NWEN302 Lab 2 Part B Report - David Burrell:300209541

TASK 1

```
============ OSPF network routing table ============
N    10.10.1.0/24          [30] area: 0.0.0.0
                           via 10.10.6.2, eth0
N    10.10.2.0/24          [40] area: 0.0.0.0
                           via 10.10.6.2, eth0
N    10.10.3.0/24          [30] area: 0.0.0.0
                           via 10.10.6.2, eth0
N    10.10.4.0/24          [20] area: 0.0.0.0
                           via 10.10.6.2, eth0
N    10.10.5.0/24          [20] area: 0.0.0.0
                           via 10.10.6.2, eth0
N    10.10.6.0/24          [10] area: 0.0.0.0
                           directly attached to eth0
N    10.10.7.0/24          [30] area: 0.0.0.0
                           via 10.10.6.2, eth0
N    10.10.8.0/24          [20] area: 0.0.0.0
                           via 10.10.6.2, eth0
N    10.10.9.0/24          [30] area: 0.0.0.0
                           via 10.10.6.2, eth0
N    10.10.10.0/24         [40] area: 0.0.0.0
                           via 10.10.6.2, eth0
N    10.10.11.0/24         [40] area: 0.0.0.0
                           via 10.10.6.2, eth0
N    10.10.12.0/24         [30] area: 0.0.0.0
                           via 10.10.6.2, eth0
N    10.10.13.0/24         [30] area: 0.0.0.0
                           via 10.10.6.2, eth0

============ OSPF router routing table =============
R    10.10.7.2             [20] area: 0.0.0.0, ASBR
                           via 10.10.6.2, eth0
R    10.10.8.2             [10] area: 0.0.0.0, ASBR
                           via 10.10.6.2, eth0
R    10.10.9.1             [20] area: 0.0.0.0, ASBR
                           via 10.10.6.2, eth0
R    10.10.9.2             [30] area: 0.0.0.0, ASBR
                           via 10.10.6.2, eth0
R    10.10.11.1            [30] area: 0.0.0.0, ASBR
                           via 10.10.6.2, eth0
R    10.10.13.1            [20] area: 0.0.0.0, ASBR
                           via 10.10.6.2, eth0

============ OSPF external routing table ===========


r7# 
```

1. Which router was the example above taken from? Briefly explain your answer.

The example above (in the lab write up, not this report) appears to be from r7 as all connections are being routed through 10.10.6.2, and r7 is the only router with one connection.

2. Will the table look the same on each router? Briefly explain your answer.

The *OSPF network routing table* should look the same for every router on the network, except for the *via* setting, as this is the address the router should be sending outgoing packets, depending on the destination in the first column.

The *OSPF router routing* table should also look the same for every router, and again the *via* setting will be different. Essentially the first table is a list of all locations on the network, and the second table is a list of only the routers on the network, and the table just holds the information in which direction to send packets bound for each address.

3. Disconnect from the OSPF process on one of the routers and run the `route` command at the Unix prompt. Describe how the Unix routing table has changed.

```
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
10.10.1.0       *               255.255.255.0   U     0      0        0 eth0
10.10.2.0       10.10.1.2       255.255.255.0   UG    20     0        0 eth0
10.10.3.0       10.10.1.2       255.255.255.0   UG    20     0        0 eth0
10.10.4.0       10.10.1.2       255.255.255.0   UG    20     0        0 eth0
10.10.5.0       10.10.1.2       255.255.255.0   UG    20     0        0 eth0
10.10.6.0       10.10.1.2       255.255.255.0   UG    20     0        0 eth0
10.10.7.0       10.10.1.2       255.255.255.0   UG    20     0        0 eth0
10.10.8.0       10.10.1.2       255.255.255.0   UG    20     0        0 eth0
10.10.9.0       10.10.1.2       255.255.255.0   UG    20     0        0 eth0
10.10.10.0      *               255.255.255.0   U     0      0        0 eth2
10.10.11.0      *               255.255.255.0   U     0      0        0 eth3
10.10.12.0      10.10.1.2       255.255.255.0   UG    20     0        0 eth0
10.10.13.0      10.10.1.2       255.255.255.0   UG    20     0        0 eth0
```

This is the output for running the command on router *r1*, as we can see the unix routing table has been updated to contain routing information for every address on the network

TASK 2

```
r2(config-ospf6)# ospf6 router-id 10.10.1.2
r2(config-ospf6)# r
r2(config-ospf6)# redistribute c
r2(config-ospf6)# redistribute connected
r2(config-ospf6)# i
r2(config-ospf6)# interface
% Command incomplete.
r2(config-ospf6)# i
r2(config-ospf6)# interface e
eth2       eth1       eth0
r2(config-ospf6)# interface eth0 area 0.0.0.0
r2(config-ospf6)# interface eth1 area 0.0.0.0
r2(config-ospf6)# interface eth2 area 0.0.0.0
r2(config-ospf6)#
```

This is the commands used for configuring *r2* (and the rest)

```
r2# show ipv6 ospf6 route
*N IA 2404:2000:2002:101::/64       ::                          eth0 00:02:00
 N E1 2404:2000:2002:101::/64       fe80::200:ff:feaa:1         eth0 00:01:55
*N IA 2404:2000:2002:102::/64       fe80::200:ff:feaa:1         eth0 00:01:55
 N E1 2404:2000:2002:102::/64       fe80::200:ff:feaa:1         eth0 00:01:55
*N IA 2404:2000:2002:108::/64       ::                          eth1 00:01:53
*N IA 2404:2000:2002:109::/64       ::                          eth2 00:01:53
*N IA 2404:2000:2002:110::/64       fe80::200:ff:feaa:1         eth0 00:01:55
 N E1 2404:2000:2002:110::/64       fe80::200:ff:feaa:1         eth0 00:01:55
*N IA 2404:2000:2002:111::/64       fe80::200:ff:feaa:1         eth0 00:01:55
 N E1 2404:2000:2002:111::/64       fe80::200:ff:feaa:1         eth0 00:01:55
```

The network routes after setting up *r1* and *r2*

```
r3# show ipv6 ospf6 route
*N IA 2404:2000:2002:101::/64       fe80::200:ff:feaa:c        eth1 00:00:47
                                    fe80::200:ff:feaa:14       eth3
 N E1 2404:2000:2002:101::/64       fe80::200:ff:feaa:c        eth1 00:00:49
                                    fe80::200:ff:feaa:14       eth3
*N IA 2404:2000:2002:102::/64       ::                         eth1 00:00:54
 N E1 2404:2000:2002:102::/64       fe80::200:ff:feaa:c        eth1 00:00:49
*N IA 2404:2000:2002:103::/64       ::                         eth2 00:00:56
*N IA 2404:2000:2002:107::/64       ::                         eth0 00:00:56
*N IA 2404:2000:2002:108::/64       fe80::200:ff:feaa:14       eth3 00:00:47
 N E1 2404:2000:2002:108::/64       fe80::200:ff:feaa:14       eth3 00:00:47
*N IA 2404:2000:2002:109::/64       ::                         eth3 00:00:47
 N E1 2404:2000:2002:109::/64       fe80::200:ff:feaa:14       eth3 00:00:47
*N IA 2404:2000:2002:110::/64       fe80::200:ff:feaa:c        eth1 00:00:49
 N E1 2404:2000:2002:110::/64       fe80::200:ff:feaa:c        eth1 00:00:49
*N IA 2404:2000:2002:111::/64       fe80::200:ff:feaa:c        eth1 00:00:49
 N E1 2404:2000:2002:111::/64       fe80::200:ff:feaa:c        eth1 00:00:49
```

The network routes after setting up *r1, r2* and *r3*

```
r4# show ipv6 ospf6 route
*N IA 2404:2000:2002:101::/64       fe80::200:ff:feaa:f        eth1 00:00:10
 N E1 2404:2000:2002:101::/64       fe80::200:ff:feaa:f        eth1 00:00:10
*N IA 2404:2000:2002:102::/64       fe80::200:ff:feaa:f        eth1 00:00:10
 N E1 2404:2000:2002:102::/64       fe80::200:ff:feaa:f        eth1 00:00:10
 N E1 2404:2000:2002:102::/64       fe80::200:ff:feaa:f        eth1 00:00:10
*N IA 2404:2000:2002:103::/64       ::                         eth1 00:00:15
 N E1 2404:2000:2002:103::/64       fe80::200:ff:feaa:f        eth1 00:00:10
*N IA 2404:2000:2002:104::/64       ::                         eth0 00:00:10
*N IA 2404:2000:2002:107::/64       fe80::200:ff:feaa:f        eth1 00:00:10
 N E1 2404:2000:2002:107::/64       fe80::200:ff:feaa:f        eth1 00:00:10
*N IA 2404:2000:2002:108::/64       fe80::200:ff:feaa:f        eth1 00:00:10
 N E1 2404:2000:2002:108::/64       fe80::200:ff:feaa:f        eth1 00:00:10
*N IA 2404:2000:2002:109::/64       fe80::200:ff:feaa:f        eth1 00:00:10
 N E1 2404:2000:2002:109::/64       fe80::200:ff:feaa:f        eth1 00:00:10
 N E1 2404:2000:2002:109::/64       fe80::200:ff:feaa:f        eth1 00:00:10
*N IA 2404:2000:2002:110::/64       fe80::200:ff:feaa:f        eth1 00:00:10
 N E1 2404:2000:2002:110::/64       fe80::200:ff:feaa:f        eth1 00:00:10
*N IA 2404:2000:2002:111::/64       fe80::200:ff:feaa:f        eth1 00:00:10
 N E1 2404:2000:2002:111::/64       fe80::200:ff:feaa:f        eth1 00:00:10
*N IA 2404:2000:2002:112::/64       ::                         eth2 00:00:10
*N IA 2404:2000:2002:113::/64       ::                         eth3 00:00:10
```

The network routes after setting up *r1, r2, r3* and *r4*

```
r5# show ipv6 ospf6 route
*N IA 2404:2000:2002:101::/64       fe80::200:ff:feaa:2        eth0 00:00:13
 N E1 2404:2000:2002:101::/64       fe80::200:ff:feaa:2        eth0 00:00:13
 N E1 2404:2000:2002:101::/64       fe80::200:ff:feaa:2        eth0 00:00:13
*N IA 2404:2000:2002:102::/64       fe80::200:ff:feaa:2        eth0 00:00:09
                                    fe80::200:ff:feaa:7        eth2
 N E1 2404:2000:2002:102::/64       fe80::200:ff:feaa:2        eth0 00:00:13
                                    fe80::200:ff:feaa:7        eth2
*N IA 2404:2000:2002:103::/64       fe80::200:ff:feaa:7        eth2 00:00:09
 N E1 2404:2000:2002:103::/64       fe80::200:ff:feaa:7        eth2 00:00:09
 N E1 2404:2000:2002:103::/64       fe80::200:ff:feaa:2        eth0 00:00:13
                                    fe80::200:ff:feaa:7        eth2
*N IA 2404:2000:2002:104::/64       ::                         eth2 00:00:09
 N E1 2404:2000:2002:104::/64       fe80::200:ff:feaa:7        eth2 00:00:09
*N IA 2404:2000:2002:105::/64       ::                         eth3 00:00:14
*N IA 2404:2000:2002:106::/64       ::                         eth1 00:00:14
*N IA 2404:2000:2002:107::/64       fe80::200:ff:feaa:2        eth0 00:00:09
                                    fe80::200:ff:feaa:7        eth2
 N E1 2404:2000:2002:107::/64       fe80::200:ff:feaa:2        eth0 00:00:13
                                    fe80::200:ff:feaa:7        eth2
*N IA 2404:2000:2002:108::/64       ::                         eth0 00:00:18
 N E1 2404:2000:2002:108::/64       fe80::200:ff:feaa:2        eth0 00:00:13
*N IA 2404:2000:2002:109::/64       fe80::200:ff:feaa:2        eth0 00:00:13
 N E1 2404:2000:2002:109::/64       fe80::200:ff:feaa:2        eth0 00:00:13
 N E1 2404:2000:2002:109::/64       fe80::200:ff:feaa:2        eth0 00:00:13
                                    fe80::200:ff:feaa:7        eth2
*N IA 2404:2000:2002:110::/64       fe80::200:ff:feaa:2        eth0 00:00:13
 N E1 2404:2000:2002:110::/64       fe80::200:ff:feaa:2        eth0 00:00:13
*N IA 2404:2000:2002:111::/64       fe80::200:ff:feaa:2        eth0 00:00:13
 N E1 2404:2000:2002:111::/64       fe80::200:ff:feaa:2        eth0 00:00:13
*N IA 2404:2000:2002:112::/64       fe80::200:ff:feaa:7        eth2 00:00:09
 N E1 2404:2000:2002:112::/64       fe80::200:ff:feaa:7        eth2 00:00:09
*N IA 2404:2000:2002:113::/64       fe80::200:ff:feaa:7        eth2 00:00:09
 N E1 2404:2000:2002:113::/64       fe80::200:ff:feaa:7        eth2 00:00:09
```

The network routes after setting up *r1, r2, r3*, *r4* and *r5*

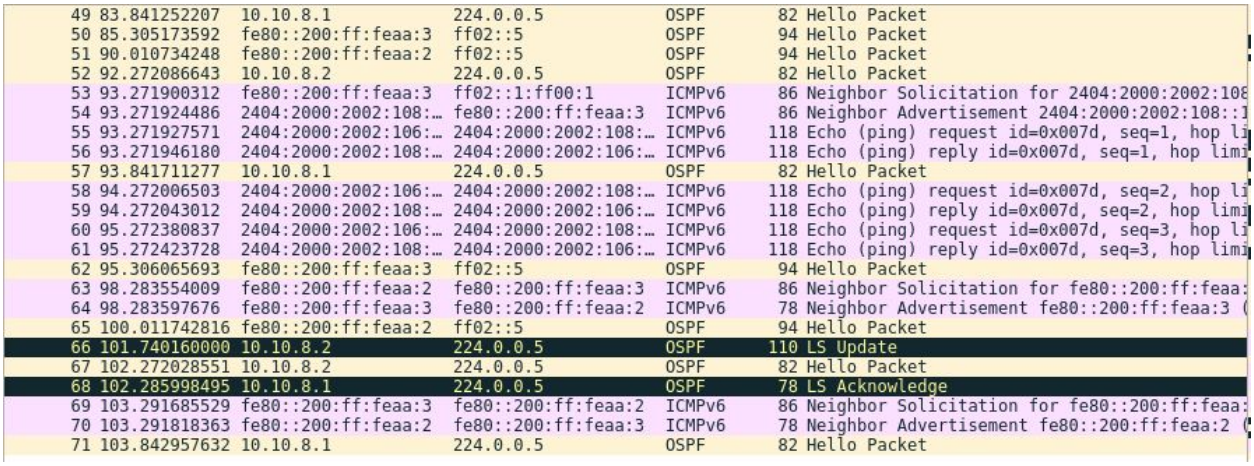
```
r6# show ipv6 ospf6 route
*N IA 2404:2000:2002:101::/64       fe80::200:ff:feaa:b       eth1 00:00:00
 N E1 2404:2000:2002:101::/64       fe80::200:ff:feaa:9       eth0 00:00:07
                                    fe80::200:ff:feaa:b       eth1
*N IA 2404:2000:2002:102::/64       fe80::200:ff:feaa:b       eth1 00:00:00
 N E1 2404:2000:2002:102::/64       fe80::200:ff:feaa:b       eth1 00:00:00
 N E1 2404:2000:2002:102::/64       fe80::200:ff:feaa:b       eth1 00:00:00
*N IA 2404:2000:2002:103::/64       fe80::200:ff:feaa:b       eth1 00:00:00
 N E1 2404:2000:2002:103::/64       fe80::200:ff:feaa:b       eth1 00:00:00
 N E1 2404:2000:2002:103::/64       fe80::200:ff:feaa:9       eth0 00:00:07
                                    fe80::200:ff:feaa:b       eth1
*N IA 2404:2000:2002:104::/64       fe80::200:ff:feaa:9       eth0 00:00:07
 N E1 2404:2000:2002:104::/64       fe80::200:ff:feaa:9       eth0 00:00:07
 N E1 2404:2000:2002:104::/64       fe80::200:ff:feaa:9       eth0 00:00:07
                                    fe80::200:ff:feaa:b       eth1
*N IA 2404:2000:2002:105::/64       ::                        eth0 00:00:12
 N E1 2404:2000:2002:105::/64       fe80::200:ff:feaa:9       eth0 00:00:07
*N IA 2404:2000:2002:106::/64       fe80::200:ff:feaa:9       eth0 00:00:07
 N E1 2404:2000:2002:106::/64       fe80::200:ff:feaa:9       eth0 00:00:07
*N IA 2404:2000:2002:107::/64       ::                        eth1 00:00:00
 N E1 2404:2000:2002:107::/64       fe80::200:ff:feaa:b       eth1 00:00:00
*N IA 2404:2000:2002:108::/64       fe80::200:ff:feaa:9       eth0 00:00:07
 N E1 2404:2000:2002:108::/64       fe80::200:ff:feaa:9       eth0 00:00:07
 N E1 2404:2000:2002:108::/64       fe80::200:ff:feaa:9       eth0 00:00:07
                                    fe80::200:ff:feaa:b       eth1
*N IA 2404:2000:2002:109::/64       fe80::200:ff:feaa:b       eth1 00:00:00
 N E1 2404:2000:2002:109::/64       fe80::200:ff:feaa:b       eth1 00:00:00
 N E1 2404:2000:2002:109::/64       fe80::200:ff:feaa:9       eth0 00:00:07
                                    fe80::200:ff:feaa:b       eth1
*N IA 2404:2000:2002:110::/64       fe80::200:ff:feaa:b       eth1 00:00:00
 N E1 2404:2000:2002:110::/64       fe80::200:ff:feaa:b       eth1 00:00:00
*N IA 2404:2000:2002:111::/64       fe80::200:ff:feaa:b       eth1 00:00:00
 N E1 2404:2000:2002:111::/64       fe80::200:ff:feaa:b       eth1 00:00:00
*N IA 2404:2000:2002:112::/64       fe80::200:ff:feaa:9       eth0 00:00:00
                                    fe80::200:ff:feaa:b       eth1
 N E1 2404:2000:2002:112::/64       fe80::200:ff:feaa:9       eth0 00:00:07
                                    fe80::200:ff:feaa:b       eth1
*N IA 2404:2000:2002:113::/64       fe80::200:ff:feaa:9       eth0 00:00:00
                                    fe80::200:ff:feaa:b       eth1
 N E1 2404:2000:2002:113::/64       fe80::200:ff:feaa:9       eth0 00:00:07
                                    fe80::200:ff:feaa:b       eth1
```

The network routes after setting up *r1, r2, r3*, *r4, r5* and *r6*

```
r7# show ipv6 ospf6 route
*N IA 2404:2000:2002:101::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:101::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:101::/64       fe80::200:ff:feaa:4       eth0 00:00:00
*N IA 2404:2000:2002:102::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:102::/64       fe80::200:ff:feaa:4       eth0 00:00:00
*N IA 2404:2000:2002:103::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:103::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:103::/64       fe80::200:ff:feaa:4       eth0 00:00:00
*N IA 2404:2000:2002:104::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:104::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:104::/64       fe80::200:ff:feaa:4       eth0 00:00:00
*N IA 2404:2000:2002:105::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:105::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:105::/64       fe80::200:ff:feaa:4       eth0 00:00:00
*N IA 2404:2000:2002:106::/64       ::                        eth0 00:00:05
 N E1 2404:2000:2002:106::/64       fe80::200:ff:feaa:4       eth0 00:00:00
*N IA 2404:2000:2002:107::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:107::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:107::/64       fe80::200:ff:feaa:4       eth0 00:00:00
*N IA 2404:2000:2002:108::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:108::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:108::/64       fe80::200:ff:feaa:4       eth0 00:00:00
*N IA 2404:2000:2002:109::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:109::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:109::/64       fe80::200:ff:feaa:4       eth0 00:00:00
*N IA 2404:2000:2002:110::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:110::/64       fe80::200:ff:feaa:4       eth0 00:00:00
*N IA 2404:2000:2002:111::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:111::/64       fe80::200:ff:feaa:4       eth0 00:00:00
*N IA 2404:2000:2002:112::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:112::/64       fe80::200:ff:feaa:4       eth0 00:00:00
*N IA 2404:2000:2002:113::/64       fe80::200:ff:feaa:4       eth0 00:00:00
 N E1 2404:2000:2002:113::/64       fe80::200:ff:feaa:4       eth0 00:00:00
```

The network routes after setting up *r1, r2, r3*, *r4, r5, r6* and *r7*

4. How would you test that this change enables IPv6 packets to be forwarded?



49	83.841252207	10.10.8.1	224.0.0.5	OSPF	82	Hello Packet
50	85.305173592	fe80::200:ff:feaa:3	ff02::5	OSPF	94	Hello Packet
51	90.010734248	fe80::200:ff:feaa:2	ff02::5	OSPF	94	Hello Packet
52	92.272086643	10.10.8.2	224.0.0.5	OSPF	82	Hello Packet
53	93.271900312	fe80::200:ff:feaa:3	ff02::1:ff00:1	ICMPv6	86	Neighbor Solicitation for 2404:2000:2002:108
54	93.271924486	2404:2000:2002:108:…	fe80::200:ff:feaa:3	ICMPv6	86	Neighbor Advertisement 2404:2000:2002:108::1
55	93.271927571	2404:2000:2002:106:…	2404:2000:2002:108:…	ICMPv6	118	Echo (ping) request id=0x007d, seq=1, hop li
56	93.271946180	2404:2000:2002:108:…	2404:2000:2002:106:…	ICMPv6	118	Echo (ping) reply id=0x007d, seq=1, hop limi
57	93.841711277	10.10.8.1	224.0.0.5	OSPF	82	Hello Packet
58	94.272006503	2404:2000:2002:106:…	2404:2000:2002:108:…	ICMPv6	118	Echo (ping) request id=0x007d, seq=2, hop li
59	94.272043012	2404:2000:2002:108:…	2404:2000:2002:106:…	ICMPv6	118	Echo (ping) reply id=0x007d, seq=2, hop limi
60	95.272380837	2404:2000:2002:106:…	2404:2000:2002:108:…	ICMPv6	118	Echo (ping) request id=0x007d, seq=3, hop li
61	95.272423728	2404:2000:2002:108:…	2404:2000:2002:106:…	ICMPv6	118	Echo (ping) reply id=0x007d, seq=3, hop limi
62	95.306065693	fe80::200:ff:feaa:3	ff02::5	OSPF	94	Hello Packet
63	98.283554009	fe80::200:ff:feaa:2	fe80::200:ff:feaa:3	ICMPv6	86	Neighbor Solicitation for fe80::200:ff:feaa:
64	98.283597676	fe80::200:ff:feaa:3	fe80::200:ff:feaa:2	ICMPv6	78	Neighbor Advertisement fe80::200:ff:feaa:3 (
65	100.011742816	fe80::200:ff:feaa:2	ff02::5	OSPF	94	Hello Packet
66	101.740160000	10.10.8.2	224.0.0.5	OSPF	110	LS Update
67	102.272028551	10.10.8.2	224.0.0.5	OSPF	82	Hello Packet
68	102.285998495	10.10.8.1	224.0.0.5	OSPF	78	LS Acknowledge
69	103.291685529	fe80::200:ff:feaa:3	fe80::200:ff:feaa:2	ICMPv6	86	Neighbor Solicitation for fe80::200:ff:feaa:
70	103.291818363	fe80::200:ff:feaa:2	fe80::200:ff:feaa:3	ICMPv6	78	Neighbor Advertisement fe80::200:ff:feaa:2 (
71	103.842957632	10.10.8.1	224.0.0.5	OSPF	82	Hello Packet

To test that this is working, I used wireshark to look at the traffic going through *r5* on *eth0* connected to *r2*, then I pinged *r2* from *r7*. I used *r7* because there is only one connection to it from the rest of the network, this means all the traffic out of *r7* must go through *r5* making the path being taken predictable.

Exploring the network from the edge:

While following the steps provided, I noticed that pinging on ipv4 addresses was still not working across the network, ipv6 was fine. So I took a look at */etc/sysctl.conf* and noticed that the line for controlling ipv4 forwarding was commented out in the same way ipv6 forwarding is. (note: cannot manage to change that file and save it to the VM). After discovering this I then used the following command:

sysctl -w net.ipv4.ip_forward=1

on all routers *r1-r7* and now my pings work across the network.

The -n flag displays network addresses as numbers rather than as hostnames, I ran the ping commands with and without this flag and could not see a difference in this case. This is useful so you can always see the exact addresses being pinged.

Before disconnecting *c2*

```
root@m4:/tmp/pycore.37980/m4.conf# traceroute -n 10.10.11.2
traceroute to 10.10.11.2 (10.10.11.2), 30 hops max, 60 byte packets
 1  10.10.13.1  0.543 ms  0.456 ms  0.441 ms
 2  10.10.3.1  0.429 ms  0.405 ms  0.392 ms
 3  10.10.2.1  0.379 ms  0.356 ms  0.339 ms
 4  10.10.11.2  0.324 ms  0.020 ms  0.013 ms
```

After disconnecting *c2*

```
root@m4:/tmp/pycore.37980/m4.conf# traceroute -n 10.10.11.2
traceroute to 10.10.11.2 (10.10.11.2), 30 hops max, 60 byte packets
 1  10.10.13.1  0.044 ms  0.012 ms  0.007 ms
 2  10.10.3.1  0.019 ms  0.010 ms  0.009 ms
 3  10.10.8.1  0.027 ms  0.013 ms  0.013 ms
 4  10.10.1.1  0.022 ms  0.013 ms  0.014 ms
 5  10.10.11.2  0.032 ms  0.077 ms  0.078 ms
```

5. What happens to the output of traceroute after disconnecting? Explain the result.

After disconnecting *c2* the route taken is rerouted through *r2*. This is shown by the step 3 before disconnecting going to 10.10.2.1(*r1)*, whereas after disconnecting, this is replaced by step 3 and 4 being jumps to 10.10.8.1(*r2)* then to 10.10.1.1(*r1*).

6. What happens if you wait for some time? Explain the result.

Using ping -R shows that the network will adjust over time, if more than one route is available.

7. What happens if you reconnect the link c2? Explain the result.

After the connection is reconnected, the route taken shown by traceroute (and traceroute6) will eventually (rather quickly) notice and use the shorter connection again.

8. The changes you see take some time to happen. How long? Explain your results and how you have worked this out.

The changes take around 5 seconds. In my test it took 4.717(3.d.p) seconds.

1	0.000000000	10.10.2.1	224.0.0.5	OSPF	78 Hello Packet
2	0.001216509	fe80::48fa:a3ff:fe8…	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
3	0.001207827	10.10.2.1	224.0.0.22	IGMPv3	54 Membership Report / Join group 224.0.0.5 f…
4	0.001224340	::	ff02::16	ICMPv6	130 Multicast Listener Report Message v2
5	0.021182197	00:00:00_aa:00:0d	Broadcast	ARP	42 Who has 10.10.2.1? Tell 10.10.2.2
6	0.021203709	00:00:00_aa:00:0c	00:00:00_aa:00:0d	ARP	42 10.10.2.1 is at 00:00:00:aa:00:0c
7	0.021214139	10.10.2.2	10.10.2.1	OSPF	122 LS Update
8	0.429234111	fe80::48fa:a3ff:fe8…	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
9	0.493271876	10.10.2.1	224.0.0.22	IGMPv3	54 Membership Report / Join group 224.0.0.5 f…
10	0.585169330	::	ff02::16	ICMPv6	130 Multicast Listener Report Message v2
11	0.741776451	fe80::200:ff:feaa:d	ff02::1:ffaa:c	ICMPv6	86 Neighbor Solicitation for fe80::200:ff:fea…
12	0.781280141	::	ff02::1:ffaa:c	ICMPv6	78 Neighbor Solicitation for fe80::200:ff:fea…
13	1.781273924	fe80::200:ff:feaa:c	ff02::16	ICMPv6	150 Multicast Listener Report Message v2
14	1.781532686	fe80::200:ff:feaa:c	ff02::5	OSPF	90 Hello Packet
15	1.789180080	fe80::200:ff:feaa:c	ff02::16	ICMPv6	110 Multicast Listener Report Message v2
16	2.241174877	fe80::200:ff:feaa:c	ff02::16	ICMPv6	170 Multicast Listener Report Message v2
17	2.321703623	fe80::200:ff:feaa:c	ff02::16	ICMPv6	110 Multicast Listener Report Message v2
18	4.017385802	10.10.2.2	224.0.0.5	OSPF	82 Hello Packet
19	4.019063923	10.10.2.1	10.10.2.2	ICMP	98 Echo (ping) request id=0x0105, seq=1/256,…
20	4.019076856	10.10.2.2	10.10.2.1	ICMP	98 Echo (ping) reply id=0x0105, seq=1/256,…
21	4.019770907	10.10.2.1	10.10.2.2	OSPF	66 DB Description
22	4.021734698	10.10.2.1	10.10.2.2	ICMP	98 Echo (ping) request id=0x0107, seq=1/256,…
23	4.021743114	10.10.2.2	10.10.2.1	ICMP	98 Echo (ping) reply id=0x0107, seq=1/256,…
24	4.022437256	10.10.2.2	10.10.2.1	OSPF	66 DB Description
25	4.022475683	10.10.2.2	10.10.2.1	OSPF	366 DB Description
26	4.022504926	10.10.2.2	224.0.0.5	OSPF	134 LS Update
27	4.023190147	10.10.2.2	10.10.2.1	ICMP	98 Echo (ping) request id=0x00d5, seq=1/256,…
28	4.023210779	10.10.2.1	10.10.2.2	ICMP	98 Echo (ping) reply id=0x00d5, seq=1/256,…
29	4.024542777	10.10.2.2	10.10.2.1	ICMP	98 Echo (ping) request id=0x00d7, seq=1/256,…
30	4.024547923	10.10.2.1	10.10.2.2	ICMP	98 Echo (ping) reply id=0x00d7, seq=1/256,…
31	4.025185990	10.10.2.1	10.10.2.2	OSPF	86 DB Description
32	4.025209377	10.10.2.1	10.10.2.2	OSPF	78 LS Acknowledge
33	4.025296887	10.10.2.2	10.10.2.1	OSPF	66 DB Description
34	4.025453532	10.10.2.2	224.0.0.5	OSPF	166 LS Update
35	4.026704168	10.10.2.1	224.0.0.5	OSPF	134 LS Update
36	4.027422363	10.10.2.1	10.10.2.2	ICMP	98 Echo (ping) request id=0x0109, seq=1/256,…
37	4.027430391	10.10.2.2	10.10.2.1	ICMP	98 Echo (ping) reply id=0x0109, seq=1/256,…
38	4.027989074	10.10.2.1	10.10.2.2	ICMP	98 Echo (ping) request id=0x010b, seq=1/256,…
39	4.027996794	10.10.2.2	10.10.2.1	ICMP	98 Echo (ping) reply id=0x010b, seq=1/256,…
40	4.028131261	10.10.2.1	224.0.0.22	IGMPv3	54 Membership Report / Join group 224.0.0.6 f…
41	4.649169006	10.10.2.1	224.0.0.22	IGMPv3	54 Membership Report / Join group 224.0.0.6 f…
42	4.717198749	10.10.11.2	10.10.13.2	ICMP	98 Echo (ping) reply id=0x0078, seq=11/281…

I used Wireshark again to track this my process is as follows:

I first set up *r1* by performing the down command on *c2* as before.

Then I started *m4* constantly pinging *m2.*

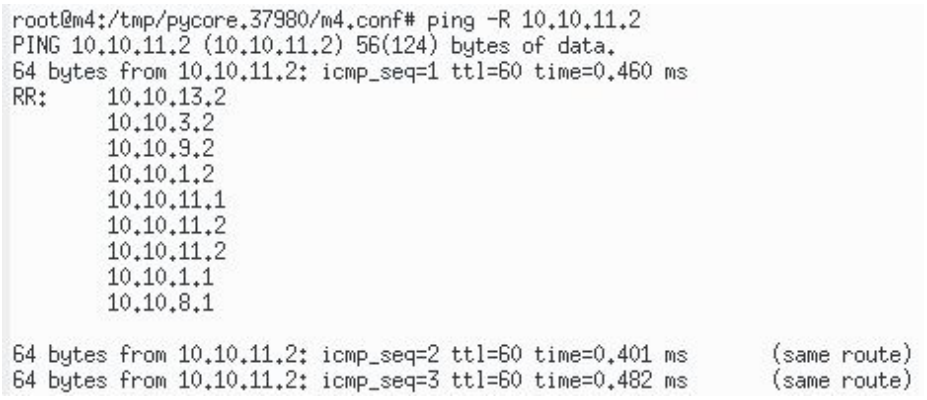
I opened the wireshark terminal looking only at *c2* on 10.10.2.1, because this was down, no traffic was coming in.

I then performed the up command on *c2* in the *r1* terminal. When this happened, Wireshark began capturing packets. This includes all the pings stored in the buffer of *r3* as shown by the source of the ping request packets being 10.10.2.2.

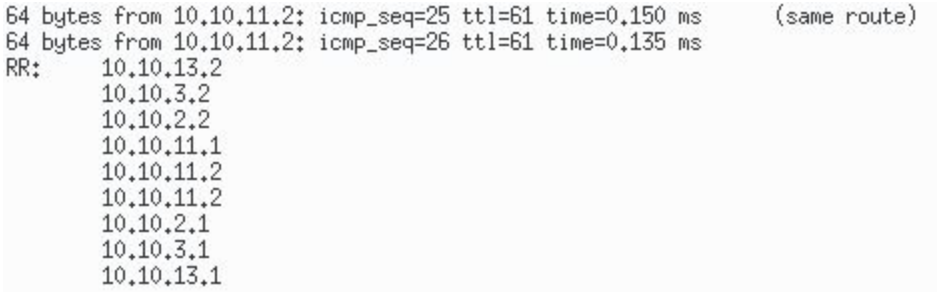
To find the time taken to have the network routing map be filled out I looked for the first ping

request or reply with source or destination being from *m2* or *m4*, this is the one highlighted in the image above.

ping -R from *m4* to *m2* with *c2* down



ping -R from *m4* to *m2* with *c2* up

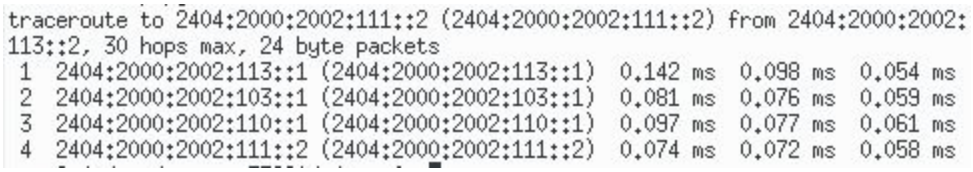


Both of these images were from the same ping command the path shown was adjusted once *c2* was put up again.

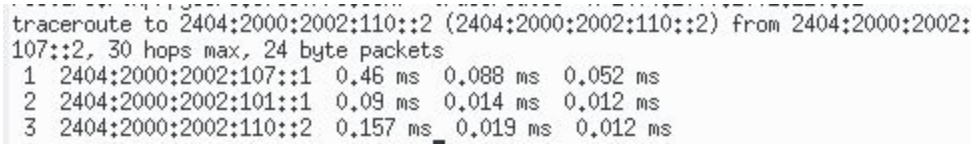
TASK 3

Make sure you also test your IPv6 network.

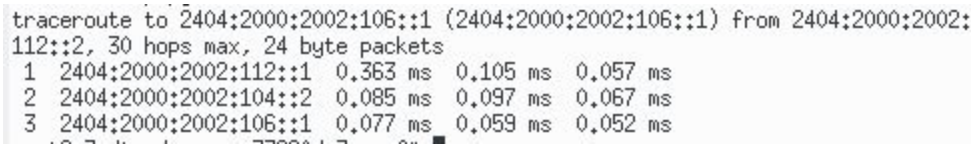
IPv6 traceroute from *m4* to *m2*



IPv6 traceroute from *r6* to *m1*



IPv6 traceroute from *m3* to *r7*



Exploring the network from the core

***c2* up**

```
r3# show ip ospf route
============ OSPF network routing table ============
N    10.10.1.0/24          [20] area: 0.0.0.0
                           via 10.10.2.1, eth1
                           via 10.10.9.1, eth3
N    10.10.2.0/24          [10] area: 0.0.0.0
                           directly attached to eth1
N    10.10.3.0/24          [10] area: 0.0.0.0
                           directly attached to eth2
N    10.10.4.0/24          [20] area: 0.0.0.0
                           via 10.10.3.2, eth2
N    10.10.5.0/24          [20] area: 0.0.0.0
                           via 10.10.7.2, eth0
N    10.10.6.0/24          [30] area: 0.0.0.0
                           via 10.10.3.2, eth2
                           via 10.10.7.2, eth0
                           via 10.10.9.1, eth3
N    10.10.7.0/24          [10] area: 0.0.0.0
                           directly attached to eth0
N    10.10.8.0/24          [20] area: 0.0.0.0
                           via 10.10.9.1, eth3
N    10.10.9.0/24          [10] area: 0.0.0.0
                           directly attached to eth3
N    10.10.10.0/24         [20] area: 0.0.0.0
                           via 10.10.2.1, eth1
N    10.10.11.0/24         [20] area: 0.0.0.0
                           via 10.10.2.1, eth1
N    10.10.12.0/24         [20] area: 0.0.0.0
                           via 10.10.3.2, eth2
N    10.10.13.0/24         [20] area: 0.0.0.0
                           via 10.10.3.2, eth2

============ OSPF router routing table =============
R    10.10.6.1             [30] area: 0.0.0.0, ASBR
                           via 10.10.3.2, eth2
                           via 10.10.7.2, eth0
                           via 10.10.9.1, eth3
R    10.10.7.2             [10] area: 0.0.0.0, ASBR
                           via 10.10.7.2, eth0
R    10.10.8.2             [20] area: 0.0.0.0, ASBR
                           via 10.10.3.2, eth2
                           via 10.10.7.2, eth0
                           via 10.10.9.1, eth3
R    10.10.9.1             [10] area: 0.0.0.0, ASBR
                           via 10.10.9.1, eth3
R    10.10.11.1            [10] area: 0.0.0.0, ASBR
                           via 10.10.2.1, eth1
R    10.10.13.1            [10] area: 0.0.0.0, ASBR
                           via 10.10.3.2, eth2
```

***c2* down**

```
r3# show ip ospf route
============ OSPF network routing table ============
N    10.10.1.0/24          [20] area: 0.0.0.0
                           via 10.10.9.1, eth3
N    10.10.2.0/24          [10] area: 0.0.0.0
                           directly attached to eth1
N    10.10.3.0/24          [10] area: 0.0.0.0
                           directly attached to eth2
N    10.10.4.0/24          [20] area: 0.0.0.0
                           via 10.10.3.2, eth2
N    10.10.5.0/24          [20] area: 0.0.0.0
                           via 10.10.7.2, eth0
N    10.10.6.0/24          [30] area: 0.0.0.0
                           via 10.10.3.2, eth2
                           via 10.10.7.2, eth0
                           via 10.10.9.1, eth3
N    10.10.7.0/24          [10] area: 0.0.0.0
                           directly attached to eth0
N    10.10.8.0/24          [20] area: 0.0.0.0
                           via 10.10.9.1, eth3
N    10.10.9.0/24          [10] area: 0.0.0.0
                           directly attached to eth3
N    10.10.10.0/24         [30] area: 0.0.0.0
                           via 10.10.9.1, eth3
N    10.10.11.0/24         [30] area: 0.0.0.0
                           via 10.10.9.1, eth3
N    10.10.12.0/24         [20] area: 0.0.0.0
                           via 10.10.3.2, eth2
N    10.10.13.0/24         [20] area: 0.0.0.0
                           via 10.10.3.2, eth2

============ OSPF router routing table =============
R    10.10.6.1             [30] area: 0.0.0.0, ASBR
                           via 10.10.3.2, eth2
                           via 10.10.7.2, eth0
                           via 10.10.9.1, eth3
R    10.10.7.2             [10] area: 0.0.0.0, ASBR
                           via 10.10.7.2, eth0
R    10.10.8.2             [20] area: 0.0.0.0, ASBR
                           via 10.10.3.2, eth2
                           via 10.10.7.2, eth0
                           via 10.10.9.1, eth3
R    10.10.9.1             [10] area: 0.0.0.0, ASBR
                           via 10.10.9.1, eth3
R    10.10.11.1            [20] area: 0.0.0.0, ASBR
                           via 10.10.9.1, eth3
R    10.10.13.1            [10] area: 0.0.0.0, ASBR
                           via 10.10.3.2, eth2
```

9. What happens to this table when you disconnect c2?

The possible paths taken to reach 10.10.1.0/24 are change down to only one possible route. And the paths to get to 10.10.10.0/24 and 10.10.11.0/24 are changed from 10.10.2.1 to 10.10.9.1 because 10.10.2.1 is down. On the routing table, the path to 10.10.11.1 is changed from 10.10.2.1 to 10.10.9.1 for the same reasons.

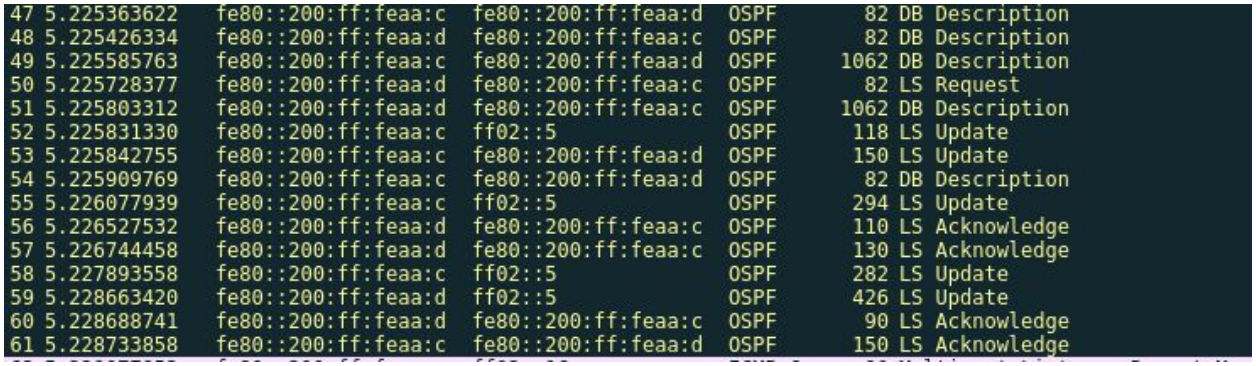
TASK 4

Use your theoretical knowledge of OSPF and sample output from the router to explain what's going on.

```
2019/09/26 23:56:14 OSPF: : LSA[Type2,id(10.10.2.2),ar(10.10.9.2)]: Install netw
ork-LSA to Area 0.0.0.0
2019/09/26 23:56:14 OSPF: : RXmtL(1)++, NBR(10.10.7.2), LSA[Type2,id(10.10.2.2),
ar(10.10.9.2)]
2019/09/26 23:56:14 OSPF: : RXmtL(2)++, NBR(10.10.11.1), LSA[Type2,id(10.10.2.2)
,ar(10.10.9.2)]
2019/09/26 23:56:14 OSPF: : RXmtL(1)++, NBR(10.10.13.1), LSA[Type2,id(10.10.2.2)
,ar(10.10.9.2)]
2019/09/26 23:56:14 OSPF: : RXmtL(1)++, NBR(10.10.9.1), LSA[Type2,id(10.10.2.2),
ar(10.10.9.2)]
2019/09/26 23:56:14 OSPF: : LSA[Type2:10.10.2.2]: Originate network-LSA 0x55ebba
4e49b0
2019/09/26 23:56:14 OSPF: :   LSA Header
2019/09/26 23:56:14 OSPF: :     LS age 0
2019/09/26 23:56:14 OSPF: :     Options 2 (*|-|-|-|-|-|E|-)
2019/09/26 23:56:14 OSPF: :     LS type 2 (network-LSA)
2019/09/26 23:56:14 OSPF: :     Link State ID 10.10.2.2
2019/09/26 23:56:14 OSPF: :     Advertising Router 10.10.9.2
2019/09/26 23:56:14 OSPF: :     LS sequence number 0x8000000a
2019/09/26 23:56:14 OSPF: :     LS checksum 0xd00a
2019/09/26 23:56:14 OSPF: :     length 32
2019/09/26 23:56:14 OSPF: : RXmtL(3)--, NBR(10.10.11.1), LSA[Type1,id(10.10.11.1
),ar(10.10.11.1)]
2019/09/26 23:56:14 OSPF: : LSA: freed 0x55ebba5774a0
2019/09/26 23:56:14 OSPF: : RXmtL(2)--, NBR(10.10.9.1), LSA[Type1,id(10.10.9.2),
ar(10.10.9.2)]
2019/09/26 23:56:14 OSPF: : RXmtL(1)--, NBR(10.10.9.1), LSA[Type2,id(10.10.2.2),
ar(10.10.9.2)]
2019/09/26 23:56:14 OSPF: : LSA: freed 0x55ebba561f00
2019/09/26 23:56:14 OSPF: : LSA[Type1:10.10.11.1]: data freed 0x55ebba575410
2019/09/26 23:56:14 OSPF: : LSA: freed 0x55ebba58f410
2019/09/26 23:56:14 OSPF: : LSA[Type1:10.10.9.2]: data freed 0x55ebba4f3020
2019/09/26 23:56:14 OSPF: : LSA: freed 0x55ebba5626e0
2019/09/26 23:56:14 OSPF: : LSA[Type2:10.10.2.2]: data freed 0x55ebba561010
2019/09/26 23:56:15 OSPF: : LSA: freed 0x55ebba5626e0
2019/09/26 23:56:15 OSPF: : RXmtL(2)--, NBR(10.10.13.1), LSA[Type1,id(10.10.9.2)
,ar(10.10.9.2)]
2019/09/26 23:56:15 OSPF: : LSA: freed 0x55ebba5626e0
2019/09/26 23:56:15 OSPF: : RXmtL(1)--, NBR(10.10.13.1), LSA[Type2,id(10.10.2.2)
,ar(10.10.9.2)]
2019/09/26 23:56:15 OSPF: : LSA: freed 0x55ebba5626e0
2019/09/26 23:56:15 OSPF: : LSA: freed 0x55ebba5626e0
2019/09/26 23:56:15 OSPF: : RXmtL(2)--, NBR(10.10.7.2), LSA[Type1,id(10.10.9.2),
ar(10.10.9.2)]
2019/09/26 23:56:15 OSPF: : LSA: freed 0x55ebba5626e0
2019/09/26 23:56:15 OSPF: : RXmtL(1)--, NBR(10.10.7.2), LSA[Type2,id(10.10.2.2),
ar(10.10.9.2)]
2019/09/26 23:56:15 OSPF: : LSA: freed 0x55ebba5626e0
2019/09/26 23:56:15 OSPF: : RXmtL(2)--, NBR(10.10.11.1), LSA[Type1,id(10.10.9.2)
,ar(10.10.9.2)]
2019/09/26 23:56:15 OSPF: : LSA: freed 0x55ebba5626e0
2019/09/26 23:56:15 OSPF: : RXmtL(1)--, NBR(10.10.11.1), LSA[Type2,id(10.10.2.2)
,ar(10.10.9.2)]
2019/09/26 23:56:15 OSPF: : LSA: freed 0x55ebba5626e0
2019/09/26 23:56:19 OSPF: : LSA[Refresh]: ospf_lsa_refresh_walker(): start
2019/09/26 23:56:19 OSPF: : LSA[Refresh]: ospf_lsa_refresh_walker(): next index
114
2019/09/26 23:56:19 OSPF: : LSA[Refresh]: ospf_lsa_refresh_walker(): refresh ind
ex 113
2019/09/26 23:56:19 OSPF: : LSA[Refresh]: ospf_lsa_refresh_walker(): end
2019/09/26 23:56:22 OSPF: : DR-Election[1st]: Backup 10.10.2.1
2019/09/26 23:56:22 OSPF: : DR-Election[1st]: DR     10.10.2.2
2019/09/26 23:56:23 OSPF: : RXmtL(0)++, NBR(10.10.7.2), LSA[Type1,id(10.10.11.1)
,ar(10.10.11.1)]
```

It looks as if when the connection goes back up, the OSPF process detects and sends out a Link State Advertisement to the network, to advertise that there is an available connection that may provide a shorter route. As this gets processed across the network other routers are updating their routing tables and sending out Link State Acknowledgements, to inform the new

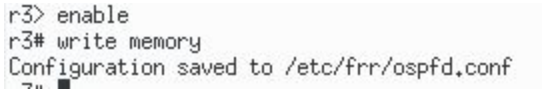
connection of the results of the advertisement.
This is also seen in the output of the Wireshark terminal (from my results in question 8)



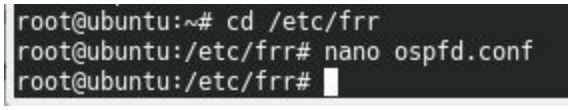
47	5.225363622	fe80::200:ff:feaa:c	fe80::200:ff:feaa:d	OSPF	82 DB Description
48	5.225426334	fe80::200:ff:feaa:d	fe80::200:ff:feaa:c	OSPF	82 DB Description
49	5.225585763	fe80::200:ff:feaa:c	fe80::200:ff:feaa:d	OSPF	1062 DB Description
50	5.225728377	fe80::200:ff:feaa:d	fe80::200:ff:feaa:c	OSPF	82 LS Request
51	5.225803312	fe80::200:ff:feaa:d	fe80::200:ff:feaa:c	OSPF	1062 DB Description
52	5.225831330	fe80::200:ff:feaa:c	ff02::5	OSPF	118 LS Update
53	5.225842755	fe80::200:ff:feaa:c	fe80::200:ff:feaa:d	OSPF	150 LS Update
54	5.225909769	fe80::200:ff:feaa:c	fe80::200:ff:feaa:d	OSPF	82 DB Description
55	5.226077939	fe80::200:ff:feaa:c	ff02::5	OSPF	294 LS Update
56	5.226527532	fe80::200:ff:feaa:d	fe80::200:ff:feaa:c	OSPF	110 LS Acknowledge
57	5.226744458	fe80::200:ff:feaa:d	fe80::200:ff:feaa:c	OSPF	130 LS Acknowledge
58	5.227893558	fe80::200:ff:feaa:c	ff02::5	OSPF	282 LS Update
59	5.228663420	fe80::200:ff:feaa:d	ff02::5	OSPF	426 LS Update
60	5.228688741	fe80::200:ff:feaa:d	fe80::200:ff:feaa:c	OSPF	90 LS Acknowledge
61	5.228733858	fe80::200:ff:feaa:c	fe80::200:ff:feaa:d	OSPF	150 LS Acknowledge

Additional Notes:

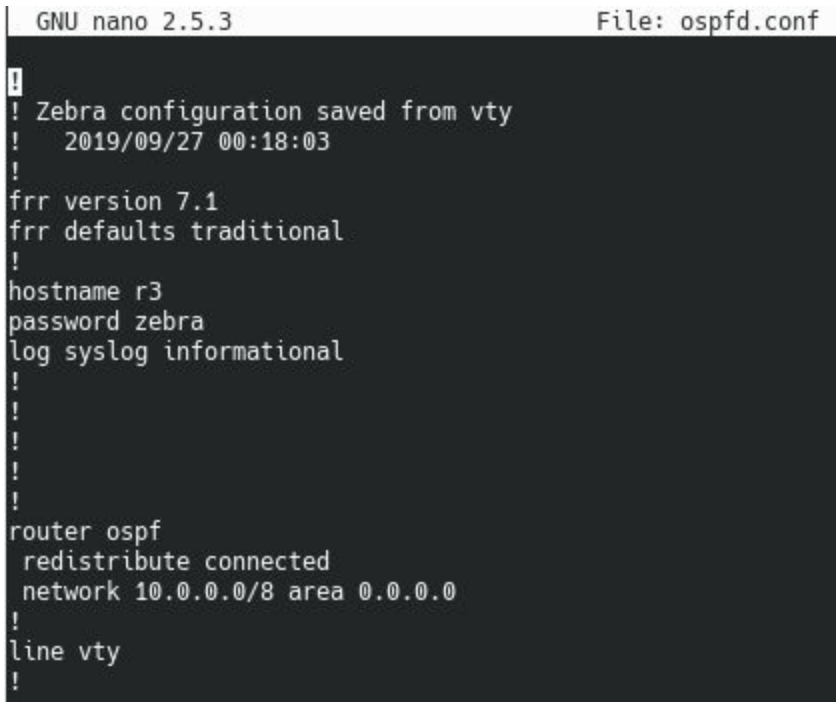
The command *write memory* in the frr/zebra terminals always said it successfully wrote to memory, however it never seemed to actually do anything, as I have opened the file */etc/frr/ospfd.conf* using nano in the console and found it to still be at default, I have done the *write memory* command at every stage of creating these tables. In case my *.imn* file I hand in does not have these details, I tried.



```
r3> enable
r3# write memory
Configuration saved to /etc/frr/ospfd.conf
```



```
root@ubuntu:~# cd /etc/frr
root@ubuntu:/etc/frr# nano ospfd.conf
root@ubuntu:/etc/frr#
```



```
  GNU nano 2.5.3                          File: ospfd.conf

!
! Zebra configuration saved from vty
!   2019/09/27 00:18:03
!
frr version 7.1
frr defaults traditional
!
hostname r3
password zebra
log syslog informational
!
!
!
!
!
router ospf
 redistribute connected
 network 10.0.0.0/8 area 0.0.0.0
!
line vty
!
```