Purpose of our Lab

For this lab, we had to set up multi-area OSPF and OSPFv3 between five different routers. During this lab we learned how to setup multi-area OSPF better than before. Because this was our first lab since the previous school year, this lab was more about doing what we already knew and making sure we remembered what we may have forgot. In the end, this lab helped us recall our knowledge, so we could use it in the upcoming year.

Background Information on the Lab

In our lab, we used our knowledge of OSPF and multi-area OSPF in order to make a network between different routers. OSPF is used to distribute IP routing information through a network. This can be used to connect networks from multiple buildings or areas together and let them work with each other. We did this for IPv4 and IPv6 which are the two primary Internet Protocols. We used multi-area OSPF so we could organize the routers and networks and it is generally used to improve performance and efficiency. The separated areas could be used to represent different buildings and is useful for making everything run better and more organized. Overall, we mainly used OSPF with IPv4 and IPv6 in order to maintain multiple networks between routers.

Lab Summary

In this lab, we set up multi-area OSPF for IPv4 and IPv6 across five routers. We started off by drawing a diagram of what our network would look like, and then we setup each router into areas 51, 0, and 17. We setup five routers and then we setup a PC at each end router. We set up OSPF and OSPFv3 on each router and IPv6 and IPv4 addresses on all devices. We ended up with a full, working network where any device could successfully ping another device in the network and you could see routes between the routers in the routing table. Overall, we successfully finished our lab by setting up OSPF for IPv4 and IPv6 and got everything to work as it should.

Lab Commands

In our lab, we used a lot of different commands in order to setup OSPF for IPv4 and IPv6. Some of the commands we used for IPv4 included the IP address command in order to setup the IPv4 addresses and the router OSPF command in order setup OSPF. Within this, we used the network command in order to allow our networks to go through OSPF. For IPv6, we used different OSPF commands and IPv6 unicast-routing. This sets up IPv6 routing on the router and allows us to setup the IPv6 addresses with the IPv6 address command and to setup OSPFv3. For OSPFv3, we used the router OSPFv3 command to setup OSPF and then used the IPv6 OSPF area command to set up each interface on the router to different areas. Along with these main commands, we used multiple troubleshooting commands to make sure everything worked. We used the ping and traceroute commands, which verify connectivity across the network, and we used the IP route and OSPF database commands. IP route lets you see the routing table of the router and it can be used to make sure all the routes from other routers are going through it. The OSPF database command allows you to see everything about OSPF from the neighbors to which area it’s in, so it was great for troubleshooting. We used a lot of commands in this lab that helped us set up multi-area OSPF successfully.

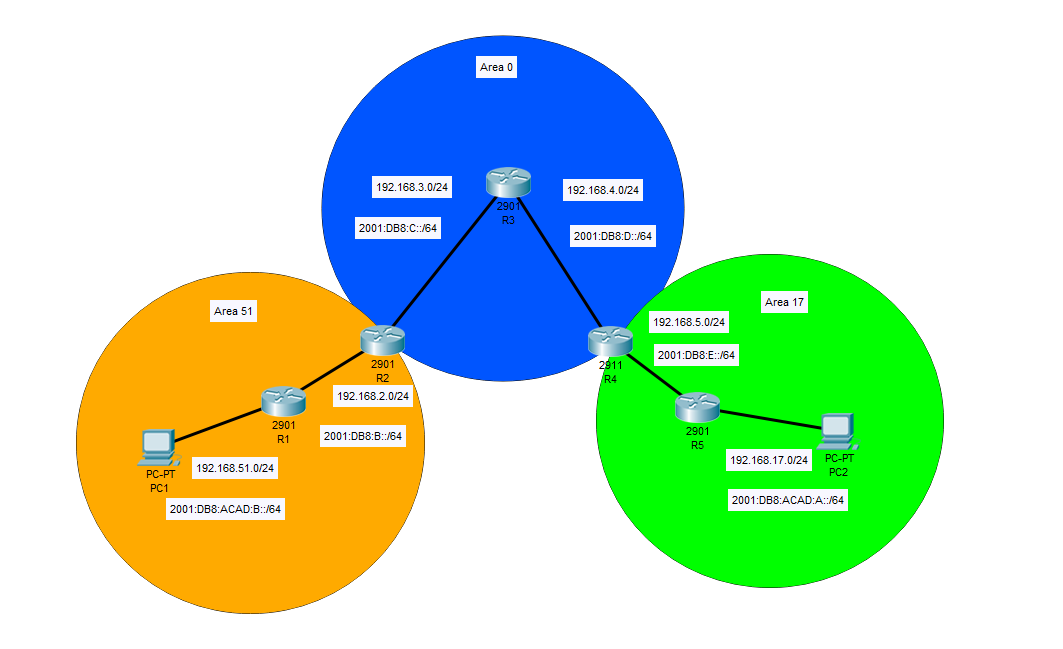
Problems

In our lab, we had multiple problems that caused us to take longer to do the lab. These problems mostly include missing commands, incorrectly spelled commands, and wrong area commands. One of our earliest problems was a problem on R2. This problem was preventing any IPv6 pings to go through it, yet IPv4 went through fine. We figured out that after resetting the interface, it began to work again, but we never figured out what was causing this problem. Another problem we had was messing up the OSPF commands. We had to remember all the CCNA concepts after three months, so we didn’t remember everything right away. We mainly messed up with setting up OSPF with IPv6 because the commands were different than with IPv4. We asked for help from our neighbors and we were able to fix this problem. The final problem we had was setting up the PCs. When we set up both PCs, it was strange because the Routers could ping all the way across yet the PCs could not. We tried a lot of troubleshooting techniques yet the solution ended up being that we restarted both computers and the pings went through fine. Overall, I learned a lot through this lab about troubleshooting and figuring out how to solve these problems without much help. Having to figure out everything was really helpful for me in improving my skills so I can solve more problems in future labs.

Conclusion

For this lab, we used multi-area OSPF and OSPFv3 to set up a connection between multiple routers. While doing the lab, we came across multiple problems such as OSPFv3 not working and pings across the routers not being successful. This lab was our first lab of the year, so we used it as an opportunity to review the concepts we had learned before the summer. After remembering what we forgot, we were able to solve our problems and succeed in the lab. Overall, we learned a lot in this lab about the concepts we will be using in the future and how it will be different for us this year in Cisco.

Network Diagram



Configurations

Running Configurations:

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Router 1:

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Last configuration change at 22:09:04 UTC Mon Sep 9 2019

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

hostname R1

boot-start-marker

boot-end-marker

no aaa new-model

memory-size iomem 10

ip cef

no ip domain lookup

ipv6 unicast-routing

ipv6 cef

multilink bundle-name authenticated

voice-card 0

license udi pid CISCO2901/K9 sn FTX1704Y038

license accept end user agreement

license boot module c2900 technology-package securityk9

license boot module c2900 technology-package uck9

vtp domain cisco

vtp mode transparent

redundancy

interface Embedded-Service-Engine0/0

no ip address

interface GigabitEthernet0/0

ip address 192.168.51.2 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::1 link-local

ipv6 address 2001:DB8:A::1/64

interface GigabitEthernet0/1

ip address 192.168.2.1 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::1 link-local

ipv6 address 2001:DB8:B::1/64

ipv6 ospf 1 area 51

interface Serial0/0/0

no ip address

clock rate 2000000

interface Serial0/0/1

no ip address

clock rate 2000000

router ospf 1

router-id 1.1.1.1

network 192.168.2.0 0.0.0.255 area 51

network 192.168.51.0 0.0.0.255 area 51

ip forward-protocol nd

no ip http server

no ip http secure-server

ipv6 router ospf 1

router-id 1.1.1.1

control-plane

mgcp profile default

gatekeeper

shutdown

line con 0

password cisco

login

line aux 0

line 2

no activation-character

no exec

transport preferred none

transport output pad telnet rlogin lapb-ta mop udptn v120 ssh

stopbits 1

line vty 0 4

login

transport input all

scheduler allocate 20000 1000

end

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Router 2:

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! Last configuration change at 21:31:21 UTC Mon Sep 9 2019

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

hostname R2

boot-start-marker

boot-end-marker

no aaa new-model

memory-size iomem 10

ip cef

ipv6 unicast-routing

ipv6 cef

multilink bundle-name authenticated

voice-card 0

license udi pid CISCO2901/K9 sn FTX15208075

license accept end user agreement

license boot module c2900 technology-package securityk9

license boot module c2900 technology-package uck9

vtp domain cisco

vtp mode transparent

redundancy

interface Embedded-Service-Engine0/0

no ip address

shutdown

interface GigabitEthernet0/0

ip address 192.168.2.2 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::2 link-local

ipv6 address 2001:DB8:B::2/64

ipv6 ospf 1 area 51

interface GigabitEthernet0/1

ip address 192.168.3.1 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::2 link-local

ipv6 address 2001:DB8:C::1/64

ipv6 ospf 1 area 0

interface Serial0/0/0

no ip address

shutdown

clock rate 2000000

interface Serial0/0/1

no ip address

shutdown

clock rate 2000000

interface GigabitEthernet0/1/0

no ip address

shutdown

duplex auto

speed auto

router ospf 1

router-id 2.2.2.2

network 192.168.2.0 0.0.0.255 area 51

network 192.168.3.0 0.0.0.255 area 0

ip forward-protocol nd

no ip http server

no ip http secure-server

ipv6 router ospf 1

router-id 2.2.2.2

control-plane

mgcp profile default

gatekeeper

shutdown

line con 0

line aux 0

line 2

no activation-character

no exec

transport preferred none

transport input all

transport output lat pad telnet rlogin lapb-ta mop udptn v120 ssh

stopbits 1

line vty 0 4

login

transport input all

scheduler allocate 20000 1000

end

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Router 3:

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! Last configuration change at 15:56:37 UTC Mon Sep 2 2002

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

hostname R3

boot-start-marker

boot-end-marker

no aaa new-model

memory-size iomem 10

ip cef

ipv6 unicast-routing

ipv6 cef

multilink bundle-name authenticated

voice-card 0

license udi pid CISCO2901/K9 sn FTX1520806V

license accept end user agreement

license boot module c2900 technology-package securityk9

license boot module c2900 technology-package uck9

vtp domain cisco

vtp mode transparent

redundancy

interface Embedded-Service-Engine0/0

no ip address

shutdown

interface GigabitEthernet0/0

ip address 192.168.4.1 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::3 link-local

ipv6 address 2001:DB8:D::1/64

ipv6 ospf 1 area 0

interface GigabitEthernet0/1

ip address 192.168.3.2 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::3 link-local

ipv6 address 2001:DB8:C::2/64

ipv6 ospf 1 area 0

interface Serial0/0/0

no ip address

clock rate 2000000

interface Serial0/0/1

no ip address

shutdown

clock rate 2000000

interface GigabitEthernet0/1/0

no ip address

duplex auto

speed auto

router ospf 1

router-id 3.3.3.3

network 192.168.3.0 0.0.0.255 area 0

network 192.168.4.0 0.0.0.255 area 0

ip forward-protocol nd

no ip http server

no ip http secure-server

ipv6 router ospf 1

router-id 3.3.3.3

control-plane

mgcp profile default

gatekeeper

shutdown

line con 0

line aux 0

line 2

no activation-character

no exec

transport preferred none

transport input all

transport output lat pad telnet rlogin lapb-ta mop udptn v120 ssh

stopbits 1

line vty 0 4

login

transport input all

scheduler allocate 20000 1000

end

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Router 4:

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! Last configuration change at 20:43:10 UTC Mon Sep 9 2019

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

hostname R4

boot-start-marker

boot-end-marker

no aaa new-model

memory-size iomem 10

ip cef

ipv6 unicast-routing

ipv6 cef

multilink bundle-name authenticated

voice-card 0

license udi pid CISCO2901/K9 sn FTX180180ME

license accept end user agreement

license boot module c2900 technology-package securityk9

license boot module c2900 technology-package uck9

vtp domain cisco

vtp mode transparent

redundancy

interface Embedded-Service-Engine0/0

no ip address

shutdown

interface GigabitEthernet0/0

ip address 192.168.5.1 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::4 link-local

ipv6 address 2001:DB8:E::1/64

ipv6 ospf 1 area 17

interface GigabitEthernet0/1

ip address 192.168.4.2 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::4 link-local

ipv6 address 2001:DB8:D::2/64

ipv6 ospf 1 area 0

interface Serial0/0/0

no ip address

shutdown

clock rate 2000000

interface Serial0/0/1

no ip address

shutdown

clock rate 2000000

interface GigabitEthernet0/1/0

no ip address

shutdown

duplex auto

speed auto

router ospf 1

router-id 4.4.4.4

network 192.168.4.0 0.0.0.255 area 0

network 192.168.5.0 0.0.0.255 area 17

ip forward-protocol nd

no ip http server

no ip http secure-server

ipv6 router ospf 1

router-id 4.4.4.4

control-plane

mgcp profile default

gatekeeper

shutdown

line con 0

line aux 0

line 2

no activation-character

no exec

transport preferred none

transport output lat pad telnet rlogin lapb-ta mop udptn v120 ssh

stopbits 1

line vty 0 4

login

transport input all

scheduler allocate 20000 1000

end

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Router 5:

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! Last configuration change at 21:22:39 UTC Mon Sep 9 2019

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

hostname R5

boot-start-marker

boot-end-marker

no aaa new-model

memory-size iomem 10

ip cef

ipv6 unicast-routing

ipv6 cef

multilink bundle-name authenticated

voice-card 0

license udi pid CISCO2901/K9 sn FTX180180MA

license accept end user agreement

license boot module c2900 technology-package securityk9

license boot module c2900 technology-package uck9

vtp domain cisco

vtp mode transparent

redundancy

interface Embedded-Service-Engine0/0

no ip address

shutdown

interface GigabitEthernet0/0

ip address 192.168.17.1 255.255.255.0

duplex auto

speed auto

interface GigabitEthernet0/1

ip address 192.168.5.2 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::5 link-local

ipv6 address 2001:DB8:E::2/64

ipv6 ospf 1 area 17

interface Serial0/0/0

no ip address

shutdown

clock rate 2000000

interface Serial0/0/1

no ip address

shutdown

clock rate 2000000

router ospf 1

router-id 5.5.5.5

network 192.168.5.0 0.0.0.255 area 17

network 192.168.17.0 0.0.0.255 area 17

ip forward-protocol nd

no ip http server

no ip http secure-server

ipv6 router ospf 1

router-id 5.5.5.5

control-plane

mgcp profile default

gatekeeper

shutdown

line con 0

line aux 0

line 2

no activation-character

no exec

transport preferred none

transport output lat pad telnet rlogin lapb-ta mop udptn v120 ssh

stopbits 1

line vty 0 4

login

transport input all

scheduler allocate 20000 1000

end

IPv4 and IPv6 Routes:

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Router 1:

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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

+ - replicated route, % - next hop override

Gateway of last resort is not set

192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.2.0/24 is directly connected, GigabitEthernet0/1

L 192.168.2.1/32 is directly connected, GigabitEthernet0/1

O IA 192.168.3.0/24 [110/2] via 192.168.2.2, 00:35:12, GigabitEthernet0/1

O IA 192.168.4.0/24 [110/3] via 192.168.2.2, 00:34:06, GigabitEthernet0/1

O IA 192.168.5.0/24 [110/4] via 192.168.2.2, 00:33:12, GigabitEthernet0/1

R1#show ipv6 route

IPv6 Routing Table - default - 6 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, H - NHRP, 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

C 2001:DB8:B::/64 [0/0]

via GigabitEthernet0/1, directly connected

L 2001:DB8:B::1/128 [0/0]

via GigabitEthernet0/1, receive

OI 2001:DB8:C::/64 [110/2]

via FE80::2, GigabitEthernet0/1

OI 2001:DB8:D::/64 [110/3]

via FE80::2, GigabitEthernet0/1

OI 2001:DB8:E::/64 [110/4]

via FE80::2, GigabitEthernet0/1

L FF00::/8 [0/0]

via Null0, receive

R1#show ospf database

OSPFv3 1 address-family ipv6 (router-id 1.1.1.1)

Router Link States (Area 51)

ADV Router Age Seq# Fragment ID Link count Bits

1.1.1.1 660 0x80000002 0 1 None

2.2.2.2 660 0x80000007 0 1 B

Net Link States (Area 51)

ADV Router Age Seq# Link ID Rtr count

2.2.2.2 660 0x80000001 4 2

Inter Area Prefix Link States (Area 51)

ADV Router Age Seq# Prefix

2.2.2.2 691 0x80000001 2001:DB8:C::/64

2.2.2.2 513 0x80000001 2001:DB8:D::/64

2.2.2.2 468 0x80000001 2001:DB8:E::/64

2.2.2.2 159 0x80000001 2001:DB8:ACAD:A::/64

Link (Type-8) Link States (Area 51)

ADV Router Age Seq# Link ID Interface

1.1.1.1 146 0x80000003 4 Gi0/0

1.1.1.1 695 0x80000005 5 Gi0/1

2.2.2.2 695 0x80000005 4 Gi0/1

Intra Area Prefix Link States (Area 51)

ADV Router Age Seq# Link ID Ref-lstype Ref-LSID

1.1.1.1 146 0x80000009 0 0x2001 0

2.2.2.2 660 0x80000001 4096 0x2002 4

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Router 2:

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R2#sh 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

+ - replicated route, % - next hop override

Gateway of last resort is not set

192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.2.0/24 is directly connected, GigabitEthernet0/0

L 192.168.2.2/32 is directly connected, GigabitEthernet0/0

192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.3.0/24 is directly connected, GigabitEthernet0/1

L 192.168.3.1/32 is directly connected, GigabitEthernet0/1

O 192.168.4.0/24 [110/2] via 192.168.3.2, 00:36:20, GigabitEthernet0/1

O IA 192.168.5.0/24 [110/3] via 192.168.3.2, 00:36:10, GigabitEthernet0/1

R2#sh ipv6 route

IPv6 Routing Table - default - 7 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP

H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea

IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO

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, l - LISP

C 2001:DB8:B::/64 [0/0]

via GigabitEthernet0/0, directly connected

L 2001:DB8:B::2/128 [0/0]

via GigabitEthernet0/0, receive

C 2001:DB8:C::/64 [0/0]

via GigabitEthernet0/1, directly connected

L 2001:DB8:C::1/128 [0/0]

via GigabitEthernet0/1, receive

O 2001:DB8:D::/64 [110/2]

via FE80::3, GigabitEthernet0/1

OI 2001:DB8:E::/64 [110/3]

via FE80::3, GigabitEthernet0/1

L FF00::/8 [0/0]

via Null0, receive

R2#show ospf neighbor

R2#show ospf database

OSPFv3 1 address-family ipv6 (router-id 2.2.2.2)

Router Link States (Area 0)

ADV Router Age Seq# Fragment ID Link count Bits

2.2.2.2 823 0x80000006 0 1 B

3.3.3.3 643 0x80000003 0 2 None

4.4.4.4 643 0x80000002 0 1 B

Net Link States (Area 0)

ADV Router Age Seq# Link ID Rtr count

3.3.3.3 824 0x80000001 5 2

4.4.4.4 644 0x80000001 5 2

Inter Area Prefix Link States (Area 0)

ADV Router Age Seq# Prefix

2.2.2.2 851 0x80000001 2001:DB8:B::/64

2.2.2.2 819 0x80000001 2001:DB8:A::/64

2.2.2.2 302 0x80000001 2001:DB8:ACAD:B::/64

4.4.4.4 685 0x80000001 2001:DB8:ACAD:A::/64

4.4.4.4 685 0x80000001 2001:DB8:E::/64

Link (Type-8) Link States (Area 0)

ADV Router Age Seq# Link ID Interface

2.2.2.2 859 0x80000005 5 Gi0/1

3.3.3.3 859 0x80000005 5 Gi0/1

Intra Area Prefix Link States (Area 0)

ADV Router Age Seq# Link ID Ref-lstype Ref-LSID

3.3.3.3 824 0x80000001 5120 0x2002 5

4.4.4.4 644 0x80000001 5120 0x2002 5

Router Link States (Area 51)

ADV Router Age Seq# Fragment ID Link count Bits

1.1.1.1 822 0x80000002 0 1 None

2.2.2.2 820 0x80000007 0 1 B

Net Link States (Area 51)

ADV Router Age Seq# Link ID Rtr count

2.2.2.2 820 0x80000001 4 2

Inter Area Prefix Link States (Area 51)

ADV Router Age Seq# Prefix

2.2.2.2 851 0x80000001 2001:DB8:C::/64

2.2.2.2 673 0x80000001 2001:DB8:D::/64

2.2.2.2 628 0x80000001 2001:DB8:E::/64

2.2.2.2 319 0x80000001 2001:DB8:ACAD:A::/64

Link (Type-8) Link States (Area 51)

ADV Router Age Seq# Link ID Interface

1.1.1.1 857 0x80000005 5 Gi0/0

2.2.2.2 856 0x80000005 4 Gi0/0

Intra Area Prefix Link States (Area 51)

ADV Router Age Seq# Link ID Ref-lstype Ref-LSID

1.1.1.1 308 0x80000009 0 0x2001 0

2.2.2.2 820 0x80000001 4096 0x2002 4

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Router 3:

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R3#sh 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

+ - replicated route, % - next hop override

Gateway of last resort is not set

O IA 192.168.2.0/24 [110/2] via 192.168.3.1, 00:39:59, GigabitEthernet0/1

192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.3.0/24 is directly connected, GigabitEthernet0/1

L 192.168.3.2/32 is directly connected, GigabitEthernet0/1

192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.4.0/24 is directly connected, GigabitEthernet0/0

L 192.168.4.1/32 is directly connected, GigabitEthernet0/0

O IA 192.168.5.0/24 [110/2] via 192.168.4.2, 00:38:21, GigabitEthernet0/0

R3#sh ipv6 route

IPv6 Routing Table - default - 7 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP

H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea

IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO

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, l - LISP

OI 2001:DB8:B::/64 [110/2]

via FE80::2, GigabitEthernet0/1

C 2001:DB8:C::/64 [0/0]

via GigabitEthernet0/1, directly connected

L 2001:DB8:C::2/128 [0/0]

via GigabitEthernet0/1, receive

C 2001:DB8:D::/64 [0/0]

via GigabitEthernet0/0, directly connected

L 2001:DB8:D::1/128 [0/0]

via GigabitEthernet0/0, receive

OI 2001:DB8:E::/64 [110/2]

via FE80::4, GigabitEthernet0/0

L FF00::/8 [0/0]

via Null0, receive

R3#show ospf database

OSPFv3 1 address-family ipv6 (router-id 3.3.3.3)

Router Link States (Area 0)

ADV Router Age Seq# Fragment ID Link count Bits

2.2.2.2 940 0x80000006 0 1 B

3.3.3.3 758 0x80000003 0 2 None

4.4.4.4 759 0x80000002 0 1 B

Net Link States (Area 0)

ADV Router Age Seq# Link ID Rtr count

3.3.3.3 939 0x80000001 5 2

4.4.4.4 759 0x80000001 5 2

Inter Area Prefix Link States (Area 0)

ADV Router Age Seq# Prefix

2.2.2.2 967 0x80000001 2001:DB8:B::/64

2.2.2.2 935 0x80000001 2001:DB8:A::/64

2.2.2.2 419 0x80000001 2001:DB8:ACAD:B::/64

4.4.4.4 799 0x80000001 2001:DB8:ACAD:A::/64

4.4.4.4 799 0x80000001 2001:DB8:E::/64

Link (Type-8) Link States (Area 0)

ADV Router Age Seq# Link ID Interface

2.2.2.2 975 0x80000005 5 Gi0/1

3.3.3.3 974 0x80000005 5 Gi0/1

3.3.3.3 793 0x80000002 4 Gi0/0

4.4.4.4 793 0x80000002 5 Gi0/0

Intra Area Prefix Link States (Area 0)

ADV Router Age Seq# Link ID Ref-lstype Ref-LSID

3.3.3.3 939 0x80000001 5120 0x2002 5

4.4.4.4 759 0x80000001 5120 0x2002 5

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Router 4:

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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

+ - replicated route, % - next hop override

Gateway of last resort is not set

O IA 192.168.2.0/24 [110/3] via 192.168.4.1, 00:38:55, GigabitEthernet0/1

O 192.168.3.0/24 [110/2] via 192.168.4.1, 00:38:55, GigabitEthernet0/1

192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.4.0/24 is directly connected, GigabitEthernet0/1

L 192.168.4.2/32 is directly connected, GigabitEthernet0/1

192.168.5.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.5.0/24 is directly connected, GigabitEthernet0/0

L 192.168.5.1/32 is directly connected, GigabitEthernet0/0

R4#show ipv6 route

IPv6 Routing Table - default - 7 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP

H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea

IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO

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, l - LISP

OI 2001:DB8:B::/64 [110/3]

via FE80::3, GigabitEthernet0/1

O 2001:DB8:C::/64 [110/2]

via FE80::3, GigabitEthernet0/1

C 2001:DB8:D::/64 [0/0]

via GigabitEthernet0/1, directly connected

L 2001:DB8:D::2/128 [0/0]

via GigabitEthernet0/1, receive

C 2001:DB8:E::/64 [0/0]

via GigabitEthernet0/0, directly connected

L 2001:DB8:E::1/128 [0/0]

via GigabitEthernet0/0, receive

L FF00::/8 [0/0]

via Null0, receive

R4#sh ospf database

OSPFv3 1 address-family ipv6 (router-id 4.4.4.4)

Router Link States (Area 0)

ADV Router Age Seq# Fragment ID Link count Bits

2.2.2.2 989 0x80000006 0 1 B

3.3.3.3 808 0x80000003 0 2 None

4.4.4.4 807 0x80000002 0 1 B

Net Link States (Area 0)

ADV Router Age Seq# Link ID Rtr count

3.3.3.3 988 0x80000001 5 2

4.4.4.4 807 0x80000001 5 2

Inter Area Prefix Link States (Area 0)

ADV Router Age Seq# Prefix

2.2.2.2 1017 0x80000001 2001:DB8:B::/64

2.2.2.2 985 0x80000001 2001:DB8:A::/64

2.2.2.2 469 0x80000001 2001:DB8:ACAD:B::/64

4.4.4.4 847 0x80000001 2001:DB8:ACAD:A::/64

4.4.4.4 847 0x80000001 2001:DB8:E::/64

Link (Type-8) Link States (Area 0)

ADV Router Age Seq# Link ID Interface

3.3.3.3 843 0x80000002 4 Gi0/1

4.4.4.4 842 0x80000002 5 Gi0/1

Intra Area Prefix Link States (Area 0)

ADV Router Age Seq# Link ID Ref-lstype Ref-LSID

3.3.3.3 988 0x80000001 5120 0x2002 5

4.4.4.4 807 0x80000001 5120 0x2002 5

Router Link States (Area 17)

ADV Router Age Seq# Fragment ID Link count Bits

4.4.4.4 847 0x80000003 0 1 B

5.5.5.5 1383 0x80000002 0 1 None

Net Link States (Area 17)

ADV Router Age Seq# Link ID Rtr count

5.5.5.5 1383 0x80000001 5 2

Inter Area Prefix Link States (Area 17)

ADV Router Age Seq# Prefix

4.4.4.4 837 0x80000001 2001:DB8:D::/64

4.4.4.4 802 0x80000001 2001:DB8:C::/64

4.4.4.4 802 0x80000001 2001:DB8:A::/64

4.4.4.4 802 0x80000001 2001:DB8:B::/64

4.4.4.4 467 0x80000001 2001:DB8:ACAD:B::/64

Link (Type-8) Link States (Area 17)

ADV Router Age Seq# Link ID Interface

4.4.4.4 1417 0x80000002 4 Gi0/0

5.5.5.5 1417 0x80000002 5 Gi0/0

Intra Area Prefix Link States (Area 17)

ADV Router Age Seq# Link ID Ref-lstype Ref-LSID

5.5.5.5 880 0x80000001 0 0x2001 0

5.5.5.5 1383 0x80000001 5120 0x2002 5

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Router 5:

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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

+ - replicated route, % - next hop override

Gateway of last resort is not set

O IA 192.168.2.0/24 [110/4] via 192.168.5.1, 00:33:47, GigabitEthernet0/1

O IA 192.168.3.0/24 [110/3] via 192.168.5.1, 00:33:47, GigabitEthernet0/1

O IA 192.168.4.0/24 [110/2] via 192.168.5.1, 00:33:47, GigabitEthernet0/1

192.168.5.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.5.0/24 is directly connected, GigabitEthernet0/1

L 192.168.5.2/32 is directly connected, GigabitEthernet0/1

R5#show ipv6 route

IPv6 Routing Table - default - 6 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP

H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea

IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO

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, l - LISP

OI 2001:DB8:B::/64 [110/4]

via FE80::4, GigabitEthernet0/1

OI 2001:DB8:C::/64 [110/3]

via FE80::4, GigabitEthernet0/1

OI 2001:DB8:D::/64 [110/2]

via FE80::4, GigabitEthernet0/1

C 2001:DB8:E::/64 [0/0]

via GigabitEthernet0/1, directly connected

L 2001:DB8:E::2/128 [0/0]

via GigabitEthernet0/1, receive

L FF00::/8 [0/0]

via Null0, receive

R5#sh ospf database

OSPFv3 1 address-family ipv6 (router-id 5.5.5.5)

Router Link States (Area 17)

ADV Router Age Seq# Fragment ID Link count Bits

4.4.4.4 897 0x80000003 0 1 B

5.5.5.5 1431 0x80000002 0 1 None

Net Link States (Area 17)

ADV Router Age Seq# Link ID Rtr count

5.5.5.5 1431 0x80000001 5 2

Inter Area Prefix Link States (Area 17)

ADV Router Age Seq# Prefix

4.4.4.4 888 0x80000001 2001:DB8:D::/64

4.4.4.4 853 0x80000001 2001:DB8:C::/64

4.4.4.4 853 0x80000001 2001:DB8:A::/64

4.4.4.4 853 0x80000001 2001:DB8:B::/64

4.4.4.4 517 0x80000001 2001:DB8:ACAD:B::/64

Link (Type-8) Link States (Area 17)

ADV Router Age Seq# Link ID Interface

5.5.5.5 929 0x80000002 4 Gi0/0

4.4.4.4 1468 0x80000002 4 Gi0/1

5.5.5.5 1467 0x80000002 5 Gi0/1

Intra Area Prefix Link States (Area 17)

ADV Router Age Seq# Link ID Ref-lstype Ref-LSID

5.5.5.5 929 0x80000001 0 0x2001 0

5.5.5.5 1431 0x80000001 5120 0x2002 5

Pings and Traceroutes from End Routers:

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PC 1🡪2:

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C:\Users\cisco>ping 192.168.17.2

Pinging 192.168.17.2 with 32 bytes of data:

Reply from 192.168.17.2: bytes=32 time=1ms TTL=123

Reply from 192.168.17.2: bytes=32 time=1ms TTL=123

Reply from 192.168.17.2: bytes=32 time=1ms TTL=123

Reply from 192.168.17.2: bytes=32 time=1ms TTL=123

Ping statistics for 192.168.17.2:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 1ms, Maximum = 1ms, Average = 1ms

C:\Users\cisco>ping 2001:db8:acad:a::2

Pinging 2001:db8:acad:a::2 with 32 bytes of data:

Reply from 2001:db8:acad:a::2: time=1ms

Reply from 2001:db8:acad:a::2: time=1ms

Reply from 2001:db8:acad:a::2: time=1ms

Reply from 2001:db8:acad:a::2: time=1ms

Ping statistics for 2001:db8:acad:a::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\cisco>tracert 192.168.17.2

Tracing route to 192.168.17.2 over a maximum of 30 hops

1 <1 ms <1 ms <1 ms 192.168.51.1

2 <1 ms <1 ms <1 ms 192.168.2.2

3 1 ms <1 ms <1 ms 192.168.3.2

4 1 ms 1 ms 1 ms 192.168.4.2

5 1 ms 1 ms 1 ms 192.168.5.2

6 1 ms 1 ms 1 ms 192.168.17.2

Trace complete.

C:\Users\cisco>tracert 2001:db8:acad:a::2

Tracing route to 2001:db8:acad:a::2 over a maximum of 30 hops

1 <1 ms <1 ms <1 ms 2001:db8:acad:b::1

2 <1 ms <1 ms <1 ms 2001:db8:b::2

3 1 ms <1 ms <1 ms 2001:db8:c::2

4 1 ms 1 ms 1 ms 2001:db8:d::2

5 1 ms 1 ms 1 ms 2001:db8:e::2

6 1 ms 1 ms 1 ms 2001:db8:acad:a::2

Trace complete.

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PC 2🡪1:

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C:\Users\cisco>ping 2001:db8:ACAD:B::2

Pinging 2001:db8:acad:b::2 with 32 bytes of data:

Reply from 2001:db8:acad:b::2: time=1ms

Reply from 2001:db8:acad:b::2: time=1ms

Reply from 2001:db8:acad:b::2: time=1ms

Reply from 2001:db8:acad:b::2: time=1ms

Ping statistics for 2001:db8:acad:b::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\cisco>ping 192.168.51.2

Pinging 192.168.51.2 with 32 bytes of data:

Reply from 192.168.51.2: bytes=32 time=1ms TTL=123

Reply from 192.168.51.2: bytes=32 time=1ms TTL=123

Reply from 192.168.51.2: bytes=32 time=1ms TTL=123

Reply from 192.168.51.2: bytes=32 time=1ms TTL=123

Ping statistics for 192.168.51.2:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 1ms, Maximum = 1ms, Average = 1ms

C:\Users\cisco>tracert 192.168.51.2

Tracing route to 192.168.51.2 over a maximum of 30 hops

1 <1 ms <1 ms <1 ms 192.168.17.1

2 <1 ms <1 ms <1 ms 192.168.5.1

3 1 ms <1 ms <1 ms 192.168.4.1

4 1 ms 1 ms 1 ms 192.168.3.1

5 1 ms 1 ms 1 ms 192.168.2.1

6 1 ms 1 ms 1 ms 192.168.51.2

Trace complete.

C:\Users\cisco>tracert 2001:db8:acad:b::2

Tracing route to 2001:db8:acad:b::2 over a maximum of 30 hops

1 <1 ms <1 ms <1 ms 2001:db8:acad:a::1

2 <1 ms <1 ms <1 ms 2001:db8:e::1

3 1 ms <1 ms <1 ms 2001:db8:d::1

4 1 ms 1 ms 1 ms 2001:db8:c::1

5 1 ms 1 ms 1 ms 2001:db8:b::1

6 1 ms 1 ms 1 ms 2001:db8:acad:b::2

Trace complete.