBS3(config-router)#network 10.13.0.0 0.0.0.3 area 13
R1WBS3(config-router)#network 10.13.1.0 0.0.0.3 area 0
R1WBS3(config-router)#

```

This is the OSPF configuration for workbench router 1. We assigned the process id to 1 for router 1 and we had to add three network areas one for each interface on the router.



```

team13@netlab-wb3pc3:~ 
File Edit View Terminal Tabs Help
R1WBS3(config)#
R1WBS3(config)#
R1WBS3(config)#interface loopback0
R1WBS3(config-if)#ip address 10.13.99.1 255.255.255.255
R1WBS3(config-if)#router ospf 1
R1WBS3(config-router)#network 192.168.13.0 0.0.0.255 area 13
R1WBS3(config-router)#network 10.13.0.0 0.0.0.3 area 13
R1WBS3(config-router)#network 10.13.1.0 0.0.0.3 area 0
R1WBS3(config-router)#
Returning to command line
[mgmtswitch] connect direct deviceport R2M3
Connecting to Device Port R2M3.
Connected to port 6. Escape sequence is ESC A
R2WBS3(config)#
R2WBS3(config)#
R2WBS3(config)#interface loopback0
R2WBS3(config-if)#ip address 10.13.99.2 255.255.255.255
R2WBS3(config-if)#router ospf 1
R2WBS3(config-if)#network 10.13.0.0 0.0.0.3 area 13
R2WBS3(config-router)#network 10.13.0.0 0.0.0.3 area 13
R2WBS3(config-router)#network 192.168.17.0 0.0.0.255 area 13
R2WBS3(config-router)#network 10.13.2.0 0.0.0.3 area 0
R2WBS3(config-router)#show ip route
% Invalid input detected at '^' marker.

R2WBS3(config-router)#
R2WBS3#show
*Feb 7 22:58:56.535: %SYS-5-CONFIG_I: Configured from console by console
R2WBS3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
        D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default, U - per-user static route
        o - ODR, P - periodic downloaded static route
Gateway of last resort is not set
O  192.168.13.8/24 [110/2] via 10.13.1.1, 00:01:26, FastEthernet0/1
    10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C  10.13.1.0/30 [110/2] via 10.13.0.1, 00:01:26, FastEthernet0/0/0
C  10.13.1.0/30 [110/2] via 10.13.0.1, 00:01:26, FastEthernet0/1
C  10.13.0.0/30 [110/2] via 10.13.0.1, 00:01:26, FastEthernet0/1
C  10.13.99.2/32 is directly connected, Loopback0
C  192.168.17.0/24 is directly connected, FastEthernet0/0/0
R2WBS3#
R2WBS3#

```

This is the OSPF configuration for workbench router 2. We assigned the process id to 2 for router 2 and we had to add three network areas one for each interface on the router.

```
[team13@netlab-wb3pc2 ~]$ traceroute 192.168.17.38  
traceroute to 192.168.17.38 (192.168.17.38), 30 hops max, 40 byte packets  
 1 (192.168.13.20) 3000.683 ms !H 3000.594 ms !H 3000.581 ms !H  
[team13@netlab-wb3pc2 ~]$ ping 192.168.17.38  
PING 192.168.17.38 (192.168.17.38) 56(84) bytes of data.  
64 bytes from 192.168.17.38: icmp_seq=1 ttl=62 time=0.497 ms  
64 bytes from 192.168.17.38: icmp_seq=2 ttl=62 time=0.422 ms  
64 bytes from 192.168.17.38: icmp_seq=3 ttl=62 time=0.461 ms  
64 bytes from 192.168.17.38: icmp_seq=4 ttl=62 time=0.464 ms  
  
... 192.168.17.30 ping statistics --  
4 packets transmitted, 4 received, 0% packet loss, time 2999ms  
rtt min/avg/max/mdev = 0.422/0.461/0.497/0.026 ms  
[team13@netlab-wb3pc2 ~]$ traceroute 192.168.17.38  
traceroute to 192.168.17.38 (192.168.17.38), 30 hops max, 40 byte packets  
 1 (192.168.13.1) 1.140 ms 1.492 ms 1.856 ms  
 2 (192.168.13.2) 1.467 ms 1.661 ms 1.929 ms  
 3 (192.168.17.30) 0.923 ms 0.916 ms 0.903 ms  
[team13@netlab-wb3pc2 ~]$ ]
```

This is the traceroute result from PC2 to the laptop. This verifies that PCs on LAN1 can reach the laptop in LAN2 and the routing path goes through the hub to reach the laptop.

```

File Edit View Terminal Tabs Help

10.14.0.0 10.14.99.2 36 0x80000001 0x00C7E1
192.168.13.0 10.13.99.1 1436 0x80000002 0x00CF79
192.168.13.0 10.13.99.2 1386 0x80000002 0x00D373
192.168.14.0 10.14.99.1 1805 0x80000002 0x00BCBA
192.168.17.0 10.13.99.1 1182 0x80000002 0x00AD96
192.168.17.0 10.13.99.2 1386 0x80000002 0x009D46
192.168.18.0 10.14.99.2 1472 0x80000002 0x008AB7

R2C#
R2C#
R2C#
R2C#

Returning to command line
[!mgmtswitch]> connect direct deviceport R2M3
Connecting to Device Port R2M3.
Connected to port 6. Escape sequence is ESC A

R2WB3#
R2WB3#
R2WB3#
R2WB3$#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      1 - IS-IS, 2 - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

0 IA 192.168.13.0/24 [110/67] via 10.13.2.1, 00:01:50, FastEthernet0/0/0
0 IA 192.168.14.0/24 [110/4] via 10.13.2.1, 00:04:39, FastEthernet0/0/0
  10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
0 IA 10.14.0.0/30 [110/3] via 10.13.2.1, 00:05:24, FastEthernet0/0/0
  10.13.3.0/30 [110/65] via 10.13.2.1, 00:45:25, FastEthernet0/0/0
0 0 10.14.1.0/30 [110/66] via 10.13.2.1, 00:45:25, FastEthernet0/0/0
0 0 10.13.2.0/30 is directly connected, FastEthernet0/0/0
0 0 10.14.2.0/30 [110/2] via 10.13.2.1, 00:45:26, FastEthernet0/0/0
  10.13.1.0/30 [110/66] via 10.13.2.1, 00:45:26, FastEthernet0/0/0
  0 0 10.14.3.0/30 [110/129] via 10.13.2.1, 00:45:26, FastEthernet0/0/0
  C 0 10.13.99.2/32 is directly connected, Loopback0
0 0 IA 192.168.18.0/24 [110/3] via 10.13.2.1, 00:45:26, FastEthernet0/0/0
R2WB3#


Returning to command line
[!mgmtswitch]> connect direct deviceport R1M3
Connecting to Device Port R1M3.
Connected to port 5. Escape sequence is ESC A

R1WB3#
R1WB3#
R1WB3$#show ip route
```

This shows the ip route for workbench router 1.

```

team13@netlab-wb3pc3:~
File Edit View Terminal Tabs Help
C 192.168.13.0/24 is directly connected, FastEthernet0/0
O IA 192.168.14.0/24 [110/3] via 10.13.1.1, 00:14:03, FastEthernet0/0/0
  10.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
O IA 10.14.4.0/30 [110/3] via 10.13.1.1, 00:14:03, FastEthernet0/0/0
O 10.13.3.0/30 [110/65] via 10.13.1.1, 00:13:41, FastEthernet0/0/0
O 10.14.1.0/30 [110/2] via 10.13.1.1, 00:14:03, FastEthernet0/0/0
O 10.13.2.8/30 [110/66] via 10.13.1.1, 00:11:48, FastEthernet0/0/0
O 10.13.1.0/30 [110/67] via 10.13.1.1, 00:11:39, FastEthernet0/0/0
C 10.13.1.0/30 [110/65] via 10.13.1.1, 00:14:05, FastEthernet0/0/0
C 10.13.0.0/30 [110/65] via 10.13.1.1, 00:14:05, FastEthernet0/0/1
C 10.13.99.1/32 is directly connected, Loopback0
O 192.168.17.0/24 [110/2] via 10.13.0.2, 00:26:57, FastEthernet0/0/0
O IA 192.168.18.0/24 [110/4] via 10.13.1.1, 00:14:06, FastEthernet0/0/0
R1B3#
R1B3#
R1B3#
R1B3#  

Returning to command line
[mgmtswitch]> connect direct deviceport R2M3
Connecting to Device Port R2M3.
Connected to port 6. Escape sequence is ESC A
R2B3#
R2B3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route
Gateway of last resort is not set
O 192.168.13.0/24 [110/2] via 10.13.0.1, 00:27:10, FastEthernet0/1
O IA 192.168.14.0/24 [110/4] via 10.13.2.1, 00:12:20, FastEthernet0/0/0
  10.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
O IA 10.14.4.0/30 [110/3] via 10.13.2.1, 00:12:20, FastEthernet0/0/0
O 10.13.3.0/30 [110/65] via 10.13.2.1, 00:12:20, FastEthernet0/0/0
O 10.14.1.0/30 [110/66] via 10.13.2.1, 00:12:20, FastEthernet0/0/0
C 10.13.2.0/30 [110/65] via 10.13.2.1, 00:12:21, FastEthernet0/0/0
O 10.13.1.0/30 [110/66] via 10.13.2.1, 00:12:21, FastEthernet0/0/0
O 10.14.3.0/30 [110/129] via 10.13.2.1, 00:12:21, FastEthernet0/0/0
C 10.13.0.0/30 [110/65] via 10.13.2.1, 00:12:22, FastEthernet0/0/1
C 10.13.99.2/32 is directly connected, Loopback0
C 192.168.17.0/24 is directly connected, FastEthernet0/0/0
O IA 192.168.18.0/24 [110/3] via 10.13.2.1, 00:12:22, FastEthernet0/0/0
R2B3#
R2B3#
R2B3#
R2B3#
```

This shows the ip route for workbench router 2.

```

team13@netlab-wb3pc3:~
File Edit View Terminal Tabs Help
C 10.13.0.0/30 [110/2] via 10.13.2.2, 00:08:02, FastEthernet0/0/0
C 10.11.99.2/32 is directly connected, Loopback0
C 10.255.255.252/30 is directly connected, Serial0/2/0.255
O IA 192.168.17.0/24 [110/2] via 10.13.2.2, 00:08:04, FastEthernet0/0/0
O IA 192.168.18.0/24 [110/2] via 10.14.2.2, 00:10:09, FastEthernet0/1/0
R2C#
R2C#  

Returning to command line
[mgmtswitch]> connect direct deviceport R1MC
Connecting to Device Port R1MC.
Connected to port 15. Escape sequence is ESC A
R1C(config)#
R1C(config)#
R1C(config)#
R1C(config)#  

R1C#  

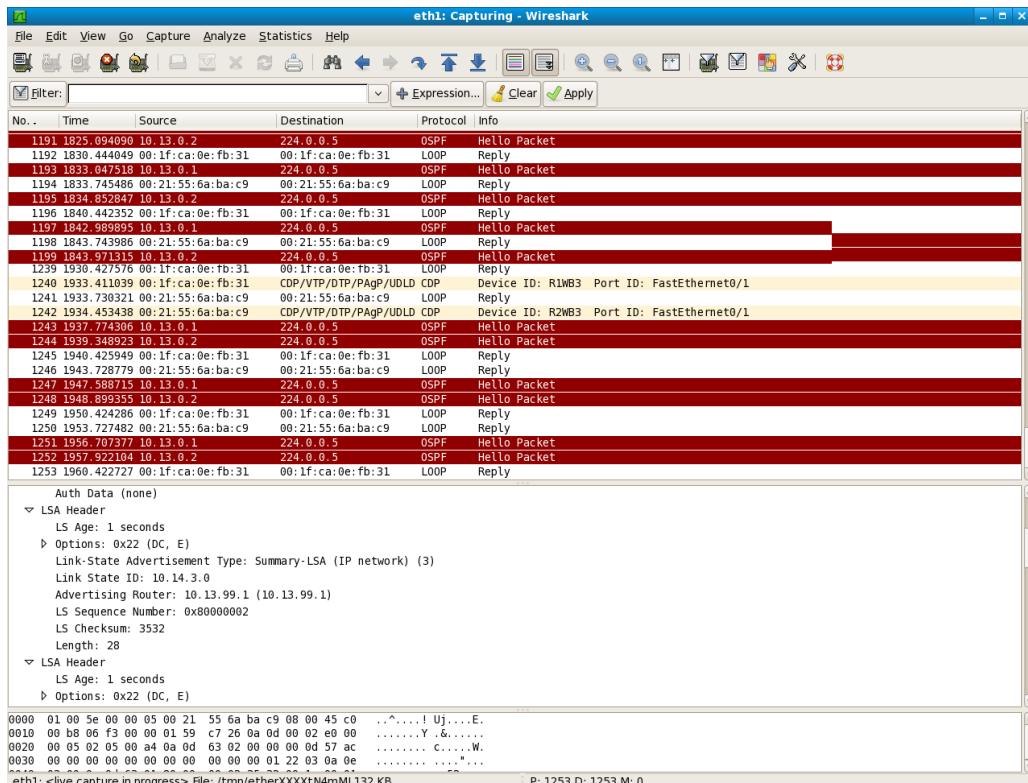
*Feb 7 23:30:30.873: %SYS-5-CONFIG_I: Configured from console by consoleow i
% Ambiguous command: "show i"
R1C#  

R1C#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route
Gateway of last resort is not set
O IA 192.168.13.0/24 [110/2] via 10.13.1.2, 00:11:57, FastEthernet0/0/0
O IA 192.168.14.0/24 [110/1] via 10.14.1.2, 00:13:17, FastEthernet0/1/0
  10.0.0.0/8 is variably subnetted, 1 subnets, 2 masks
C 10.11.1.0/30 is directly connected, FastEthernet0/1/0
C 10.11.3.0/30 is directly connected, Serial0/2/0.1
O IA 10.14.0.0/30 [110/2] via 10.14.1.2, 00:13:17, FastEthernet0/1/0
C 10.13.3.0/30 is directly connected, Serial0/2/0.3
C 10.14.1.0/30 is directly connected, FastEthernet0/1/0
O 10.13.2.0/30 [110/65] via 10.13.3.2, 00:09:43, Serial0/2/0.3
O 10.14.2.0/30 [110/65] via 10.13.3.2, 00:09:53, Serial0/2/0.3
C 10.13.1.0/30 is directly connected, FastEthernet0/0/0
C 10.14.3.0/30 is directly connected, Serial0/2/0.4
O IA 10.13.0.0/30 [110/2] via 10.13.1.2, 00:11:58, FastEthernet0/0/0
C 10.11.99.1/32 is directly connected, Loopback0
C 10.255.255.252/30 is directly connected, Serial0/2/0.255
O IA 192.168.17.0/24 [110/3] via 10.13.1.2, 00:11:59, FastEthernet0/0/0
O IA 192.168.18.0/24 [110/3] via 10.14.1.2, 00:13:19, FastEthernet0/1/0
R1C#
R1C#
R1C#
R1C#
```

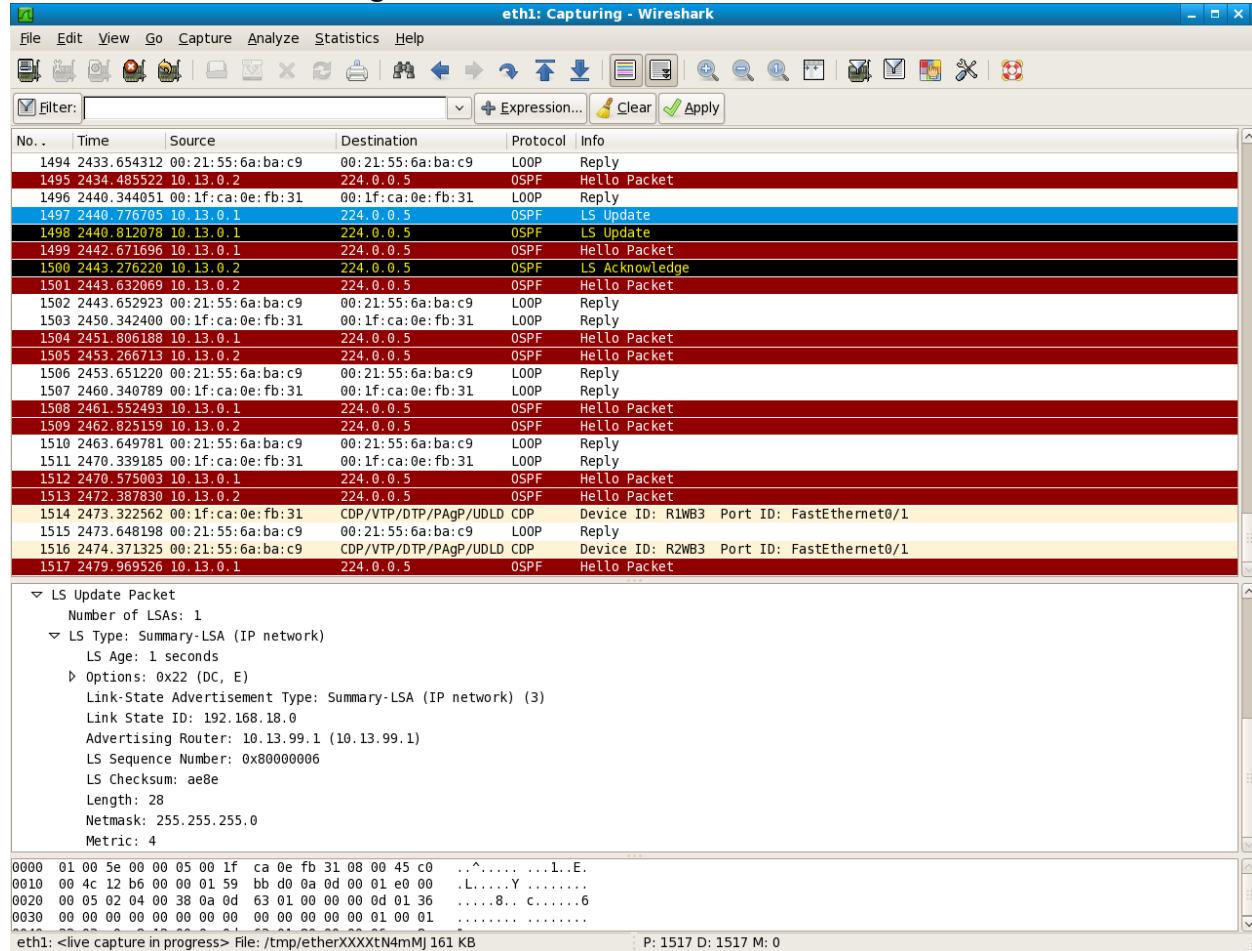
This shows the ip route for core router 1.

```
team13@netlab-wb3pc3:~$ show ip route
Gateway of last resort is not set
O IA 192.168.13.0/24 [10/3] via 10.13.2.2, 00:07:22, FastEthernet0/0/0
O IA 192.168.14.0/24 [10/3] via 10.14.2.2, 00:09:28, FastEthernet0/1/0
  10.0.0.0/8 is variably subnetted, 12 subnets, 2 masks
    10.0.1.0/24 is directly connected, Serial0/0/0.1
    10.11.0.0/30 is directly connected, Serial0/0/0.1
C 10.11.2.0/30 is directly connected, FastEthernet0/0/0
O IA 10.14.0.0/30 [10/2] via 10.14.2.2, 00:09:28, FastEthernet0/1/0
C 10.13.3.0/30 is directly connected, Serial0/0/0.3
O 10.14.1.0/30 [10/65] via 10.13.3.1, 00:07:32, Serial0/0/0.3
C 10.13.2.0/30 is directly connected, FastEthernet0/0/0
C 10.14.2.0/30 is directly connected, FastEthernet0/1/0
O 10.13.3.0/30 [10/65] via 10.13.3.1, 00:07:32, Serial0/0/0.4
C 10.13.3.0/30 is directly connected, Serial0/0/0.4
O IA 10.13.0.0/30 [10/2] via 10.13.2.2, 00:07:23, FastEthernet0/0/0
C 10.11.99.2/32 is directly connected, Loopback0
C 10.255.255.252/30 is directly connected, Serial0/0/0.255
O IA 192.168.17.0/24 [10/2] via 10.13.2.2, 00:07:25, FastEthernet0/0/0
O IA 192.168.18.0/24 [10/2] via 10.14.2.2, 00:09:31, FastEthernet0/1/0
R2c#
R2c#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route
Gateway of last resort is not set
O IA 192.168.13.0/24 [10/3] via 10.13.2.2, 00:08:01, FastEthernet0/0/0
O IA 192.168.14.0/24 [10/3] via 10.14.2.2, 00:10:07, FastEthernet0/1/0
  10.0.0.0/8 is variably subnetted, 12 subnets, 2 masks
    10.11.0.0/24 is directly connected, Serial0/0/0.1
    10.12.0.0/30 is directly connected, Serial0/0/0.1
C 10.14.0.0/30 [10/2] via 10.14.2.2, 00:10:07, FastEthernet0/1/0
C 10.13.3.0/30 is directly connected, Serial0/0/0.3
O 10.14.1.0/30 [10/65] via 10.13.3.1, 00:08:11, Serial0/0/0.3
C 10.13.2.0/30 is directly connected, FastEthernet0/0/0
C 10.14.2.0/30 is directly connected, FastEthernet0/1/0
O 10.13.1.0/30 [10/65] via 10.13.3.1, 00:08:12, Serial0/0/0.3
C 10.14.3.0/30 is directly connected, Serial0/0/0.4
O IA 10.13.0.0/30 [10/2] via 10.13.2.2, 00:08:02, FastEthernet0/0/0
C 10.11.99.2/32 is directly connected, Loopback0
C 10.255.255.252/30 is directly connected, Serial0/0/0.255
O IA 192.168.17.0/24 [10/2] via 10.13.2.2, 00:08:04, FastEthernet0/0/0
O IA 192.168.18.0/24 [10/2] via 10.14.2.2, 00:10:09, FastEthernet0/1/0
R2c#
R2c#[
```

This shows the ip route for core router 2.



This wireshark output shows the OSPF Hello Packets and it shows the Summary LSA which is a Type 3 LSA. The Summary LSA takes information it learned from one of the attached areas and summarizes it before sending it out to other connected areas.



This shows the LS Update and LS Acknowledge packets which are OSPF packet type 4. LS update packets carries of collection of LS advertisements one hop further from the origin. LS update packets are multicast packets.

RIP uses UDP as its transport protocol and OSPF does not use any transport protocols. OSPF encapsulates the data into IP packets using protocol number 89. OSPF routes packets solely based on their destination IP address and it supports Ipv4, Ipv6, and the CIDR addressing model. OSPF uses multicast addressing within a broadcast domain. The multicast delivers a message to a group of node that have interest in receiving the message. They use the multicast transmission mode to send the Hello packets and LS updates. The Multicast Open Shortest Path First (MOSPF) protocol is used to support multicast routing which allows router to share information about group memberships.

```

File Edit View Terminal Tabs Help
team13@netlab-wb3pc1:~
64 bytes from 192.168.17.30: icmp_seq=12 ttl=62 time=0.472 ms
64 bytes from 192.168.17.30: icmp_seq=13 ttl=62 time=0.462 ms
64 bytes from 192.168.17.30: icmp_seq=14 ttl=62 time=0.463 ms
64 bytes from 192.168.17.30: icmp_seq=15 ttl=62 time=0.464 ms
64 bytes from 192.168.17.30: icmp_seq=16 ttl=62 time=0.486 ms
64 bytes from 192.168.17.30: icmp_seq=17 ttl=62 time=0.491 ms
64 bytes from 192.168.17.30: icmp_seq=18 ttl=62 time=0.513 ms
64 bytes from 192.168.17.30: icmp_seq=19 ttl=62 time=0.489 ms
64 bytes from 192.168.17.30: icmp_seq=20 ttl=62 time=0.468 ms
64 bytes from 192.168.17.30: icmp_seq=21 ttl=62 time=0.489 ms
64 bytes from 192.168.17.30: icmp_seq=22 ttl=62 time=0.499 ms
64 bytes from 192.168.17.30: icmp_seq=23 ttl=62 time=0.492 ms
64 bytes from 192.168.17.30: icmp_seq=24 ttl=62 time=0.478 ms
64 bytes from 192.168.17.30: icmp_seq=25 ttl=62 time=0.477 ms
64 bytes from 192.168.17.30: icmp_seq=26 ttl=62 time=0.477 ms
64 bytes from 192.168.17.30: icmp_seq=27 ttl=62 time=0.478 ms
64 bytes from 192.168.17.30: icmp_seq=28 ttl=62 time=0.495 ms
64 bytes from 192.168.17.30: icmp_seq=29 ttl=62 time=0.488 ms
64 bytes from 192.168.17.30: icmp_seq=30 ttl=62 time=0.489 ms
64 bytes from 192.168.17.30: icmp_seq=31 ttl=62 time=0.483 ms
64 bytes from 192.168.17.30: icmp_seq=32 ttl=62 time=0.499 ms
64 bytes from 192.168.17.30: icmp_seq=33 ttl=62 time=0.470 ms
64 bytes from 192.168.17.30: icmp_seq=34 ttl=62 time=0.487 ms
64 bytes from 192.168.17.30: icmp_seq=35 ttl=62 time=0.451 ms
64 bytes from 192.168.17.30: icmp_seq=36 ttl=62 time=0.471 ms
64 bytes from 192.168.17.30: icmp_seq=37 ttl=62 time=0.446 ms
64 bytes from 192.168.17.30: icmp_seq=38 ttl=62 time=0.469 ms
64 bytes from 192.168.17.30: icmp_seq=39 ttl=62 time=0.464 ms
64 bytes from 192.168.17.30: icmp_seq=40 ttl=62 time=0.456 ms
64 bytes from 192.168.17.30: icmp_seq=41 ttl=62 time=0.492 ms
64 bytes from 192.168.17.30: icmp_seq=42 ttl=62 time=0.462 ms
64 bytes from 192.168.17.30: icmp_seq=43 ttl=62 time=0.447 ms
64 bytes from 192.168.17.30: icmp_seq=44 ttl=62 time=0.458 ms
64 bytes from 192.168.17.30: icmp_seq=45 ttl=62 time=0.472 ms
64 bytes from 192.168.17.30: icmp_seq=46 ttl=62 time=0.457 ms
64 bytes from 192.168.17.30: icmp_seq=47 ttl=62 time=0.458 ms
64 bytes from 192.168.17.30: icmp_seq=48 ttl=62 time=0.450 ms
64 bytes from 192.168.17.30: icmp_seq=49 ttl=62 time=0.499 ms
From 192.168.13.1 icmp_seq=61 Destination Host Unreachable
From 192.168.13.1 icmp_seq=62 Destination Host Unreachable
From 192.168.13.1 icmp_seq=63 Destination Host Unreachable
From 192.168.13.1 icmp_seq=64 Destination Host Unreachable
From 192.168.13.1 icmp_seq=65 Destination Host Unreachable
64 bytes from 192.168.17.30: icmp_seq=66 ttl=60 time=24.5 ms
64 bytes from 192.168.17.30: icmp_seq=67 ttl=60 time=24.5 ms
64 bytes from 192.168.17.30: icmp_seq=68 ttl=60 time=24.5 ms
64 bytes from 192.168.17.30: icmp_seq=69 ttl=60 time=24.5 ms
64 bytes from 192.168.17.30: icmp_seq=70 ttl=60 time=24.4 ms
64 bytes from 192.168.17.30: icmp_seq=71 ttl=60 time=24.4 ms
64 bytes from 192.168.17.30: icmp_seq=72 ttl=60 time=24.5 ms
64 bytes from 192.168.17.30: icmp_seq=73 ttl=60 time=24.5 ms

```

This is when we connected eth1 of PC3 to the core hub to capture the OSPF messages. We disconnected both workbench routers to see how long it would take for the ping session to resume once it had to find the alternate path of going through the core routers to reach from LAN1 to LAN2. It took 24.5 - .496 = 24.004 msec to resume the ping session.

```

File Edit View Terminal Tabs Help
team13@netlab-wb3pc1:~
64 bytes from 192.168.17.30: icmp_seq=83 ttl=62 time=0.489 ms
64 bytes from 192.168.17.30: icmp_seq=84 ttl=62 time=0.499 ms
64 bytes from 192.168.17.30: icmp_seq=85 ttl=62 time=0.494 ms
64 bytes from 192.168.17.30: icmp_seq=86 ttl=62 time=0.519 ms
64 bytes from 192.168.17.30: icmp_seq=87 ttl=62 time=0.513 ms
64 bytes from 192.168.17.30: icmp_seq=88 ttl=62 time=0.474 ms
64 bytes from 192.168.17.30: icmp_seq=89 ttl=62 time=0.473 ms
64 bytes from 192.168.17.30: icmp_seq=90 ttl=62 time=0.463 ms
64 bytes from 192.168.17.30: icmp_seq=91 ttl=62 time=0.461 ms
64 bytes from 192.168.17.30: icmp_seq=92 ttl=62 time=0.463 ms
64 bytes from 192.168.17.30: icmp_seq=93 ttl=62 time=0.473 ms
64 bytes from 192.168.17.30: icmp_seq=94 ttl=62 time=0.465 ms
64 bytes from 192.168.17.30: icmp_seq=95 ttl=62 time=0.490 ms
64 bytes from 192.168.17.30: icmp_seq=96 ttl=62 time=0.459 ms
64 bytes from 192.168.17.30: icmp_seq=97 ttl=62 time=0.484 ms
64 bytes from 192.168.17.30: icmp_seq=98 ttl=62 time=0.460 ms
64 bytes from 192.168.17.30: icmp_seq=99 ttl=62 time=0.473 ms
64 bytes from 192.168.17.30: icmp_seq=100 ttl=62 time=0.470 ms
64 bytes from 192.168.17.30: icmp_seq=101 ttl=62 time=0.476 ms
64 bytes from 192.168.17.30: icmp_seq=102 ttl=62 time=0.476 ms
64 bytes from 192.168.17.30: icmp_seq=103 ttl=62 time=0.454 ms
64 bytes from 192.168.17.30: icmp_seq=104 ttl=62 time=0.476 ms
64 bytes from 192.168.17.30: icmp_seq=105 ttl=62 time=0.468 ms
64 bytes from 192.168.17.30: icmp_seq=106 ttl=62 time=0.458 ms
64 bytes from 192.168.17.30: icmp_seq=107 ttl=62 time=0.479 ms
64 bytes from 192.168.17.30: icmp_seq=108 ttl=62 time=0.476 ms
64 bytes from 192.168.17.30: icmp_seq=109 ttl=62 time=0.472 ms
64 bytes from 192.168.17.30: icmp_seq=110 ttl=62 time=0.471 ms
64 bytes from 192.168.17.30: icmp_seq=111 ttl=62 time=0.462 ms
64 bytes from 192.168.17.30: icmp_seq=112 ttl=62 time=0.471 ms
64 bytes from 192.168.17.30: icmp_seq=113 ttl=62 time=0.450 ms
64 bytes from 192.168.17.30: icmp_seq=114 ttl=62 time=0.469 ms
64 bytes from 192.168.17.30: icmp_seq=115 ttl=62 time=0.476 ms
64 bytes from 192.168.17.30: icmp_seq=116 ttl=62 time=0.458 ms
64 bytes from 192.168.17.30: icmp_seq=117 ttl=62 time=0.498 ms
64 bytes from 192.168.17.30: icmp_seq=118 ttl=62 time=0.462 ms
64 bytes from 192.168.17.30: icmp_seq=119 ttl=62 time=0.469 ms
64 bytes from 192.168.17.30: icmp_seq=120 ttl=62 time=0.490 ms
64 bytes from 192.168.17.30: icmp_seq=121 ttl=62 time=0.462 ms
64 bytes from 192.168.17.30: icmp_seq=122 ttl=62 time=0.459 ms
64 bytes from 192.168.17.30: icmp_seq=123 ttl=62 time=0.463 ms
64 bytes from 192.168.17.30: icmp_seq=124 ttl=62 time=0.466 ms
64 bytes from 192.168.17.30: icmp_seq=125 ttl=62 time=0.470 ms
64 bytes from 192.168.17.30: icmp_seq=126 ttl=62 time=0.472 ms
64 bytes from 192.168.17.30: icmp_seq=127 ttl=62 time=0.478 ms
64 bytes from 192.168.17.30: icmp_seq=128 ttl=62 time=0.457 ms
64 bytes from 192.168.17.30: icmp_seq=129 ttl=62 time=0.471 ms

```

... 192.168.17.30 ping statistics ...
129 packets transmitted, 129 received, 0% packet loss, time 127999ms
rtt min/avg/max/mdev = 0.442/0.403/24.583/8.528 ms
[team13@netlab-wb3pc1 ~]\$

This is when the workbench routers were plugged into the workbench hub and we could verify that LAN1 could communicate with LAN2. This step was done after we disconnected both

workbench routers to see how the routing tables would change and how long it would take for the ping session to resume.

```
team13@netlab-wb3pc3:~
```

```
File Edit View Terminal Tabs Help
R1W3B#
Feb 8 00:38:48.167: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R1W3B#
R1W3B#
R1W3B#
Feb 8 00:39:31.163: %OSPF-5-ADJCHG: Process 1, Nbr 10.13.99.2 on FastEthernet0/1 from LOADING to FULL, Loading Done
R1W3B#
R1W3B#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      1 - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route
Gateway of last resort is not set

C    192.168.13.0/24 is directly connected, FastEthernet0/0
0  IA 192.168.14.0/24 [110/67] via 10.13.1.1, 00:53:26, FastEthernet0/0
   0.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
0    10.14.0.0/30 [119/67] via 10.13.1.1, 00:00:00, FastEthernet0/0
0    10.13.3.0/30 [110/65] via 10.13.1.1, 00:53:02, FastEthernet0/0/0
0    10.14.1.0/30 [110/21] via 10.13.1.1, 00:53:25, FastEthernet0/0/0
0    10.13.2.0/30 [110/66] via 10.13.1.1, 00:51:09, FastEthernet0/0/0
0    10.14.2.0/30 [110/66] via 10.13.1.1, 00:51:21, FastEthernet0/0/0
C    10.13.1.0/30 is directly connected, FastEthernet0/0/0
0    10.14.3.0/30 [110/65] via 10.13.1.1, 00:53:26, FastEthernet0/0/0
0    10.13.0.0/30 is directly connected, FastEthernet0/0/1
C    10.13.99.1/32 is directly connected, Loopback0
0  IA 192.168.17.0/24 [110/2] via 10.13.0.2, 00:00:02, FastEthernet0/0
0  IA 192.168.18.0/24 [110/67] via 10.13.1.1, 00:06:57, FastEthernet0/0/0
R1W3B#
```

This is the routing table of workbench 1 while both worbench routers are plugged in. This is step when we needed to capture the OSPF messages on the CR2-R2 link. It shows LAN2's network address as 192.168.17.0/24.

```

team13@netlab-wb3pc3:~ 
File Edit View Terminal Help
o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C 192.168.13.0/24 is directly connected, FastEthernet0/0
0 IA 192.168.14.0/24 [110/3] via 10.13.1.1, 00:53:25, FastEthernet0/0/0
  10.0.0.8/8 is variably subnetted, 9 subnets, 2 masks
    0_ 10.14.0.0/8 [110/67] via 10.13.1.1, 00:00:00, FastEthernet0/0/0
      0_ 10.13.3.0/8 [110/65] via 10.13.1.1, 00:53:02, FastEthernet0/0/0
      0_ 10.14.1.0/8 [110/2] via 10.13.1.1, 00:53:25, FastEthernet0/0/0
      0_ 10.13.2.0/8 [110/66] via 10.13.1.1, 00:51:09, FastEthernet0/0/0
      0_ 10.14.2.0/8 [110/66] via 10.13.1.1, 00:51:21, FastEthernet0/0/0
    C 10.13.1.0/8 is directly connected, FastEthernet0/0/0
    0_ 10.14.3.0/8 [110/65] via 10.13.1.1, 00:53:26, FastEthernet0/0/0
  C 10.13.8.0/8 is directly connected, FastEthernet0/1
  C 10.13.99.1/32 is directly connected, Loopback0
  C 192.168.17.0/24 [110/2] via 10.13.0.2, 00:00:02, FastEthernet0/1
0 IA 192.168.18.0/24 [110/67] via 10.13.1.1, 00:06:57, FastEthernet0/0/0
R1WB3# 

Returning to command line
[mgmtswitch]> connect direct deviceport R2M3
Connecting to Device Port R2M3.
Connected to port 6. Escape sequence is ESC A

R2WB3#
R2WB3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

0 192.168.13.0/24 [110/2] via 10.13.0.1, 00:01:02, FastEthernet0/1
0 IA 192.168.14.0/24 [110/4] via 10.13.2.1, 00:00:52, FastEthernet0/0/0
  10.0.0.8/8 is variably subnetted, 9 subnets, 2 masks
    0_ 10.14.0.0/8 [110/3] via 10.13.2.1, 00:00:52, FastEthernet0/0/0
      0_ 10.13.3.0/8 [110/65] via 10.13.2.1, 00:52:16, FastEthernet0/0/0
      0_ 10.14.1.0/8 [110/4] via 10.13.2.1, 00:00:52, FastEthernet0/0/0
    C 10.13.2.0/8 is directly connected, FastEthernet0/0/0
    0_ 10.14.2.0/8 [110/2] via 10.13.2.1, 00:52:17, FastEthernet0/0/0
    0_ 10.13.1.0/8 [110/5] via 10.13.2.1, 00:00:53, FastEthernet0/0/0
    0_ 10.14.3.0/8 [110/68] via 10.13.2.1, 00:00:53, FastEthernet0/0/0
  C 10.13.8.0/8 is directly connected, FastEthernet0/1
  C 10.13.99.1/32 is directly connected, Loopback0
  C 192.168.17.0/24 is directly connected, FastEthernet0/0
0 IA 192.168.18.0/24 [110/3] via 10.13.2.1, 00:52:18, FastEthernet0/0/0
R2WB3# 
```

This is the routing table of workbench 2 while both worbench routers are plugged in. It shows LAN2's network address as 192.168.17.0/24.

When comparing the RIP and OSPF routing tables, the RIP routing table when not plugged in did not have LAN2's network address while OSPF's did. OSPF routers communicate with other routers to establish the states of all adjacent routers.

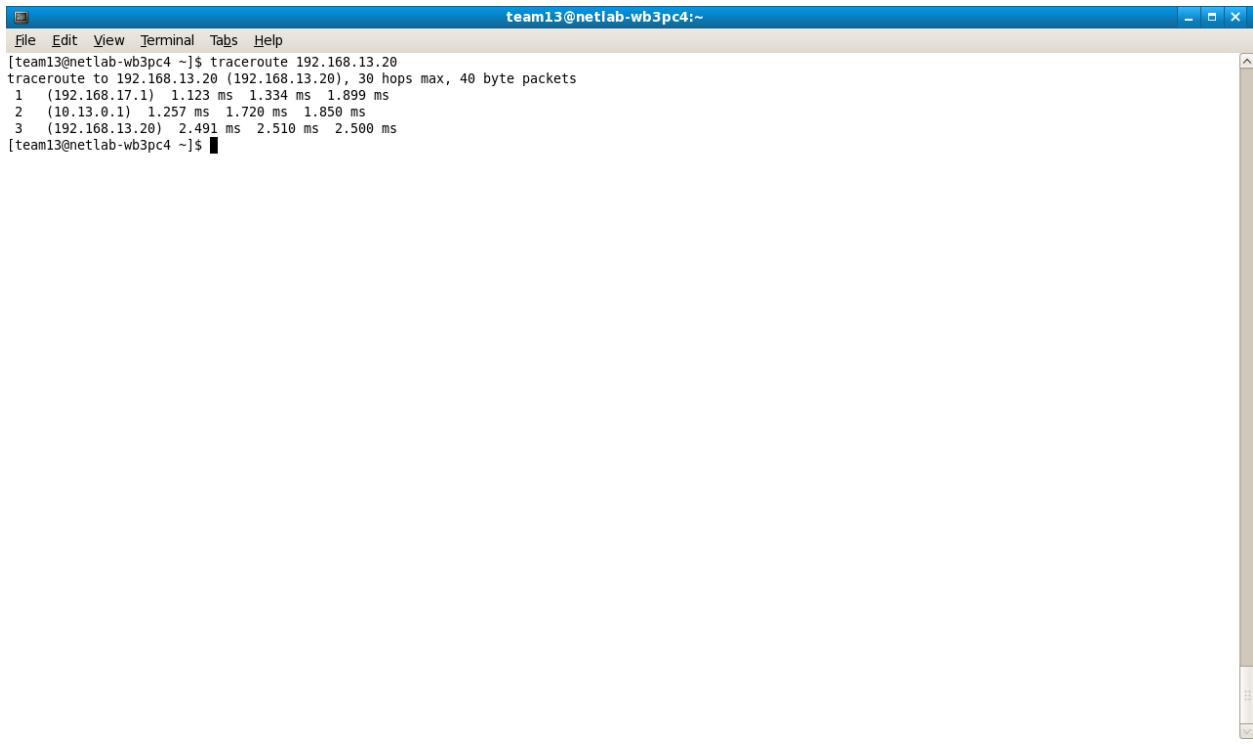
When setting the cost of interface fa0/1 of router to a very high value such as 1000, OSPF will see that and avoid that route to get to its destination. Therefore, when sending packets from PC1 to the laptop, it will avoid the hub and choose the core router path as the optimal path to take. The path will travel from LAN1 to interface fa0/0 of router 1, to the serial interface se0/2/0.3 of core router 1, connecting to the other serial interface se0/2/0.3, to interface fa0/0/0 of router 2 where it will reach the laptop in LAN2. We forgot to take a picture of this traceroute result.

```

team13@netlab-wb3pc1:~
File Edit View Terminal Tabs Help
From 172.30.2.31 icmp_seq=11 Destination Host Unreachable
From 172.30.2.31 icmp_seq=12 Destination Host Unreachable
From 172.30.2.31 icmp_seq=14 Destination Host Unreachable
From 172.30.2.31 icmp_seq=15 Destination Host Unreachable
From 172.30.2.31 icmp_seq=16 Destination Host Unreachable
From 172.30.2.31 icmp_seq=18 Destination Host Unreachable
From 172.30.2.31 icmp_seq=19 Destination Host Unreachable
From 172.30.2.31 icmp_seq=20 Destination Host Unreachable
From 172.30.2.31 icmp_seq=22 Destination Host Unreachable
From 172.30.2.31 icmp_seq=23 Destination Host Unreachable
From 172.30.2.31 icmp_seq=24 Destination Host Unreachable
From 172.30.2.31 icmp_seq=26 Destination Host Unreachable
From 172.30.2.31 icmp_seq=27 Destination Host Unreachable
From 172.30.2.31 icmp_seq=28 Destination Host Unreachable
From 172.30.2.31 icmp_seq=30 Destination Host Unreachable
From 172.30.2.31 icmp_seq=31 Destination Host Unreachable
From 172.30.2.31 icmp_seq=32 Destination Host Unreachable
From 172.30.2.31 icmp_seq=34 Destination Host Unreachable
From 172.30.2.31 icmp_seq=35 Destination Host Unreachable
From 172.30.2.31 icmp_seq=36 Destination Host Unreachable
From 172.30.2.31 icmp_seq=37 Destination Host Unreachable
From 172.30.2.31 icmp_seq=38 Destination Host Unreachable
From 172.30.2.31 icmp_seq=39 Destination Host Unreachable
64 bytes from 192.168.17.30: icmp_seq=40 ttl=62 time=3.53 ms
64 bytes from 192.168.17.30: icmp_seq=41 ttl=62 time=0.476 ms
64 bytes from 192.168.17.30: icmp_seq=42 ttl=62 time=0.495 ms
64 bytes from 192.168.17.30: icmp_seq=43 ttl=62 time=0.471 ms
64 bytes from 192.168.17.30: icmp_seq=44 ttl=62 time=0.485 ms
64 bytes from 192.168.17.30: icmp_seq=45 ttl=62 time=0.482 ms
64 bytes from 192.168.17.30: icmp_seq=46 ttl=62 time=0.492 ms
64 bytes from 192.168.17.30: icmp_seq=47 ttl=62 time=0.493 ms
64 bytes from 192.168.17.30: icmp_seq=48 ttl=62 time=0.482 ms
64 bytes from 192.168.17.30: icmp_seq=49 ttl=62 time=0.464 ms
64 bytes from 192.168.17.30: icmp_seq=50 ttl=62 time=0.488 ms
64 bytes from 192.168.17.30: icmp_seq=51 ttl=62 time=0.463 ms
64 bytes from 192.168.17.30: icmp_seq=52 ttl=62 time=0.486 ms
64 bytes from 192.168.17.30: icmp_seq=53 ttl=62 time=0.485 ms
64 bytes from 192.168.17.30: icmp_seq=54 ttl=62 time=0.495 ms
64 bytes from 192.168.17.30: icmp_seq=55 ttl=62 time=0.479 ms
64 bytes from 192.168.17.30: icmp_seq=56 ttl=62 time=0.513 ms
64 bytes from 192.168.17.30: icmp_seq=57 ttl=62 time=0.500 ms
64 bytes from 192.168.17.30: icmp_seq=58 ttl=62 time=0.478 ms

--- 192.168.17.30 ping statistics ---
58 packets transmitted, 19 received, +30 errors, 67% packet loss, time 56999ms
rtt min/avg/max/mdev = 0.463/0.645/3.539/0.682 ms, pipe 4
[team13@netlab-wb3pc1 ~]$ traceroute 192.168.17.30
traceroute to 192.168.17.30 (192.168.17.30), 30 hops max, 40 byte packets
 1  (192.168.13.1)  1.079 ms  1.506 ms  1.818 ms
 2  (10.13.0.2)    1.398 ms  1.623 ms  1.851 ms
 3  (192.168.17.30)  0.984 ms  1.026 ms  1.015 ms
[team13@netlab-wb3pc1 ~]$ 
```

This is the traceroute result from PC1 to the laptop after all the areas are set from area 13 to area 0.



A screenshot of a terminal window titled "team13@netlab-wb3pc4:~". The window contains the following command and its output:

```
team13@netlab-wb3pc4 ~$ traceroute 192.168.13.20
traceroute to 192.168.13.20 (192.168.13.20), 30 hops max, 40 byte packets
 1  (192.168.17.1)  1.123 ms  1.334 ms  1.899 ms
 2  (10.13.0.1)  1.257 ms  1.720 ms  1.850 ms
 3  (192.168.13.20)  2.491 ms  2.510 ms  2.500 ms
[team13@netlab-wb3pc4 ~]$
```

This is the traceroute result from the laptop to PC1. This is when we set the OSPF area number from 13 to 0, so the all paths from the laptop to PC1 all have the same area number. It will now choose the path through the hub because they all share the same area number. It is different from the previous result where it went through the core routers due to the high cost of the interface fa0/1 of router 1.

We see the same intermediate router when sending a packet from LAN1 to LAN2 and vice versa. The cost of the path is calculated by a decreasing order of preference where an intra-area will be selected even if it has a higher cost than an inter area.