Stubbiness in OSPF

CCNP LAB 4

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CCNP: Mason and Hoffman Period 6-8

Purpose

The purpose of this lab is to apply the different subgroups of OSPF that we learned after researching into our own OSPF topology. These OSPF subgroups help reduce the CPU load of individual branches of routers in a topology.

Background

What are LSAs?

LSAs (Link-State Advertisements) are bits of information exchanged through routers running the OSPF routing protocol. These bits of information transfer information about the topology of the current running network that the router is currently based in. Each LSA routing packet contains information about the current section of the OSPF network that the router is based in. All routers within the OSPF network will exchange LSA update packets until all routers in the network have the exact same topology database stored within the hard drive of the routers.

Different types of LSAs

All OSPF routers don't send the same kind of LSA packet to other routers. These are currently 6 main types of LSAs that OSPF routers output.

Type 1 LSAs get sent to other routers to acknowledge that the originating router is part of the OSPF network. This type of LSA stays in the same OSPF area that it was sent through. This LSA essentially tells other routers that the current router has just joined the topology.

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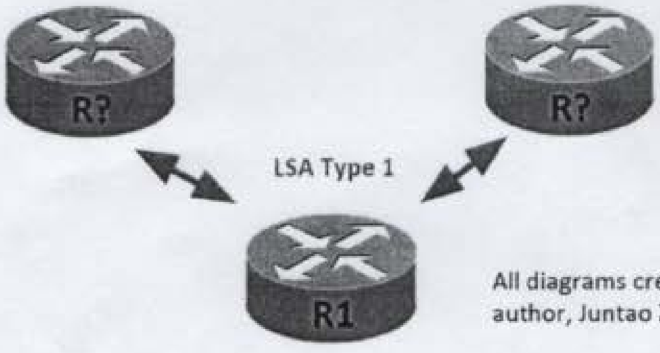
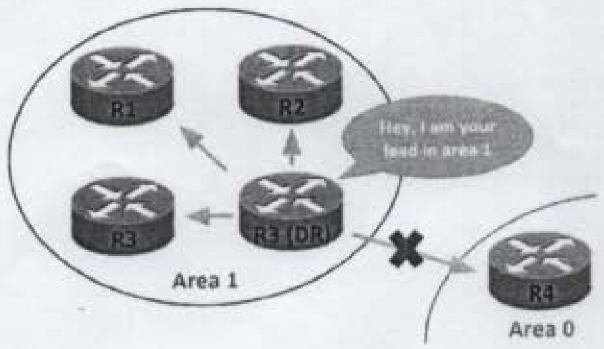
?

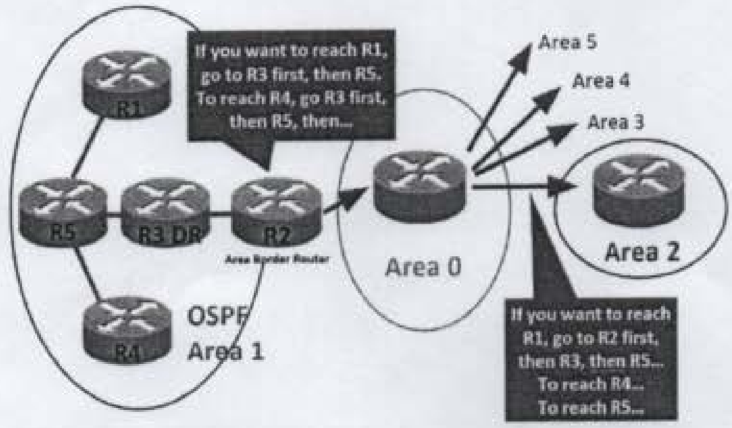


All diagrams created by author, Juntao Zhong

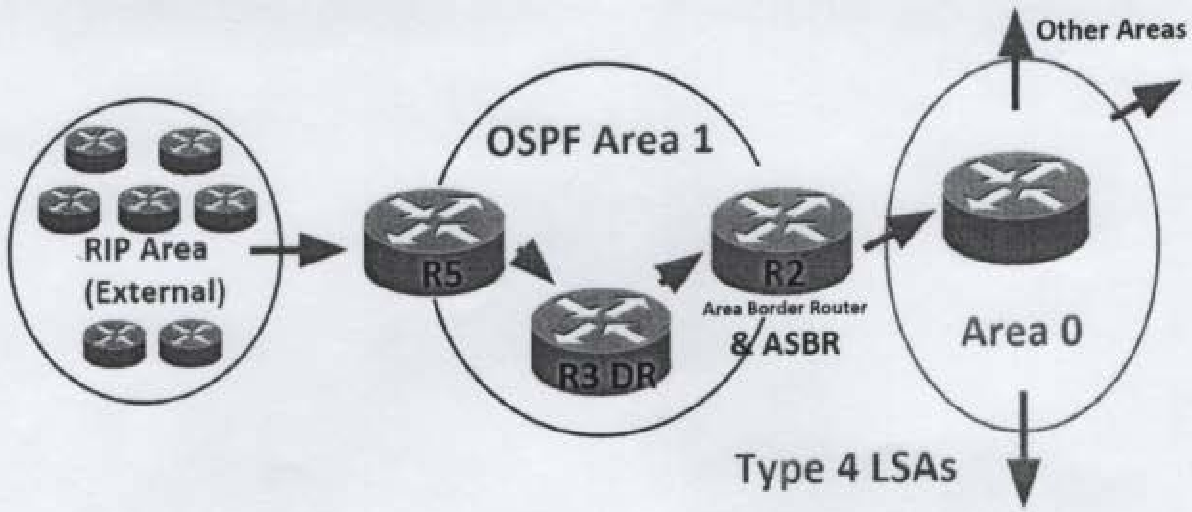
Type 2 LSAs are sent to other routers from the DR (Designated Router). This type of packet explains that the originating router is the DR of all other routers in the current OSPF area. These are constantly sent from the DR to the other routers.



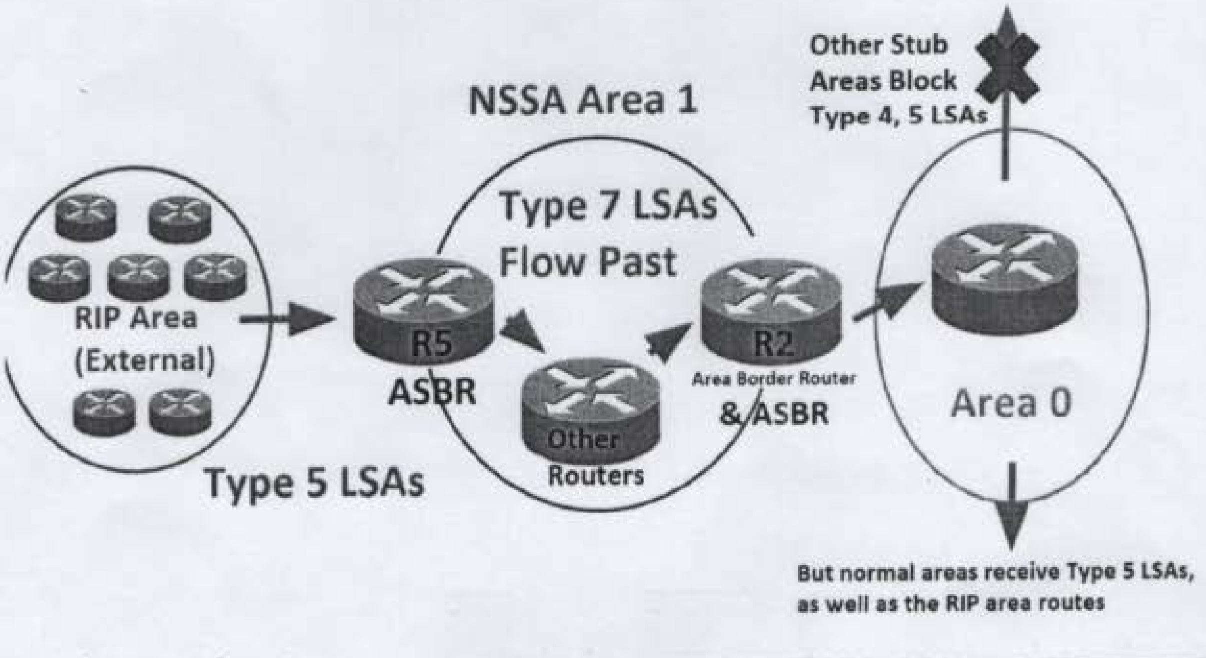
Type 3 LSAs are sent by the ABR (Area Border Router). ABRs are routers that border the current OSPF area. These LSAs summarize information gathered about the network into a small packet of information that is sent to other routers. These LSAs also tell other routers the best way to reach routers within the current area to other routers in different areas. (A roadmap, essentially.)



Type 4 LSAs are sent by ABRs. These kinds of packets contain the summarized information on Type 5 packets. (Since type 5 packets are external) These types of packets are sent to other OSPF areas.



Type 5 LSAs are received by routers that border another routing protocol, (EIGRP, RIP, etc.) and these packets are transformed into Type 4 packets to be sent to the OSPF network.



Type 7 LSAs are present in routers in an NSSA (Not So Stubby Area). These routers do not receive type 7 packets from the ABRs, but they send external routes for redistribution. On the other hand, Type 7 LSAs are sent to ABRs to notify them that the NSSA routers have received routing information.

The different kinds of OSPF Areas

Standard OSPF Areas –

These areas route LSA Types 1 – 5. Standard OSPF routers route all of these routes to all of the routers in the OSPF network. This type of OSPF is optimal for small to medium scale topologies, but when the OSPF topology becomes too big, each router in the network will experience performance issues. In this situation, the topology should be modified to include Stubby areas such as the Stubby area, the NSSA, and Totally Stubby Areas.

Stubby OSPF Areas –

Instead of routing all common LSA types, Stubby area routers only route Type 1,2 and for Type 3 LSA packets, the routers summarizes all external routes into one default route, thus reducing the load on the routers in the Stubby area.

NSSA routes –

NSSA (Not So Stubby Area) areas only route Type 7 LSAs. These routers convert Type 7 LSAs (Raw network information) into Type 5 LSAs, which are readable by the main OSPF network. These routers also eliminate the need for Type 3 LSAs to be transmitted throughout the main network, thus reducing the CPU load on most routers within the OSPF network.

Totally Stubby Areas –

Routers in Totally stubby areas only route LSA Type 4 & 5, thus making them more restrictive than Stubby Areas and NSSAs. These routers sole purpose is to summarize all of the LSAs received by other routers into Type 1 and Type 2 LSA packets. These routers also help alleviate performance issues on the routers in other OSPF areas.

In conclusion, Stubbiness in OSPF networks exist to help alleviate excessive but necessary routing information from over encumbering all of the routers within the OSPF network.

Observing Stubbiness and LSAs through Wireshark

Using the program Wireshark, you can observe OSPF packets since they come with their own tag, "OSPF". When the user clicks on the packet, the LSA type would be revealed through the "LS type" tag and the displayed link state ID. This would allow the user to find out which OSPF area the packet originated from and its destination.

Image sources

All graphics and images are provided by Juntao "Jimmy" Zhong.

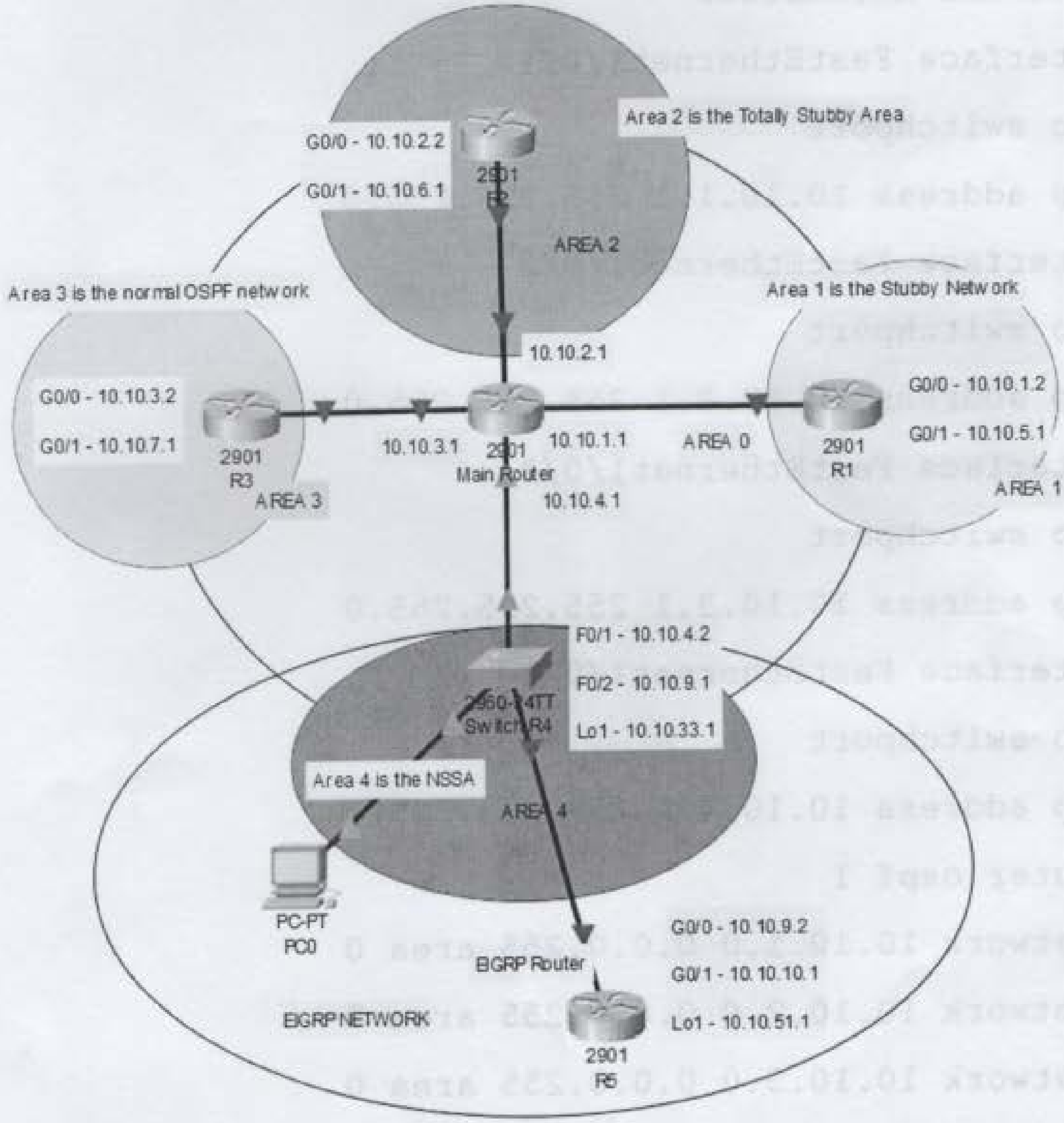
Lab Summary

Before we initialized any of the routers, we brainstormed how our topology would look. We used packet tracer on our PCs and came up with a topology that would include:

1. 1x Layer 3 Switch
2. 5x Cisco 2901 Routers
3. 1x End Device (PCs)

Next, we initialized the routers and connected the Switch to our topology. We first applied our preconfigured IP addresses to the routers, and made sure that they could properly "ping" each other. After that, we initialized the OSPF protocol on each of the routers. The Layer 3 switch was converted to a router, and it serves as our main Router in the topology. After that, we made sure our OSPF networks were properly connected and then we separated a router into each defined area. Area 1 Routers would become the

Stubby network, Area 2 routers would become the Totally Stubby Area, and Area 4 would become the NSSA. Area 3 would remain a control area, so no changes would be made to that area. Then, we connected the NSSA network (Area 4) to the EIGRP network (Outside the OSPF network) and hooked up the EIGRP router to an End device. We made sure that the network still retained full connectivity, then we used Wireshark to view the LSA traffic updates going through the wires. Our topology as followed:



Configurations

Main Router

```
Ip routing
hostname MainRouter
interface FastEthernet1/0/1
 no switchport
 ip address 10.10.1.1 255.255.255.0
interface FastEthernet1/0/2
 no switchport
 ip address 10.10.2.1 255.255.255.0
interface FastEthernet1/0/3
 no switchport
 ip address 10.10.3.1 255.255.255.0
interface FastEthernet1/0/4
 no switchport
 ip address 10.10.4.1 255.255.255.0
router ospf 1
 network 10.10.1.0 0.0.0.255 area 0
 network 10.10.2.0 0.0.0.255 area 0
 network 10.10.3.0 0.0.0.255 area 0
```

```
network 10.10.4.0 0.0.0.255 area 0
```

Router 1

```
hostname R1
interface GigabitEthernet0/0
 ip address 10.10.1.2 255.255.255.0
interface GigabitEthernet0/1
 ip address 10.10.5.1 255.255.255.0
router ospf 1
 area 1 stubby
 network 10.10.1.0 0.0.0.255 area 0
 network 10.10.5.0 0.0.0.255 area 1
```

Router 2

```
hostname R2
interface GigabitEthernet0/0
ip address 10.10.2.2 255.255.255.0
interface GigabitEthernet0/1
ip address 10.10.6.1 255.255.255.0
router ospf 1
area 2 stubby no-summary
network 10.10.2.0 0.0.0.255 area 0
network 10.10.6.0 0.0.0.255 area 2
```

Router 3

```
hostname R3
 interface GigabitEthernet0/0
 ip address 10.10.3.2 255.255.255.0
interface GigabitEthernet0/1
 ip address 10.10.7.1 255.255.255.0
router ospf 1
 network 10.10.3.0 0.0.0.255 area 0
 network 10.10.7.0 0.0.0.255 area 3
```

Router 4

```
hostname R4
interface Loopback1
 ip address 10.10.33.1 255.255.255.0
interface FastEthernet1/0/1
 no switchport
 ip address 10.10.4.2 255.255.255.0
interface FastEthernet1/0/2
 no switchport
 ip address 10.10.9.1 255.255.255.0
interface FastEthernet1/0/3
 no switchport
 ip address 10.10.8.1 255.255.255.0
```

```
no shutdownipv6 ospf 1 area 4
interface GigabitEthernet0/1/0
 ip address 192.168.6.1 255.255.255.0
router eigrp 1
 network 10.10.9.0 0.0.0.255
 network 10.10.9.0 0.0.0.255 area 4
 network 10.10.33.0 0.0.0.255 area 4
 redistribute ospf 1 metric 1544 200 255 1 1500
router ospf 1
 area 4 nssa
 redistribute eigrp 1 metric 100 subnets
 network 10.10.4.0 0.0.0.255 area 0
 network 10.10.9.0 0.0.0.255 area 4
 network 10.10.33.0 0.0.0.255 area 4
monitor session 1 source interface Fa1/0/2
monitor session 1 destination interface Fa1/0/24
```

Router 5

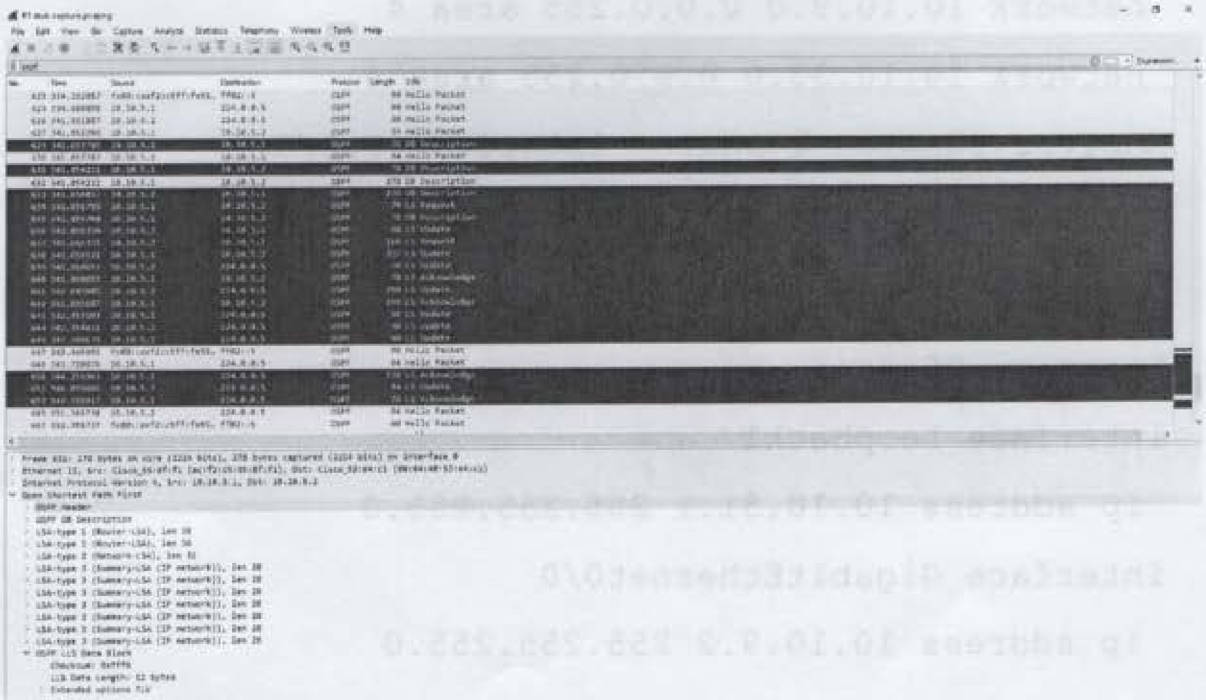
```
hostname R5
interface Loopback1
 ip address 10.10.51.1 255.255.255.0
interface GigabitEthernet0/0
 ip address 10.10.9.2 255.255.255.0
```

```
interface GigabitEthernet0/1
 ip address 10.10.10.1 255.255.255.0
router eigrp 1
 network 10.10.9.0 0.0.0.255
 network 10.10.10.1 0.0.0.255
 network 10.10.51.1 0.0.0.255
```

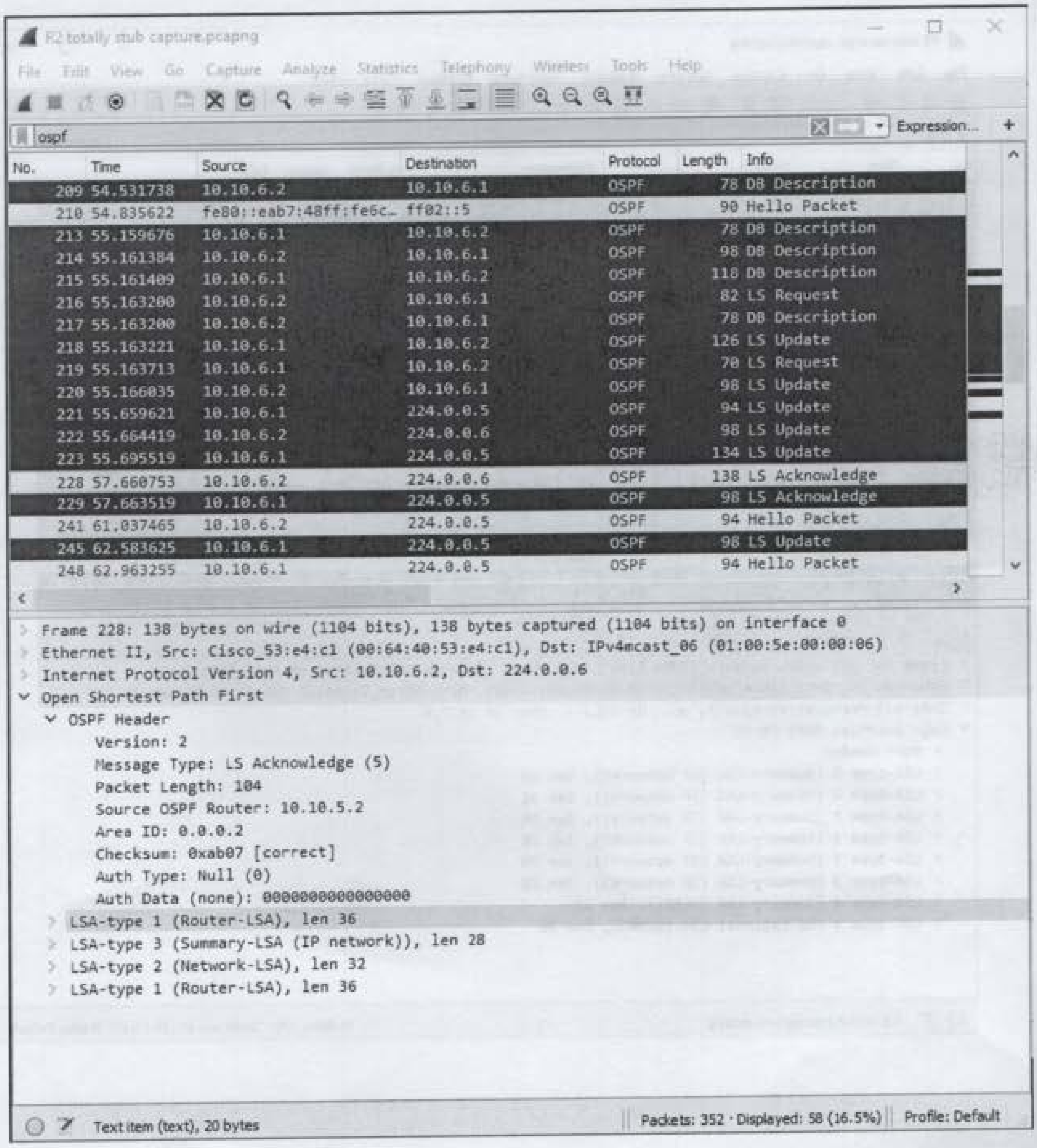
Wireshark Screenshots

These screenshots serve to show the flow of the OSPF packets throughout the network. Each screenshot was captured through the Main Router Layer 3 switch.

LSA Type 1, 2, & 3



LSA Type 5



R2 totally stub capture.pcapng

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

ospf

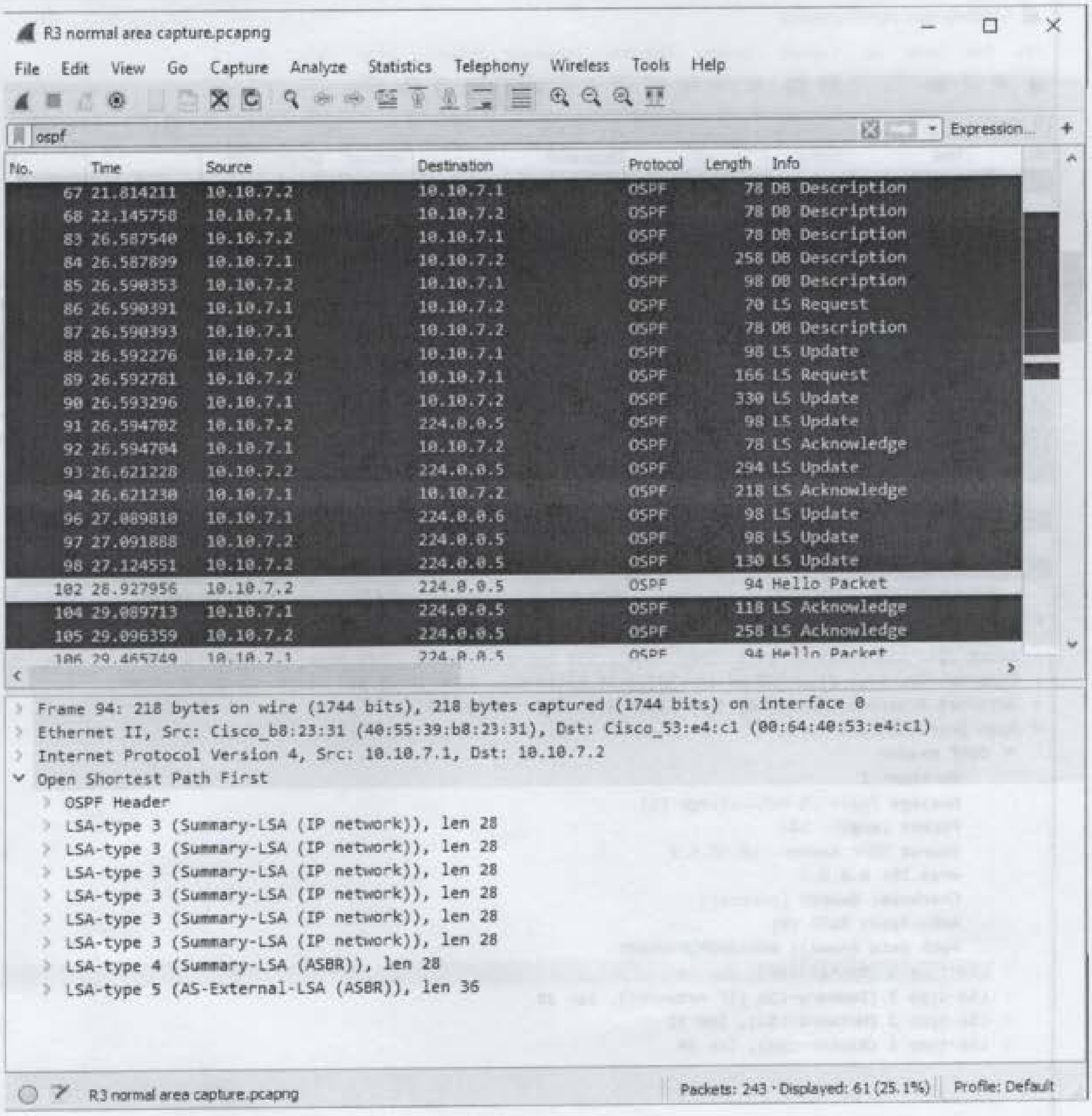
Expression... +

No.	Time	Source	Destination	Protocol	Length	Info
209	54.531738	10.10.6.2	10.10.6.1	OSPF	78	DB Description
210	54.835622	fe80::eab7:48ff:fe6c…	ff02::5	OSPF	90	Hello Packet
213	55.159676	10.10.6.1	10.10.6.2	OSPF	78	DB Description
214	55.161384	10.10.6.2	10.10.6.1	OSPF	98	DB Description
215	55.161409	10.10.6.1	10.10.6.2	OSPF	118	DB Description
216	55.163200	10.10.6.2	10.10.6.1	OSPF	82	LS Request
217	55.163200	10.10.6.2	10.10.6.1	OSPF	78	DB Description
218	55.163221	10.10.6.1	10.10.6.2	OSPF	126	LS Update
219	55.163713	10.10.6.1	10.10.6.2	OSPF	70	LS Request
220	55.166035	10.10.6.2	10.10.6.1	OSPF	98	LS Update
221	55.659621	10.10.6.1	224.0.0.5	OSPF	94	LS Update
222	55.664419	10.10.6.2	224.0.0.6	OSPF	98	LS Update
223	55.695519	10.10.6.1	224.0.0.5	OSPF	134	LS Update
228	57.660753	10.10.6.2	224.0.0.6	OSPF	138	LS Acknowledge
229	57.663519	10.10.6.1	224.0.0.5	OSPF	98	LS Acknowledge
241	61.037465	10.10.6.2	224.0.0.5	OSPF	94	Hello Packet
245	62.583625	10.10.6.1	224.0.0.5	OSPF	98	LS Update
248	62.963255	10.10.6.1	224.0.0.5	OSPF	94	Hello Packet

```
> Frame 228: 138 bytes on wire (1104 bits), 138 bytes captured (1104 bits) on interface 0
> Ethernet II, Src: Cisco_53:e4:c1 (00:64:40:53:e4:c1), Dst: IPv4mcast_06 (01:00:5e:00:00:06)
> Internet Protocol Version 4, Src: 10.10.6.2, Dst: 224.0.0.6
v Open Shortest Path First
  v OSPF Header
      Version: 2
      Message Type: LS Acknowledge (5)
      Packet Length: 104
      Source OSPF Router: 10.10.5.2
      Area ID: 0.0.0.2
      Checksum: 0xab07 [correct]
      Auth Type: Null (0)
      Auth Data (none): 0000000000000000
  > LSA-type 1 (Router-LSA), len 36
  > LSA-type 3 (Summary-LSA (IP network)), len 28
  > LSA-type 2 (Network-LSA), len 32
  > LSA-type 1 (Router-LSA), len 36
```

Text item (text), 20 bytes | Packets: 352 · Displayed: 58 (16.5%) | Profile: Default

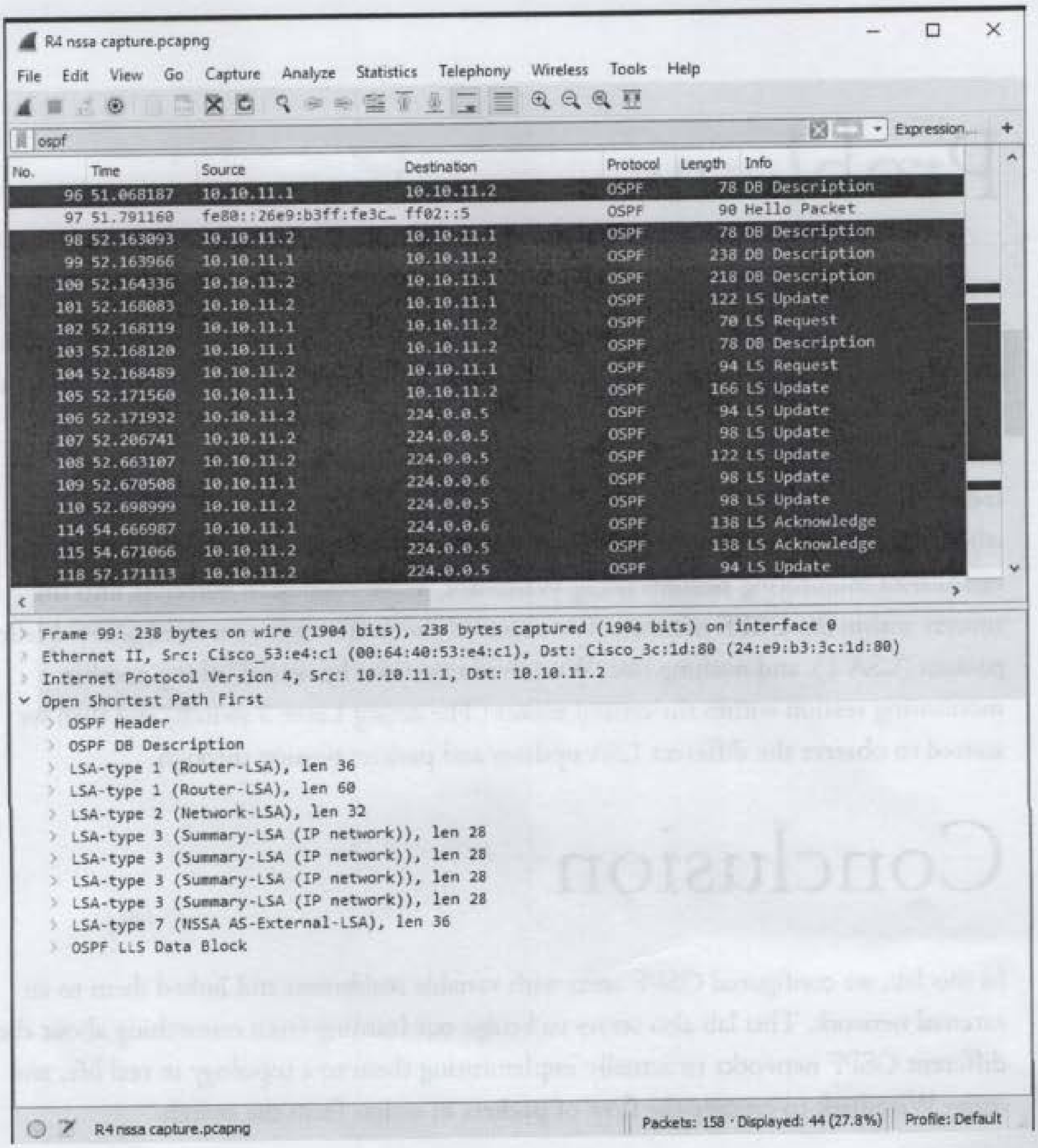
LSA Type 3, 4 & 5



No.	Time	Source	Destination	Protocol	Length	Info
67	21.814211	10.10.7.2	10.10.7.1	OSPF	78	DB Description
68	22.145758	10.10.7.1	10.10.7.2	OSPF	78	DB Description
83	26.587540	10.10.7.2	10.10.7.1	OSPF	78	DB Description
84	26.587899	10.10.7.1	10.10.7.2	OSPF	258	DB Description
85	26.590353	10.10.7.2	10.10.7.1	OSPF	98	DB Description
86	26.590391	10.10.7.1	10.10.7.2	OSPF	70	LS Request
87	26.590393	10.10.7.1	10.10.7.2	OSPF	78	DB Description
88	26.592276	10.10.7.2	10.10.7.1	OSPF	98	LS Update
89	26.592781	10.10.7.2	10.10.7.1	OSPF	166	LS Request
90	26.593296	10.10.7.1	10.10.7.2	OSPF	330	LS Update
91	26.594702	10.10.7.2	224.0.0.5	OSPF	98	LS Update
92	26.594704	10.10.7.1	10.10.7.2	OSPF	78	LS Acknowledge
93	26.621228	10.10.7.2	224.0.0.5	OSPF	294	LS Update
94	26.621230	10.10.7.1	10.10.7.2	OSPF	218	LS Acknowledge
96	27.089818	10.10.7.1	224.0.0.6	OSPF	98	LS Update
97	27.091888	10.10.7.2	224.0.0.5	OSPF	98	LS Update
98	27.124551	10.10.7.2	224.0.0.5	OSPF	130	LS Update
102	28.927956	10.10.7.2	224.0.0.5	OSPF	94	Hello Packet
104	29.089713	10.10.7.1	224.0.0.5	OSPF	118	LS Acknowledge
105	29.096359	10.10.7.2	224.0.0.5	OSPF	258	LS Acknowledge
106	29.465749	10.10.7.1	224.0.0.5	OSPF	94	Hello Packet

```
> Frame 94: 218 bytes on wire (1744 bits), 218 bytes captured (1744 bits) on interface 0
> Ethernet II, Src: Cisco_b8:23:31 (40:55:39:b8:23:31), Dst: Cisco_53:e4:c1 (00:64:40:53:e4:c1)
> Internet Protocol Version 4, Src: 10.10.7.1, Dst: 10.10.7.2
v Open Shortest Path First
    > OSPF Header
    > LSA-type 3 (Summary-LSA (IP network)), len 28
    > LSA-type 3 (Summary-LSA (IP network)), len 28
    > LSA-type 3 (Summary-LSA (IP network)), len 28
    > LSA-type 3 (Summary-LSA (IP network)), len 28
    > LSA-type 3 (Summary-LSA (IP network)), len 28
    > LSA-type 3 (Summary-LSA (IP network)), len 28
    > LSA-type 4 (Summary-LSA (ASBR)), len 28
    > LSA-type 5 (AS-External-LSA (ASBR)), len 36
```

LSA Type I, 3, & 7


R4 nssa capture.pcapng
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
ospf
Expression...
No. Time Source Destination Protocol Length Info
96 51.068187 10.10.11.1 10.10.11.2 OSPF 78 DB Description
97 51.791160 fe80::26e9:b3ff:fe3c… ff02::5 OSPF 90 Hello Packet
98 52.163093 10.10.11.2 10.10.11.1 OSPF 78 DB Description
99 52.163966 10.10.11.1 10.10.11.2 OSPF 238 DB Description
100 52.164336 10.10.11.2 10.10.11.1 OSPF 218 DB Description
101 52.168083 10.10.11.2 10.10.11.1 OSPF 122 LS Update
102 52.168119 10.10.11.1 10.10.11.2 OSPF 70 LS Request
103 52.168120 10.10.11.1 10.10.11.2 OSPF 78 DB Description
104 52.168489 10.10.11.2 10.10.11.1 OSPF 94 LS Request
105 52.171560 10.10.11.1 10.10.11.2 OSPF 166 LS Update
106 52.171932 10.10.11.2 224.0.0.5 OSPF 94 LS Update
107 52.206741 10.10.11.2 224.0.0.5 OSPF 98 LS Update
108 52.663107 10.10.11.2 224.0.0.5 OSPF 122 LS Update
109 52.670508 10.10.11.1 224.0.0.6 OSPF 98 LS Update
110 52.698999 10.10.11.2 224.0.0.5 OSPF 98 LS Update
114 54.666987 10.10.11.1 224.0.0.6 OSPF 138 LS Acknowledge
115 54.671066 10.10.11.2 224.0.0.5 OSPF 138 LS Acknowledge
118 57.171113 10.10.11.2 224.0.0.5 OSPF 94 LS Update
Frame 99: 238 bytes on wire (1904 bits), 238 bytes captured (1904 bits) on interface 0
Ethernet II, Src: Cisco_53:e4:c1 (00:64:40:53:e4:c1), Dst: Cisco_3c:1d:80 (24:e9:b3:3c:1d:80)
Internet Protocol Version 4, Src: 10.10.11.1, Dst: 10.10.11.2
Open Shortest Path First
OSPF Header
OSPF DB Description
LSA-type 1 (Router-LSA), len 36
LSA-type 1 (Router-LSA), len 60
LSA-type 2 (Network-LSA), len 32
LSA-type 3 (Summary-LSA (IP network)), len 28
LSA-type 3 (Summary-LSA (IP network)), len 28
LSA-type 3 (Summary-LSA (IP network)), len 28
LSA-type 3 (Summary-LSA (IP network)), len 28
LSA-type 7 (NSSA AS-External-LSA), len 36
OSPF LLS Data Block
R4 nssa capture.pcapng
Packets: 158 · Displayed: 44 (27.8%)
Profile: Default

Problems

A few issues we ran into while configuring our stubby OSPF networks were establishing connectivity between the OSPF network and the EIGRP external network. What ended up happening was the two networks recognized each other's presence but were unable to communicate to one another, like 2 people acknowledging each other's presence but they each spoke different languages. To fix the issue, we would make the routers redistribute each of the routes as the OSPF ABR would redistribute EIGRP routes while EIGRP redistributed OSPF routes. Another issue we encountered was when we established monitoring sessions using Wireshark, as we connected ourselves into the routers within the OSPF network. We observed the traffic only contained OSPF Hello packets (LSA 1), and nothing else. We solved that issue by reestablishing another monitoring session within the central router (The acting Layer 3 switch) and then we started to observe the different LSA updates and packets passing through.

Conclusion

In this lab, we configured OSPF areas with variable stubbiness and linked them to an external network. This lab also serves to bridge our learning from researching about the different OSPF networks to actually implementing them to a topology in real life, and using Wireshark to capture the flow of packets in action from the switch.