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# Lab 2 - Dual Stack Routing

## **Purpose**

The purpose of this lab was to familiarize ourselves with running IPv4 and IPv6 simultaneously using OSPF, OSPF v3, RIP, and RIPng as routing protocols. Throughout this lab I was required to set up 8 different networks. In order to successfully ping between them, I had to learn how to redistribute different routing protocols in each IPv4 and IPv6.

## **Background Information on Lab Concepts**

OSPF, or Open Short Path First, is a link-state routing protocol that makes use of a unique domain (single autonomous system, or AS) by gathering information from every router and creating a topology. It uses path cost as its metric. OSPF v3 is a simply variation of OSPF that allows routing between IPv6 addresses.

RIP, or Routing Information Protocol, is a distance-vector routing protocol that allows information to be transferred across the network without routing loops. It also uses hop count as its metric, and the maximum number of hops that a packet may travel is 15. Like OSPF v3, RIPng is a variation of RIP that allows routing between IPv6 addresses.

To run all 4 routing protocols simultaneously, I used an IPv6 implementation called Dual Stack. Dual Stack is a concurrent run of IPv4 and IPv6 addresses with their respective routing protocols; it does not need the encapsulation of IPv6 to IPv4, which is also known as tunneling. Dual Stack, although sometimes difficult to implement, is more efficient than tunneling since IPv4 and IPv6 can run together without interference.

## **Lab Summary**

In this lab, I used a Catalyst 6500 Switch in the middle with 6 different Routers. I configured the top 2 routers with RIP and RIPng and the bottom 4 Routers and Switch with OSPF and OSPF v3. The Switch in the middle acted as a branch for redistribution.

To do this, I had to enable IPv6 unicast-routing on each Router/Switch, set up respective IPv4 and IPv6 addresses, and enable the protocols. Setting up IPv6 was relatively simple; I did not need any additional commands besides **ipv6 unicast-routing** (which allows IPv6 to be enabled on a Router/Switch) and

After my initial setup was completed, I set up the routing protocols, OSPF and OSPF v3 on the bottom Routers and Switch, and RIP and RIPng on the top Routers and Switch.

To ensure that communication between networks, including redistribution, was functioning properly for both IPv4 and IPv6, I used the commands **show ipv6 route** and **show ip route**. Initially, some routers did not have any routes marked as either "R" or "O," so I quickly checked

the absent network portions and troubleshot using the command **show run** and implemented missing commands.

However, as soon as I notice that networks with "O E2" marked next to them were not present, began to troubleshoot for the redistribution commands that were entered. After a considerable amount of time, I realized that the command that needed to be issued was **redistribute ospf 1 metric** command.

Finally, to ensure everything worked properly, I used the **show ip route**, **show ipv6 route**, **tracert**, **and ping** command once again to verify that communication was properly functioning. All the hosts could ping which meant that Dual Stack Routing was enabled successfully.

#### **Lab Commands**

To initially enable IPv6, the command *Router* (config) # ipv6 unicast-routing must be issued on every Router and Switch. Since we are enabling Dual Stack Routing, both IPv4 and IPv6 addresses must be entered on every interface. I simply used the command *Router* (config-if) # ipv6 address [network::number/64] to issue an IPv6 address. The Switch configuration commands are the same as those of Routers. Before doing the next steps, set up RIP and OSPF for IPv4 (as well as the router ids).

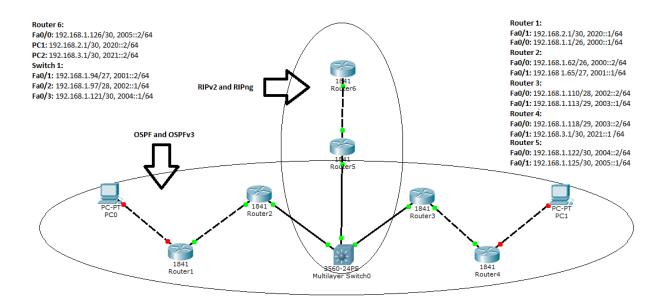
After setting up the IPs, issue the command *Router* (config-if) # ipv6 router rip [name] and on the top two Routers and Switch to enable RIPng. To run dual stack, the RIP for IPv4 must also be configured. Note that RIPng is configured on each interface while RIP is configured on each router (global config mode).

Now we must set up OSPF v3. To do this, issue the command *Router (config) # ipv6 router ospf 1* on the bottom Routers and Switch. This command does not need additional network statements for OSPF v3 to function; the command automatically establishes the network statements. After that, set the router id by issuing the command *Router (config) # router-id [ip address]*.

Finally, we must redistribute routes for RIP and RIPng, and OSPF and RIP to communicate with each other. For IPv4 redistribution, simply type in the commands *Switch* (*config*)# router ospf 1 then *Switch* (*config-rtr*) # redistribute rip subnets. Then, issue the command *Switch* (*config*) # router rip then *Switch* (*config-rtr*) # redistribute ospf 1 metric 10. These two commands will enable redistribution between RIP and OSPF.

For IPv6 (RIPng and OSPF v3), after typing the command Switch (config)# ipv6 router ospf 1, which directs us to Switch (config-rtr) #, issue the command Switch (config-rtr) # redistribute rip cisco metric 10. Do the same for RIP: after typing Switch (config) # ipv6 router rip cisco, issue the command Switch (config) # redistribute ospf 1 metric 10. These two commands will allow redistribution between RIPng and OSPF v3.

### **Network Diagram with IP's**



Note: On the Switch, the interfaces were fa4/1, fa4/2, and fa4/3. The area id for OSPF and OSPF v3 is 1.

## **Configurations**

# Ping and Tracert between both PCs and Router 6

```
Administrator: C:\Windows\system32\cmd.exe
  Pinging 2005::2 with 32 bytes of data:
leply from 2005::2: time=4ms
leply from 2005::2: time=ims
leply from 2005::2: time=ims
leply from 2005::2: time=ims
Ping statistics for 2005::2:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 4ms, Average = 1ms
  ::\Users\Admin>ping 2021::2
 Pinging 2021::2 with 32 bytes of data:
Reply from 2021::2: time-Ims
Reply from 2021::2: time-Ims
Reply from 2021::2: time-Ims
Reply from 2021::2: time-Ims
Ping statistics for 2021::2:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli—seconds:
Minimum = 1ms, Maximum = 1ms, Average = 1ms
  ::\Users\Admin>ping 192.168.1.126
Ping statistics for 192.168.1.126:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 1ms, Average = 1ms
        JSEPS (Admin)
Users\Admin)
Users\Admin)
Users\Admin)
Users\Admin)ping 192.168.3.2
Ping statistics for 192.168.3.2:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 1ms, Average = 1ms
C:\Users\Admin>tracert 2021::1
Tracing route to 2021::1 over a maximum of 30 hops
                2 ms <1 ms <1 ms 2020:1

1 ms <1 ms <1 ms 2000:1

<1 ms <1 ms <1 ms 2000:2

× × × Request

1 ms 1 ms <1 ms 2003:2

4 ms 1 ms 1 ms 2021::2
    :\Users\Admin>_
```

## PC1 ipconfig

```
Administrator: C:\Windows\system32\cmd.exe
                  1 ms
                          <1 ms
Trace complete.
C:\Users\Admin>ipconfig
Windows IP Configuration
Ethernet adapter Local Area Connection:
   Connection-specific DNS Suffix
IPv6 Address
IPv6 Address
IPv6 Address
Iemporary IPv6 Address
Link-local IPv6 Address
IPv4 Address
Subnet Mask
Default Gateway
Ethernet adapter UMware Network Adapter UMnet1:
   Ethernet adapter UMware Network Adapter UMnet8:
   Tunnel adapter isatap.{AACE8791-5527-4A5A-9310-04
   Media State . . . . . . . . . . . . Media disc
Connection-specific DNS Suffix . :
Tunnel adapter isatap.{E2CC3B72-E264-498A-89F8-43
   Tunnel adapter isatap.<647D2DBA-1FC7-4380-BC04-CA
   Tunnel adapter Teredo Tunneling Pseudo-Interface:
   Media State . . . . . . . . . . . . . Media disc
Connection-specific DNS Suffix . :
C:\Users\Admin>
```

# PC2 ipconfig

```
Administrator: C:\Windows\system32\cmd.exe
   \Users\Admin>ipconfig
Windows IP Configuration
Ethernet adapter Local Area Connection:
   2021::2
2021::cdef:1f3c:7edf:3c5a
2021::b9f0:cb68:6ee6:a8ad
fe80::cdef:1f3c:7edf:3c5ax11
192-168-3-2
255-255-255.252
2021::1
fe80::4255:39ff:feb7:61e9x11
192-168-3-1
Ethernet adapter UMware Network Adapter UMnet1:
   Connection-specific DNS Suffix . :
Link-local IPv6 Address . . . . : fe80::201c:d6fe:aae3:e8e7%12
IPv4 Address . . . . . . . : 192.168.112.1
Subnet Mask . . . . . . . : 255.255.25
Default Gateway . . . . . . . . . :
Ethernet adapter UMware Network Adapter UMnet8:
   Connection—specific DNS Suffix . :
Link—local IPv6 Address . . . . : fe80::517c:c367:6816:faac%13
IPv4 Address . . . . . . : 192.168.146.1
Subnet Mask . . . . . . : 255.255.25
Tunnel adapter isatap.<AACE8791-5527-4A5A-9310-049B51E260FC>:
    Media State . . . . . . . . . . . . . . . Media disconnected Connection—specific DNS Suffix . :
Tunnel adapter isatap.<E2CC3B72-E264-498A-89F8-43E763E78808>:
   Tunnel adapter isatap.<647D2DBA-1FC7-4380-BC04-CAD7D63A093A>:
   Tunnel adapter Teredo Tunneling Pseudo-Interface:
    Media State . . . . . . . . . . . . . . . Media disconnected Connection-specific DNS Suffix . :
C:\Users\Admin>
```

# IPv4 tracert and ping

# Router/Switch show run and show ip route / show ipv6 route

```
ipv6 unicast-routing
Router 1
                                               ipv6 cef
Building configuration...
                                               ip source-route
                                               ip cef
Current configuration: 1496 bytes
! Last configuration change at 14:55:17
UTC Fri Sep 20 2013
version 15.1
no service timestamps debug uptime
                                               multilink bundle-name authenticated
no service timestamps log uptime
no service password-encryption
                                               crypto pki token default removal
hostname R1
                                               timeout 0
1
!
no aaa new-model
                                               license udi pid CISCO2901/K9 sn
memory-size iomem 10
                                               FTX1704Y03B
```

```
192.168.1.0/26 is directly
                                               connected, GigabitEthernet0/0
interface GigabitEthernet0/0
                                                       192.168.1.1/32 is directly
 ip address 192.168.1.1 255.255.255.192
                                               connected, GigabitEthernet0/0
duplex auto
                                                        192.168.1.64/27
 speed auto
                                                          [110/2] via 192.168.1.62,
ipv6 address 2000::1/64
                                               01:06:26, GigabitEthernet0/0
ipv6 ospf 1 area 0
                                                        192.168.1.96/28
1
                                                          [110/3] via 192.168.1.62,
interface GigabitEthernet0/1
                                               01:06:26, GigabitEthernet0/0
ip address 192.168.2.5 255.255.252
                                                        192.168.1.112/29
duplex auto
                                                          [110/4] via 192.168.1.62,
speed auto
                                               01:05:48, GigabitEthernet0/0
ipv6 address 2020::1/64
                                                        192.168.1.120/30
ipv6 ospf 1 area 0
                                                          [110/20] via 192.168.1.62,
                                               01:06:26, GigabitEthernet0/0
router ospf 1
                                               O E2 192.168.1.124/30
router-id 192.168.1.1
                                                          [110/20] via 192.168.1.62,
network 192.168.1.0 0.0.0.63 area 0
                                               00:36:28, GigabitEthernet0/0
network 192.168.2.4 0.0.0.3 area 0
                                                    192.168.2.0/24 is variably
                                               subnetted, 2 subnets, 2 masks
ip forward-protocol nd
                                                       192.168.2.4/30 is directly
                                               connected, GigabitEthernet0/1
no ip http server
                                                       192.168.2.5/32 is directly
no ip http secure-server
                                               connected, GigabitEthernet0/1
                                                    192.168.3.0/30 is subnetted, 1
                                               subnets
ipv6 router ospf 1
                                                        192.168.3.0 [110/5] via
                                               \cap
router-id 192.168.1.1
                                               192.168.1.62, 01:05:48,
                                               GigabitEthernet0/0
!
                                               IPv6 Routing Table - default - 10
                                               entries
control-plane
                                               Codes: C - Connected, L - Local, S -
                                               Static, U - Per-user Static route
                                                     B - BGP, R - RIP, I1 - ISIS L1,
                                               I2 - ISIS L2
line con 0
                                                     IA - ISIS interarea, IS - ISIS
line aux 0
                                               summary, D - EIGRP, EX - EIGRP external
                                                     ND - Neighbor Discovery, 1 -
no activation-character
                                               LISP
no exec
                                                      O - OSPF Intra, OI - OSPF Inter,
transport preferred none
                                               OE1 - OSPF ext 1, OE2 - OSPF ext 2
transport input all
                                                     ON1 - OSPF NSSA ext 1, ON2 -
transport output pad telnet rlogin
                                               OSPF NSSA ext 2
lapb-ta mop udptn v120 ssh
                                               C 2000::/64 [0/0]
stopbits 1
                                                    via GigabitEthernet0/0, directly
line vty 0 4
                                               connected
login
                                                  2000::1/128 [0/0]
transport input all
                                                    via GigabitEthernet0/0, receive
                                                 2001::/64 [110/2]
scheduler allocate 20000 1000
                                                   via FE80::217:E0FF:FE51:B2B0,
                                               GigabitEthernet0/0
                                                  2002::/64 [110/3]
                                                    via FE80::217:E0FF:FE51:B2B0,
                                               GigabitEthernet0/0
      192.168.1.0/24 is variably
                                                  2003::/64 [110/4]
subnetted, 7 subnets, 6 masks
                                                    via FE80::217:E0FF:FE51:B2B0,
                                               GigabitEthernet0/0
```

```
OE2 2005::/64 [110/10]
                                                  via GigabitEthernet0/1, receive
    via FE80::217:E0FF:FE51:B2B0,
                                            0 2021::/64 [110/5]
GigabitEthernet0/0
                                                   via FE80::217:E0FF:FE51:B2B0,
C 2020::/64 [0/0]
                                              GigabitEthernet0/0
    via GigabitEthernet0/1, directly
                                              L FF00::/8 [0/0]
connected
                                                   via NullO, receive
L 2020::1/128 [0/0]
                                               network 192.168.1.0 0.0.0.63 area 0
                                               network 192.168.1.64 0.0.0.31 area 0
                                              1
Router 2
                                              ip forward-protocol nd
Current configuration: 1619 bytes
                                              no ip http server
                                              no ip http secure-server
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
                                              ipv6 router ospf 1
                                               router-id 192.168.1.65
hostname R2
                                               log-adjacency-changes
boot-start-marker
boot-end-marker
                                              control-plane
logging message-counter syslog
                                              line con 0
no aaa new-model
                                              line aux 0
memory-size iomem 10
                                              line vty 0 4
                                               login
dot11 syslog
ip source-route
                                              scheduler allocate 20000 1000
1
1
ip cef
                                              IPv6 Routing Table - Default - 11
                                              entries
ipv6 unicast-routing
                                              Codes: C - Connected, L - Local, S -
ipv6 cef
                                              Static, U - Per-user Static route
                                                     B - BGP, M - MIPv6, R - RIP, I1
                                              - ISIS L1
interface FastEthernet0/0
                                                     I2 - ISIS L2, IA - ISIS
ip address 192.168.1.62
                                              interarea, IS - ISIS summary, D - EIGRP
255.255.255.192
                                                     EX - EIGRP external
duplex auto
                                                     O - OSPF Intra, OI - OSPF Inter,
speed auto
                                              OE1 - OSPF ext 1, OE2 - OSPF ext 2
ipv6 address 2000::2/64
                                                    ON1 - OSPF NSSA ext 1, ON2 -
                                              OSPF NSSA ext 2
ipv6 ospf 1 area 0
                                              C 2000::/64 [0/0]
interface FastEthernet0/1
                                                   via FastEthernet0/0, directly
ip address 192.168.1.65
                                              connected
255.255.255.224
                                              L 2000::2/128 [0/0]
duplex auto
                                                   via FastEthernet0/0, receive
speed auto
                                                2001::/64 [0/0]
ipv6 address 2001::1/64
                                                  via FastEthernet0/1, directly
ipv6 ospf 1 area 0
                                              connected
                                              L 2001::1/128 [0/0]
                                                   via FastEthernet0/1, receive
router ospf 1
                                              0 2002::/64 [110/2]
router-id 192.168.1.65
```

log-adjacency-changes

```
via FE80::2D0:2BFF:FE15:110A,
                                                o - ODR, P - periodic downloaded
FastEthernet0/1
                                         static route
0 2003::/64 [110/3]
    via FE80::2D0:2BFF:FE15:110A,
                                         Gateway of last resort is not set
FastEthernet0/1
0 2004::/64 [110/2]
                                              192.168.1.0/24 is variably
    via FE80::2D0:2BFF:FE15:110A, subnetted, 6 subnets, 5 masks
FastEthernet0/1
                                         O 192.168.1.96/28 [110/2] via
OE2 2005::/64 [110/10]
                                         192.168.1.94, 01:15:18, FastEthernet0/1
                                         O E2 192.168.1.120/30 [110/20] via
    via FE80::2D0:2BFF:FE15:110A,
FastEthernet0/1
                                          192.168.1.94, 01:15:18, FastEthernet0/1
0 2020::/64 [110/2]
                                         O E2 192.168.1.124/30 [110/20] via
   via FE80::AEF2:C5FF:FE55:9788,
                                         192.168.1.94, 00:45:18, FastEthernet0/1
FastEthernet0/0
                                         O 192.168.1.112/29 [110/3] via
0 2021::/64 [110/4]
                                         192.168.1.94, 01:14:38, FastEthernet0/1
   via FE80::2D0:2BFF:FE15:110A,
                                         C 192.168.1.64/27 is directly
                                          connected, FastEthernet0/1
FastEthernet0/1
L FF00::/8 [0/0]
                                          C 192.168.1.0/26 is directly
    via NullO, receive
                                         connected, FastEthernet0/0
                                              192.168.2.0/30 is subnetted, 1
                                          subnets
Codes: C - connected, S - static, R -
                                         O 192.168.2.4 [110/2] via
RIP, M - mobile, B - BGP
                                         192.168.1.1, 01:15:09, FastEthernet0/0
     D - EIGRP, EX - EIGRP external,
                                              192.168.3.0/30 is subnetted, 1
O - OSPF, IA - OSPF inter area
                                         subnets
     N1 - OSPF NSSA external type 1,
                                        O 192.168.3.0 [110/4] via
N2 - OSPF NSSA external type 2
                                         192.168.1.94, 01:14:39, FastEthernet0/1
    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
```

#### **Router 3**

route

```
Current configuration: 1454 bytes
                                            ip cef
version 12.4
                                            no ip domain lookup
no service timestamps debug uptime
no service timestamps log uptime
                                            ipv6 unicast-routing
no service password-encryption
                                            ipv6 cef
hostname R3
                                             multilink bundle-name authenticated
boot-start-marker
boot-end-marker
logging message-counter syslog
no aaa new-model
memory-size iomem 10
                                             interface FastEthernet0/0
1
                                             ip address 192.168.1.110
dot11 syslog
                                             255.255.255.240
ip source-route
                                             duplex auto
                                              speed auto
```

```
ipv6 ospf 1 area 0
                                              192.168.1.97, 01:16:06, FastEthernet0/0
                                              O E2 192.168.1.124/30 [110/20] via
                                              192.168.1.97, 00:46:36, FastEthernet0/0
interface FastEthernet0/1
ip address 192.168.1.113
                                              C 192.168.1.112/29 is directly
255.255.255.248
                                              connected, FastEthernet0/1
                                              O 192.168.1.64/27 [110/2] via
duplex auto
speed auto
                                              192.168.1.97, 01:16:06, FastEthernet0/0
ipv6 address 2003::1/64
                                              O 192.168.1.0/26 [110/3] via
ipv6 ospf 1 area 0
                                              192.168.1.97, 01:16:06, FastEthernet0/0
                                                  192.168.2.0/30 is subnetted, 1
router ospf 1
                                              subnets
                                                     192.168.2.4 [110/4] via
router-id 192.168.1.113
log-adjacency-changes
                                              192.168.1.97, 01:16:07, FastEthernet0/0
network 192.168.1.96 0.0.0.15 area 0
                                                  192.168.3.0/30 is subnetted, 1
network 192.168.1.112 0.0.0.7 area 0
                                              subnets
                                                    192.168.3.0 [110/2] via
ip forward-protocol nd
                                              192.168.1.118, 01:15:57,
no ip http server
                                              FastEthernet0/1
no ip http secure-server
1
1
                                              IPv6 Routing Table - Default - 11
                                              entries
ipv6 router ospf 1
                                              Codes: C - Connected, L - Local, S -
router-id 192.168.1.113
                                              Static, U - Per-user Static route
log-adjacency-changes
                                                    B - BGP, M - MIPv6, R - RIP, I1
                                              - ISIS L1
                                                    I2 - ISIS L2, IA - ISIS
1
                                              interarea, IS - ISIS summary, D - EIGRP
!
line con 0
                                                    EX - EIGRP external
                                                    O - OSPF Intra, OI - OSPF Inter,
line aux 0
line vty 0 4
                                              OE1 - OSPF ext 1, OE2 - OSPF ext 2
                                                     ON1 - OSPF NSSA ext 1, ON2 -
login
                                              OSPF NSSA ext 2
1
end
                                              0 2000::/64 [110/3]
                                                  via FE80::2D0:2BFF:FE15:110A,
Codes: C - connected, S - static, R -
                                              FastEthernet0/0
RIP, M - mobile, B - BGP
                                              0 2001::/64 [110/2]
     D - EIGRP, EX - EIGRP external,
                                                  via FE80::2D0:2BFF:FE15:110A,
O - OSPF, IA - OSPF inter area
                                              FastEthernet0/0
     N1 - OSPF NSSA external type 1,
                                              C 2002::/64 [0/0]
N2 - OSPF NSSA external type 2
                                                  via FastEthernet0/0, directly
      E1 - OSPF external type 1, E2 -
                                             connected
                                             L 2002::2/128 [0/0]
OSPF external type 2
      i - IS-IS, su - IS-IS summary,
                                                  via FastEthernet0/0, receive
L1 - IS-IS level-1, L2 - IS-IS level-2
                                            C 2003::/64 [0/0]
      ia - IS-IS inter area, * -
                                                  via FastEthernet0/1, directly
candidate default, U - per-user static
                                              connected
                                              L 2003::1/128 [0/0]
      o - ODR, P - periodic downloaded
                                                  via FastEthernet0/1, receive
                                              0 2004::/64 [110/2]
static route
                                                  via FE80::2D0:2BFF:FE15:110A,
Gateway of last resort is not set
                                            FastEthernet0/0
                                              OE2 2005::/64 [110/10]
    192.168.1.0/24 is variably
                                                  via FE80::2D0:2BFF:FE15:110A,
subnetted, 6 subnets, 5 masks FastEthernet0/0 C 192.168.1.96/28 is directly O 2020::/64 [110/4]
connected, FastEthernet0/0
```

ipv6 address 2002::2/64

O E2 192.168.1.120/30 [110/20] via

#### **Router 4**

```
Current configuration: 1290 bytes
                                               log-adjacency-changes
                                               network 192.168.1.112 0.0.0.7 area 0
                                               network 192.168.3.0 0.0.0.3 area 0
version 15.0
no service timestamps debug uptime
                                               ip forward-protocol nd
no service timestamps log uptime
no service password-encryption
                                               no ip http server
!
                                               no ip http secure-server
hostname R4
!
boot-start-marker
                                               ipv6 router ospf 1
boot-end-marker
                                               router-id 192.168.1.112
                                               log-adjacency-changes
no aaa new-model
                                               line con 0
                                               line aux 0
                                               line vty 0 4
memory-size iomem 25
                                               login
ipv6 unicast-routing
                                               scheduler allocate 20000 1000
ipv6 cef
                                               end
ip source-route
ip cef
                                               Codes: L - local, 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 -
interface GigabitEthernet0/0
                                               OSPF external type 2
ip address 192.168.1.118
                                                     i - IS-IS, su - IS-IS summary,
255.255.255.248
                                               L1 - IS-IS level-1, L2 - IS-IS level-2
                                                     ia - IS-IS inter area, * -
duplex auto
speed auto
                                               candidate default, U - per-user static
ipv6 address 2003::2/64
ipv6 ospf 1 area 0
                                                      o - ODR, P - periodic downloaded
                                               static route, + - replicated route
interface GigabitEthernet0/1
                                               Gateway of last resort is not set
 ip address 192.168.3.1 255.255.255.252
duplex auto
                                                    192.168.1.0/24 is variably
                                               subnetted, 7 subnets, 6 masks
speed auto
ipv6 address 2021::1/64
                                                 192.168.1.0/26
ipv6 ospf 1 area 0
                                                         [110/4] via 192.168.1.113,
                                               01:17:33, GigabitEthernet0/0
1
                                                      192.168.1.64/27
                                                         [110/3] via 192.168.1.113,
router ospf 1
router-id 192.168.1.112
                                               01:17:33, GigabitEthernet0/0
```

```
192.168.1.96/28
                                                 O - OSPF Intra, OI - OSPF Inter,
         [110/2] via 192.168.1.113, OE1 - OSPF ext 1, OE2 - OSPF ext 2
01:17:33, GigabitEthernet0/0
                                                 ON1 - OSPF NSSA ext 1, ON2 -
C 192.168.1.112/29 is directly OSPF NSSA ext 2
                                           0 2000::/64 [110/4]
connected, GigabitEthernet0/0
L 192.168.1.118/32 is directly
                                               via FE80::218:19FF:FECD:92C9,
connected, GigabitEthernet0/0
                                           GigabitEthernet0/0
O E2 192.168.1.120/30
                                           0 2001::/64 [110/3]
         [110/20] via 192.168.1.113,
                                               via FE80::218:19FF:FECD:92C9,
01:17:33, GigabitEthernet0/0
                                           GigabitEthernet0/0
O E2 192.168.1.124/30
                                           0 2002::/64 [110/2]
         [110/20] via 192.168.1.113,
                                               via FE80::218:19FF:FECD:92C9,
00:48:12, GigabitEthernet0/0
                                         GigabitEthernet0/0
    192.168.2.0/30 is subnetted, 1
                                          C 2003::/64 [0/0]
                                               via GigabitEthernet0/0, directly
        192.168.2.4 [110/5] via
                                          connected
192.168.1.113, 01:17:34,
                                           L 2003::2/128 [0/0]
GigabitEthernet0/0
                                               via GigabitEthernet0/0, receive
    192.168.3.0/24 is variably
                                         0 2004::/64 [110/3]
subnetted, 2 subnets, 2 masks
                                               via FE80::218:19FF:FECD:92C9,
C 192.168.3.0/30 is directly
                                         GigabitEthernet0/0
                                          OE2 2005::/64 [110/10]
connected, GigabitEthernet0/1
L 192.168.3.1/32 is directly
                                               via FE80::218:19FF:FECD:92C9,
connected, GigabitEthernet0/1
                                         GigabitEthernet0/0
                                           0 2020::/64 [110/5]
                                               via FE80::218:19FF:FECD:92C9,
IPv6 Routing Table - default - 11
                                         GigabitEthernet0/0
entries
                                          C 2021::/64 [0/0]
Codes: C - Connected, L - Local, S -
                                               via GigabitEthernet0/1, directly
Static, U - Per-user Static route
                                          connected
      B - BGP, HA - Home Agent, MR -
                                         L 2021::1/128 [0/0]
Mobile Router, R - RIP
                                               via GigabitEthernet0/1, receive
      I1 - ISIS L1, I2 - ISIS L2, IA - L FF00::/8 [0/0]
ISIS interarea, IS - ISIS summary
                                              via NullO, receive
     D - EIGRP, EX - EIGRP external,
ND - Neighbor Discovery
Router 5
Current configuration: 1464 bytes
                                           ipv6 unicast-routing
                                           ipv6 cef
version 15.0
                                           ip source-route
service timestamps debug datetime msec
                                           ip cef
service timestamps log datetime msec
no service password-encryption
1
                                           interface Tunnel0
hostname R5
                                           no ip address
boot-start-marker
                                            ipv6 address 2010::1/64
boot-end-marker
                                            tunnel source GigabitEthernet0/1
                                            tunnel destination 192.168.1.126
                                            !
no aaa new-model
                                           interface GigabitEthernet0/0
!
                                           ip address 192.168.1.122
                                           255.255.255.252
```

duplex auto

memory-size iomem 10

```
ipv6 address 2004::2/64
                                              subnetted, 8 subnets, 6 masks
 ipv6 rip cisco enable
                                                       192.168.1.0/26
                                                         [120/10] via 192.168.1.121,
1
                                              00:00:22, GigabitEthernet0/0
!
interface GigabitEthernet0/1
                                                       192.168.1.64/27
ip address 192.168.1.125
                                                         [120/1] via 192.168.1.121,
255.255.255.252
                                              00:00:22, GigabitEthernet0/0
duplex auto
                                                      192.168.1.96/28
speed auto
                                                        [120/1] via 192.168.1.121,
ipv6 address 2005::1/64
                                              00:00:22, GigabitEthernet0/0
ipv6 rip cisco enable
                                                      192.168.1.112/29
                                                        [120/10] via 192.168.1.121,
!
                                              00:00:22, GigabitEthernet0/0
                                                      192.168.1.120/30 is directly
                                              connected, GigabitEthernet0/0
                                                     192.168.1.122/32 is directly
router rip
version 2
                                              connected, GigabitEthernet0/0
                                                 192.168.1.124/30 is directly
network 192.168.1.0
no auto-summary
                                              connected, GigabitEthernet0/1
                                              L 192.168.1.125/32 is directly
                                              connected, GigabitEthernet0/1
ip forward-protocol nd
                                                   192.168.2.0/30 is subnetted, 1
no ip http server
                                              subnets
no ip http secure-server
                                              R 192.168.2.4 [120/10] via
                                              192.168.1.121, 00:00:23,
                                              GigabitEthernet0/0
ipv6 router rip cisco
                                                  192.168.3.0/30 is subnetted, 1
                                              subnets
                                              R 192.168.3.0 [120/10] via
                                              192.168.1.121, 00:00:23,
line con 0
line aux 0
                                              GigabitEthernet0/0
line vty 0 4
login
!
                                              IPv6 Routing Table - default - 11
scheduler allocate 20000 1000
                                              Codes: C - Connected, L - Local, S -
                                              Static, U - Per-user Static route
                                                    B - BGP, HA - Home Agent, MR -
Codes: L - local, C - connected, S -
                                              Mobile Router, R - RIP
static, R - RIP, M - mobile, B - BGP
                                                    I1 - ISIS L1, I2 - ISIS L2, IA -
      D - EIGRP, EX - EIGRP external,
                                              ISIS interarea, IS - ISIS summary
O - OSPF, IA - OSPF inter area
                                                    D - EIGRP, EX - EIGRP external,
      N1 - OSPF NSSA external type 1,
                                              ND - Neighbor Discovery
N2 - OSPF NSSA external type 2
                                                   O - OSPF Intra, OI - OSPF Inter,
     E1 - OSPF external type 1, E2 -
                                              OE1 - OSPF ext 1, OE2 - OSPF ext 2
                                                    ON1 - OSPF NSSA ext 1, ON2 -
OSPF external type 2
      i - IS-IS, su - IS-IS summary,
                                              OSPF NSSA ext 2
L1 - IS-IS level-1, L2 - IS-IS level-2
                                              R 2000::/64 [120/11]
      ia - IS-IS inter area, * -
                                                   via FE80::2D0:2BFF:FE15:110A,
candidate default, U - per-user static
                                              GigabitEthernet0/0
                                              R 2001::/64 [120/2]
       o - ODR, P - periodic downloaded
                                                  via FE80::2D0:2BFF:FE15:110A,
static route, + - replicated route
                                              GigabitEthernet0/0
                                              R 2002::/64 [120/2]
Gateway of last resort is not set
                                                   via FE80::2D0:2BFF:FE15:110A,
                                              GigabitEthernet0/0
                                              R 2003::/64 [120/11]
```

speed auto

192.168.1.0/24 is variably

```
L 2005::1/128 [0/0]
    via FE80::2D0:2BFF:FE15:110A,
GigabitEthernet0/0
                                                 via GigabitEthernet0/1, receive
  2004::/64 [0/0]
                                             R 2020::/64 [120/11]
    via GigabitEthernet0/0, directly
                                                 via FE80::2D0:2BFF:FE15:110A,
                                             GigabitEthernet0/0
connected
L 2004::2/128 [0/0]
                                             R 2021::/64 [120/11]
    via GigabitEthernet0/0, receive
                                                 via FE80::2D0:2BFF:FE15:110A,
  2005::/64 [0/0]
                                            GigabitEthernet0/0
    via GigabitEthernet0/1, directly
                                            L FF00::/8 [0/0]
                                                via NullO, receive
connected
```

#### **Router 6**

```
Current configuration: 1957 bytes
                                              router rip
                                               version 2
version 12.4
                                               network 192.168.1.0
no service timestamps debug uptime
                                               no auto-summary
no service timestamps log uptime
no service password-encryption
                                              ip forward-protocol nd
                                              no ip http server
hostname R6
                                               no ip http secure-server
boot-start-marker
boot-end-marker
!
                                              ipv6 router ospf 1
logging message-counter syslog
                                               router-id 192.168.1.126
                                               log-adjacency-changes
no aaa new-model
memory-size iomem 10
                                               ipv6 router rip cisco
no network-clock-participate slot 1
!
dot11 syslog
ip source-route
                                               line con 0
                                               line aux 0
                                               line vty 0 4
                                               login
ip cef
                                               scheduler allocate 20000 1000
ipv6 unicast-routing
ipv6 cef
                                               Codes: C - connected, S - static, R -
                                               RIP, M - mobile, B - BGP
archive
                                                     D - EIGRP, EX - EIGRP external,
log config
                                               O - OSPF, IA - OSPF inter area
hidekeys
                                                    N1 - OSPF NSSA external type 1,
                                               N2 - OSPF NSSA external type 2
                                                     E1 - OSPF external type 1, E2 -
interface FastEthernet0/0
ip address 192.168.1.126
                                               OSPF external type 2
255.255.255.252
                                                     i - IS-IS, su - IS-IS summary,
                                               L1 - IS-IS level-1, L2 - IS-IS level-2
duplex auto
speed auto
                                                     ia - IS-IS inter area, * -
ipv6 address 2005::2/64
                                               candidate default, U - per-user static
ipv6 rip cisco enable
                                                      o - ODR, P - periodic downloaded
1
router ospf 1
                                               static route
router-id 192.168.1.126
log-adjacency-changes
                                               Gateway of last resort is not set
```

```
B - BGP, M - MIPv6, R - RIP, I1
    192.168.1.0/24 is variably
subnetted, 6 subnets, 5 masks
                                           - ISIS L1
R 192.168.1.96/28 [120/2] via
                                                 I2 - ISIS L2, IA - ISIS
192.168.1.125, 00:00:18,
                                            interarea, IS - ISIS summary, D - EIGRP
FastEthernet0/0
                                                EX - EIGRP external
R 192.168.1.120/30 [120/1] via
                                                 O - OSPF Intra, OI - OSPF Inter,
192.168.1.125, 00:00:18,
                                            OE1 - OSPF ext 1, OE2 - OSPF ext 2
FastEthernet0/0
                                                  ON1 - OSPF NSSA ext 1, ON2 -
    192.168.1.124/30 is directly
                                          OSPF NSSA ext 2
connected, FastEthernet0/0
                                           R 2000::/64 [120/12]
R 192.168.1.112/29 [120/11] via
                                                via FE80::EAB7:48FF:FE6E:89,
192.168.1.125, 00:00:18,
                                           FastEthernet0/0
FastEthernet0/0
                                          R 2002::/64 [120/3]
    192.168.1.64/27 [120/2] via
                                               via FE80::EAB7:48FF:FE6E:89,
192.168.1.125, 00:00:18,
                                           FastEthernet0/0
FastEthernet0/0
                                           R 2003::/64 [120/12]
                                                via FE80::EAB7:48FF:FE6E:89,
    192.168.1.0/26 [120/11] via
                                          FastEthernet0/0
192.168.1.125, 00:00:18,
                                          R 2004::/64 [120/2]
FastEthernet0/0
                                               via FE80::EAB7:48FF:FE6E:89,
    192.168.2.0/30 is subnetted, 1
                                          FastEthernet0/0
                                          C 2005::/64 [0/0]
subnets
R 192.168.2.4 [120/11] via
                                               via FastEthernet0/0, directly
192.168.1.125, 00:00:20,
                                          connected
FastEthernet0/0
                                           L 2005::2/128 [0/0]
    192.168.3.0/30 is subnetted, 1
                                               via FastEthernet0/0, receive
                                           R 2020::/64 [120/12]
subnets
R 192.168.3.0 [120/11] via
                                               via FE80::EAB7:48FF:FE6E:89,
192.168.1.125, 00:00:20,
                                           FastEthernet0/0
FastEthernet0/0
                                           R 2021::/64 [120/12]
                                                via FE80::EAB7:48FF:FE6E:89,
                                           FastEthernet0/0
IPv6 Routing Table - Default - 9
                                           L FF00::/8 [0/0]
                                               via NullO, receive
Codes: C - Connected, L - Local, S -
Static, U - Per-user Static route
Switch 1
Building configuration...
                                            1
Current configuration: 16931 bytes
                                           ipv6 unicast-routing
upgrade fpd auto
version 12.2
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
service counters max age 5
!
                                           vlan internal allocation policy
hostname S1
                                            ascending
!
boot system slot0:s222-
adventerprisek9 wan-mz.122-
18.SXF17b.bin
!
no aaa new-model
                                           interface FastEthernet4/1
```

ip subnet-zero

```
ip address 192.168.1.94
                                              Codes: C - Connected, L - Local, S -
255.255.255.224
                                              Static, R - RIP, B - BGP
ipv6 address 2001::2/64
                                                    U - Per-user Static route
ipv6 ospf 1 area 0
                                                     I1 - ISIS L1, I2 - ISIS L2, IA -
                                              ISIS interarea, IS - ISIS summary
no shutdown
                                                    O - OSPF intra, OI - OSPF inter,
                                              OE1 - OSPF ext 1, OE2 - OSPF ext 2
interface FastEthernet4/2
ip address 192.168.1.97
                                                     ON1 - OSPF NSSA ext 1, ON2 -
                                              OSPF NSSA ext 2
255.255.255.240
ipv6 address 2002::1/64
                                              0 2000::/64 [110/2]
ipv6 ospf 1 area 0
                                                   via FE80::217:E0FF:FE51:B2B1,
no shutdown
                                              FastEthernet4/1
                                              C 2001::/64 [0/0]
interface FastEthernet4/3
                                                  via ::, FastEthernet4/1
ip address 192.168.1.121
                                              L 2001::2/128 [0/0]
255.255.255.252
                                                  via ::, FastEthernet4/1
                                              C 2002::/64 [0/0]
ipv6 address 2004::1/64
ipv6 rip cisco enable
                                                   via ::, FastEthernet4/2
                                              L 2002::1/128 [0/0]
no shutdown
                                                  via ::, FastEthernet4/2
                                              0 2003::/64 [110/2]
router ospf 1
router-id 192.168.1.121
                                                  via FE80::218:19FF:FECD:92C8,
log-adjacency-changes
                                              FastEthernet4/2
redistribute rip subnets
                                              C 2004::/64 [0/0]
network 192.168.1.64 0.0.0.31 area 0
                                                  via ::, FastEthernet4/3
network 192.168.1.96 0.0.0.15 area 0
                                              L 2004::1/128 [0/0]
                                                  via ::, FastEthernet4/3
                                              R 2005::/64 [120/2]
router rip
version 2
                                                  via FE80::EAB7:48FF:FE6E:88,
redistribute ospf 1 metric 10
                                              FastEthernet4/3
network 192.168.1.0
                                              0 2020::/64 [110/3]
no auto-summary
                                                   via FE80::217:E0FF:FE51:B2B1,
                                              FastEthernet4/1
1
                                              0 2021::/64 [110/3]
ip classless
                                                   via FE80::218:19FF:FECD:92C8,
no ip http server
                                              FastEthernet4/2
                                              L FE80::/10 [0/0]
ipv6 router ospf 1
                                                  via ::, Null0
router-id 192.168.1.121
                                              L FF00::/8 [0/0]
log-adjacency-changes
                                                  via ::, Null0
redistribute rip cisco metric 10
                                              Codes: C - connected, S - static, R -
ipv6 router rip cisco
redistribute ospf 1 metric 10
                                              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
line con 0
line vty 0 4
                                                    E1 - OSPF external type 1, E2 -
                                              OSPF external type 2, E - EGP
login
                                                    i - IS-IS, su - IS-IS summary,
                                              L1 - IS-IS level-1, L2 - IS-IS level-2
no cns aaa enable
                                                     ia - IS-IS inter area, * -
end
                                              candidate default, U - per-user static
                                                     o - ODR, P - periodic downloaded
IPv6 Routing Table - 13 entries
                                              static route
```

```
C 192.168.1.64/27 is directly
Gateway of last resort is not set
                                                                                                                                                                                          connected, FastEthernet4/1
connected - 15 variably subjected, 6 subnets, 5 masks

C 192.168.1.96/28 is directly connected, FastEthernet4/2

C 192.168.1.120/30 - Connected - Conn
                                                                                                                                                                                         O 192.168.1.0/26 [110/2] via
                                                                                                                                                                                    192.168.1.65, 00:58:18, FastEthernet4/1 192.168.2.0/30 is subnetted, 1 subnets
C 192.168.1.120/30 is directly 0 192.168.2.4 [110/3] via
                                                                                                                                                                                          192.168.1.65, 00:58:19, FastEthernet4/1
                                                                                                                                                                                      192
subnets
R 192.168.1.124/30 [120/1] via
                                                                                                                                                                                                                     192.168.3.0/30 is subnetted, 1
 192.168.1.122, 00:00:05,
                                                                                                                                                                                          0
 FastEthernet4/3
                                                                                                                                                                                                                                192.168.3.0 [110/3] via
O 192.168.1.112/29 [110/2] via 192.168.1.110, 00:58:19,
 192.168.1.110, 00:58:18,
                                                                                                                                                                                           FastEthernet4/2
 FastEthernet4/2
```

#### **Problems**

Problems with redistribution were prevalent in this lab. As I mentioned earlier, network statements with "O E2" were not showing up on any routers and I could not ping nor trace route between any of the top Routers with the bottom routers. The process of researching the appropriate protocols consumed more time than I expected. I eventually reached the point where all routes were present except the redistribution and thus had to struggle to fix the redistribution problems.

### Conclusion

Although the lab consumed more time than I had expected due to the difficulty with redistributing different routing protocols, the overall result of this lab was satisfactory. I enabled the concurrent run on IPv4 and IPv6 on every network present being able to ping and trace route from one end to the other. I've learned how to manage OSPF, OSPF v3, RIP, and RIPng simultaneously, with IPv4 and IPv6 addresses, an experience that I never had in CCNA.