Special Area OSPF

CCNP Lab 3

2018-2019

Nipun Chhajed

Cisco CCNP - Hoffman and Mason - Periods 6 and 7

Special Area OSPF Lab 3

Purpose

The purpose behind this lab was to explore the implementation of different areas of OSPF (stubby, totally stubby, not-so-stubby), and to see how they affect traffic flow in a network. Another reason was to learn how to identify the different types of areas in a WireShark capture.

Background Information

1. What is a LSA and what are the different types?

Link-state advertisements (LSAs) are the ways that OSPF communicates updates to the routing topology throughout the network, to the routers located in the same area. Think of it like CNN giving updates about each state's voting percentage, during the presidential election, that all the civilians can see and hear about. The 6 main types of LSAs are:

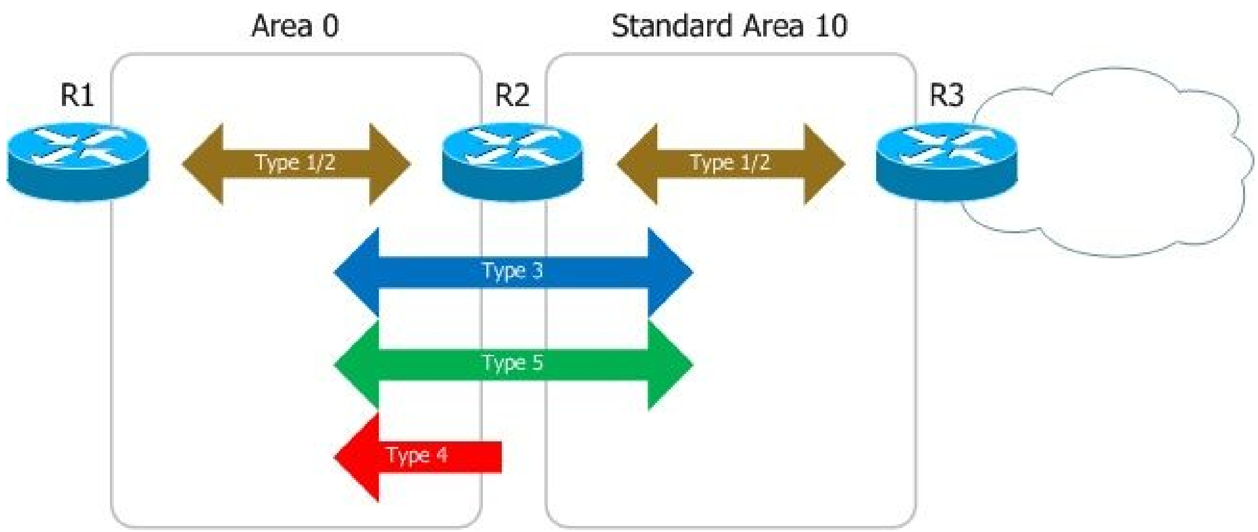
Type 1: Router LSA	The router communicates its presence and shows the links to other routers/networks in the same area.
Type 2: Network LSA	The designated router (DR) or the area border router (ABR) lists which routers are joined together by some segment, such as ethernet.
Type 3: Summary LSA	The area border router summarizes all the information of an area, before sending it out to the other areas it is connected to.

Type 4: ASBR Summary LSA	This works in conjunction with type 5 LSA. Since routers that use type 5 LSA might not have information about next-hops, type 4 must be used as well. It allows for an ABR to flood the information for a router, such as an autonomous system border router (ASBR), where the type 5 originated from.
Type 5: External LSA	This LSA distributes information that is imported into OSPF from other routing processes, and these area flooded to all areas unchanged (except in stubby and not so stubby areas)..
Type 7: Not So Stubby Area LSA	Routers that are in a not so stubby area, do not get information about external LSAs (type 5) from the ABR, but they are allowed to tell information about external routes to the ABR, so that it can distribute that info to the rest of the network, by translating it to a type 5 LSA.

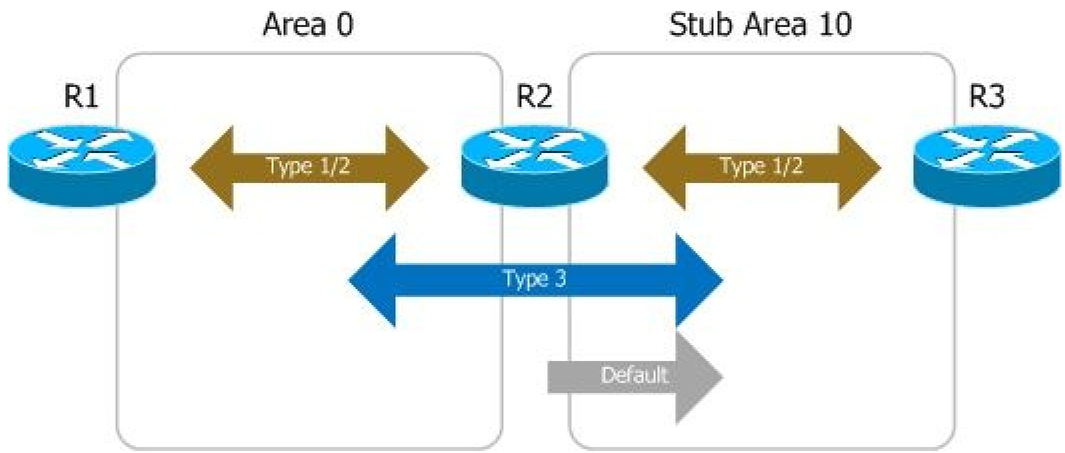
2. What are the different types of OSPF areas, and how area LSA's used in them? How do they compare and contrast?

There are 4 main types of OSPF areas. They are stubby areas, not so stubby areas (NSSA), totally stubby areas and standard areas.

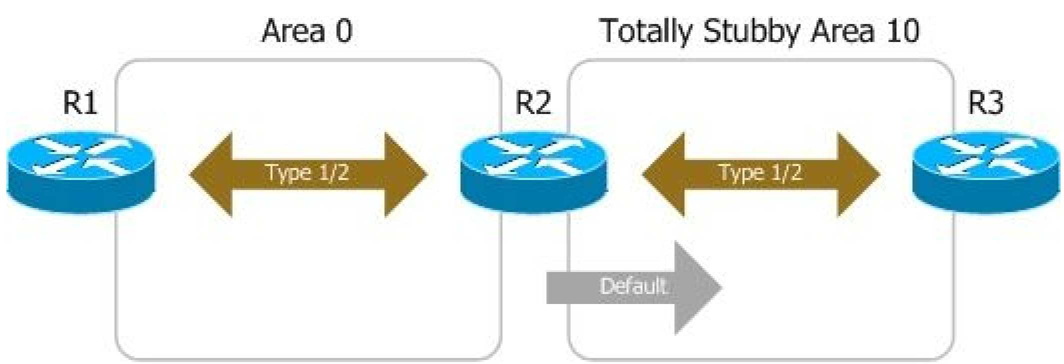
Standard areas are what OSPF makes all areas by default (besides area 0 which is always backbone). The area border router (ABR) is basically what connects the areas in a regular ospf network, like how a tunnel connects different places. The ABR floods type 1 and type 2 LSAs to routers that are located in a common area, so like, a router in area 1 will not get area 2 LSA information. This is comparable to watching live french news in France, which cannot be watched in the USA. Type 3 LSAs, which describe internal summarized routes are automatically distributed through all areas, and type 5 LSAs, which are external routes, are automatically distributed through all areas. Type 4 LSAs, which give information about OSPF to routers that may not have the full information, are also distributed into areas, that have an autonomous system border router (ASBR), which is sort of like an ambassador that represents some country in another. However, this at times can cause router's to have to carry out multiple computations, which can damage routers, and some routers might even be incapable of carrying a lot of information in their database. This is where stubby areas come in since, they block certain LSAs creating less entries in the database.



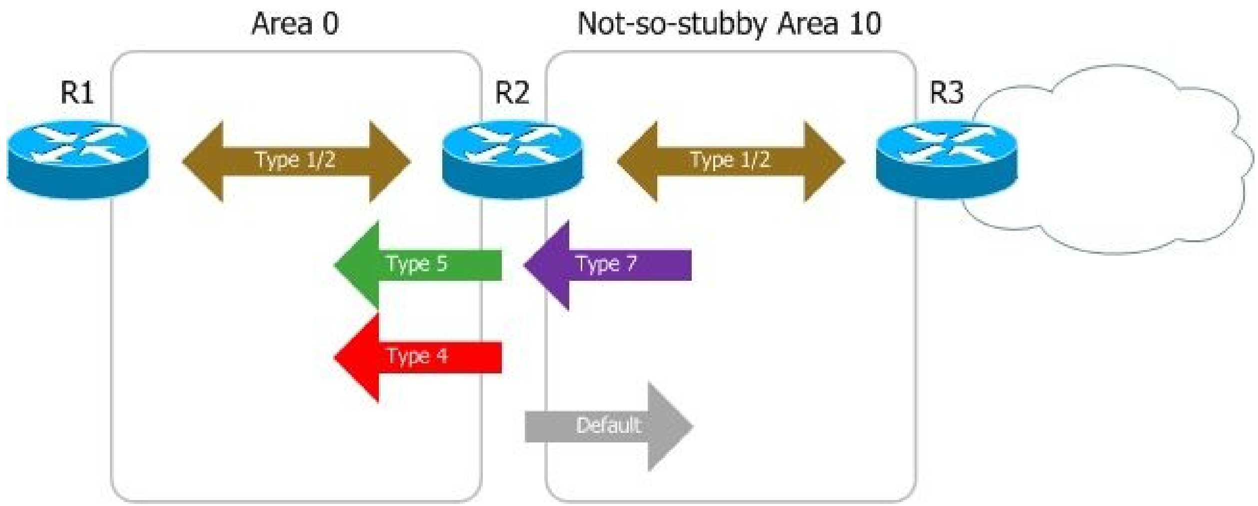
Stubby areas are areas that do not contain excessive information about OSPF. They restrict the internal route LSAs (type 3 LSA) to only one default route, so that routers in a stubby area can route to external destination without having to maintain each individual route in the link-state database. It's like an organization giving general information about some topics to its employees. An extension of this is where for many specific external routes, only a single default route is applied, and this can work for internal routes, which is what defines a totally stubby area.



Totally stubby areas are even more restricted, only allowing type 1 and 2 LSAs to be distributed within the same area. All external and internal routes are converted into a single default route, which makes the database of each router extremely small. The drawback is that you can't use an ASBR since type 4 and 5 LSAs are restricted, and this is where a not-so-stubby area (NSSA) comes in.



Finally, there are not-so-stubby areas (NSSA) which uses type 7 LSAs so that an ASBR can send information about external links to an ABR, and the ABR converts that information to type 5 LSAs so that it can be distributed to the rest of the network. Type 3 LSAs, can passin in and out of areas, usually however, a default route is configured so that the link-state database size is reduced.



Stubby, totally stubby, and NSSAs were all made to improve the scalability of OSPF, so that routers did not have to undergo the computational stress of handling a large amount of routes that occur in standard areas. Basically routers in standard areas, receive and hold all information in OSPF, including external routes. In contrast, stubby areas only communicate one type 3 LSA which is a default route, so that all external routes can be stored as one, not individually stored. Totally stubby areas take this a step further by compressing all internal and external routes into one default route, eliminating the need to communicate type 3 LSAs. And finally, since stubby and totally stubby areas are very restrictive, there are not-so-stubby areas which can communicate external and internal routes, and allow the use of ASBRs, while reducing the size of each router's database.

3. How to view OSPF in wireshark

In a wireshark capture, you can easily find OSPF packets, as they have their own packets denoted by "ospf". When you click on this packet for more information you can find out the LSA types from "LS Type" and from the link state id. This will in turn allow you to figure out which type of OSPF area is in use.

Lab Summary

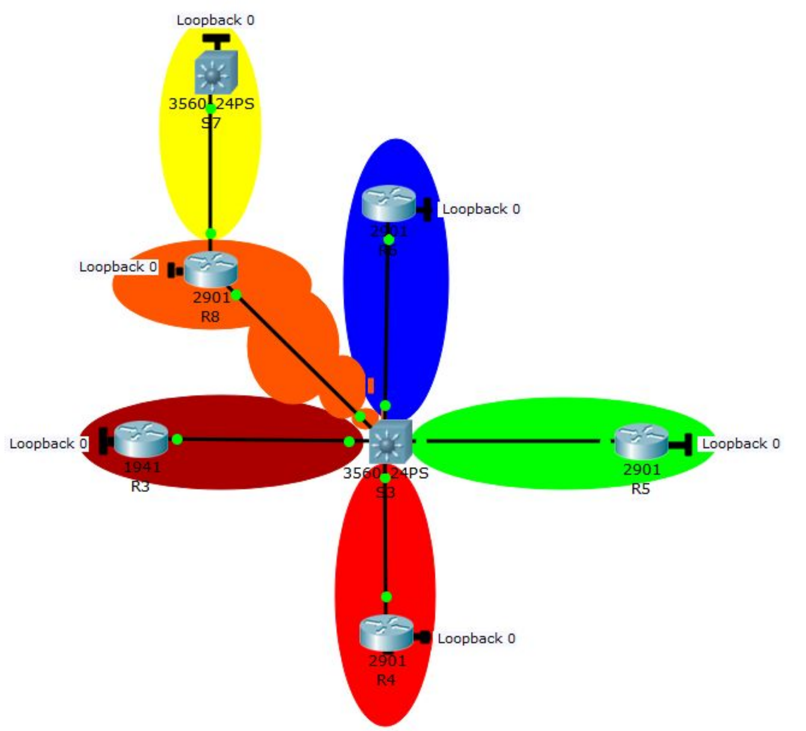
In this lab we designed a network that implements the different types of OSPF areas: stubby, totally stubby and not-so-stubby (NSSA). To do this we used 4 routers and two multilayer switches, which were configured to function as routers. The multilayer switch and two routers have ports connected to area 0 (backbone area) and another area. We then developed a routing scheme for each device, using IPv4. Then we configured the routers to use the different areas, tested for full connectivity in the network, and WireShark captured the different OSPF packets.

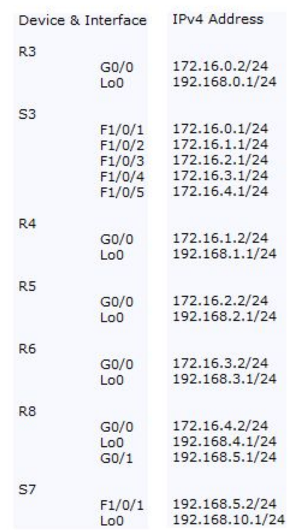
Lab Commands

ip routing	Enables a multilayer switch to route and become a router
router ospf [process-id]	Enables OSPF process on router/multilayer switch for IPv4
network [network address] [wildcard mask] [area-id]	Creates the ospf network in designated area for IPv4
show ip route	Generates the routing table for IPv4
show ip ospf neighbors	Shows the adjacencies and neighbors that each device has from OSPF - IPv4
ping [ip-address]	Shows the connectivity between the device and another one.
ip address [address]	Sets up the IPv4 address in an interface
no switchport	Allows for an ip address to be configured on a multilayer switch interface

router rip	Enables the rip protocol on the router
default-information originate	Allows for routing protocol to generate a default route
no auto-summary	To prevent route summarization

Network Diagram





Device & Interface		IPv4 Address
R3		
	G0/0	172.16.0.2/24
	Lo0	192.168.0.1/24
S3		
	F1/0/1	172.16.0.1/24
	F1/0/2	172.16.1.1/24
	F1/0/3	172.16.2.1/24
	F1/0/4	172.16.3.1/24
	F1/0/5	172.16.4.1/24
R4		
	G0/0	172.16.1.2/24
	Lo0	192.168.1.1/24
R5		
	G0/0	172.16.2.2/24
	Lo0	192.168.2.1/24
R6		
	G0/0	172.16.3.2/24
	Lo0	192.168.3.1/24
R8		
	G0/0	172.16.4.2/24
	Lo0	192.168.4.1/24
	G0/1	192.168.5.1/24
S7		
	F1/0/1	192.168.5.2/24
	Lo0	192.168.10.1/24

Configurations

Router 3 Configuration:

R3# show run

```
hostname R3
interface Loopback0
 ip address 192.168.0.1 255.255.255.0
interface GigabitEthernet0/0
 ip address 172.16.0.2 255.255.255.0
 duplex auto
 speed auto
interface GigabitEthernet0/1
 ip address 209.165.200.1 255.255.255.0
 duplex auto
 speed auto
router ospf 1
 router-id 1.1.1.1
 passive-interface Loopback0
 network 172.16.0.0 0.0.0.255 area 0
 network 192.168.0.0 0.0.0.255 area 0
```

```
 network 209.165.200.0 0.0.0.255 area 0
 default-information originate
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0
end
```

Router 3 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
       + - replicated route, % - next hop override

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

S*    0.0.0.0/0 is directly connected, GigabitEthernet0/0
      172.16.0.0/16 is variably subnetted, 6 subnets, 2 masks
C        172.16.0.0/24 is directly connected, GigabitEthernet0/0
L        172.16.0.2/32 is directly connected, GigabitEthernet0/0
O IA     172.16.1.0/24 [110/2] via 172.16.0.1, 00:08:42, GigabitEthernet0/0
O IA     172.16.2.0/24 [110/2] via 172.16.0.1, 00:08:42, GigabitEthernet0/0
O IA     172.16.3.0/24 [110/2] via 172.16.0.1, 00:08:42, GigabitEthernet0/0
O IA     172.16.4.0/24 [110/2] via 172.16.0.1, 00:08:42, GigabitEthernet0/0
      192.168.0.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.0.0/24 is directly connected, Loopback0
L        192.168.0.1/32 is directly connected, Loopback0
      192.168.1.0/32 is subnetted, 1 subnets
O IA     192.168.1.1 [110/3] via 172.16.0.1, 00:08:42, GigabitEthernet0/0
      192.168.2.0/32 is subnetted, 1 subnets
O IA     192.168.2.1 [110/3] via 172.16.0.1, 00:08:42, GigabitEthernet0/0
      192.168.3.0/32 is subnetted, 1 subnets
O IA     192.168.3.1 [110/3] via 172.16.0.1, 00:08:42, GigabitEthernet0/0
      192.168.4.0/32 is subnetted, 1 subnets
O IA     192.168.4.1 [110/3] via 172.16.0.1, 00:08:42, GigabitEthernet0/0
O E2  192.168.5.0/24 [110/20] via 172.16.0.1, 00:07:58, GigabitEthernet0/0
O E2  192.168.10.0/24 [110/20] via 172.16.0.1, 00:07:36, GigabitEthernet0/0
O IA  209.165.200.0/24 [110/2] via 172.16.0.1, 00:08:42, GigabitEthernet0/0
```

Router 4 Configuration:

R4# show run

```
hostname R4
interface Loopback0
```

```
 ip address 192.168.1.1 255.255.255.0
interface GigabitEthernet0/0
 ip address 172.16.1.2 255.255.255.0
 duplex auto
 speed auto
interface GigabitEthernet0/1
 ip address 209.165.201.1 255.255.255.0
 duplex auto
 speed auto
router ospf 1
 router-id 3.3.3.3
 passive-interface Loopback0
 network 172.16.1.0 0.0.0.255 area 1
 network 192.168.1.0 0.0.0.255 area 1
 network 209.165.201.0 0.0.0.255 area 1
 default-information originate
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0
end
```

Router 4 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
       + - replicated route, % - next hop override

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

S*    0.0.0.0/0 is directly connected, GigabitEthernet0/0
      172.16.0.0/16 is variably subnetted, 6 subnets, 2 masks
O IA     172.16.0.0/24 [110/2] via 172.16.1.1, 00:08:02, GigabitEthernet0/0
C        172.16.1.0/24 is directly connected, GigabitEthernet0/0
L        172.16.1.2/32 is directly connected, GigabitEthernet0/0
O IA     172.16.2.0/24 [110/2] via 172.16.1.1, 00:08:02, GigabitEthernet0/0
O IA     172.16.3.0/24 [110/2] via 172.16.1.1, 00:08:02, GigabitEthernet0/0
O IA     172.16.4.0/24 [110/2] via 172.16.1.1, 00:08:02, GigabitEthernet0/0
      192.168.0.0/32 is subnetted, 1 subnets
O IA     192.168.0.1 [110/3] via 172.16.1.1, 00:08:02, GigabitEthernet0/0
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
```

```
C        192.168.1.0/24 is directly connected, Loopback0
L        192.168.1.1/32 is directly connected, Loopback0
      192.168.2.0/32 is subnetted, 1 subnets
O IA     192.168.2.1 [110/3] via 172.16.1.1, 00:08:02, GigabitEthernet0/0
      192.168.3.0/32 is subnetted, 1 subnets
O IA     192.168.3.1 [110/3] via 172.16.1.1, 00:08:02, GigabitEthernet0/0
      192.168.4.0/32 is subnetted, 1 subnets
O IA     192.168.4.1 [110/3] via 172.16.1.1, 00:08:02, GigabitEthernet0/0
O E2  192.168.5.0/24 [110/20] via 172.16.1.1, 00:07:15, GigabitEthernet0/0
O E2  192.168.10.0/24 [110/20] via 172.16.1.1, 00:06:53, GigabitEthernet0/0
O IA  209.165.200.0/24 [110/2] via 172.16.1.1, 00:08:02, GigabitEthernet0/0
```

Router 5 Configuration:

R5# show run

```
hostname R5
interface Loopback0
 ip address 192.168.2.1 255.255.255.0
interface GigabitEthernet0/0
 ip address 172.16.2.2 255.255.255.0
 duplex auto
 speed auto
 bridge-group 1
interface GigabitEthernet0/1
 ip address 209.165.201.1 255.255.255.0
 duplex auto
 speed auto
 bridge-group 1
router ospf 1
 router-id 4.4.4.4
 area 2 stub
 passive-interface Loopback0
 network 172.16.2.0 0.0.0.255 area 2
 network 192.168.2.0 0.0.0.255 area 2
 network 209.165.201.0 0.0.0.255 area 2
 default-information originate
end
```

Router 5 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
       + - replicated route, % - next hop override

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

S*    0.0.0.0/0 is directly connected, GigabitEthernet0/0
      172.16.0.0/16 is variably subnetted, 6 subnets, 2 masks
O IA     172.16.0.0/24 [110/2] via 172.16.2.1, 00:07:28, GigabitEthernet0/0
O IA     172.16.1.0/24 [110/2] via 172.16.2.1, 00:07:28, GigabitEthernet0/0
C        172.16.2.0/24 is directly connected, GigabitEthernet0/0
L        172.16.2.2/32 is directly connected, GigabitEthernet0/0
O IA     172.16.3.0/24 [110/2] via 172.16.2.1, 00:07:28, GigabitEthernet0/0
O IA     172.16.4.0/24 [110/2] via 172.16.2.1, 00:07:28, GigabitEthernet0/0
      192.168.0.0/32 is subnetted, 1 subnets
O IA     192.168.0.1 [110/3] via 172.16.2.1, 00:07:28, GigabitEthernet0/0
      192.168.1.0/32 is subnetted, 1 subnets
O IA     192.168.1.1 [110/3] via 172.16.2.1, 00:07:28, GigabitEthernet0/0
      192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.2.0/24 is directly connected, Loopback0
L        192.168.2.1/32 is directly connected, Loopback0
      192.168.3.0/32 is subnetted, 1 subnets
O IA     192.168.3.1 [110/3] via 172.16.2.1, 00:07:28, GigabitEthernet0/0
      192.168.4.0/32 is subnetted, 1 subnets
O IA     192.168.4.1 [110/3] via 172.16.2.1, 00:07:28, GigabitEthernet0/0
O IA  209.165.200.0/24 [110/2] via 172.16.2.1, 00:07:28, GigabitEthernet0/0
```

Router 6 Configuration:

R6# show run

```
hostname R6
interface Loopback0
 ip address 192.168.3.1 255.255.255.0
interface GigabitEthernet0/0
 ip address 172.16.3.2 255.255.255.0
 duplex auto
 speed auto
router ospf 1
 router-id 5.5.5.5
 area 3 stub no-summary
 passive-interface Loopback0
 network 172.16.3.0 0.0.0.255 area 3
```

```
 network 192.168.3.0 0.0.0.255 area 3
 default-information originate
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0
end
```

Router 6 Routing Table:

R6# 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 0.0.0.0 to network 0.0.0.0

S*    0.0.0.0/0 is directly connected, GigabitEthernet0/0
      172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.16.3.0/24 is directly connected, GigabitEthernet0/0
L        172.16.3.2/32 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, Loopback0
L        192.168.3.1/32 is directly connected, Loopback0
```

Router 8 Configuration:

R8# show run

```
hostname R8
interface Loopback0
 ip address 192.168.4.1 255.255.255.0
interface GigabitEthernet0/0
 ip address 172.16.4.2 255.255.255.0
 duplex auto
 speed auto
interface GigabitEthernet0/1
 ip address 192.168.5.1 255.255.255.0
 duplex auto
 speed auto
router ospf 1
 log-adjacency-changes
 area 4 nssa default-information-originate
```

```
 redistribute static
 redistribute rip subnets
 redistribute eigrp 1
 passive-interface Loopback0
 network 172.16.4.0 0.0.0.255 area 4
 network 192.168.4.0 0.0.0.255 area 4
 default-information originate
router rip
 version 2
 redistribute ospf 1
 passive-interface Loopback0
 network 192.168.5.0
 default-information originate
 no auto-summary
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0
end
```

Router 8 Routing Tables:

R8# 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, + - replicated route

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

S*    0.0.0.0/0 is directly connected, GigabitEthernet0/0
      172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.16.4.0/24 is directly connected, GigabitEthernet0/0
L        172.16.4.2/32 is directly connected, GigabitEthernet0/0
      192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.4.0/24 is directly connected, Loopback0
L        192.168.4.1/32 is directly connected, Loopback0
      192.168.5.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.5.0/24 is directly connected, GigabitEthernet0/1
L        192.168.5.1/32 is directly connected, GigabitEthernet0/1
R     192.168.10.0/24 [120/1] via 192.168.5.2, 00:00:29, GigabitEthernet0/1
O     209.165.200.0/24 [110/2] via 172.16.4.1, 00:05:11, GigabitEthernet0/0
```

Multilayer Switch 3 Configuration:

S3# show run

```
hostname S3
ip routing
interface FastEthernet1/0/1
 no switchport
 ip address 172.16.0.1 255.255.255.0
interface FastEthernet1/0/2
 no switchport
 ip address 172.16.1.1 255.255.255.0
interface FastEthernet1/0/3
 no switchport
 ip address 172.16.2.1 255.255.255.0
interface FastEthernet1/0/4
 no switchport
 ip address 172.16.3.1 255.255.255.0
interface FastEthernet1/0/5
 no switchport
 ip address 172.16.4.1 255.255.255.0
interface FastEthernet1/0/6
 no switchport
 ip address 209.165.200.1 255.255.255.0
router ospf 1
 router-id 2.2.2.2
 area 2 stub
 area 3 stub no-summary
 area 4 nssa no-summary
 network 172.16.0.0 0.0.0.255 area 0
 network 172.16.1.0 0.0.0.255 area 1
 network 172.16.2.0 0.0.0.255 area 2
 network 172.16.3.0 0.0.0.255 area 3
 network 172.16.4.0 0.0.0.255 area 4
 network 209.165.200.0 0.0.0.255 area 4
 default-information originate
ip route 0.0.0.0 0.0.0.0 192.168.3.2
ip route 172.16.1.0 255.255.255.0 FastEthernet1/0/2
ip route 192.168.1.0 255.255.255.0 FastEthernet1/0/2
ip route 192.168.2.0 255.255.255.0 FastEthernet1/0/3
ip route 192.168.3.0 255.255.255.0 FastEthernet1/0/4
```

```
ip route 192.168.4.0 255.255.255.0 FastEthernet1/0/5
end
```

Multilayer Switch 3 Routing Table:

```
S3# 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 172.16.1.2 to network 0.0.0.0

O*E2  0.0.0.0/0 [110/1] via 172.16.1.2, 00:04:19, FastEthernet1/0/2
                [110/1] via 172.16.0.2, 00:04:19, FastEthernet1/0/1
      172.16.0.0/16 is variably subnetted, 10 subnets, 2 masks
C        172.16.0.0/24 is directly connected, FastEthernet1/0/1
L        172.16.0.1/32 is directly connected, FastEthernet1/0/1
C        172.16.1.0/24 is directly connected, FastEthernet1/0/2
L        172.16.1.1/32 is directly connected, FastEthernet1/0/2
C        172.16.2.0/24 is directly connected, FastEthernet1/0/3
L        172.16.2.1/32 is directly connected, FastEthernet1/0/3
C        172.16.3.0/24 is directly connected, FastEthernet1/0/4
L        172.16.3.1/32 is directly connected, FastEthernet1/0/4
C        172.16.4.0/24 is directly connected, FastEthernet1/0/5
L        172.16.4.1/32 is directly connected, FastEthernet1/0/5
      192.168.0.0/32 is subnetted, 1 subnets
O        192.168.0.1 [110/2] via 172.16.0.2, 00:04:19, FastEthernet1/0/1
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
S        192.168.1.0/24 is directly connected, FastEthernet1/0/2
O        192.168.1.1/32 [110/2] via 172.16.1.2, 00:04:19, FastEthernet1/0/2
      192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
S        192.168.2.0/24 is directly connected, FastEthernet1/0/3
O        192.168.2.1/32 [110/2] via 172.16.2.2, 00:04:19, FastEthernet1/0/3
      192.168.3.0/32 is subnetted, 1 subnets
O        192.168.3.1 [110/2] via 172.16.3.2, 00:04:19, FastEthernet1/0/4
      192.168.4.0/32 is subnetted, 1 subnets
O        192.168.4.1 [110/2] via 172.16.4.2, 00:04:19, FastEthernet1/0/5
O N2  192.168.5.0/24 [110/20] via 172.16.4.2, 00:03:32, FastEthernet1/0/5
O N2  192.168.10.0/24 [110/20] via 172.16.4.2, 00:03:10, FastEthernet1/0/5
      209.165.200.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.200.0/24 is directly connected, FastEthernet1/0/6
L        209.165.200.1/32 is directly connected, FastEthernet1/0/6
```

Multilayer Switch 7 Configuration:

S7# show run

```
hostname S7
ip routing
interface Loopback0
 ip address 192.168.10.1 255.255.255.0
interface FastEthernet1/0/1
 no switchport
 ip address 192.168.5.2 255.255.255.0
router rip
 version 2
 passive-interface Loopback0
 network 192.168.5.0
 network 192.168.10.0
 default-information originate
 no auto-summary
ip route 0.0.0.0 0.0.0.0 FastEthernet1/0/1
end
```

Multilayer Switch 7 Routing Table:

S7# 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 0.0.0.0 to network 0.0.0.0

S*    0.0.0.0/0 is directly connected, FastEthernet1/0/1
      192.168.5.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.5.0/24 is directly connected, FastEthernet1/0/1
L        192.168.5.2/32 is directly connected, FastEthernet1/0/1
      192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.10.0/24 is directly connected, Loopback0
L        192.168.10.1/32 is directly connected, Loopback0
```

WireShark Captures

Stubby - LSA Type 1:

```
LSA-type 1 (Router-LSA), len 36
    .000 0000 0010 1011 = LS Age (seconds): 43
    0... .... .... .... = Do Not Age Flag: 0
  > Options: 0x20, (DC) Demand Circuits
    LS Type: Router-LSA (1)
    Link State ID: 2.2.2.2
    Advertising Router: 2.2.2.2
    Sequence Number: 0x80000011
    Checksum: 0xaea5
    Length: 36
  > Flags: 0x01, (B) Area border router
    Number of Links: 1
  > Type: Stub     ID: 172.16.2.0      Data: 255.255.255.0   Metric: 1
```

Stubby - LSA Type 2:

```
LSA-type 2 (Network-LSA), len 32
    .000 0010 0000 1110 = LS Age (seconds): 526
    0... .... .... .... = Do Not Age Flag: 0
  > Options: 0x20, (DC) Demand Circuits
    LS Type: Network-LSA (2)
    Link State ID: 172.16.2.2
    Advertising Router: 4.4.4.4
    Sequence Number: 0x80000008
    Checksum: 0x74d7
    Length: 32
    Netmask: 255.255.255.0
    Attached Router: 4.4.4.4
    Attached Router: 2.2.2.2
```

Stubby - LSA Type 3:

```
LSA-type 3 (Summary-LSA (IP network)), len 28
    .000 0000 0010 1100 = LS Age (seconds): 44
    0... .... .... .... = Do Not Age Flag: 0
  > Options: 0x20, (DC) Demand Circuits
    LS Type: Summary-LSA (IP network) (3)
    Link State ID: 0.0.0.0
    Advertising Router: 2.2.2.2
    Sequence Number: 0x80000006
    Checksum: 0x6bc5
    Length: 28
    Netmask: 0.0.0.0
    TOS: 0
    Metric: 1
```

NSSA - LSA Type 1:

```
> OSPF DB Description
v LSA-type 1 (Router-LSA), len 36
    .000 0000 0010 1010 = LS Age (seconds): 42
    0... .... .... .... = Do Not Age Flag: 0
  > Options: 0x28, (DC) Demand Circuits, (N) NSSA
    LS Type: Router-LSA (1)
    Link State ID: 2.2.2.2
    Advertising Router: 2.2.2.2
    Sequence Number: 0x80000010
    Checksum: 0x50f8
    Length: 36
v LSA-type 1 (Router-LSA), len 48
    .000 0000 1000 1000 = LS Age (seconds): 136
    0... .... .... .... = Do Not Age Flag: 0
  > Options: 0x28, (DC) Demand Circuits, (N) NSSA
    LS Type: Router-LSA (1)
    Link State ID: 192.168.4.1
    Advertising Router: 192.168.4.1
    Sequence Number: 0x8000000c
    Checksum: 0xd568
    Length: 48
```

NSSA - LSA Type 2 & 3:

```
v LSA-type 2 (Network-LSA), len 32
    .000 0000 1101 1111 = LS Age (seconds): 223
    0... .... .... .... = Do Not Age Flag: 0
  > Options: 0x28, (DC) Demand Circuits, (N) NSSA
    LS Type: Network-LSA (2)
    Link State ID: 172.16.4.2
    Advertising Router: 192.168.4.1
    Sequence Number: 0x80000005
    Checksum: 0x6622
    Length: 32
v LSA-type 3 (Summary-LSA (IP network)), len 28
    .000 0000 0010 1011 = LS Age (seconds): 43
    0... .... .... .... = Do Not Age Flag: 0
  > Options: 0x28, (DC) Demand Circuits, (N) NSSA
    LS Type: Summary-LSA (IP network) (3)
    Link State ID: 0.0.0.0
    Advertising Router: 2.2.2.2
    Sequence Number: 0x80000001
    Checksum: 0xfc31
    Length: 28
```

NSSA - LSA Type 7:

```
LSA-type 7 (NSSA AS-External-LSA), len 36
    .000 0001 0000 1010 = LS Age (seconds): 266
    0... .... .... .... = Do Not Age Flag: 0
    Options: 0x28, (DC) Demand Circuits, (P) Propagate
    LS Type: NSSA AS-External-LSA (7)
    Link State ID: 0.0.0.0
    Advertising Router: 192.168.4.1
    Sequence Number: 0x80000003
    Checksum: 0xd4f5
    Length: 36
LSA-type 7 (NSSA AS-External-LSA), len 36
    .000 0000 1000 1000 = LS Age (seconds): 136
    0... .... .... .... = Do Not Age Flag: 0
    Options: 0x28, (DC) Demand Circuits, (P) Propagate
    LS Type: NSSA AS-External-LSA (7)
    Link State ID: 192.168.5.0
    Advertising Router: 192.168.4.1
    Sequence Number: 0x80000004
    Checksum: 0xa89f
    Length: 36
LSA-type 7 (NSSA AS-External-LSA), len 36
    .000 0000 1000 1000 = LS Age (seconds): 136
    0... .... .... .... = Do Not Age Flag: 0
    Options: 0x28, (DC) Demand Circuits, (P) Propagate
    LS Type: NSSA AS-External-LSA (7)
    Link State ID: 192.168.10.0
    Advertising Router: 192.168.4.1
    Sequence Number: 0x80000002
    Checksum: 0x75cf
    Length: 36
```

Totally Stubby - LSA Type 1 & 2:

```
⌄ LSA-type 1 (Router-LSA), len 48
    .000 0000 0010 0111 = LS Age (seconds): 39
    0... .... .... .... = Do Not Age Flag: 0
  > Options: 0x20, (DC) Demand Circuits
    LS Type: Router-LSA (1)
    Link State ID: 5.5.5.5
    Advertising Router: 5.5.5.5
    Sequence Number: 0x8000000c
    Checksum: 0x14ae
    Length: 48
⌄ LSA-type 2 (Network-LSA), len 32
    .000 1110 0001 0000 = LS Age (seconds): 3600
    0... .... .... .... = Do Not Age Flag: 0
  > Options: 0x20, (DC) Demand Circuits
    LS Type: Network-LSA (2)
    Link State ID: 172.16.3.2
    Advertising Router: 5.5.5.5
    Sequence Number: 0x80000007
    Checksum: 0x6fd4
    Length: 32
⌄ LSA-type 1 (Router-LSA), len 48
    .000 0000 0000 0001 = LS Age (seconds): 1
    0... .... .... .... = Do Not Age Flag: 0
  > Options: 0x20, (DC) Demand Circuits
    LS Type: Router-LSA (1)
    Link State ID: 5.5.5.5
    Advertising Router: 5.5.5.5
    Sequence Number: 0x8000000d
    Checksum: 0xa757
    Length: 48
```

Totally Stubby - LSA Type 3:

```
⌄ LSA-type 3 (Summary-LSA (IP network)), len 28
    .000 0110 1101 1100 = LS Age (seconds): 1756
    0... .... .... .... = Do Not Age Flag: 0
  > Options: 0x20, (DC) Demand Circuits
    LS Type: Summary-LSA (IP network) (3)
    Link State ID: 0.0.0.0
    Advertising Router: 2.2.2.2
    Sequence Number: 0x80000002
    Checksum: 0x73c1
    Length: 28
```

Problems

During the lab there were certain problems that took some time to resolve. The first one was configuring the wrong ip address on the wrong interface on the wrong routers. This was easily solved by entering a “no ip address” command on the router interface and then correctly retyping the ip address with a “no shut” command on the interface to enable it once again. The second problem we faced was the interfaces on the multilayer switches not accepting ip addresses. This was fixed by doing a little research, and we found that we must use the “no switchport” command on the interface. The biggest hurdle we faced was the type 7 LSA packets not showing up in the wireshark. After doing a lot of research, we found that you need to set up a monitor session on certain ports of a switch, so that traffic data can be copied and sent to other interfaces. After this was implemented, we successfully got all the captures we were looking for.

Conclusion

In conclusion, we set up special OSPF areas in a network and monitored the traffic throughout the entire network. There were only some problems, most being very small, such as wrong ip addressing and the “no switchport” command, with one major problem; the certain data we were looking for in the WireShark captures wasn’t showing up, causing us to research and implement monitor sessions so that data could be successfully copied and sent to different places in the network. We learned how to troubleshoot issues within the network, and how to implement the different types of OSPF areas, and how to recognize them in WireShark captures.