TCOM 515 IP Routing

Lab3: OSPF Routing

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NOTE: Normally in Tuesday's Lab

Lab Report Submission: Mar 21-2011

Router: Miami

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1. Introduction

In order for packets to be routed throughout the network, each router must generate a routing table. This routing table serves as a map to direct which interface the packet needs to be sent at. There are three ways the routing table is created.

1. Directly connected interfaces. (C-connected)
2. Static routes. (S-static)
3. Dynamic routing protocols. (O-OSPF/R-RIP/B-BGP)

In this lab, dynamic routing protocol, specifically OSPF, will be explored to generate a routing table.

OSPF is a Link-State routing protocol which uses Dijkstra's Algorithm. Each node knows the information about the complete network topology. OSFP has a much faster convergence time compared to the RIP routing protocol.

The route table will contain the following information:

1. Destination Address – network address of a subnet
2. Next Hop – interface or IP address of next hop in path
3. Egress interface – the interface to the next hop
4. Type of route – C-Connect, S-Static, R-RIP, O-OSPF
5. Metric – arbitrary number used to help choose the best route. Cost to the next route.
6. Number of Hops – number of hops to the destination.
   <*Information from TCOM515 Lecture1>

2. Purpose

The goal of this lab is stated as follows:

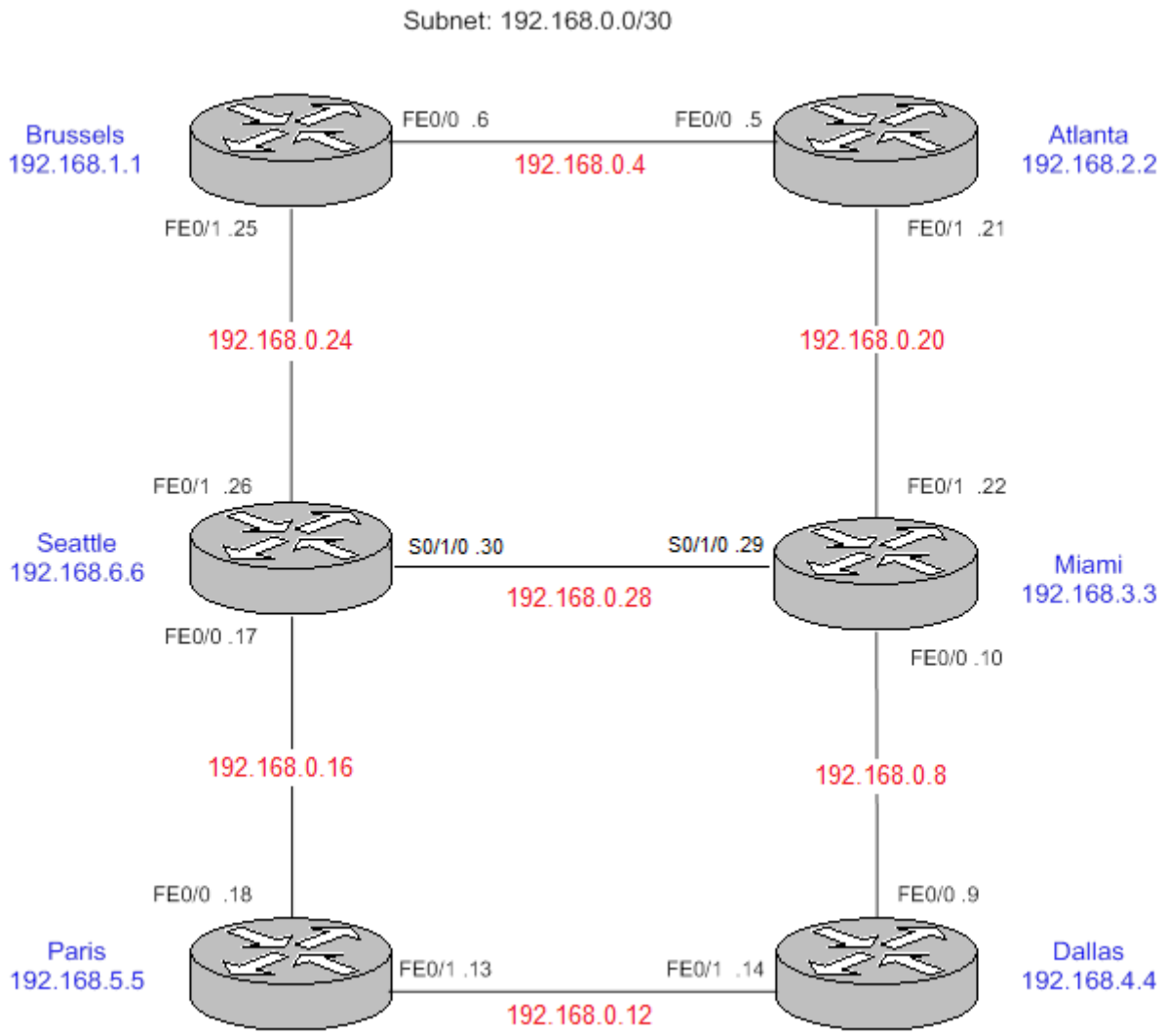
1. Recap from Lab1&2
   a. Learn to establish hardware(router) connections.
   b. Learn to login to terminal server via telnet
   c. Learn to configure router and its interfaces
      (get familiar with Cisco iOS commands & environment)
   d. Clear router configuration
2. Understand How OSPF route tables are created/updated then configure the OSPF network with different areas.

3. Procedure

1. Make Physical Connectivity Between Devices

The six Cisco 2811 ISRs were set up in the topology shown in figure below. The router that I configured was Miami (192.168.3.3 – loopback address) and made connection as follows:

- Miami FE0/0 .10 ←→ Dallas FE0/0 .9
- Miami FE0/1 .22 ←→ Atlanta FE0/1 .21
- Miami S0/1/0 .29 ←→ Seattle S0/1/0 .30



Note: the serial link between Seattle and Miami which creates the network of 192.168.0.28 was initially not turned on. The management network of the routers were connected through the Cisco 2511 (terminal server) and connected to the PC workstations.

NOTE: The following is the color scheme for this lab report:

- `Input into the command prompt`
- `Output of the command prompt`
- `Comment or syntax of the command`

2. Login to the router.

When I first login the the router, I am in the "USER MODE". The command line shows: `Router>`

Entering "ENABLE MODE":

```
Router>enable
Router#
```

Entering "Global Config Mode":

```
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#
```

Entering "Global Config Mode" of the miami router:

```
Router(config)#hostname Miami
Miami(config)#
```

Disabling the DNS lookup for our lab purposes. This prevents long waits for ping wait time as it is not expecting a response from the DNS server:

```
Miami(config)#no ip domain lookup
```

Entering the router's "Global Line Configure Mode":

```
Miami(config)#line console 0
Miami(config-line)#

Miami(config-line)#logging synchronous
```

Exit the router's "Global Line Configure Mode":

```
Miami(config-line)#^Z            % can also enter "end"
Miami#
```

3. Configure the Router

Configuring the physical interfaces. Based on the below table the connections were made as such:

- Miami 192.168.0.9/30 ←→ Miami 192.168.0.10/30
- Miami 192.168.0.14/30 ←→ Paris 192.168.0.13/30

Router Name	Loopback0	FastEthernet Interface 0/0 and mask	FastEthernet Interface 0/1 and mask
Brussels	192.168.1.1/32	192.168.0.6/30	192.168.0.25/30
Atlanta	192.168.2.2/32	192.168.0.5/30	192.168.0.21/30
Miami	**192.168.3.3/32**	192.168.0.10/30	192.168.0.22/30
Dallas	192.168.4.4/32	192.168.0.9/30	192.168.0.14/30
Paris	192.168.5.5/32	192.168.0.18/30	192.168.0.13/30
Seattle	192.168.6.6/32	192.168.0.17/30	192.168.0.26/30

(Configuring Miami←→Atlanta Interface)

```
Miami(config-if)#int fa 0/1
Miami(config-if)#ip address 192.168.0.22 255.255.255.252
Miami(config-if)#no shut
*Mar  7 23:42:42.783: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
```

(Configuring Miami←→Dallas Interface)

```
Miami(config-if)#int fa 0/0
Miami(config-if)#ip address 192.168.0.10 255.255.255.252
Miami(config-if)#no shut
*Mar  7 23:42:21.075: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  7 23:42:22.075: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up/1
```

(Configuring Loopback Interface)

```
Miami(config)#int lo0
*Mar  7 23:40:36.879: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
Miami(config-if)#ip address 192.168.3.3 255.255.255.255
Miami(config-if)#no shut
```

(Configuring Miami←→Seattle Serial Interface)

```
Miami(config)#interface Serial0/1/0
Miami(config-if)#ip address 192.168.0.29 255.255.255.252
Miami(config-if)#exit
```

Checking the interface configuration:

```
Miami#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            192.168.0.10    YES manual up                    up
FastEthernet0/1            192.168.0.22    YES manual up                    up
FastEthernet0/0/0          unassigned      YES unset  up                    down
FastEthernet0/0/1          unassigned      YES unset  up                    down
FastEthernet0/0/2          unassigned      YES unset  down                  down
FastEthernet0/0/3          unassigned      YES unset  up                    down
Serial0/1/0                192.168.0.29    YES manual administratively down down
Serial0/1/1                unassigned      YES unset  administratively down down
Vlan1                      unassigned      YES unset  up                    down
SSLVPN-VIF0                unassigned      NO  unset  up                    up
Loopback0                  192.168.3.3     YES manual up                    up

Miami(config)#exit
Miami#
```

3.1 The interfaces, FastE0/0, FastE0/1, and Loopback0, which were configured, are up. The Serial0/1/0 interface was configured, but was not set to up.

3.2 “Show ip route” shows the three connected(C) entries; loopback, Miami2Atlanta, Miami2Dallas.

```
Miami#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
     192.168.0.0/30 is subnetted, 2 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
C       192.168.0.20 is directly connected, FastEthernet0/1
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0
```

4. Configure OSPF

(Turning on OSPF)

In Global Config Mode type:

**Note: Serial link OSPF has not been turned on.

```
Miami(config)#exit
*Mar  8 00:04:47.131: %SYS-5-CONFIG_I: Configured from console by console
Miami#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Miami(config)#router ospf 1
Miami(config-router)#network 192.168.0.20 255.255.255.252 area 0
Miami(config-router)#network 192.168.0.20 255.255.255.252 area 0
*Mar  8 00:06:41.219: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.2.2 on FastEthernet0/1 from LOADING to FULL,
Loading Done
Miami(config-router)#network 192.168.0.8 255.255.255.252 area 0
Miami(config-router)#network 192.168.3.3 255.255.255.252 area 0
Miami(config-router)#no network 192.168.3.3 255.255.255.252 area 0
Miami(config-router)#no network 192.168.3.3 255.255.255.255 area 0
Miami(config-router)#network 192.168.3.3 255.255.255.255 area 0
```

See the OSPF configuration:

- “Show IP route”

```
Miami#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
     192.168.4.0/32 is subnetted, 1 subnets
O       192.168.4.4 [110/2] via 192.168.0.9, 00:02:15, FastEthernet0/0
     192.168.5.0/32 is subnetted, 1 subnets
O       192.168.5.5 [110/3] via 192.168.0.9, 00:04:01, FastEthernet0/0
     192.168.6.0/32 is subnetted, 1 subnets
O       192.168.6.6 [110/4] via 192.168.0.21, 00:11:42, FastEthernet0/1
                    [110/4] via 192.168.0.9, 00:04:01, FastEthernet0/0
     192.168.0.0/30 is subnetted, 6 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
O       192.168.0.12 [110/2] via 192.168.0.9, 00:04:02, FastEthernet0/0
O       192.168.0.4 [110/2] via 192.168.0.21, 00:11:43, FastEthernet0/1
O       192.168.0.24 [110/3] via 192.168.0.21, 00:11:43, FastEthernet0/1
O       192.168.0.16 [110/3] via 192.168.0.9, 00:04:02, FastEthernet0/0
C       192.168.0.20 is directly connected, FastEthernet0/1
     192.168.1.0/32 is subnetted, 1 subnets
O       192.168.1.1 [110/3] via 192.168.0.21, 00:11:45, FastEthernet0/1
     192.168.2.0/32 is subnetted, 1 subnets
O       192.168.2.2 [110/2] via 192.168.0.21, 00:11:45, FastEthernet0/1
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0
```

4.1 There are 9-OSPF and 3-Connected entries in the route table. All the OSPF routes are now entered into the route table as we have just turned them “up”.

4.2 OSPF Entry format:

```
Code(O=OSPF)       DestAddress [AD/Cost] via NextHopAddress, LastConvergedTime, InterfaceType
O                 192.168.2.2 [110/2]    via 192.168.0.21,   00:11:45,          FastEthernet0/1
    AD(Administrative Distance). Smaller AD, the higher priority.  AD = 110 indicates OSPF.
```

- “Show IP route summary”

```
Miami#show ip route summary
IP routing table name is Default-IP-Routing-Table(0)
IP routing table maximum-paths is 32
Route Source    Networks    Subnets     Overhead    Memory (bytes)
connected       0           3           192         456
static          0           0           0           0
ospf 1          0           9           640         1368
  Intra-area: 9 Inter-area: 0 External-1: 0 External-2: 0
  NSSA External-1: 0 NSSA External-2: 0
internal        7                                   8204
Total           7           12          832         10028
Removing Queue Size 0
Miami#
Miami#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.3.3
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    192.168.0.8 0.0.0.3 area 0
    192.168.0.20 0.0.0.3 area 0
    192.168.3.3 0.0.0.0 area 0
 Reference bandwidth unit is 100 mbps
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.4.4          110      00:03:50
```

```
    192.168.1.1          110      00:13:17
    192.168.2.2          110      00:13:17
    192.168.5.5          110      00:05:36
    192.168.6.6          110      00:05:36
  Distance: (default is 110)
```

- "Show IP OSPF"

```
Miami#show ip ospf
 Routing Process "ospf 1" with ID 192.168.3.3
 Start time: 00:57:46.800, Time elapsed: 00:20:22.860
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
 IETF NSF helper support enabled
 Cisco NSF helper support enabled
    Area BACKBONE(0)
        Number of interfaces in this area is 3 (1 loopback)
        Area has no authentication
        SPF algorithm last executed 00:07:15.344 ago
        SPF algorithm executed 9 times
        Area ranges are
        Number of LSA 12. Checksum Sum 0x065463
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
```

- "Show IP OSPF neighbor"

```
Miami#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.4.4       1   FULL/BDR        00:00:37    192.168.0.9     FastEthernet0/0
192.168.2.2       1   FULL/DR         00:00:31    192.168.0.21    FastEthernet0/1
```

4.3 My current OSPF neighbors are 192.168.4.4 and 192.168.2.2.

- "Show IP OSPF database"

```
Miami#show ip ospf database
            OSPF Router with ID (192.168.3.3) (Process ID 1)
                Router Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum Link count
192.168.1.1     192.168.1.1     1329        0x80000005 0x005195 3
192.168.2.2     192.168.2.2     1183        0x80000005 0x0045A5 3
192.168.3.3     192.168.3.3     607         0x80000007 0x00A830 3
192.168.4.4     192.168.4.4     493         0x80000005 0x00E005 3
192.168.5.5     192.168.5.5     605         0x80000004 0x00FFD1 3
192.168.6.6     192.168.6.6     1291        0x80000009 0x000CA1 3
                Net Link States (Area 0)
```

```
Link ID         ADV Router      Age         Seq#       Checksum
192.168.0.6     192.168.1.1     1329        0x80000001 0x008AFE
192.168.0.10    192.168.3.3     607         0x80000001 0x00A4D4
192.168.0.13    192.168.5.5     605         0x80000001 0x0092DB
192.168.0.17    192.168.6.6     1291        0x80000001 0x008BD8
192.168.0.21    192.168.2.2     1183        0x80000001 0x00155F
192.168.0.26    192.168.6.6     1434        0x80000001 0x00C49E
```

4.4 There are six LSA (Link State Advertisement)

***Note: the seq# shows which is the more recent LSA (Link State Advertisement).

4.5 How does LS database compare to your neighbor's database?

- Traceroute to Seattle:

```
Miami>traceroute 192.168.6.6
Type escape sequence to abort.
Tracing the route to 192.168.6.6
  1 192.168.0.21 0 msec
    192.168.0.9 4 msec
    192.168.0.21 0 msec
  2 192.168.0.13 0 msec
    192.168.0.6 0 msec
    192.168.0.13 0 msec
  3 192.168.0.26 4 msec
    192.168.0.17 0 msec *
```

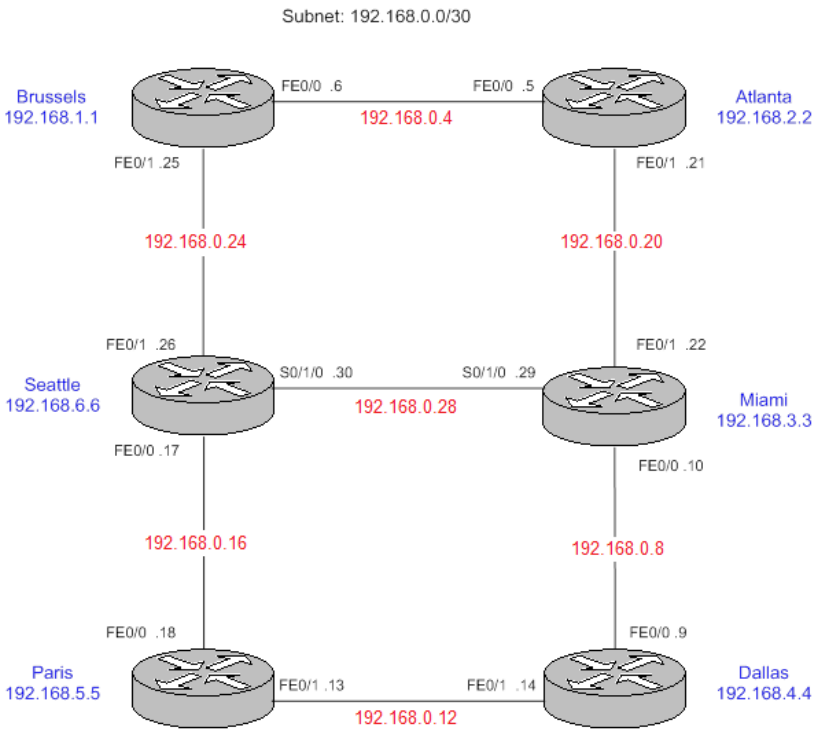
4.6 The total cost to the destination is the addition of the cost of all the links to Seattle.

Path1: 192.168.0.21 → 192.168.0.6 → 192.168.0.26
Cost:

Path2: 192.168.0.9 → 192.168.0.13 → 192.168.0.17
Cost: 3+

5. Turn up one additional link

Turn up the serial link between Seattle←→Miami as follows:



Monitor RIP Advertising:

```
Miami#debug ip rip
*Feb 23 01:03:55.787: RIP: received v2 update from 192.168.0.13 on FastEthernet0/1
*Feb 23 01:03:55.787:      192.168.0.4/30 via 0.0.0.0 in 3 hops
*Feb 23 01:03:55.787:      192.168.0.16/30 via 0.0.0.0 in 1 hops
*Feb 23 01:03:55.787:      192.168.0.24/30 via 0.0.0.0 in 2 hops
*Feb 23 01:03:55.787:      192.168.0.28/30 via 0.0.0.0 in 2 hops
*Feb 23 01:03:55.787:      192.168.1.1/32 via 0.0.0.0 in 3 hops
*Feb 23 01:03:55.787:      192.168.5.5/32 via 0.0.0.0 in 1 hops
*Feb 23 01:03:55.787:      192.168.6.6/32 via 0.0.0.0 in 2 hops
Miami#
*Feb 23 01:04:00.339: RIP: received v2 update from 192.168.0.10 on FastEthernet0/0
*Feb 23 01:04:00.339:      192.168.0.4/30 via 0.0.0.0 in 2 hops
*Feb 23 01:04:00.339:      192.168.0.16/30 via 0.0.0.0 in 2 hops
*Feb 23 01:04:00.339:      192.168.0.20/30 via 0.0.0.0 in 1 hops
*Feb 23 01:04:00.339:      192.168.0.24/30 via 0.0.0.0 in 2 hops
*Feb 23 01:04:00.339:      192.168.0.28/30 via 0.0.0.0 in 1 hops
*Feb 23 01:04:00.339:      192.168.1.1/32 via 0.0.0.0 in 3 hops
*Feb 23 01:04:00.339:      192.168.2.2/32 via 0.0.0.0 in 2 hops
*Feb 23 01:04:00.339:      192.168.3.3/32 via 0.0.0.0 in 1 hops
*Feb 23 01:04:00.339:      192.168.6.6/32 via 0.0.0.0 in 2 hops
```

Stop monitoring RIP Advertisement:

```
Miami#no debug ip rip
RIP protocol debugging is off
```

Check the New IP Route Table:

```
Miami#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
```

```
     192.168.4.0/32 is subnetted, 1 subnets
C       192.168.4.4 is directly connected, Loopback0
     192.168.5.0/32 is subnetted, 1 subnets
R       192.168.5.5 [120/1] via 192.168.0.13, 00:00:25, FastEthernet0/1
     192.168.6.0/32 is subnetted, 1 subnets
R       192.168.6.6 [120/2] via 192.168.0.13, 00:00:25, FastEthernet0/1
                    [120/2] via 192.168.0.10, 00:00:21, FastEthernet0/0
     192.168.0.0/30 is subnetted, 7 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
C       192.168.0.12 is directly connected, FastEthernet0/1
R       192.168.0.4 [120/2] via 192.168.0.10, 00:00:22, FastEthernet0/0
R       192.168.0.24 [120/2] via 192.168.0.13, 00:00:27, FastEthernet0/1
                     [120/2] via 192.168.0.10, 00:00:22, FastEthernet0/0
R       192.168.0.28 [120/1] via 192.168.0.10, 00:00:24, FastEthernet0/0
R       192.168.0.16 [120/1] via 192.168.0.13, 00:00:00, FastEthernet0/1
R       192.168.0.20 [120/1] via 192.168.0.10, 00:00:24, FastEthernet0/0
     192.168.1.0/32 is subnetted, 1 subnets
R       192.168.1.1 [120/3] via 192.168.0.13, 00:00:00, FastEthernet0/1
                    [120/3] via 192.168.0.10, 00:00:24, FastEthernet0/0
     192.168.2.0/32 is subnetted, 1 subnets
R       192.168.2.2 [120/2] via 192.168.0.10, 00:00:24, FastEthernet0/0
     192.168.3.0/32 is subnetted, 1 subnets
R       192.168.3.3 [120/1] via 192.168.0.10, 00:00:24, FastEthernet0/0
```

5.1 The new IP route table shows the new Network(192.168.0.28). It also shows the redundant paths that are available for reaching Seattle Loopback(192.168.6.6) and Network(192.168.0.28).

5.2 The new updates reflect the new network and interfaces that can be reached.

```
*Feb 23 01:03:55.787: RIP: received v2 update from 192.168.0.13 on FastEthernet0/1
*Feb 23 01:03:55.787:      192.168.0.4/30 via 0.0.0.0 in 3 hops
*Feb 23 01:03:55.787:      192.168.0.16/30 via 0.0.0.0 in 1 hops
*Feb 23 01:03:55.787:      192.168.0.24/30 via 0.0.0.0 in 2 hops
*Feb 23 01:03:55.787:      192.168.0.28/30 via 0.0.0.0 in 2 hops
*Feb 23 01:03:55.787:      192.168.1.1/32 via 0.0.0.0 in 3 hops
*Feb 23 01:03:55.787:      192.168.5.5/32 via 0.0.0.0 in 1 hops
*Feb 23 01:03:55.787:      192.168.6.6/32 via 0.0.0.0 in 2 hops
Miami#
*Feb 23 01:04:00.339: RIP: received v2 update from 192.168.0.10 on FastEthernet0/0
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*Feb 23 01:04:00.339:      192.168.0.24/30 via 0.0.0.0 in 2 hops
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*Feb 23 01:04:00.339:      192.168.1.1/32 via 0.0.0.0 in 3 hops
*Feb 23 01:04:00.339:      192.168.2.2/32 via 0.0.0.0 in 2 hops
*Feb 23 01:04:00.339:      192.168.3.3/32 via 0.0.0.0 in 1 hops
*Feb 23 01:04:00.339:      192.168.6.6/32 via 0.0.0.0 in 2 hops
```

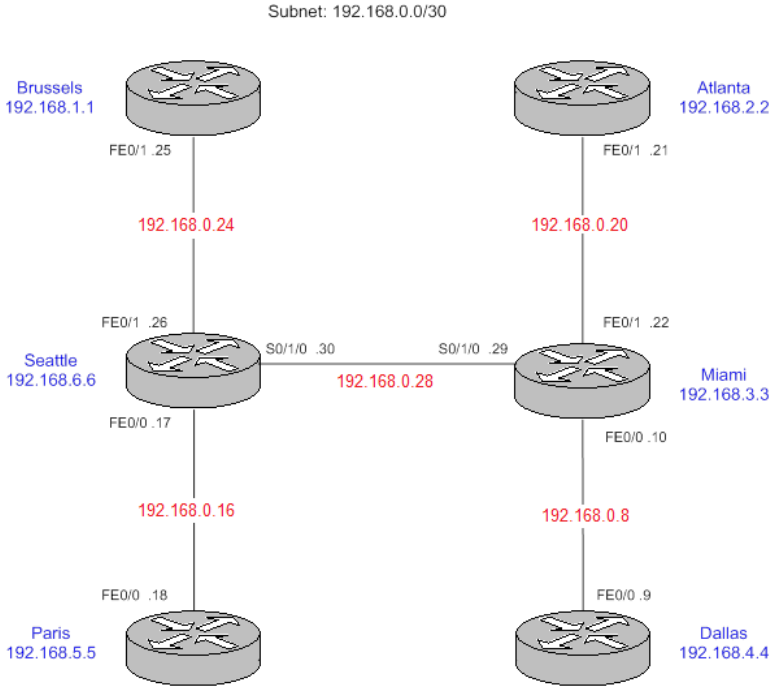
(Pinging Seattle loopback)

```
Miami#traceroute 192.168.6.6
Type escape sequence to abort.
Tracing the route to 192.168.6.6
  1 192.168.0.10 0 msec
    192.168.0.13 4 msec
    192.168.0.10 0 msec
  2 192.168.0.17 0 msec
    192.168.0.30 4 msec *
```

5.3 When pinging the Seattle loop back again we notice that the 2nd ICMP packet is taking another route compared ot the 1st and 3rd ICMP packet. This is because there exists two paths with equal administrative distance and the number of hops to this destination.

6. Shut down two existing links

Shut down the two links between Paris←→Miami and Brussels←→Atlanta as shown in below diagram.



Monitor RIP Advertising with the new configuration and look for RIP advertisements:

```
Miami#debug ip rip
RIP protocol debugging is on
*Feb 23 01:18:14.939: RIP: received v2 update from 192.168.0.10 on FastEthernet0/0
*Feb 23 01:18:14.939:      192.168.0.16/30 via 0.0.0.0 in 2 hops
*Feb 23 01:18:14.939:      192.168.0.20/30 via 0.0.0.0 in 1 hops
*Feb 23 01:18:14.939:      192.168.0.24/30 via 0.0.0.0 in 2 hops
*Feb 23 01:18:14.939:      192.168.0.28/30 via 0.0.0.0 in 1 hops
*Feb 23 01:18:14.939:      192.168.1.1/32 via 0.0.0.0 in 3 hops
*Feb 23 01:18:14.939:      192.168.2.2/32 via 0.0.0.0 in 2 hops
*Feb 23 01:18:14.939:      192.168.3.3/32 via 0.0.0.0 in 1 hops
*Feb 23 01:18:14.939:      192.168.5.5/32 via 0.0.0.0 in 3 hops
*Feb 23 01:18:14.939:      192.168.6.6/32 via 0.0.0.0 in 2 hops
Miami#
Miami#
*Feb 23 01:18:23.039: RIP: sending v2 update to 224.0.0.9 via FastEthernet0/0 (192.168.0.9)
*Feb 23 01:18:23.039: RIP: build update entries
*Feb 23 01:18:23.039:   192.168.4.4/32 via 0.0.0.0, metric 1, tag 0
Miami#
*Feb 23 01:18:26.239: RIP: sending v2 update to 224.0.0.9 via Loopback0 (192.168.4.4)
*Feb 23 01:18:26.239: RIP: build update entries
*Feb 23 01:18:26.239:   192.168.0.8/30 via 0.0.0.0, metric 1, tag 0
*Feb 23 01:18:26.239:   192.168.0.16/30 via 0.0.0.0, metric 3, tag 0
*Feb 23 01:18:26.239:   192.168.0.20/30 via 0.0.0.0, metric 2, tag 0
*Feb 23 01:18:26.239:   192.168.0.24/30 via 0.0.0.0, metric 3, tag 0
*Feb 23 01:18:26.239:   192.168.0.28/30 via 0.0.0.0, metric 2, tag 0
*Feb 23 01:18:26.239:   192.168.1.1/32 via 0.0.0.0, metric 4, tag 0
*Feb 23 01:18:26.239:   192.168.2.2/32 via 0.0.0.0, metric 3, tag 0
*Feb 23 01:18:26.239:   192.168.3.3/32 via 0.0.0.0, metric 2, tag 0
Miami#
*Feb 23 01:18:26.239:   192.168.5.5/32 via 0.0.0.0, metric 4, tag 0
*Feb 23 01:18:26.239:   192.168.6.6/32 via 0.0.0.0, metric 3, tag 0
*Feb 23 01:18:26.239: RIP: ignored v2 packet from 192.168.4.4 (sourced from oneof our addresses)
Miami#
Miami#
*Feb 23 01:18:44.551: RIP: received v2 update from 192.168.0.10 on FastEthernet0/0
*Feb 23 01:18:44.551:      192.168.0.16/30 via 0.0.0.0 in 2 hops
*Feb 23 01:18:44.551:      192.168.0.20/30 via 0.0.0.0 in 1 hops
*Feb 23 01:18:44.551:      192.168.0.24/30 via 0.0.0.0 in 2 hops
*Feb 23 01:18:44.551:      192.168.0.28/30 via 0.0.0.0 in 1 hops
*Feb 23 01:18:44.551:      192.168.1.1/32 via 0.0.0.0 in 3 hops
```

```
*Feb 23 01:18:44.551:      192.168.2.2/32 via 0.0.0.0 in 2 hops
*Feb 23 01:18:44.551:      192.168.3.3/32 via 0.0.0.0 in 1 hops
*Feb 23 01:18:44.551:      192.168.5.5/32 via 0.0.0.0 in 3 hops
*Feb 23 01:18:44.551:      192.168.6.6/32 via 0.0.0.0 in 2 hops
*Feb 23 01:18:52.511: RIP: sending v2 update to 224.0.0.9 via FastEthernet0/0 (192.168.0.9)
*Feb 23 01:18:52.511: RIP: build update entries
*Feb 23 01:18:52.511:   192.168.4.4/32 via 0.0.0.0, metric 1, tag 0
```

Stop monitoring RIP Advertisement:

```
Miami#no debug ip rip
RIP protocol debugging is off
```

Check the New IP Route Table:

```
Miami#show ip route
```

6.1 The IP route table now removes the redundant interface to Seattle's Loopback(192.168.6.6) and to network (192.168.0.24). It also removed the networks that have been brought down(192.168.0.4 & 192.168.0.12)

6.2 The new RIP updates reflect the new network and interfaces that can be reached.

6.3 The networks that have been brought down(192.168.0.4 & 192.168.0.12) can no longer be pinged.

```
Miami#
Miami#ping 192.168.0.12
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.12, timeout is 2 seconds:
.....
Miami#
Miami#
Miami#ping 192.168.0.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.4, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

6.4 Now that the redundant paths to Seattle has been brought down, traceroute only shows one definitive path to Seattle's Loopback interface.

```
Miami#traceroute 192.168.6.6
Type escape sequence to abort.
Tracing the route to 192.168.6.6
  1 192.168.0.10 0 msec 0 msec 4 msec
  2 192.168.0.30 8 msec *  8 msec
```

Additional Lab Questions:

1. What was the most important piece of knowledge you took away from this lab?
   - It takes time for the RIP route table to update and converge.
   - RIP is classful routing protocol. To make RIP work with the classful structure we have, we had to use the "no auto-summary" command:

     RIP Commands

     Use the commands in this chapter to configure and monitor Routing Information Protocol (RIP). For RIP configuration information and examples, refer to the "Configuring Routing Information Protocol" chapter of the Cisco IOS *IP and IP Routing Configuration Guide*.

     auto-summary (RIP)

     To restore the default behavior of automatic summarization of subnet routes into network-level routes, use the **auto-summary** command in router configuration mode. To disable this function and send subprefix routing information across classful network boundaries, use the **no** form of this command.

     auto-summary

     no auto-summary

     Source: http://www.cisco.com/en/US/docs/ios/12_1/iproute/command/reference/1rdrip.html#wp1017389

2. What new command did you find most useful and why?
   - Check the New IP Route Table:
     - `Miami#show ip route`
   - Watching RIP advertisements:
     - `Miami(config-router)#debug ip rip`
     - `Miami#debug ip rip` (can be done in any mode)
   - Stop Monitoring RIP advertisements:
     - `Miami(config-router)#no debug ip rip`

3. Identify at least one problem you experienced in this lab. How did you figure out the problem? How did you resolve it?
   - In Part6, when instructed to pull down interface FE0/1 to Paris, I accidently pulled down both FE0/1 to Paris and FE0/0 to Miami. I noticed this rightaway and turned back on the FE0/0 to Miami within a minute. The RIP route table adjusted to reflect this and I was able to ping Seattle as instructed.

4. List and explain the various RIP timers.
   - Update – how often to send updates (sec)
   - Invalid – time(sec) it takes for a route to go stale. If no valid Update in x sec, then the route will be invalid and will go into hold down state.
   - Hold Down – time(sec) in which the route is not discarded, but lower priority route will override this route in the route table.
   - Flush – time(sec) from the last valid update at which the route will be discarded.

OSPF can specify subnet mask whereas RIP cannot.

iOS Command Prompt Script:

```
login: student
Password:
Miami(config)#converges fast
Miami(config)#int lo0
*Mar  7 23:40:36.879: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
Miami(config-if)#ip address 192.168.3.3 255.255.255.255
Miami(config-if)#no shut

Miami(config-if)#int fa 0/0
Miami(config-if)#ip address 192.168.0.10 255.255.255.252
Miami(config-if)#no shut
*Mar  7 23:42:21.075: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  7 23:42:22.075: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up/1

Miami(config-if)#ip address 192.168.0.22 255.255.255.252
Miami(config-if)#no shut
*Mar  7 23:42:42.783: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up

Miami(config-if)#interface S
Miami(config-if)#exit
Miami(config)#int serial
Miami(config)#int serial ?
  <0-2>  Serial interface number

Miami(config)#do show ip int bri
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            192.168.0.10    YES manual up                    up
FastEthernet0/1            192.168.0.22    YES manual up                    down
FastEthernet0/0/0          unassigned      YES unset  up                    down
FastEthernet0/0/1          unassigned      YES unset  up                    down
FastEthernet0/0/2          unassigned      YES unset  up                    down
FastEthernet0/0/3          unassigned      YES unset  up                    down
Serial0/1/0                unassigned      YES unset  administratively down down
Serial0/1/1                unassigned      YES unset  administratively down down
Vlan1                      unassigned      YES unset  up                    down
SSLVPN-VIF0                unassigned      NO  unset  up                    up
Loopback0                  192.168.3.3     YES manual up                    up

Miami(config)#interface Serial0/1/0
*Mar  7 23:44:40.483: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to down
*Mar  7 23:44:42.143: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
*Mar  7 23:45:07.843: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to down

Miami(config-if)#ip address 192.168.0.29 255.255.255.252
Miami(config-if)#exit
Miami(config)#do show ip int bri
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            192.168.0.10    YES manual up                    down
FastEthernet0/1            192.168.0.22    YES manual up                    down
FastEthernet0/0/0          unassigned      YES unset  up                    down
FastEthernet0/0/1          unassigned      YES unset  up                    down
FastEthernet0/0/2          unassigned      YES unset  up                    down
FastEthernet0/0/3          unassigned      YES unset  up                    down
Serial0/1/0                192.168.0.29    YES manual administratively down down
Serial0/1/1                unassigned      YES unset  administratively down down
Vlan1                      unassigned      YES unset  up                    down
SSLVPN-VIF0                unassigned      NO  unset  up                    up
Loopback0                  192.168.3.3     YES manual up                    up

Miami(config)#exit
Miami#
*Mar  7 23:47:00.099: %SYS-5-CONFIG_I: Configured from console by consoleconfig
Configuring from terminal, memory, or network [terminal]? t
Enter configuration commands, one per line.  End with CNTL/Z.
Miami(config)#no ip domain lookup
Miami(config)#line console 0
Miami(config-line)#logging synchronous
Miami(config-line)#do 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
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0

Miami(config-line)#int fa 0/0
Miami(config-if)#description Link to Miami 192.168.0.8
Miami(config-if)#int fa 0/1
Miami(config-if)#description Link to Atlanta 192.168.0.20
Miami(config-if)#do show ip int fa 0/1
FastEthernet0/1 is up, line protocol is down
  Internet address is 192.168.0.22/30
  Broadcast address is 255.255.255.255
  Address determined by setup command
  MTU is 1500 bytes
  Helper address is not set
  Directed broadcast forwarding is disabled
  Outgoing access list is not set
  Inbound  access list is not set
  Proxy ARP is enabled
  Local Proxy ARP is disabled
  Security level is default
  Split horizon is enabled
  ICMP redirects are always sent
  ICMP unreachables are always sent
  ICMP mask replies are never sent
  IP fast switching is enabled
  IP fast switching on the same interface is disabled
  IP Flow switching is disabled
  IP CEF switching is enabled
  IP CEF switching turbo vector
  IP multicast fast switching is enabled
  IP multicast distributed fast switching is disabled
  IP route-cache flags are Fast, CEF
```

```
  Router Discovery is disabled
  IP output packet accounting is disabled
  IP access violation accounting is disabled
  TCP/IP header compression is disabled
  RTP/IP header compression is disabled
  Policy routing is disabled
  Network address translation is disabled
  BGP Policy Mapping is disabled
  Input features: MCI Check
  WCCP Redirect outbound is disabled
  WCCP Redirect inbound is disabled
  WCCP Redirect exclude is disabled

Miami(config-if)#int lo0
Miami(config-if)#description Loopback Address 192.168.3.3
Miami(config-if)#do show ip int bri
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            192.168.0.10    YES manual up                    down
FastEthernet0/1            192.168.0.22    YES manual up                    down
FastEthernet0/0/0          unassigned      YES unset  up                    down
FastEthernet0/0/1          unassigned      YES unset  up                    down
FastEthernet0/0/2          unassigned      YES unset  up                    down
FastEthernet0/0/3          unassigned      YES unset  up                    down
Serial0/1/0                192.168.0.29    YES manual administratively down down
Serial0/1/1                unassigned      YES unset  administratively down down
Vlan1                      unassigned      YES unset  up                    down
SSLVPN-VIF0                unassigned      NO  unset  up                    up
Loopback0                  192.168.3.3     YES manual up                    up

Miami(config-if)#
Miami(config-if)#END of PART3
                 ^
% Invalid input detected at '^' marker.

Miami(config-if)#show ip inter
Miami(config-if)#
Miami#
*Mar  7 23:53:09.407: %SYS-5-CONFIG_I: Configured from console by console
Miami#config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Miami(config)#end
Miami#
*Mar  7 23:53:22.395: %SYS-5-CONFIG_I: Configured from console by console
Miami#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            192.168.0.10    YES manual up                    down
FastEthernet0/1            192.168.0.22    YES manual up                    down
FastEthernet0/0/0          unassigned      YES unset  up                    down
FastEthernet0/0/1          unassigned      YES unset  up                    down
FastEthernet0/0/2          unassigned      YES unset  up                    down
FastEthernet0/0/3          unassigned      YES unset  up                    down
Serial0/1/0                192.168.0.29    YES manual administratively down down
Serial0/1/1                unassigned      YES unset  administratively down down
Vlan1                      unassigned      YES unset  up                    down
SSLVPN-VIF0                unassigned      NO  unset  up                    up
Loopback0                  192.168.3.3     YES manual up                    up

Miami#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
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0
Miami#
*Mar  7 23:54:47.847: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up
*Mar  7 23:54:49.843: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0/2, changed state to up
*Mar  7 23:54:50.987: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0/2, changed state to down
*Mar  7 23:54:50.987: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to down
*Mar  7 23:54:51.991: %LINK-3-UPDOWN: Interface FastEthernet0/0/2, changed state to down
*Mar  7 23:56:13.623: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up

Miami#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            192.168.0.10    YES manual up                    up
FastEthernet0/1            192.168.0.22    YES manual up                    down
FastEthernet0/0/0          unassigned      YES unset  up                    down
FastEthernet0/0/1          unassigned      YES unset  up                    down
FastEthernet0/0/2          unassigned      YES unset  down                  down
FastEthernet0/0/3          unassigned      YES unset  up                    down
Serial0/1/0                192.168.0.29    YES manual administratively down down
Serial0/1/1                unassigned      YES unset  administratively down down
Vlan1                      unassigned      YES unset  up                    down
SSLVPN-VIF0                unassigned      NO  unset  up                    up
Loopback0                  192.168.3.3     YES manual up                    up

Miami#
*Mar  7 23:57:00.379: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up

Miami#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            192.168.0.10    YES manual up                    up
FastEthernet0/1            192.168.0.22    YES manual up                    up
FastEthernet0/0/0          unassigned      YES unset  up                    down
FastEthernet0/0/1          unassigned      YES unset  up                    down
FastEthernet0/0/2          unassigned      YES unset  down                  down
FastEthernet0/0/3          unassigned      YES unset  up                    down
Serial0/1/0                192.168.0.29    YES manual administratively down down
Serial0/1/1                unassigned      YES unset  administratively down down
Vlan1                      unassigned      YES unset  up                    down
SSLVPN-VIF0                unassigned      NO  unset  up                    up
Loopback0                  192.168.3.3     YES manual up                    up

Miami#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            192.168.0.10    YES manual up                    up
```

```
FastEthernet0/1            192.168.0.22    YES manual up                    up
FastEthernet0/0/0          unassigned      YES unset  up                    down
FastEthernet0/0/1          unassigned      YES unset  up                    down
FastEthernet0/0/2          unassigned      YES unset  down                  down
FastEthernet0/0/3          unassigned      YES unset  up                    down
Serial0/1/0                192.168.0.29    YES manual administratively down down
Serial0/1/1                unassigned      YES unset  administratively down down
Vlan1                      unassigned      YES unset  up                    down
SSLVPN-VIF0                unassigned      NO  unset  up                    up
Loopback0                  192.168.3.3     YES manual up                    up

Miami#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
     192.168.0.0/30 is subnetted, 2 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
C       192.168.0.20 is directly connected, FastEthernet0/1
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0

Miami#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
     192.168.0.0/30 is subnetted, 2 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
C       192.168.0.20 is directly connected, FastEthernet0/1
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0

Miami#END of Section 3
        ^
% Invalid input detected at '^' marker.

Miami#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Miami(config)#
Miami(config)#route?
route-map  router
Miami(config)#exit
*Mar  8 00:04:47.131: %SYS-5-CONFIG_I: Configured from console by console
Miami#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Miami(config)#router ospf 1
Miami(config-router)#network FastEth
Miami(config-router)#network 192.168.0.20 255.255.255.252 area 0
Miami(config-router)#network 192.168.0.20 255.255.255.252 area 0
*Mar  8 00:06:41.219: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.2.2 on FastEthernet0/1 from LOADING to FULL, Loading Done
Miami(config-router)#network 192.168.0.8 255.255.255.252 area 0
Miami(config-router)#network 192.168.3.3 255.255.255.252 area 0
Miami(config-router)#no network 192.168.3.3 255.255.255.252 area 0
Miami(config-router)#no network 192.168.3.3 255.255.255.255 area 0
Miami(config-router)#network 192.168.3.3 255.255.255.255 area 0

Miami(config-router)#do 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
     192.168.5.0/32 is subnetted, 1 subnets
O       192.168.5.5 [110/5] via 192.168.0.21, 00:00:40, FastEthernet0/1
     192.168.6.0/32 is subnetted, 1 subnets
O       192.168.6.6 [110/4] via 192.168.0.21, 00:00:40, FastEthernet0/1
     192.168.0.0/30 is subnetted, 6 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
O       192.168.0.12 [110/5] via 192.168.0.21, 00:00:40, FastEthernet0/1
O       192.168.0.4 [110/2] via 192.168.0.21, 00:00:40, FastEthernet0/1
O       192.168.0.24 [110/3] via 192.168.0.21, 00:00:41, FastEthernet0/1
O       192.168.0.16 [110/4] via 192.168.0.21, 00:00:41, FastEthernet0/1
C       192.168.0.20 is directly connected, FastEthernet0/1
     192.168.1.0/32 is subnetted, 1 subnets
O       192.168.1.1 [110/3] via 192.168.0.21, 00:00:41, FastEthernet0/1
     192.168.2.0/32 is subnetted, 1 subnets
O       192.168.2.2 [110/2] via 192.168.0.21, 00:00:44, FastEthernet0/1
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0

Miami(config-router)#do 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
     192.168.5.0/32 is subnetted, 1 subnets
O       192.168.5.5 [110/5] via 192.168.0.21, 00:02:16, FastEthernet0/1
     192.168.6.0/32 is subnetted, 1 subnets
O       192.168.6.6 [110/4] via 192.168.0.21, 00:02:16, FastEthernet0/1
     192.168.0.0/30 is subnetted, 6 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
O       192.168.0.12 [110/5] via 192.168.0.21, 00:02:16, FastEthernet0/1
O       192.168.0.4 [110/2] via 192.168.0.21, 00:02:16, FastEthernet0/1
O       192.168.0.24 [110/3] via 192.168.0.21, 00:02:17, FastEthernet0/1
```

```
O       192.168.0.16 [110/4] via 192.168.0.21, 00:02:17, FastEthernet0/1
C       192.168.0.20 is directly connected, FastEthernet0/1
     192.168.1.0/32 is subnetted, 1 subnets
O       192.168.1.1 [110/3] via 192.168.0.21, 00:02:17, FastEthernet0/1
     192.168.2.0/32 is subnetted, 1 subnets
O       192.168.2.2 [110/2] via 192.168.0.21, 00:02:19, FastEthernet0/1
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0

Miami(config-router)#Miami Loopback not up
                    ^
% Invalid input detected at '^' marker.

Miami(config-router)#exit
Miami(config)#exit
*Mar  8 00:13:13.799: %SYS-5-CONFIG_I: Configured from console by console

Miami#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
     192.168.5.0/32 is subnetted, 1 subnets
O       192.168.5.5 [110/5] via 192.168.0.21, 00:04:36, FastEthernet0/1
     192.168.6.0/32 is subnetted, 1 subnets
O       192.168.6.6 [110/4] via 192.168.0.21, 00:04:36, FastEthernet0/1
     192.168.0.0/30 is subnetted, 6 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
O       192.168.0.12 [110/5] via 192.168.0.21, 00:04:36, FastEthernet0/1
O       192.168.0.4 [110/2] via 192.168.0.21, 00:04:36, FastEthernet0/1
O       192.168.0.24 [110/3] via 192.168.0.21, 00:04:38, FastEthernet0/1
O       192.168.0.16 [110/4] via 192.168.0.21, 00:04:38, FastEthernet0/1
C       192.168.0.20 is directly connected, FastEthernet0/1
     192.168.1.0/32 is subnetted, 1 subnets
O       192.168.1.1 [110/3] via 192.168.0.21, 00:04:38, FastEthernet0/1
     192.168.2.0/32 is subnetted, 1 subnets
O       192.168.2.2 [110/2] via 192.168.0.21, 00:04:49, FastEthernet0/1
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0

Miami#show route summary
route-map summary not found

Miami#show ip route summary
IP routing table name is Default-IP-Routing-Table(0)
IP routing table maximum-paths is 32
Route Source    Networks    Subnets     Overhead    Memory (bytes)
connected       0           3           192         456
static          0           0           0           0
ospf 1          0           8           512         1216
  Intra-area: 8 Inter-area: 0 External-1: 0 External-2: 0
  NSSA External-1: 0 NSSA External-2: 0
internal        6                                   7032
Total           6           11          704         8704
Removing Queue Size 0
Miami#
*Mar  8 00:16:16.763: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.4.4 on FastEthernet
0/0 from LOADING to FULL, Loading Done

Miami#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
     192.168.4.0/32 is subnetted, 1 subnets
O       192.168.4.4 [110/2] via 192.168.0.9, 00:00:29, FastEthernet0/0
     192.168.5.0/32 is subnetted, 1 subnets
O       192.168.5.5 [110/3] via 192.168.0.9, 00:02:14, FastEthernet0/0
     192.168.6.0/32 is subnetted, 1 subnets
O       192.168.6.6 [110/4] via 192.168.0.21, 00:09:56, FastEthernet0/1
                    [110/4] via 192.168.0.9, 00:02:14, FastEthernet0/0
     192.168.0.0/30 is subnetted, 6 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
O       192.168.0.12 [110/2] via 192.168.0.9, 00:02:15, FastEthernet0/0
O       192.168.0.4 [110/2] via 192.168.0.21, 00:09:57, FastEthernet0/1
O       192.168.0.24 [110/3] via 192.168.0.21, 00:09:57, FastEthernet0/1
O       192.168.0.16 [110/3] via 192.168.0.9, 00:02:15, FastEthernet0/0
C       192.168.0.20 is directly connected, FastEthernet0/1
     192.168.1.0/32 is subnetted, 1 subnets
O       192.168.1.1 [110/3] via 192.168.0.21, 00:09:58, FastEthernet0/1
     192.168.2.0/32 is subnetted, 1 subnets
O       192.168.2.2 [110/2] via 192.168.0.21, 00:09:58, FastEthernet0/1
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0

Miami#All links are up!
      ^
% Invalid input detected at '^' marker.

Miami#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
     192.168.4.0/32 is subnetted, 1 subnets
O       192.168.4.4 [110/2] via 192.168.0.9, 00:02:15, FastEthernet0/0
     192.168.5.0/32 is subnetted, 1 subnets
O       192.168.5.5 [110/3] via 192.168.0.9, 00:04:01, FastEthernet0/0
```

```
     192.168.6.0/32 is subnetted, 1 subnets
O       192.168.6.6 [110/4] via 192.168.0.21, 00:11:42, FastEthernet0/1
                    [110/4] via 192.168.0.9, 00:04:01, FastEthernet0/0
     192.168.0.0/30 is subnetted, 6 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
O       192.168.0.12 [110/2] via 192.168.0.9, 00:04:02, FastEthernet0/0
O       192.168.0.4 [110/2] via 192.168.0.21, 00:11:43, FastEthernet0/1
O       192.168.0.24 [110/3] via 192.168.0.21, 00:11:43, FastEthernet0/1
O       192.168.0.16 [110/3] via 192.168.0.9, 00:04:02, FastEthernet0/0
C       192.168.0.20 is directly connected, FastEthernet0/1
     192.168.1.0/32 is subnetted, 1 subnets
O       192.168.1.1 [110/3] via 192.168.0.21, 00:11:45, FastEthernet0/1
     192.168.2.0/32 is subnetted, 1 subnets
O       192.168.2.2 [110/2] via 192.168.0.21, 00:11:45, FastEthernet0/1
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0

Miami#show ip route summary
IP routing table name is Default-IP-Routing-Table(0)
IP routing table maximum-paths is 32
Route Source    Networks    Subnets     Overhead    Memory (bytes)
connected       0           3           192         456
static          0           0           0           0
ospf 1          0           9           640         1368
  Intra-area: 9 Inter-area: 0 External-1: 0 External-2: 0
  NSSA External-1: 0 NSSA External-2: 0
internal        7                                   8204
Total           7           12          832         10028
Removing Queue Size 0
Miami#
Miami#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.3.3
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    192.168.0.8 0.0.0.3 area 0
    192.168.0.20 0.0.0.3 area 0
    192.168.3.3 0.0.0.0 area 0
 Reference bandwidth unit is 100 mbps
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.4.4          110      00:03:50
    192.168.1.1          110      00:13:17
    192.168.2.2          110      00:13:17
    192.168.5.5          110      00:05:36
    192.168.6.6          110      00:05:36
  Distance: (default is 110)

Miami#show ip ospf
 Routing Process "ospf 1" with ID 192.168.3.3
 Start time: 00:57:46.800, Time elapsed: 00:20:22.860
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
 IETF NSF helper support enabled
 Cisco NSF helper support enabled
    Area BACKBONE(0)
        Number of interfaces in this area is 3 (1 loopback)
        Area has no authentication
        SPF algorithm last executed 00:07:15.344 ago
        SPF algorithm executed 9 times
        Area ranges are
        Number of LSA 12. Checksum Sum 0x065463
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

Miami#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.4.4       1   FULL/BDR        00:00:37    192.168.0.9     FastEthernet0/0
192.168.2.2       1   FULL/DR         00:00:31    192.168.0.21    FastEthernet0/1

Miami#show ip ospf database
            OSPF Router with ID (192.168.3.3) (Process ID 1)
                Router Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum Link count
192.168.1.1     192.168.1.1     1329        0x80000005 0x005195 3
192.168.2.2     192.168.2.2     1183        0x80000005 0x0045A5 3
192.168.3.3     192.168.3.3     607         0x80000007 0x00A830 3
192.168.4.4     192.168.4.4     493         0x80000005 0x00E005 3
192.168.5.5     192.168.5.5     605         0x80000004 0x00FFD1 3
192.168.6.6     192.168.6.6     1291        0x80000009 0x000CA1 3
                Net Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum
192.168.0.6     192.168.1.1     1329        0x80000001 0x008AFE
192.168.0.10    192.168.3.3     607         0x80000001 0x00A4D4
192.168.0.13    192.168.5.5     605         0x80000001 0x0092DB
```

```
192.168.0.17    192.168.6.6     1291        0x80000001 0x008BD8
192.168.0.21    192.168.2.2     1183        0x80000001 0x00155F
192.168.0.26    192.168.6.6     1434        0x80000001 0x00C49E

Miami#traceroute 192.168.6.6
Type escape sequence to abort.
Tracing the route to 192.168.6.6
  1 192.168.0.9 0 msec
    192.168.0.21 4 msec
    192.168.0.9 0 msec
  2 192.168.0.6 4 msec
    192.168.0.13 0 msec
    192.168.0.6 0 msec
  3 192.168.0.17 4 msec
    192.168.0.26 0 msec *

Miami#
Miami con0 is now available
Press RETURN to get started.
Miami>

Miami>traceroute 192.168.6.6
Type escape sequence to abort.
Tracing the route to 192.168.6.6
  1 192.168.0.21 0 msec
    192.168.0.9 4 msec
    192.168.0.21 0 msec
  2 192.168.0.13 0 msec
    192.168.0.6 0 msec
    192.168.0.13 0 msec
  3 192.168.0.26 4 msec
    192.168.0.17 0 msec *
Miami>show ip ospf database router 192.168.0.6
            OSPF Router with ID (192.168.3.3) (Process ID 1)
Miami>show ip ospf database router 192.168.6.6
            OSPF Router with ID (192.168.3.3) (Process ID 1)
                Router Link States (Area 0)
  LS age: 181
  Options: (No TOS-capability, DC)
  LS Type: Router Links
  Link State ID: 192.168.6.6
  Advertising Router: 192.168.6.6
  LS Seq Number: 8000000A
  Checksum: 0xAA2
  Length: 60
  Number of Links: 3
    Link connected to: a Stub Network
     (Link ID) Network/subnet number: 192.168.6.6
     (Link Data) Network Mask: 255.255.255.255
      Number of TOS metrics: 0
       TOS 0 Metrics: 1
    Link connected to: a Transit Network
     (Link ID) Designated Router address: 192.168.0.17
     (Link Data) Router Interface address: 192.168.0.17
      Number of TOS metrics: 0
       TOS 0 Metrics: 1
    Link connected to: a Transit Network
     (Link ID) Designated Router address: 192.168.0.26
     (Link Data) Router Interface address: 192.168.0.26
      Number of TOS metrics: 0
       TOS 0 Metrics: 1

Miami>show ip ospf database network ?
  A.B.C.D         Link state ID (as an IP address)
  adv-router      Advertising Router link states
  internal        Internal LSA information
  self-originate  Self-originated link states
  |               Output modifiers
  <cr>

Miami>show ip ospf database network 192.168.6.6
            OSPF Router with ID (192.168.3.3) (Process ID 1)

Miami>show ip ospf database network ?
  A.B.C.D         Link state ID (as an IP address)
  adv-router      Advertising Router link states
  internal        Internal LSA information
  self-originate  Self-originated link states
  |               Output modifiers
  <cr>

Miami>show ip ospf database ?
  adv-router        Advertising Router link states
  asbr-summary      ASBR summary link states
  database-summary  Summary of database
  external          External link states
  network           Network link states
  nssa-external     NSSA External link states
  opaque-area       Opaque Area link states
  opaque-as         Opaque AS link states
  opaque-link       Opaque Link-Local link states
  router            Router link states
  self-originate    Self-originated link states
  summary           Network summary link states
  |                 Output modifiers
  <cr>

Miami>show ip ospf database network ?
  A.B.C.D         Link state ID (as an IP address)
  adv-router      Advertising Router link states
  internal        Internal LSA information
  self-originate  Self-originated link states
  |               Output modifiers
  <cr>

Miami>show ip ospf database network
            OSPF Router with ID (192.168.3.3) (Process ID 1)
                Net Link States (Area 0)
  Routing Bit Set on this LSA
  LS age: 283
```

```
  Options: (No TOS-capability, DC)
  LS Type: Network Links
  Link State ID: 192.168.0.6 (address of Designated Router)
  Advertising Router: 192.168.1.1
  LS Seq Number: 80000002
  Checksum: 0x88FF
  Length: 32
  Network Mask: /30
        Attached Router: 192.168.1.1
        Attached Router: 192.168.2.2
  Routing Bit Set on this LSA
  LS age: 1590
  Options: (No TOS-capability, DC)
  LS Type: Network Links
  Link State ID: 192.168.0.10 (address of Designated Router)
  Advertising Router: 192.168.3.3
  LS Seq Number: 80000001
  Checksum: 0xA4D4
  Length: 32
  Network Mask: /30
        Attached Router: 192.168.3.3
        Attached Router: 192.168.4.4
  Routing Bit Set on this LSA
  LS age: 1594
  Options: (No TOS-capability, DC)
  LS Type: Network Links
  Link State ID: 192.168.0.13 (address of Designated Router)
  Advertising Router: 192.168.5.5
  LS Seq Number: 80000001
  Checksum: 0x92DB
  Length: 32
  Network Mask: /30
        Attached Router: 192.168.5.5
        Attached Router: 192.168.4.4
  Routing Bit Set on this LSA
  LS age: 298
  Options: (No TOS-capability, DC)
  LS Type: Network Links
  Link State ID: 192.168.0.17 (address of Designated Router)
  Advertising Router: 192.168.6.6
  LS Seq Number: 80000002
  Checksum: 0x89D9
  Length: 32
  Network Mask: /30
        Attached Router: 192.168.6.6
        Attached Router: 192.168.5.5
  Routing Bit Set on this LSA
  LS age: 304
  Options: (No TOS-capability, DC)
  LS Type: Network Links
  Link State ID: 192.168.0.21 (address of Designated Router)
  Advertising Router: 192.168.2.2
  LS Seq Number: 80000002
  Checksum: 0x1360
  Length: 32
  Network Mask: /30
        Attached Router: 192.168.2.2
        Attached Router: 192.168.3.3
  Routing Bit Set on this LSA
  LS age: 557
  Options: (No TOS-capability, DC)
  LS Type: Network Links
  Link State ID: 192.168.0.26 (address of Designated Router)
  Advertising Router: 192.168.6.6
  LS Seq Number: 80000002
  Checksum: 0xC29F
  Length: 32
  Network Mask: /30
        Attached Router: 192.168.6.6
        Attached Router: 192.168.1.1

Miami>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
     192.168.4.0/32 is subnetted, 1 subnets
O       192.168.4.4 [110/2] via 192.168.0.9, 00:27:29, FastEthernet0/0
     192.168.5.0/32 is subnetted, 1 subnets
O       192.168.5.5 [110/3] via 192.168.0.9, 00:29:15, FastEthernet0/0
     192.168.6.0/32 is subnetted, 1 subnets
O       192.168.6.6 [110/4] via 192.168.0.21, 00:36:56, FastEthernet0/1
                    [110/4] via 192.168.0.9, 00:29:15, FastEthernet0/0
     192.168.0.0/30 is subnetted, 6 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
O       192.168.0.12 [110/2] via 192.168.0.9, 00:29:16, FastEthernet0/0
O       192.168.0.4 [110/2] via 192.168.0.21, 00:36:57, FastEthernet0/1
O       192.168.0.24 [110/3] via 192.168.0.21, 00:36:57, FastEthernet0/1
O       192.168.0.16 [110/3] via 192.168.0.9, 00:29:16, FastEthernet0/0
C       192.168.0.20 is directly connected, FastEthernet0/1
     192.168.1.0/32 is subnetted, 1 subnets
O       192.168.1.1 [110/3] via 192.168.0.21, 00:36:59, FastEthernet0/1
     192.168.2.0/32 is subnetted, 1 subnets
O       192.168.2.2 [110/2] via 192.168.0.21, 00:36:59, FastEthernet0/1
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0
Miami>enable
Miami#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Miami(config)#interface serial0/1/0
Miami(config-if)#no shut
*Mar  8 00:48:48.295: %LINK-3-UPDOWN: Interface Serial0/1/0, changed state to up
*Mar  8 00:48:49.295: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1/0, changed state to up
Miami(config-if)#router ospf 1
Miami(config-router)#network 192.168.0.28 255.255.255.252 area 0
*Mar  8 00:49:43.743: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.6.6 on Serial0/1/0 from LOADING to FULL, Loading Done
```

```
Miami(config-router)#
Miami#show ip
*Mar  8 00:50:00.423: %SYS-5-CONFIG_I: Configured from console by console

Miami#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
     192.168.4.0/32 is subnetted, 1 subnets
O       192.168.4.4 [110/2] via 192.168.0.9, 00:31:47, FastEthernet0/0
     192.168.5.0/32 is subnetted, 1 subnets
O       192.168.5.5 [110/3] via 192.168.0.9, 00:33:32, FastEthernet0/0
     192.168.6.0/32 is subnetted, 1 subnets
O       192.168.6.6 [110/4] via 192.168.0.21, 00:41:14, FastEthernet0/1
                    [110/4] via 192.168.0.9, 00:33:32, FastEthernet0/0
     192.168.0.0/30 is subnetted, 7 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
O       192.168.0.12 [110/2] via 192.168.0.9, 00:33:33, FastEthernet0/0
O       192.168.0.4 [110/2] via 192.168.0.21, 00:41:15, FastEthernet0/1
O       192.168.0.24 [110/3] via 192.168.0.21, 00:41:15, FastEthernet0/1
C       192.168.0.28 is directly connected, Serial0/1/0
O       192.168.0.16 [110/3] via 192.168.0.9, 00:33:35, FastEthernet0/0
C       192.168.0.20 is directly connected, FastEthernet0/1
     192.168.1.0/32 is subnetted, 1 subnets
O       192.168.1.1 [110/3] via 192.168.0.21, 00:41:16, FastEthernet0/1
     192.168.2.0/32 is subnetted, 1 subnets
O       192.168.2.2 [110/2] via 192.168.0.21, 00:41:16, FastEthernet0/1
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0

Miami#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
     192.168.4.0/32 is subnetted, 1 subnets
O       192.168.4.4 [110/2] via 192.168.0.9, 00:33:24, FastEthernet0/0
     192.168.5.0/32 is subnetted, 1 subnets
O       192.168.5.5 [110/3] via 192.168.0.9, 00:35:10, FastEthernet0/0
     192.168.6.0/32 is subnetted, 1 subnets
O       192.168.6.6 [110/4] via 192.168.0.21, 00:42:51, FastEthernet0/1
                    [110/4] via 192.168.0.9, 00:35:10, FastEthernet0/0
     192.168.0.0/30 is subnetted, 7 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
O       192.168.0.12 [110/2] via 192.168.0.9, 00:35:11, FastEthernet0/0
O       192.168.0.4 [110/2] via 192.168.0.21, 00:42:52, FastEthernet0/1
O       192.168.0.24 [110/3] via 192.168.0.21, 00:42:52, FastEthernet0/1
C       192.168.0.28 is directly connected, Serial0/1/0
O       192.168.0.16 [110/3] via 192.168.0.9, 00:35:12, FastEthernet0/0
C       192.168.0.20 is directly connected, FastEthernet0/1
     192.168.1.0/32 is subnetted, 1 subnets
O       192.168.1.1 [110/3] via 192.168.0.21, 00:42:53, FastEthernet0/1
     192.168.2.0/32 is subnetted, 1 subnets
O       192.168.2.2 [110/2] via 192.168.0.21, 00:42:53, FastEthernet0/1
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0

Miami#show ip route summary
IP routing table name is Default-IP-Routing-Table(0)
IP routing table maximum-paths is 32
Route Source    Networks    Subnets     Overhead    Memory (bytes)
connected       0           4           296         608
static          0           0           0           0
ospf 1          0           9           640         1368
  Intra-area: 9 Inter-area: 0 External-1: 0 External-2: 0
  NSSA External-1: 0 NSSA External-2: 0
internal        7                                   8204
Total           7           13          936         10180
Removing Queue Size 0

Miami#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.3.3
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    192.168.0.8 0.0.0.3 area 0
    192.168.0.20 0.0.0.3 area 0
    192.168.0.28 0.0.0.3 area 0
    192.168.3.3 0.0.0.0 area 0
 Reference bandwidth unit is 100 mbps
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.4.4          110      00:33:44
    192.168.1.1          110      00:43:11
    192.168.2.2          110      00:43:11
    192.168.5.5          110      00:35:29
    192.168.6.6          110      00:03:07
  Distance: (default is 110)

Miami#show ip ospf
 Routing Process "ospf 1" with ID 192.168.3.3
 Start time: 00:57:46.800, Time elapsed: 00:47:01.704
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
```

```
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
 IETF NSF helper support enabled
 Cisco NSF helper support enabled
    Area BACKBONE(0)
        Number of interfaces in this area is 4 (1 loopback)
        Area has no authentication
        SPF algorithm last executed 00:02:21.568 ago
        SPF algorithm executed 11 times
        Area ranges are
        Number of LSA 12. Checksum Sum 0x0663D0
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

Miami#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.6.6       0   FULL/  -        00:00:37    192.168.0.30    Serial0/1/0
192.168.4.4       1   FULL/BDR        00:00:31    192.168.0.9     FastEthernet0/0
192.168.2.2       1   FULL/DR         00:00:39    192.168.0.21    FastEthernet0/1

Miami#show ip ospf database
            OSPF Router with ID (192.168.3.3) (Process ID 1)
                Router Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum Link count
192.168.1.1     192.168.1.1     873         0x80000006 0x004F96 3
192.168.2.2     192.168.2.2     886         0x80000006 0x0043A6 3
192.168.3.3     192.168.3.3     173         0x80000009 0x0073A6 5
192.168.4.4     192.168.4.4     175         0x80000006 0x00DE06 3
192.168.5.5     192.168.5.5     161         0x80000005 0x00FDD2 3
192.168.6.6     192.168.6.6     176         0x8000000C 0x00648E 5
                Net Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum
192.168.0.6     192.168.1.1     873         0x80000002 0x0088FF
192.168.0.10    192.168.3.3     326         0x80000002 0x00A2D5
192.168.0.13    192.168.5.5     161         0x80000002 0x0090DC
192.168.0.17    192.168.6.6     882         0x80000002 0x0089D9
192.168.0.21    192.168.2.2     886         0x80000002 0x001360
192.168.0.26    192.168.6.6     1138        0x80000002 0x00C29F

Miami#traceroute 192.168.6.6
Type escape sequence to abort.
Tracing the route to 192.168.6.6
  1 192.168.0.9 0 msec
    192.168.0.21 4 msec
    192.168.0.9 0 msec
  2 192.168.0.6 4 msec
    192.168.0.13 0 msec
    192.168.0.6 0 msec
  3 192.168.0.17 4 msec
    192.168.0.26 0 msec *

Miami#show ip ospf ?
  <1-65535>            Process ID number
  border-routers       Border and Boundary Router Information
  database             Database summary
  flood-list           Link state flood list
  interface            Interface information
  max-metric           Max-metric origination information
  mpls                 MPLS related information
  neighbor             Neighbor list
  request-list         Link state request list
  retransmission-list  Link state retransmission list
  rib                  Routing Information Base (RIB)
  sham-links           Sham link information
  statistics           Various OSPF Statistics
  summary-address      Summary-address redistribution Information
  timers               OSPF timers information
  traffic              Traffic related statistics
  virtual-links        Virtual link information
  |                    Output modifiers
  <cr>

Miami#show ip ospf database router ?
  A.B.C.D          Link state ID (as an IP address)
  adv-router       Advertising Router link states
  internal         Internal LSA information
  self-originate   Self-originated link states
  |                Output modifiers
  <cr>
Miami#show ip ospf database router 192.168.6.6
            OSPF Router with ID (192.168.3.3) (Process ID 1)
                Router Link States (Area 0)
  LS age: 603
  Options: (No TOS-capability, DC)
  LS Type: Router Links
  Link State ID: 192.168.6.6
  Advertising Router: 192.168.6.6
  LS Seq Number: 8000000C
  Checksum: 0x648E
  Length: 84
  Number of Links: 5
    Link connected to: another Router (point-to-point)
     (Link ID) Neighboring Router ID: 192.168.3.3
     (Link Data) Router Interface address: 192.168.0.30
```

```
      Number of TOS metrics: 0
       TOS 0 Metrics: 781
    Link connected to: a Stub Network
     (Link ID) Network/subnet number: 192.168.0.28
     (Link Data) Network Mask: 255.255.255.252
      Number of TOS metrics: 0
       TOS 0 Metrics: 781
    Link connected to: a Stub Network
     (Link ID) Network/subnet number: 192.168.6.6
     (Link Data) Network Mask: 255.255.255.255
      Number of TOS metrics: 0
       TOS 0 Metrics: 1
    Link connected to: a Transit Network
     (Link ID) Designated Router address: 192.168.0.17
     (Link Data) Router Interface address: 192.168.0.17
      Number of TOS metrics: 0
       TOS 0 Metrics: 1
    Link connected to: a Transit Network
     (Link ID) Designated Router address: 192.168.0.26
     (Link Data) Router Interface address: 192.168.0.26
      Number of TOS metrics: 0
       TOS 0 Metrics: 1



Miami#Section6
Translating "Section6"
Translating "Section6"
% Unknown command or computer name, or unable to find computer address
Miami#########################are we up?

Miami#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
     192.168.4.0/32 is subnetted, 1 subnets
O       192.168.4.4 [110/2] via 192.168.0.9, 00:51:52, FastEthernet0/0
     192.168.5.0/32 is subnetted, 1 subnets
O       192.168.5.5 [110/783] via 192.168.0.30, 00:05:37, Serial0/1/0
     192.168.6.0/32 is subnetted, 1 subnets
O       192.168.6.6 [110/782] via 192.168.0.30, 00:05:37, Serial0/1/0
     192.168.0.0/30 is subnetted, 7 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
O IA    192.168.0.12 [110/2] via 192.168.0.9, 00:03:59, FastEthernet0/0
O IA    192.168.0.4 [110/2] via 192.168.0.21, 00:06:39, FastEthernet0/1
O       192.168.0.24 [110/782] via 192.168.0.30, 00:05:38, Serial0/1/0
C       192.168.0.28 is directly connected, Serial0/1/0
O       192.168.0.16 [110/782] via 192.168.0.30, 00:05:38, Serial0/1/0
C       192.168.0.20 is directly connected, FastEthernet0/1
     192.168.1.0/32 is subnetted, 1 subnets
O       192.168.1.1 [110/783] via 192.168.0.30, 00:05:39, Serial0/1/0
     192.168.2.0/32 is subnetted, 1 subnets
O       192.168.2.2 [110/2] via 192.168.0.21, 01:01:21, FastEthernet0/1
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0

Miami#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
     192.168.4.0/32 is subnetted, 1 subnets
O       192.168.4.4 [110/2] via 192.168.0.9, 00:52:27, FastEthernet0/0
     192.168.5.0/32 is subnetted, 1 subnets
O       192.168.5.5 [110/783] via 192.168.0.30, 00:06:12, Serial0/1/0
     192.168.6.0/32 is subnetted, 1 subnets
O       192.168.6.6 [110/782] via 192.168.0.30, 00:06:12, Serial0/1/0
     192.168.0.0/30 is subnetted, 7 subnets
C       192.168.0.8 is directly connected, FastEthernet0/0
O IA    192.168.0.12 [110/2] via 192.168.0.9, 00:04:34, FastEthernet0/0
O IA    192.168.0.4 [110/2] via 192.168.0.21, 00:07:14, FastEthernet0/1
O       192.168.0.24 [110/782] via 192.168.0.30, 00:06:13, Serial0/1/0
C       192.168.0.28 is directly connected, Serial0/1/0
O       192.168.0.16 [110/782] via 192.168.0.30, 00:06:13, Serial0/1/0
C       192.168.0.20 is directly connected, FastEthernet0/1
     192.168.1.0/32 is subnetted, 1 subnets
O       192.168.1.1 [110/783] via 192.168.0.30, 00:06:14, Serial0/1/0
     192.168.2.0/32 is subnetted, 1 subnets
O       192.168.2.2 [110/2] via 192.168.0.21, 01:01:57, FastEthernet0/1
     192.168.3.0/32 is subnetted, 1 subnets
C       192.168.3.3 is directly connected, Loopback0

Miami#show ip route summary
IP routing table name is Default-IP-Routing-Table(0)
IP routing table maximum-paths is 32
Route Source    Networks    Subnets     Overhead    Memory (bytes)
connected       0           4           296         608
static          0           0           0           0
ospf 1          0           9           576         1368
  Intra-area: 7 Inter-area: 2 External-1: 0 External-2: 0
  NSSA External-1: 0 NSSA External-2: 0
internal        7                                   8204
Total           7           13          872         10180
Removing Queue Size 0

Miami#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.3.3
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
```

```
  Maximum path: 4
  Routing for Networks:
    192.168.0.8 0.0.0.3 area 0
    192.168.0.20 0.0.0.3 area 0
    192.168.0.28 0.0.0.3 area 0
    192.168.3.3 0.0.0.0 area 0
 Reference bandwidth unit is 100 mbps
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.4.4          110      00:06:25
    192.168.1.1          110      00:08:03
    192.168.2.2          110      00:09:05
    192.168.5.5          110      00:08:03
    192.168.6.6          110      00:08:03
  Distance: (default is 110)

Miami#show ip ospf
 Routing Process "ospf 1" with ID 192.168.3.3
 Start time: 00:57:46.800, Time elapsed: 01:07:36.704
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
 IETF NSF helper support enabled
 Cisco NSF helper support enabled
    Area BACKBONE(0)
        Number of interfaces in this area is 4 (1 loopback)
        Area has no authentication
        SPF algorithm last executed 00:03:23.864 ago
        SPF algorithm executed 23 times
        Area ranges are
        Number of LSA 14. Checksum Sum 0x064F2D
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

Miami#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.6.6       0   FULL/  -        00:00:37    192.168.0.30    Serial0/1/0
192.168.4.4       1   FULL/BDR        00:00:37    192.168.0.9     FastEthernet0/0
192.168.2.2       1   FULL/DR         00:00:35    192.168.0.21    FastEthernet0/1

Miami#show ip ospf database
            OSPF Router with ID (192.168.3.3) (Process ID 1)
                Router Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum Link count
192.168.1.1     192.168.1.1     616         0x80000008 0x00874A 2
192.168.2.2     192.168.2.2     579         0x80000009 0x009F34 2
192.168.3.3     192.168.3.3     1400        0x80000009 0x0073A6 5
192.168.4.4     192.168.4.4     495         0x80000008 0x005788 2
192.168.5.5     192.168.5.5     225         0x8000000A 0x00C9FD 2
192.168.6.6     192.168.6.6     1403        0x8000000C 0x00648E 5
                Net Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum
192.168.0.10    192.168.3.3     1553        0x80000002 0x00A2D5
192.168.0.17    192.168.6.6     101         0x80000003 0x0087DA
192.168.0.21    192.168.2.2     89          0x80000003 0x001161
192.168.0.26    192.168.6.6     357         0x80000003 0x00C0A0
                Summary Net Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum
192.168.0.4     192.168.1.1     612         0x80000001 0x008ED7
192.168.0.4     192.168.2.2     576         0x80000001 0x0081E2
192.168.0.12    192.168.4.4     492         0x80000001 0x001741
192.168.0.12    192.168.5.5     223         0x80000001 0x000A4C

Miami#show ip ospf 1 0 database
            OSPF Router with ID (192.168.3.3) (Process ID 1)
                Router Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum Link count
192.168.1.1     192.168.1.1     836         0x80000008 0x00874A 2
192.168.2.2     192.168.2.2     798         0x80000009 0x009F34 2
192.168.3.3     192.168.3.3     1620        0x80000009 0x0073A6 5
192.168.4.4     192.168.4.4     714         0x80000008 0x005788 2
192.168.5.5     192.168.5.5     445         0x8000000A 0x00C9FD 2
192.168.6.6     192.168.6.6     1622        0x8000000C 0x00648E 5
                Net Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum
192.168.0.10    192.168.3.3     1772        0x80000002 0x00A2D5
192.168.0.17    192.168.6.6     321         0x80000003 0x0087DA
192.168.0.21    192.168.2.2     308         0x80000003 0x001161
192.168.0.26    192.168.6.6     577         0x80000003 0x00C0A0
                Summary Net Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum
192.168.0.4     192.168.1.1     831         0x80000001 0x008ED7
192.168.0.4     192.168.2.2     796         0x80000001 0x0081E2
192.168.0.12    192.168.4.4     712         0x80000001 0x001741
192.168.0.12    192.168.5.5     442         0x80000001 0x000A4C

Miami#show ip ospf 1 1 database
%OSPF: No area 1 for process 1
```

```
Miami#show ip ospf 1 2 database
%OSPF: No area 2 for process 1

Miami#traceroute 192.168.6.6
Type escape sequence to abort.
Tracing the route to 192.168.6.6
  1 192.168.0.30 8 msec *  8 msec

Miami#traceroute 192.168.1.1
Type escape sequence to abort.
Tracing the route to 192.168.1.1
  1 192.168.0.30 8 msec 8 msec 8 msec
  2 192.168.0.25 8 msec *  8 msec

Miami#Paris
Translating "Paris"
Translating "Paris"
% Unknown command or computer name, or unable to find computer address

Miami#traceroute 192.168.5.5
Type escape sequence to abort.
Tracing the route to 192.168.5.5
  1 192.168.0.30 8 msec 8 msec 8 msec
  2 192.168.0.18 8 msec *  8 msec

Miami#
Miami con0 is now available
Press RETURN to get started.
*Mar  8 01:42:40.899: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
*Mar  8 01:42:40.899: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.2.2 on FastEthernet
```