MULTI-AREA OSPF, OSPFV3

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Period 678

CISCO

CCNP LAB REPORT

Purpose

Through setting up a multi-router network with two Layer 3 switches routed by OSPF, this lab simultaneously covers the setup of multi-Area OSPF and the use of a Layer 3 switch for router purposes. We coordinate multiple distinct devices to form a connected network even if devices are split into various OSPF areas.

Background Information

The main concept of this lab is OSPF setup. OSPF (Open Shortest Path First) is a 1989 link-state routing protocol which automatically routes packets across networks to their destination. The algorithm allows each router to create their own shortest path tree to route packets forward. Due to the use of Dijkstra's algorithm as a basis, OSPF allows routers to consider link speeds in calculation to ensure the most efficient past is being taken.

Without an automatic routing protocol, network engineers must physically enter static routes to each possible destination in the network on each router. In addition to scalability issues, static routing is unable to react to changes to the network. The only way to mitigate the issues of link breakdowns would be to add even more floating routes to each router, and the network will run into further issues in case of expansion. However, by using an automatic routing protocol such as OSPF, routers will automatically react to changes in the network in an instant and adapt to changes or additions to the network without delay.

Though there are many other automatic routing protocols, OSPF is widely used in enterprise networks due to its efficiency, open standards, and versatility. As suggested by the name, OSPF is an open protocol, meaning it works universally across all routing devices. As a result, whereas protocols such as EIGRP would only work on CISCO devices, OSPF works across routers and devices from many vendors. Therefore, a company relying on OSPF for their network has the choice of which vendor to buy from expanding their network.

In expansion, companies should not worry about the size of their network. Whereas some protocols such as RIP have a hop limit, meaning routes cannot be found if two devices are more than a certain limit of hops apart (15 in the case of RIP), the protocol will fail to find a route. Such an issue does not exist for OSPF, which has no hop limit.

Another common issue with expansion is the convergence time and bandwidth. Whereas many other protocols send the entire routing table across the network for decision making on a periodic interval, OSPF's decentralized nature of having each device calculate their own routing table means that the only messages sent are small link-state update packets. Each router will converge quickly and autonomously when changes are automatically detected.

OSPF allows the user to configure nearly every aspect of its operation. The metric cost of each link, determined by the speed of the link by default, may be altered based on the users' needs. Through the assignment of router IDs, users may further determine other features of OSPF

operation, in which the assignment of the Designated Router and Backup Designated Router in charge of managing the Link-State messages may be altered.

Though OSPF allows complex configurations, for users who plan on applying default settings, it simultaneously provides the service of simple configuration. Protocols such as IS-IS run on Network Entity Title rather than traditional TCP/IP, technicians agree that it is more difficult to configure due to its increased reliance on network layer knowledge. However, OSPF may be configured with a few lines on each device to connect the entire network automatically.

The final advantage and feature of OSPF is the use of multiple areas. Around backbone area 0, users may add new numbered areas according to their network design. The use of multiple areas allows for the operation of a large-scale network without network congestion, since each area operates link-state operations individually. Despite this, the areas are connected in the same process as usual with OSPF Inter-Area routes. The use of multiple areas further allows separate management, such as if different departments sharing the same network should be managed separately.

The equipment used in this lab includes both regular CISCO routers and Layer 3 Switches. Though Layer 3 Switches are typically more costly, their dual functions as both a layer 2 switch and layer 3 router, as well as their increased port counts are indispensable benefits to many networking scenarios. Overall, these features allow them to perform high-speed routing, establish VLAN separation, and serve as the connection between different networks. Therefore, even though the complexities configuration process and economic cost of Layer 3 Switches are disadvantages, they have grown to become ubiquitous features of complex networks.

Lab Summary

In this lab, we construct a network consisting of five routers and two Layer 3 switches which are routed using the OSPF protocol. The devices are distributed over three OSPF areas: the backbone area 0, area 1, and area 9. There is a router on the “border” of area 0 and area 1 which has one port in each area and a Layer 3 switch on a similar “border” between area 0 and area 9. There are two other routers entirely within area 0 connecting the other two areas, one Layer 3 switch entirely within area 9, and two more routers entirely within area 1 which are all connected by a graphical tree structure.

Each device is configured with both an IP address and an IPv6 address. Both OSPF and OSPFv3 are configured, meaning the network is completely connected in both addressing systems.

Lab Commands

To enable router functionalities on a layer 3 switch to direct IPv4 traffic, we enter the following command.

```
Switch(config-if)# ip routing
```

On both the router and switch, to enable IPv6 routing, we enter the following command.

```
Router(config-if)# ipv6 unicast-routing
```

On the layer-3 switch, interfaces are configured as switch ports by default. To assign an IP address to a port and enable OSPF on interface g1/0/x, we enter the following commands.

```
Switch(config)# int g1/0/x
Switch(config-if)# no switchport
```

To enable OSPF on a certain interface for a certain area, we use the following command. The x is the process number and y the area number.

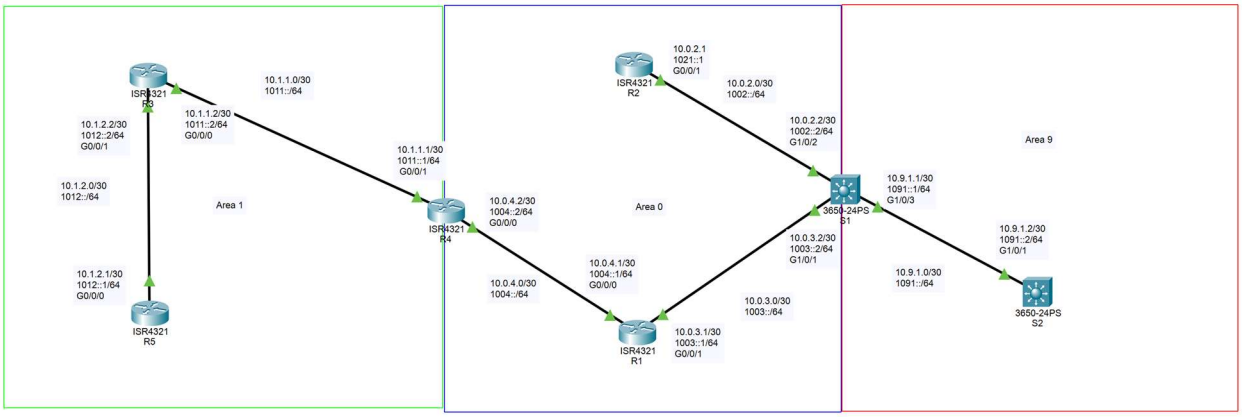
```
Router(config-if)# ip ospf x area y
```

To enable OSPFv3 on a certain interface for a certain area, we use the following command. The x is the process number and y the area number.

```
Router(config-if)# ipv6 ospf x area y
```

Network Diagram with IPs

The routers are pairwise connected by straight-through copper ethernet cables.



Problems

During the network design, we wished to have one device support connect to at least three other devices such that the network is not linear. However, the routers ended up with only two ports supporting the normal OSPF operation, so we adjusted the network design for the layer 3 switch to be connected to more devices.

Initially, when connecting the routers, the link lights consistently failed to show up for one of the routers. Though we initially believed it was a problem with the cable or the router, we eventually realized that the router was not properly reset. We consoled in and reloaded the router, and the problem was resolved.

During configuration on the Layer-3 switches, it was originally impossible to assign any IP or IPv6 addresses on the interfaces. After searching the error up, we discovered the need to use the **`no switchport`** command.

After the network was built, we believed that we had connectivity throughout the entire network. Indeed, all the devices could ping each other over IP. However, when testing IPv3, we found that R5 was unable to ping S2 even though S2's IP address shows up in its routing table. After testing a tracert from R5 to S2 and between S1 and S2, we eventually discovered the issue: there was no route back from R5 to S2. We opened S2's configuration and discovered that the wrong interface received the OSPFv3 configuration.

Configuration

R1 Configuration

```
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname R1
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
login on-success log
subscriber templating
ipv6 unicast-routing
multilink bundle-name authenticated
crypto pki trustpoint TP-self-signed-1312775118
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-1312775118
revocation-check none
```

```
rsakeypair TP-self-signed-1312775118
crypto pki certificate chain TP-self-signed-1312775118
certificate self-signed 01
30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
69666963 6174652D 31333132 37373531 3138301E 170D3235 30393135 32313333
34335A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D31 33313237
37353131 38308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
A028201 01009129 E96360F6 988660C4 DB36A792 E1FAE4F3 B90E49AB E1E28C1E
96D52754 F4794100 7C1B4CE7 92B7259B 550D8DC7 D609FC15 4499AA23 BD8FF271
76BC50F5 B22EF457 0101669C 1309A522 71D6674C C5E32839 208D07EB F5B3E924
344A99E6 D3F00687 57D20D7C 571B12A7 A8E401A5 6DC6749D CC695108 10A4CE26
D2011FDF EA95FC02 4DF8A2DB 68DE79B1 E2EB9C28 1F3D105E 653D034F 68AD35B7
A910B5D3 E37D72D5 D0B2C0CB 0A183CA7 A4A656E3 2F8FDC56 DD8DBCC5 A1907CE1
1A568117 FB762921 E285B1C3 C2C1F853 EDACF031 C425414E E4DB7B86 1FEE0C7B
39AE6667 F980D539 A33CD758 DF5D263C 17AC0538 81E96D1F 93D42280 F2197492
1A185599 2D350203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
301F0603 551D2304 18301680 1494803F 398E98DE B2E01830 E878928F A2461655
11301D06 03551D0E 04160414 94803F39 8E98DEB2 E01830E8 78928FA2 46165511
300D0609 2A864886 F70D0101 05050003 82010100 7F12D1EE 5ECCEC3E B70A9C12
A7B0E81B 0BE52932 E46F843F 061D731F 9084806D B33E443A CF743D37 24F10728
6A5AF15F 3B7BCDBC 42C50B1C 2E8794C3 3CBBC21B F0BC2C5F 53EC3F3D 401120D4
F64446AB 86956957 9BCC4C55 C177CAB6 EE3C6E2B 58E37550 EC7DB500 EE566115
C8AC87D5 C993419E 1E1D735F CB96E1BE 7E3DEF90 DA998BDC 10EA41C1 FAFE858B
F6772FE8 2923C264 9F620476 13F3D2EF 122CA62B 86AFF876 2DC94F03 E0FEAB98
1B281ECF 36823424 54BADF0A 0295B494 3F1DE7EB 8C63EB8F 3B9BF216 B30A50DC
DF06E6D5 C8584951 D6E6142D 20C462E8 25CA2BC7 D774035A 39A4585D ABFA0C12
4EC303CB 2AF0DF45 B5B898A7 2F0B7F29 BAF130F3
quit
license udi pid ISR4321/K9 sn FDO21060Z52
no license smart enable
diagnostic bootup level minimal
```

```
spanning-tree extend system-id
redundancy
mode none
interface GigabitEthernet0/0/0
ip address 10.0.4.1 255.255.255.252
ip ospf 1 area 0
negotiation auto
ipv6 address 1004::1/64
ipv6 ospf 1 area 0
interface GigabitEthernet0/0/1
ip address 10.0.3.1 255.255.255.252
ip ospf 1 area 0
negotiation auto
ipv6 address 1003::1/64
ipv6 ospf 1 area 0
interface Serial0/1/0
interface Serial0/1/1
interface Service-Engine0/2/0
no ip address
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
router ospf 1
network 10.0.3.0 0.0.0.3 area 0
network 10.0.4.0 0.0.0.3 area 0
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
ipv6 router ospf 1
```

```
control-plane
line con 0
transport input none
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

R2 Configuration

```
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname R2
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
--More--
*Sep 15 22:19:36.821: %SYS-5-CONFIG_I: Configured from console  exit-address-family
no aaa new-model
login on-success log
subscriber templating
ipv6 unicast-routing
multilink bundle-name authenticated
crypto pki trustpoint TP-self-signed-3485044676
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-3485044676
revocation-check none
```

```
rsakeypair TP-self-signed-3485044676
crypto pki certificate chain TP-self-signed-3485044676
certificate self-signed 01
30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
69666963 6174652D 33343835 30343436 3736301E 170D3235 30393135 32313139
34375A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D33 34383530
34343637 36308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
A028201 0100AF91 E8B99692 C090C5FE 305D1FB2 D3A3BA29 A376DE9E C3851717
49314BD6 0802D215 E322D8FF 6F800951 E27F0D88 018D854C DD9F43D1 779846FB
D5D27874 32EA70E4 B1CE9709 7220C170 81E5221D 743ED8D7 E375DAA8 B8C7A6C8
F15413C7 D2E62737 21E951BF 129CC8AC E3B9BADF 58DAF704 48D6FD86 BE7C979F
BDB48D9D D7B0E19D 88BD13C3 18F2DA18 3580023B E890FF27 5353DC73 FCF50906
9A0311A3 1EFE6015 C10DC42C E93BEA1E DDB9E9B2 B47DD215 2BCBFCBE 2C9BE3A0
11FB74F4 C2B187C5 31DAA135 45D75F51 DE600C31 5C103F3C 7DF03E53 ED033409
25ACE23F 2613AD9C E4A968E4 2680DF6A 62A4C681 D6771340 FBCBC901 2CD3AB70
8DFBC4D8 DCB10203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
301F0603 551D2304 18301680 14499C1D 4B87583E 7B1BF580 DDF75403 D4117D1C
95301D06 03551D0E 04160414 499C1D4B 87583E7B 1BF580DD F75403D4 117D1C95
300D0609 2A864886 F70D0101 05050003 82010100 A4FD85A7 3E5080FE CEFD37D7
54ECCA89 835F3646 37B72D0C 0F41EBC2 865E837C 49E6DF79 62AB9E49 7BCCFA1F
EC6FB44C CA744F5E 2FFFCB17 B0D6E77D 9506FE7C 67322048 EEB8FC90 15E6C1E8
E5260830 17FF22D5 8B44774A 09C20F4E 961B5FCB B830DC74 07D2239A EB2C42B8
C8D11B96 037C76C0 7352D035 D20CFCF9 91F2A030 0E1364A6 2642791D 591D6FE8
4EF8141C 8F266ABB 4B196C4B D96CAC52 C74A6184 CE5EB6D6 D40FDA69 134C9E46
3B8EDBC3 BEB41CF6 C97328D5 3C61220D DE04F1F3 BE546CEC 497552A7 F75F9B6A
FD285077 9B2C5C15 5DFAD4C8 B6E09114 E6D2EB02 5009E751 01FABFBF 9EA6E270
B4706B46 B024839E 48D4FBA0 5F8DBFC9 271141A4
quit
license udi pid ISR4321/K9 sn FDO21082HVD
no license smart enable
diagnostic bootup level minimal
```

```
spanning-tree extend system-id
redundancy
mode none
interface GigabitEthernet0/0/0
no ip address
negotiation auto
interface GigabitEthernet0/0/1
ip address 10.0.2.1 255.255.255.252
negotiation auto
ipv6 address 1002::1/64
ipv6 ospf 1 area 0
interface Serial0/1/0
no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface Service-Engine0/2/0
no ip address
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
router ospf 1
network 10.0.2.0 0.0.0.3 area 0
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
ipv6 router ospf 1
control-plane
```

```
line con 0
transport input none
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

R3 Configuration

```
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname R2
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
no aaa new-model
login on-success log
subscriber templating
ipv6 unicast-routing
multilink bundle-name authenticated
crypto pki trustpoint TP-self-signed-3485044676
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-3485044676
revocation-check none
rsakeypair TP-self-signed-3485044676
crypto pki certificate chain TP-self-signed-3485044676
certificate self-signed 01
```

```
30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
69666963 6174652D 33343835 30343436 3736301E 170D3235 30393135 32313139
34375A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D33 34383530
34343637 36308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
A028201 0100AF91 E8B99692 C090C5FE 305D1FB2 D3A3BA29 A376DE9E C3851717
49314BD6 0802D215 E322D8FF 6F800951 E27F0D88 018D854C DD9F43D1 779846FB
D5D27874 32EA70E4 B1CE9709 7220C170 81E5221D 743ED8D7 E375DAA8 B8C7A6C8
F15413C7 D2E62737 21E951BF 129CC8AC E3B9BADF 58DAF704 48D6FD86 BE7C979F
BDB48D9D D7B0E19D 88BD13C3 18F2DA18 3580023B E890FF27 5353DC73 FCF50906
9A0311A3 1EFE6015 C10DC42C E93BEA1E DDB9E9B2 B47DD215 2BCBFCBE 2C9BE3A0
11FB74F4 C2B187C5 31DAA135 45D75F51 DE600C31 5C103F3C 7DF03E53 ED033409
25ACE23F 2613AD9C E4A968E4 2680DF6A 62A4C681 D6771340 FBCBC901 2CD3AB70
8DFBC4D8 DCB10203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
301F0603 551D2304 18301680 14499C1D 4B87583E 7B1BF580 DDF75403 D4117D1C
95301D06 03551D0E 04160414 499C1D4B 87583E7B 1BF580DD F75403D4 117D1C95
300D0609 2A864886 F70D0101 05050003 82010100 A4FD85A7 3E5080FE CEFD37D7
54ECCA89 835F3646 37B72D0C 0F41EBC2 865E837C 49E6DF79 62AB9E49 7BCCFA1F
EC6FB44C CA744F5E 2FFFCB17 B0D6E77D 9506FE7C 67322048 EEB8FC90 15E6C1E8
E5260830 17FF22D5 8B44774A 09C20F4E 961B5FCB B830DC74 07D2239A EB2C42B8
C8D11B96 037C76C0 7352D035 D20CFCF9 91F2A030 0E1364A6 2642791D 591D6FE8
4EF8141C 8F266ABB 4B196C4B D96CAC52 C74A6184 CE5EB6D6 D40FDA69 134C9E46
3B8EDBC3 BEB41CF6 C97328D5 3C61220D DE04F1F3 BE546CEC 497552A7 F75F9B6A
FD285077 9B2C5C15 5DFAD4C8 B6E09114 E6D2EB02 5009E751 01FABFBF 9EA6E270
B4706B46 B024839E 48D4FBA0 5F8DBFC9 271141A4
quit
license udi pid ISR4321/K9 sn FDO21082HVD
no license smart enable
diagnostic bootup level minimal
spanning-tree extend system-id
redundancy
mode none
```

```
interface GigabitEthernet0/0/0
no ip address
negotiation auto
interface GigabitEthernet0/0/1
ip address 10.0.2.1 255.255.255.252
negotiation auto
ipv6 address 1002::1/64
ipv6 ospf 1 area 0
interface Serial0/1/0
no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface Service-Engine0/2/0
no ip address
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
router ospf 1
network 10.0.2.0 0.0.0.3 area 0
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
ipv6 router ospf 1
control-plane
line con 0
transport input none
stopbits 1
```

```
line aux 0
stopbits 1
line vty 0 4
login
end
```

R4 Configuration

```
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname R4
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
login on-success log
subscriber templating
ipv6 unicast-routing
multilink bundle-name authenticated
crypto pki trustpoint TP-self-signed-1192009516
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-1192009516
revocation-check none
rsakeypair TP-self-signed-1192009516
crypto pki certificate chain TP-self-signed-1192009516
certificate self-signed 01
30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
```

```
69666963 6174652D 31313932 30303935 3136301E 170D3235 30393135 32313234
32365A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D31 31393230
30393531 36308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
A028201 0100A920 52C6CD73 E7A7F1F3 18C3ECEC 9814BB04 B8BC5A32 99AB5C4B
F18246BE CA2ED3E5 82C74AC0 0069BBD9 29F30F37 893D83EF 10751E57 9CDEED47
4A51DC63 D58234B9 47FDC8A3 C2367F00 28D61418 839B5BE7 806C38FA 035B72BC
A8AFE3B4 B840DFA8 EF1B2749 5538B954 1A858A3A EF5EAEC7 171367A1 F5F357C7
E08DCB43 83D6233A 710CA8F4 F70F9643 8C097A9E 72FDC5E3 86060700 66CBDCF3
F5CBB06A 32AEBD41 F696FD22 01A0B7EA FD55423B BBB29B08 97EE4020 3E7F0AA4
75AB413D 0434746B 7FB06C77 E545ACC9 284B4175 EA4DEBF7 92606BAA BD5B74BA
AA591472 1E84B3DE 27F738BE 35819203 BBD2E56F BBB53190 7C3AE134 096A253D
1F26CD35 23F10203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
301F0603 551D2304 18301680 146B9E84 37ACDA49 F1BF9583 9A7DFB34 3BB71669
30301D06 03551D0E 04160414 6B9E8437 ACDA49F1 BF95839A 7DFB343B B7166930
300D0609 2A864886 F70D0101 05050003 82010100 8A25F866 EDA87B09 22622186
52FE527B 1D02BD4F 60854B66 5823C869 40DF1EE9 2ACEC3E6 03B6137C 3D087CF5
B9EFC451 86448D75 79FB60BB 32A882E5 52DFF72B B205559F C4ADAC8F ED21CDDD
747ADDC1 05587B34 5E75941C B5F93A89 065B0964 E3B414E2 3AB56A4E AF200343
7D5F7B59 7FB410CB 1BFA5174 85B8C1E7 9DBA372A 64076473 732ACE71 6DEF9922
EAEF99C2 895C9077 668D6CD0 8B61E763 56D89405 A7A223C9 1F4A9BF9 F46D78B9
515B226C 30D8D4CF CAF9FC55 B8970729 D9D4F9A8 883D3AFF 0724F0AA 6136DCF1
A9A3F188 0639844C EB740F8F EAECB0DF B939C859 4F9364C6 872722D7 86938F6F
DC23328A DDE29BB9 C5F7C543 A1B7BCA2 8F515A8D
quit
license udi pid ISR4321/K9 sn FDO21482DVS
no license smart enable
diagnostic bootup level minimal
spanning-tree extend system-id
redundancy
mode none
interface GigabitEthernet0/0/0
ip address 10.0.4.2 255.255.255.252
```

```
ip ospf 1 area 0
negotiation auto
ipv6 address 1004::2/64
ipv6 ospf 1 area 0
interface GigabitEthernet0/0/1
ip address 10.1.1.1 255.255.255.252
ip ospf 1 area 1
negotiation auto
ipv6 address 1011::1/64
ipv6 ospf 1 area 1
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
router ospf 1
router-id 4.4.4.4
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
ipv6 router ospf 1
control-plane
line con 0
transport input none
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

R5 Configuration

```
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname R5
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
login on-success log
subscriber templating
ipv6 unicast-routing
multilink bundle-name authenticated
crypto pki trustpoint TP-self-signed-3875574019
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-3875574019
revocation-check none
rsakeypair TP-self-signed-3875574019
crypto pki certificate chain TP-self-signed-3875574019
certificate self-signed 01
30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
69666963 6174652D 33383735 35373430 3139301E 170D3235 30393135 32313333
34345A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D33 38373535
```

```
37343031 39308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
A028201 0100C1F5 32DC40AB 083A810C 04EC62BC F1915B12 7C919B17 22716734
B56207FF CA41D301 C1772D56 005B1CE0 6FB6F0ED 70877A39 25B7B5CB 03B52858
DCA87091 8560546D 6796B2D2 EF40F192 AEF089FA DAB50562 4A32A568 41639919
9FF9FD25 75AB45DF 59805331 E249B436 7E2E3E15 B5382CE6 D2F37515 C3FB6FF4
FACF51BC 257C7A29 6CAB5ED9 86C74E4C 3F8ABBBF A068F4B4 7071FBF4 AB074E0A
35E97E7E E433FCE1 DA88FDD2 7FAB8AFB 31DBAC48 E828ED46 6BD0B7C9 6F5CFA21
C0231A20 E90C7DFA 09B68F76 2F8734BF 262A85CB 2A956E08 5411ACF5 32353E2D
960C5C0 9D52538D DD6FF91D 84369AEE C65F993C 893DD925 869EB60C 6ECCCE74
A4CA1D17 C6A10203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
301F0603 551D2304 18301680 1488EC2F B337DCC2 5C20163B 68636F62 D4DE0EA6
B4301D06 03551D0E 04160414 88EC2FB3 37DCC25C 20163B68 636F62D4 DE0EA6B4
300D0609 2A864886 F70D0101 05050003 82010100 623BD748 E59E18F4 156317E3
9F46B22A 80343353 88348537 3400524B 4C733CF9 DC6ABD19 FC4EA066 CD065ABB
84CC772F 7F24FA7A 9C348819 EFE9B7B3 C854B35E 8DE6B959 1ACB4873 35F1A055
2BCD8EE8 DD3D0CDF 01058346 212F6EEC 08179784 50F3092C E2CA4482 5A2A6171
C9BD6ECE 58FBDE8E 85D15244 8E8C438D 60B8DC06 2B7BA9BB 76830AB9 97BFD352
C40980D0 CB843E78 5C1C01A3 57881987 9C2B2E55 3515D621 8BDDE945 0DED7252
8363F85B 36C0C3A0 220744F6 C017F26F 0ED9203F 3E92551D CF7A5A9C 30638713
64235B15 E0D7A984 BF38BC15 DC2AF0B1 B474E84D 211CBBE6 3DC40608 40C63407
E7619B8A FB378082 E463B20A 654956EC 05C776C2
quit
license udi pid ISR4321/K9 sn FLM2407014D
no license smart enable
diagnostic bootup level minimal
spanning-tree extend system-id
redundancy
mode none
interface GigabitEthernet0/0/0
ip address 10.1.2.1 255.255.255.252
```

```
ip ospf 1 area 1
negotiation auto
ipv6 address 1012::1/64
ipv6 ospf 1 area 1
interface GigabitEthernet0/0/1
no ip address
shutdown
negotiation auto
interface GigabitEthernet0/2/0
no ip address
shutdown
negotiation auto
interface GigabitEthernet0/2/1
no ip address
shutdown
negotiation auto
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
router ospf 1
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
ipv6 router ospf 1
control-plane
line con 0
```

```
transport input none
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

S1 Configuration

```
version 16.9
no service pad
service timestamps debug datetime msec
service timestamps log datetime msec
Call-home is enabled by Smart-Licensing.
service call-home
no platform punt-keepalive disable-kernel-core
hostname S1
vrf definition Mgmt-vrf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
switch 1 provision c9200l-24t-4g
ip routing
ip arp entry learn 10240
login on-success log
ipv6 unicast-routing
call-home
If contact email address in call-home is configured as sch-smart-licensing@cisco.com
the email address configured in Cisco Smart License Portal will be used as contact
email address to send SCH notifications.
contact-email-addr sch-smart-licensing@cisco.com
```

```
profile "CiscoTAC-1"
active
destination transport-method http
no destination transport-method email
crypto pki trustpoint TP-self-signed-3161893787
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-3161893787
revocation-check none
rsakeypair TP-self-signed-3161893787
crypto pki trustpoint SLA-TrustPoint
enrollment pkcs12
revocation-check crl
crypto pki certificate chain TP-self-signed-3161893787
certificate self-signed 01
30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
69666963 6174652D 33313631 38393337 3837301E 170D3235 30393135 32313239
32365A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D33 31363138
39333738 37308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
0A028201 0100D743 86D80366 572A1801 EC4A23BC 7DF1AE08 711D3493 2A0E3898
FB368E77 28FBCA03 0BD916E3 B4E19356 5BAD3879 147E31D1 F66A709B 26DCE6A2
944A3346 FC656904 085647F2 28BC40CE A418967E AB7264DC BDADC7C4 92308CF2
9EDB4D75 07D900E6 80B6184F 0706676A 7C2B27FE D810943B 35A84F53 F5ACE829
D4894717 2472C3FC 44119B3A 174525E7 3D81339C C98D7BFC 5EF735CE 94BC4B0D
A860AFAC 88A51D53 5ABBC585 4DC26A7E 1DB614D8 473AF621 650E2F14 5DFEA01E
1810ACBC 168C2746 72104FFA DDAC4891 FE21C688 ADB725F2 8D1ABCF7 D735EEE2
83CD1FF7 D0EB5EA0 72913BE1 8E636809 401DEECD F165621B 9B676034 6258515A
702E5AEF 8CD30203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
301F0603 551D2304 18301680 14B246FE F808D8BF 72193393 5ED22D34 35DCDACB
CB301D06 03551D0E 04160414 B246FEF8 08D8BF72 1933935E D22D3435 DCDACBCB
300D0609 2A864886 F70D0101 05050003 82010100 68442370 8BFC63AA C66E3CC3
3705680A 4A833E6F 98885D85 7FE41276 858D77A0 72076535 BE7B6B86 1F30E494
```

```
4B35A48D 75D11B29 D00FF03A C4A934D7 55BE301F 3FD3719F 2FB26D8F C1535429
D65330E6 E517672A 2379B631 5EA50C6E E0A90169 95C2F2A4 2AD218E3 BAC242F9
6CFAE9D2 47319EBD 9439D12A 5B5E54B0 21A6CFF1 C73EFAC9 D4E25E29 82546B33
39999D2B 9DABF8E5 D275931D 87B3B784 4206985F E155CC0C DD2C9B3B 5B0B2743
12D192A5 3BB44782 EE10B678 FEA6C7D0 ED8B4314 1F932E30 FD2E17B0 98FE422C
1138FF1C B8988EAB 99D37414 C0D8766A A4EF1F2D C928377B 0399CF8A D68BD482
ED350795 D02221BD AD746320 F0D98E30 7BD60DCD
quit
crypto pki certificate chain SLA-TrustPoint
certificate ca 01
30820321 30820209 A0030201 02020101 300D0609 2A864886 F70D0101 0B050030
32310E30 0C060355 040A1305 43697363 6F312030 1E060355 04031317 43697363
6F204C69 63656E73 696E6720 526F6F74 20434130 1E170D31 33303533 30313934
3834375A 170D3338 30353330 31393438 34375A30 32310E30 0C060355 040A1305
43697363 6F312030 1E060355 04031317 43697363 6F204C69 63656E73 696E6720
526F6F74 20434130 82012230 0D06092A 864886F7 0D010101 05000382 010F0030
82010A02 82010100 A6BCBD96 131E05F7 145EA72C 2CD686E6 17222EA1 F1EFF64D
CBB4C798 212AA147 C655D8D7 9471380D 8711441E 1AAF071A 9CAE6388 8A38E520
1C394D78 462EF239 C659F715 B98C0A59 5BBB5CBD 0CFEBEA3 700A8BF7 D8F256EE
4AA4E80D DB6FD1C9 60B1FD18 FFC69C96 6FA68957 A2617DE7 104FDC5F EA2956AC
7390A3EB 2B5436AD C847A2C5 DAB553EB 69A9A535 58E9F3E3 C0BD23CF 58BD7188
68E69491 20F320E7 948E71D7 AE3BCC84 F10684C7 4BC8E00F 539BA42B 42C68BB7
C7479096 B4CB2D62 EA2F505D C7B062A4 6811D95B E8250FC4 5D5D5FB8 8F27D191
C55F0D76 61F9A4CD 3D992327 A8BB03BD 4E6D7069 7CBADF8B DF5F4368 95135E44
DFC7C6CF 04DD7FD1 02030100 01A34230 40300E06 03551D0F 0101FF04 04030201
06300F06 03551D13 0101FF04 05300301 01FF301D 0603551D 0E041604 1449DC85
4B3D31E5 1B3E6A17 606AF333 3D3B4C73 E8300D06 092A8648 86F70D01 010B0500
03820101 00507F24 D3932A66 86025D9F E838AE5C 6D4DF6B0 49631C78 240DA905
604EDCDE FF4FED2B 77FC460E CD636FDB DD44681E 3A5673AB 9093D3B1 6C9E3D8B
D98987BF E40CBD9E 1AECA0C2 2189BB5C 8FA85686 CD98B646 5575B146 8DFC66A8
467A3DF4 4D565700 6ADF0F0D CF835015 3C04FF7C 21E878AC 11BA9CD2 55A9232C
7CA7B7E6 C1AF74F6 152E99B7 B1FCF9BB E973DE7F 5BDDEB86 C71E3B49 1765308B
5FB0DA06 B92AFE7F 494E8A9E 07B85737 F3A58BE1 1A48A229 C37C1E69 39F08678
```

```
80DDCD16 D6BACECA EEBC7CF9 8428787B 35202CDC 60E4616A B623CDBD 230E3AFB
418616A9 4093E049 4D10AB75 27E86F73 932E35B5 8862FDAE 0275156F 719BB2F0
D697DF7F 28
quit
license boot level network-essentials addon dna-essentials
diagnostic bootup level minimal
spanning-tree mode rapid-pvst
spanning-tree extend system-id
redundancy
mode sso
class-map match-any system-cpp-police-topology-control
description Topology control
class-map match-any system-cpp-police-sw-forward
description Sw forwarding, L2 LVX data, LOGGING
class-map match-any system-cpp-default
description Inter FED, EWLC control, EWLC data
class-map match-any system-cpp-police-sys-data
description Learning cache ovfl, High Rate App, Exception, EGR Exception, NFL SAMPLED
DATA, RPF Failed
class-map match-any system-cpp-police-punt-webauth
description Punt Webauth
class-map match-any system-cpp-police-l2lvx-control
description L2 LVX control packets
class-map match-any system-cpp-police-forus
description Forus Address resolution and Forus traffic
class-map match-any system-cpp-police-multicast-end-station
description MCAST END STATION
class-map match-any system-cpp-police-multicast
description Transit Traffic and MCAST Data
class-map match-any system-cpp-police-l2-control
description L2 control
class-map match-any system-cpp-police-dot1x-auth
description DOT1X Auth
```

```
class-map match-any system-cpp-police-data
description ICMP redirect, ICMP_GEN and BROADCAST
class-map match-any system-cpp-police-stackwise-virt-control
description Stackwise Virtual
class-map match-any non-client-nrt-class
class-map match-any system-cpp-police-routing-control
description Routing control and Low Latency
class-map match-any system-cpp-police-protocol-snooping
description Protocol snooping
class-map match-any system-cpp-police-dhcp-snooping
description DHCP snooping
class-map match-any system-cpp-police-system-critical
description System Critical and Gold Pkt
policy-map system-cpp-policy
interface GigabitEthernet0/0
vrf forwarding Mgmt-vrf
no ip address
shutdown
negotiation auto
interface GigabitEthernet1/0/1
no switchport
ip address 10.0.3.2 255.255.255.252
ip ospf 1 area 0
ipv6 address 1003::2/64
ipv6 ospf 1 area 0
interface GigabitEthernet1/0/2
no switchport
ip address 10.0.2.2 255.255.255.252
ip ospf 1 area 0
ipv6 address 1002::2/64
ipv6 ospf 1 area 0
interface GigabitEthernet1/0/3
no switchport
```

```
ip address 10.9.1.1 255.255.255.252
ip ospf 1 area 9
ipv6 address 1091::1/64
ipv6 ospf 1 area 9
interface GigabitEthernet1/0/4
interface GigabitEthernet1/0/5
interface GigabitEthernet1/0/6
interface GigabitEthernet1/0/7
interface GigabitEthernet1/0/8
interface GigabitEthernet1/0/9
interface GigabitEthernet1/0/10
interface GigabitEthernet1/0/11
interface GigabitEthernet1/0/12
interface GigabitEthernet1/0/13
interface GigabitEthernet1/0/14
interface GigabitEthernet1/0/15
interface GigabitEthernet1/0/16
interface GigabitEthernet1/0/17
interface GigabitEthernet1/0/18
interface GigabitEthernet1/0/19
interface GigabitEthernet1/0/20
interface GigabitEthernet1/0/21
interface GigabitEthernet1/0/22
interface GigabitEthernet1/0/23
interface GigabitEthernet1/0/24
interface GigabitEthernet1/1/1
interface GigabitEthernet1/1/2
interface GigabitEthernet1/1/3
interface GigabitEthernet1/1/4
interface Vlan1
no ip address
shutdown
router ospf 1
```

```
network 10.9.1.0 0.0.0.3 area 9
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ipv6 router ospf 1
control-plane
service-policy input system-cpp-policy
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
line vty 5 15
login
end
```

S2 Configuration

```
version 16.9
no service pad
service timestamps debug datetime msec
service timestamps log datetime msec
Call-home is enabled by Smart-Licensing.
service call-home
no platform punt-keepalive disable-kernel-core
hostname S2
vrf definition Mgmt-vrf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
switch 1 provision c9200l-24t-4g
```

```
ip routing

ip arp entry learn 10240

login on-success log

ipv6 unicast-routing

call-home

If contact email address in call-home is configured as sch-smart-licensing@cisco.com

the email address configured in Cisco Smart License Portal will be used as contact
email address to send SCH notifications.

contact-email-addr sch-smart-licensing@cisco.com

profile "CiscoTAC-1"

active

destination transport-method http

no destination transport-method email

crypto pki trustpoint SLA-TrustPoint

enrollment pkcs12

revocation-check crl

crypto pki trustpoint TP-self-signed-2617307985

enrollment selfsigned

subject-name cn=IOS-Self-Signed-Certificate-2617307985

revocation-check none

rsakeypair TP-self-signed-2617307985

crypto pki certificate chain SLA-TrustPoint

certificate ca 01

30820321 30820209 A0030201 02020101 300D0609 2A864886 F70D0101 0B050030

32310E30 0C060355 040A1305 43697363 6F312030 1E060355 04031317 43697363

6F204C69 63656E73 696E6720 526F6F74 20434130 1E170D31 33303533 30313934

3834375A 170D3338 30353330 31393438 34375A30 32310E30 0C060355 040A1305

43697363 6F312030 1E060355 04031317 43697363 6F204C69 63656E73 696E6720

526F6F74 20434130 82012230 0D06092A 864886F7 0D010101 05000382 010F0030

82010A02 82010100 A6BCBD96 131E05F7 145EA72C 2CD686E6 17222EA1 F1EFF64D

CBB4C798 212AA147 C655D8D7 9471380D 8711441E 1AAF071A 9CAE6388 8A38E520

1C394D78 462EF239 C659F715 B98C0A59 5BBB5CBD 0CFEBEA3 700A8BF7 D8F256EE

4AA4E80D DB6FD1C9 60B1FD18 FFC69C96 6FA68957 A2617DE7 104FDC5F EA2956AC
```

```
7390A3EB 2B5436AD C847A2C5 DAB553EB 69A9A535 58E9F3E3 C0BD23CF 58BD7188
68E69491 20F320E7 948E71D7 AE3BCC84 F10684C7 4BC8E00F 539BA42B 42C68BB7
C7479096 B4CB2D62 EA2F505D C7B062A4 6811D95B E8250FC4 5D5D5FB8 8F27D191
C55F0D76 61F9A4CD 3D992327 A8BB03BD 4E6D7069 7CBADF8B DF5F4368 95135E44
DFC7C6CF 04DD7FD1 02030100 01A34230 40300E06 03551D0F 0101FF04 04030201
06300F06 03551D13 0101FF04 05300301 01FF301D 0603551D 0E041604 1449DC85
4B3D31E5 1B3E6A17 606AF333 3D3B4C73 E8300D06 092A8648 86F70D01 010B0500
03820101 00507F24 D3932A66 86025D9F E838AE5C 6D4DF6B0 49631C78 240DA905
604EDCDE FF4FED2B 77FC460E CD636FDB DD44681E 3A5673AB 9093D3B1 6C9E3D8B
D98987BF E40CBD9E 1AECA0C2 2189BB5C 8FA85686 CD98B646 5575B146 8DFC66A8
467A3DF4 4D565700 6ADF0F0D CF835015 3C04FF7C 21E878AC 11BA9CD2 55A9232C
7CA7B7E6 C1AF74F6 152E99B7 B1FCF9BB E973DE7F 5BDDEB86 C71E3B49 1765308B
5FB0DA06 B92AFE7F 494E8A9E 07B85737 F3A58BE1 1A48A229 C37C1E69 39F08678
80DDCD16 D6BACECA EEBC7CF9 8428787B 35202CDC 60E4616A B623CDBD 230E3AFB
418616A9 4093E049 4D10AB75 27E86F73 932E35B5 8862FDAE 0275156F 719BB2F0
D697DF7F 28
quit
crypto pki certificate chain TP-self-signed-2617307985
certificate self-signed 01
30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
69666963 6174652D 32363137 33303739 3835301E 170D3235 30393135 31373531
30385A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D32 36313733
30373938 35308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
0A028201 01009E8B 48B178D1 A34ECC15 886A782B D6F7EA6F 773D4E29 0B8595D5
2B97D277 5A99CCFB D0B9C288 FC7934F8 8B01DAA1 7A88998A AD84C439 17317F65
D43BAAB8 6EE988CB D4D2410D BC23FDF8 CECF9619 E6BDEF41 C43B4395 67AEEA7A
8BFBA93A B17E984B FB12641B AD3588FE BAE41700 8EFBBAFD 220D8347 213021AD
0CC04CB9 9862CA1F 0EFF2FD7 BE17644F 419F3EE9 9879D71C 3ED002C2 7979C91D
0EDC4234 A5EF49B2 46481B92 B3926D47 D068BFE6 266510F1 D3836296 5BC15B3D
F1E70EF7 0E21479F 6800F7FA CB2517CF 55F514CB 797F5362 2F471C02 B943A07A
4ADEDC3D 1EE860F1 BC2CCD66 5E60934A BFEE8C04 E04706CD 0F451A5B 666F9AFD
```

```
97B61B7E 12B70203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
301F0603 551D2304 18301680 142FDCFF D966DAB2 C7F2F808 36941696 F8726816
2C301D06 03551D0E 04160414 2FDCFFD9 66DAB2C7 F2F80836 941696F8 7268162C
300D0609 2A864886 F70D0101 05050003 82010100 206948B9 9E044E74 B1F74315
199827BC F183D1E6 19A30435 E7DC5E0E FB07732C EB3A4800 7EF6842C 5FCAFD95
E1E30D31 640754FB E7AF6A6E C5A2DB81 7E5C675F 40F2A037 F365B4CC D796CBE6
3AC08218 D67D4A78 C941DCDF 9FC9F585 FE032900 B1DCC6DE 528EDC5C 71CAE474
80C01D0E 6DA52AFA CF526D64 FB9DEA50 EEF55189 9765185D 0A929615 9A85FEA9
D40DE576 F2576AEE 5DC3CAD7 7AF3DCE5 72083B5D F26131C8 21EFC539 795BBE35
FDD031BC 192E3E4A 1E0A8AD7 809CB946 C1C588B0 C41EA60C 69CA7DF6 220CAD34
D089C2DF 4A44E122 C7B519F0 70C4CFB9 680D129F 20EE9D9C FED47081 3CCFB5B4
7326A47C 7F082833 ECC935E2 8A91D63D 5437DE8B
quit
license boot level network-essentials addon dna-essentials
diagnostic bootup level minimal
spanning-tree mode rapid-pvst
spanning-tree extend system-id
redundancy
mode sso
class-map match-any system-cpp-police-topology-control
description Topology control
class-map match-any system-cpp-police-sw-forward
description Sw forwarding, L2 LVX data, LOGGING
class-map match-any system-cpp-default
description Inter FED, EWLC control, EWLC data
class-map match-any system-cpp-police-sys-data
description Learning cache ovfl, High Rate App, Exception, EGR Exception, NFL SAMPLED
DATA, RPF Failed
class-map match-any system-cpp-police-punt-webauth
description Punt Webauth
class-map match-any system-cpp-police-l2lvx-control
description L2 LVX control packets
class-map match-any system-cpp-police-forus
```

```
description Forus Address resolution and Forus traffic
class-map match-any system-cpp-police-multicast-end-station
description MCAST END STATION
class-map match-any system-cpp-police-multicast
description Transit Traffic and MCAST Data
class-map match-any system-cpp-police-l2-control
description L2 control
class-map match-any system-cpp-police-dot1x-auth
description DOT1X Auth
class-map match-any system-cpp-police-data
description ICMP redirect, ICMP_GEN and BROADCAST
class-map match-any system-cpp-police-stackwise-virt-control
description Stackwise Virtual
class-map match-any non-client-nrt-class
class-map match-any system-cpp-police-routing-control
description Routing control and Low Latency
class-map match-any system-cpp-police-protocol-snooping
description Protocol snooping
class-map match-any system-cpp-police-dhcp-snooping
description DHCP snooping
class-map match-any system-cpp-police-system-critical
description System Critical and Gold Pkt
policy-map system-cpp-policy
interface GigabitEthernet0/0
vrf forwarding Mgmt-vrf
no ip address
shutdown
negotiation auto
interface GigabitEthernet1/0/1
no switchport
ip address 10.9.1.2 255.255.255.252
ip ospf 1 area 9
ipv6 address 1091::2/64
```

```
ipv6 ospf 1 area 9
interface GigabitEthernet1/0/2
interface GigabitEthernet1/0/3
interface GigabitEthernet1/0/4
interface GigabitEthernet1/0/5
interface GigabitEthernet1/0/6
interface GigabitEthernet1/0/7
interface GigabitEthernet1/0/8
interface GigabitEthernet1/0/9
interface GigabitEthernet1/0/10
interface GigabitEthernet1/0/11
interface GigabitEthernet1/0/12
interface GigabitEthernet1/0/13
interface GigabitEthernet1/0/14
interface GigabitEthernet1/0/15
interface GigabitEthernet1/0/16
interface GigabitEthernet1/0/17
interface GigabitEthernet1/0/18
interface GigabitEthernet1/0/19
interface GigabitEthernet1/0/20
interface GigabitEthernet1/0/21
interface GigabitEthernet1/0/22
interface GigabitEthernet1/0/23
interface GigabitEthernet1/0/24
interface GigabitEthernet1/1/1
interface GigabitEthernet1/1/2
interface GigabitEthernet1/1/3
interface GigabitEthernet1/1/4
interface Vlan1
no ip address
shutdown
router ospfv3 1
address-family ipv6 unicast
```

```
exit-address-family
router ospf 1
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
control-plane
service-policy input system-cpp-policy
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
line vty 5 15
login
end
```

R1 Routing Table

```
R1#show ip route
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 - 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, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR



Gateway of last resort is not set
```

```
      10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
O        10.0.2.0/30 [110/2] via 10.0.3.2, 00:33:26, GigabitEthernet0/0/1
C        10.0.3.0/30 is directly connected, GigabitEthernet0/0/1
L        10.0.3.1/32 is directly connected, GigabitEthernet0/0/1
C        10.0.4.0/30 is directly connected, GigabitEthernet0/0/0
L        10.0.4.1/32 is directly connected, GigabitEthernet0/0/0
O IA     10.1.1.0/30 [110/2] via 10.0.4.2, 00:49:10, GigabitEthernet0/0/0
O IA     10.1.2.0/30 [110/3] via 10.0.4.2, 00:48:25, GigabitEthernet0/0/0
O IA     10.9.1.0/30 [110/2] via 10.0.3.2, 00:33:27, GigabitEthernet0/0/1
R1#show ipv6 route
IPv6 Routing Table - default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
       IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application
O   1002::/64 [110/2]
     via FE80::C64D:84FF:FE2B:E5E4, GigabitEthernet0/0/1
C   1003::/64 [0/0]
     via GigabitEthernet0/0/1, directly connected
L   1003::1/128 [0/0]
     via GigabitEthernet0/0/1, receive
C   1004::/64 [0/0]
     via GigabitEthernet0/0/0, directly connected
L   1004::1/128 [0/0]
     via GigabitEthernet0/0/0, receive
OI  1011::/64 [110/2]
     via FE80::267E:12FF:FE4D:E7B0, GigabitEthernet0/0/0
OI  1012::/64 [110/3]
     via FE80::267E:12FF:FE4D:E7B0, GigabitEthernet0/0/0
```

```
OI  1091::/64 [110/2]
     via FE80::C64D:84FF:FE2B:E5E4, GigabitEthernet0/0/1
L   FF00::/8 [0/0]
     via Null0, receive
```

R2 Routing Table

```
R2#show ip route
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 - 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, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
C        10.0.2.0/30 is directly connected, GigabitEthernet0/0/1
L        10.0.2.1/32 is directly connected, GigabitEthernet0/0/1
O        10.0.3.0/30 [110/2] via 10.0.2.2, 00:34:02, GigabitEthernet0/0/1
O        10.0.4.0/30 [110/3] via 10.0.2.2, 00:34:02, GigabitEthernet0/0/1
O IA     10.1.1.0/30 [110/4] via 10.0.2.2, 00:34:02, GigabitEthernet0/0/1
O IA     10.1.2.0/30 [110/5] via 10.0.2.2, 00:34:02, GigabitEthernet0/0/1
O IA     10.9.1.0/30 [110/2] via 10.0.2.2, 00:34:02, GigabitEthernet0/0/1
R2#show ipv
R2#show ipv6 route
IPv6 Routing Table - default - 8 entries
```

```
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
       IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application
C   1002::/64 [0/0]
     via GigabitEthernet0/0/1, directly connected
L   1002::1/128 [0/0]
     via GigabitEthernet0/0/1, receive
O   1003::/64 [110/2]
     via FE80::C64D:84FF:FE2B:E5D6, GigabitEthernet0/0/1
O   1004::/64 [110/3]
     via FE80::C64D:84FF:FE2B:E5D6, GigabitEthernet0/0/1
OI  1011::/64 [110/4]
     via FE80::C64D:84FF:FE2B:E5D6, GigabitEthernet0/0/1
OI  1012::/64 [110/5]
     via FE80::C64D:84FF:FE2B:E5D6, GigabitEthernet0/0/1
OI  1091::/64 [110/2]
     via FE80::C64D:84FF:FE2B:E5D6, GigabitEthernet0/0/1
L   FF00::/8 [0/0]
     via Null0, receive
```

R3 Routing Table

```
R3#show ip route
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 - 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, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
```

```
Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
O IA     10.0.2.0/30 [110/4] via 10.1.1.1, 00:34:30, GigabitEthernet0/0/0
O IA     10.0.3.0/30 [110/3] via 10.1.1.1, 00:40:05, GigabitEthernet0/0/0
O IA     10.0.4.0/30 [110/2] via 10.1.1.1, 00:49:30, GigabitEthernet0/0/0
C        10.1.1.0/30 is directly connected, GigabitEthernet0/0/0
L        10.1.1.2/32 is directly connected, GigabitEthernet0/0/0
C        10.1.2.0/30 is directly connected, GigabitEthernet0/0/1
L        10.1.2.2/32 is directly connected, GigabitEthernet0/0/1
O IA     10.9.1.0/30 [110/4] via 10.1.1.1, 00:34:30, GigabitEthernet0/0/0
R3#show ipv6 route
IPv6 Routing Table - default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
       IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application
OI  1002::/64 [110/4]
     via FE80::267E:12FF:FE4D:E7B1, GigabitEthernet0/0/0
OI  1003::/64 [110/3]
     via FE80::267E:12FF:FE4D:E7B1, GigabitEthernet0/0/0
OI  1004::/64 [110/2]
     via FE80::267E:12FF:FE4D:E7B1, GigabitEthernet0/0/0
C   1011::/64 [0/0]
     via GigabitEthernet0/0/0, directly connected
L   1011::2/128 [0/0]
```

```
     via GigabitEthernet0/0/0, receive
C    1012::/64 [0/0]
     via GigabitEthernet0/0/1, directly connected
L    1012::2/128 [0/0]
     via GigabitEthernet0/0/1, receive
OI   1091::/64 [110/4]
     via FE80::267E:12FF:FE4D:E7B1, GigabitEthernet0/0/0
L    FF00::/8 [0/0]
     via Null0, receive
```

R4 Routing Table

```
R4#show ip route
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 - 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, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
O        10.0.2.0/30 [110/3] via 10.0.4.1, 00:34:59, GigabitEthernet0/0/0
O        10.0.3.0/30 [110/2] via 10.0.4.1, 00:40:43, GigabitEthernet0/0/0
C        10.0.4.0/30 is directly connected, GigabitEthernet0/0/0
L        10.0.4.2/32 is directly connected, GigabitEthernet0/0/0
C        10.1.1.0/30 is directly connected, GigabitEthernet0/0/1
```

```
L        10.1.1.1/32 is directly connected, GigabitEthernet0/0/1
O        10.1.2.0/30 [110/2] via 10.1.1.2, 00:49:59, GigabitEthernet0/0/1
O IA     10.9.1.0/30 [110/3] via 10.0.4.1, 00:34:59, GigabitEthernet0/0/0
R4#show ipv6 route
IPv6 Routing Table - default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
       IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application
O   1002::/64 [110/3]
     via FE80::72D3:79FF:FE02:8160, GigabitEthernet0/0/0
O   1003::/64 [110/2]
     via FE80::72D3:79FF:FE02:8160, GigabitEthernet0/0/0
C   1004::/64 [0/0]
     via GigabitEthernet0/0/0, directly connected
L   1004::2/128 [0/0]
     via GigabitEthernet0/0/0, receive
C   1011::/64 [0/0]
     via GigabitEthernet0/0/1, directly connected
L   1011::1/128 [0/0]
     via GigabitEthernet0/0/1, receive
O   1012::/64 [110/2]
     via FE80::521C:B0FF:FE63:37A0, GigabitEthernet0/0/1
OI  1091::/64 [110/3]
     via FE80::72D3:79FF:FE02:8160, GigabitEthernet0/0/0
L   FF00::/8 [0/0]
     via Null0, receive
```

R5 Routing Table

```
R5#show ip route
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 - 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, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O IA     10.0.2.0/30 [110/5] via 10.1.2.2, 00:35:26, GigabitEthernet0/0/0
O IA     10.0.3.0/30 [110/4] via 10.1.2.2, 00:41:00, GigabitEthernet0/0/0
O IA     10.0.4.0/30 [110/3] via 10.1.2.2, 00:50:22, GigabitEthernet0/0/0
O        10.1.1.0/30 [110/2] via 10.1.2.2, 00:51:10, GigabitEthernet0/0/0
C        10.1.2.0/30 is directly connected, GigabitEthernet0/0/0
L        10.1.2.1/32 is directly connected, GigabitEthernet0/0/0
O IA     10.9.1.0/30 [110/5] via 10.1.2.2, 00:35:26, GigabitEthernet0/0/0
R5#show ipv6 route
IPv6 Routing Table - default - 8 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
       IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
```

```
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application
OI  1002::/64 [110/5]
     via FE80::521C:B0FF:FE63:37A1, GigabitEthernet0/0/0
OI  1003::/64 [110/4]
     via FE80::521C:B0FF:FE63:37A1, GigabitEthernet0/0/0
OI  1004::/64 [110/3]
     via FE80::521C:B0FF:FE63:37A1, GigabitEthernet0/0/0
O   1011::/64 [110/2]
     via FE80::521C:B0FF:FE63:37A1, GigabitEthernet0/0/0
C   1012::/64 [0/0]
     via GigabitEthernet0/0/0, directly connected
L   1012::1/128 [0/0]
     via GigabitEthernet0/0/0, receive
OI  1091::/64 [110/5]
     via FE80::521C:B0FF:FE63:37A1, GigabitEthernet0/0/0
L   FF00::/8 [0/0]
     via Null0, receive
```

S1 Routing Table

```
S1#show ip route
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 - 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, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
```

```
Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
C        10.0.2.0/30 is directly connected, GigabitEthernet1/0/2
L        10.0.2.2/32 is directly connected, GigabitEthernet1/0/2
C        10.0.3.0/30 is directly connected, GigabitEthernet1/0/1
L        10.0.3.2/32 is directly connected, GigabitEthernet1/0/1
O        10.0.4.0/30 [110/2] via 10.0.3.1, 00:35:51, GigabitEthernet1/0/1
O IA     10.1.1.0/30 [110/3] via 10.0.3.1, 00:35:51, GigabitEthernet1/0/1
O IA     10.1.2.0/30 [110/4] via 10.0.3.1, 00:35:51, GigabitEthernet1/0/1
C        10.9.1.0/30 is directly connected, GigabitEthernet1/0/3
L        10.9.1.1/32 is directly connected, GigabitEthernet1/0/3
S1#show ipv6 route
IPv6 Routing Table - default - 10 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       R - RIP, D - EIGRP, EX - EIGRP external, ND - ND Default
       NDp - ND Prefix, DCE - Destination, NDr - Redirect, O - OSPF Intra
       OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1
       ON2 - OSPF NSSA ext 2
C   1002::/64 [0/0]
     via GigabitEthernet1/0/2, directly connected
L   1002::2/128 [0/0]
     via GigabitEthernet1/0/2, receive
C   1003::/64 [0/0]
     via GigabitEthernet1/0/1, directly connected
L   1003::2/128 [0/0]
     via GigabitEthernet1/0/1, receive
```

```
O   1004::/64 [110/2]
     via FE80::72D3:79FF:FE02:8161, GigabitEthernet1/0/1
OI  1011::/64 [110/3]
     via FE80::72D3:79FF:FE02:8161, GigabitEthernet1/0/1
OI  1012::/64 [110/4]
     via FE80::72D3:79FF:FE02:8161, GigabitEthernet1/0/1
C   1091::/64 [0/0]
     via GigabitEthernet1/0/3, directly connected
L   1091::1/128 [0/0]
     via GigabitEthernet1/0/3, receive
L   FF00::/8 [0/0]
     via Null0, receive
```

S2 Routing Table

```
S2#show ip route
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 - 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, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR



Gateway of last resort is not set
```

```
      10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O IA     10.0.2.0/30 [110/2] via 10.9.1.1, 00:36:30, GigabitEthernet1/0/1
O IA     10.0.3.0/30 [110/2] via 10.9.1.1, 00:36:30, GigabitEthernet1/0/1
O IA     10.0.4.0/30 [110/3] via 10.9.1.1, 00:36:22, GigabitEthernet1/0/1
O IA     10.1.1.0/30 [110/4] via 10.9.1.1, 00:36:22, GigabitEthernet1/0/1
O IA     10.1.2.0/30 [110/5] via 10.9.1.1, 00:36:22, GigabitEthernet1/0/1
C        10.9.1.0/30 is directly connected, GigabitEthernet1/0/1
L        10.9.1.2/32 is directly connected, GigabitEthernet1/0/1
S2#show ipv6 route
IPv6 Routing Table - default - 8 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       R - RIP, D - EIGRP, EX - EIGRP external, ND - ND Default
       NDp - ND Prefix, DCE - Destination, NDr - Redirect, O - OSPF Intra
       OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1
       ON2 - OSPF NSSA ext 2
OI  1002::/64 [110/2]
     via FE80::C64D:84FF:FE2B:E5D8, GigabitEthernet1/0/1
OI  1003::/64 [110/2]
     via FE80::C64D:84FF:FE2B:E5D8, GigabitEthernet1/0/1
OI  1004::/64 [110/3]
     via FE80::C64D:84FF:FE2B:E5D8, GigabitEthernet1/0/1
OI  1011::/64 [110/4]
     via FE80::C64D:84FF:FE2B:E5D8, GigabitEthernet1/0/1
OI  1012::/64 [110/5]
     via FE80::C64D:84FF:FE2B:E5D8, GigabitEthernet1/0/1
C   1091::/64 [0/0]
     via GigabitEthernet1/0/1, directly connected
L   1091::2/128 [0/0]
     via GigabitEthernet1/0/1, receive
L   FF00::/8 [0/0]
```

```
     via Null0, receive
```

Proof of multi-Area OSPF on R4

```
R4#show ospf 1
 OSPFv3 1 address-family ipv6
 Router ID 10.0.4.2
 Supports NSSA (compatible with RFC 3101)
 Supports Database Exchange Summary List Optimization (RFC 5243)
 Event-log enabled, Maximum number of events: 1000, Mode: cyclic
 It is an area border router
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 50 msecs
 Minimum hold time between two consecutive SPFs 200 msecs
 Maximum wait time between two consecutive SPFs 5000 msecs
 Initial LSA throttle delay 50 msecs
 Minimum hold time for LSA throttle 200 msecs
 Maximum wait time for LSA throttle 5000 msecs
 Minimum LSA arrival 100 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Retransmission limit dc 24 non-dc 24
 EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
 Number of external LSA 0. Checksum Sum 0x000000
 Number of areas in this router is 2. 2 normal 0 stub 0 nssa
 Graceful restart helper support enabled
 Reference bandwidth unit is 100 mbps
 RFC1583 compatibility enabled
    Area BACKBONE(0)
        Number of interfaces in this area is 1
        SPF algorithm executed 26 times
```

```
        Number of LSA 15. Checksum Sum 0x079082
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
    Area 1
        Number of interfaces in this area is 1
        SPF algorithm executed 3 times
        Number of LSA 13. Checksum Sum 0x0784F7
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
```

Proof of multi-Area OSPF on S1

```
S1#show ospf 1
 OSPFv3 1 address-family ipv6
 Router ID 10.0.3.2
 Supports NSSA (compatible with RFC 3101)
 Supports Database Exchange Summary List Optimization (RFC 5243)
 Event-log enabled, Maximum number of events: 1000, Mode: cyclic
 It is an area border router
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 50 msecs
 Minimum hold time between two consecutive SPFs 200 msecs
 Maximum wait time between two consecutive SPFs 5000 msecs
 Initial LSA throttle delay 50 msecs
 Minimum hold time for LSA throttle 200 msecs
 Maximum wait time for LSA throttle 5000 msecs
 Minimum LSA arrival 100 msecs
 LSA group pacing timer 240 secs
```

```
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
Retransmission limit dc 24 non-dc 24
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
Number of external LSA 0. Checksum Sum 0x000000
Number of areas in this router is 2. 2 normal 0 stub 0 nssa
Graceful restart helper support enabled
Reference bandwidth unit is 100 mbps
RFC1583 compatibility enabled
   Area BACKBONE(0)
       Number of interfaces in this area is 2
       SPF algorithm executed 15 times
       Number of LSA 19. Checksum Sum 0x08EDE7
       Number of DCbitless LSA 0
       Number of indication LSA 0
       Number of DoNotAge LSA 0
       Flood list length 0
   Area 9
       Number of interfaces in this area is 1
       SPF algorithm executed 5 times
       Number of LSA 11. Checksum Sum 0x05704F
       Number of DCbitless LSA 0
       Number of indication LSA 0
       Number of DoNotAge LSA 0
       Flood list length 0
```

Conclusion

Though we experienced unexpected issues during the OSPF lab which delayed our progress, the lab was finished without major changes to the plan. Through the experience, we familiarized ourselves with the configuration of both OSPF and OSPFv3 concurrently on multiple devices. Furthermore, we experimented with the use of a multi-layer switch. In our final network, we had seven devices spread over three areas, including two layer 3 switches configured to run as

routers. We are now prepared to apply these skills to larger networks with more complicated devices.

Signoff Page