Name: Andrew Hayes
E-mail: a.hayes18@universityofgalway.ie
ID: 21321503

CT3531

2023–11–15

Assignment 02: Build & Test OSPF Routed Network

1 Network Topology

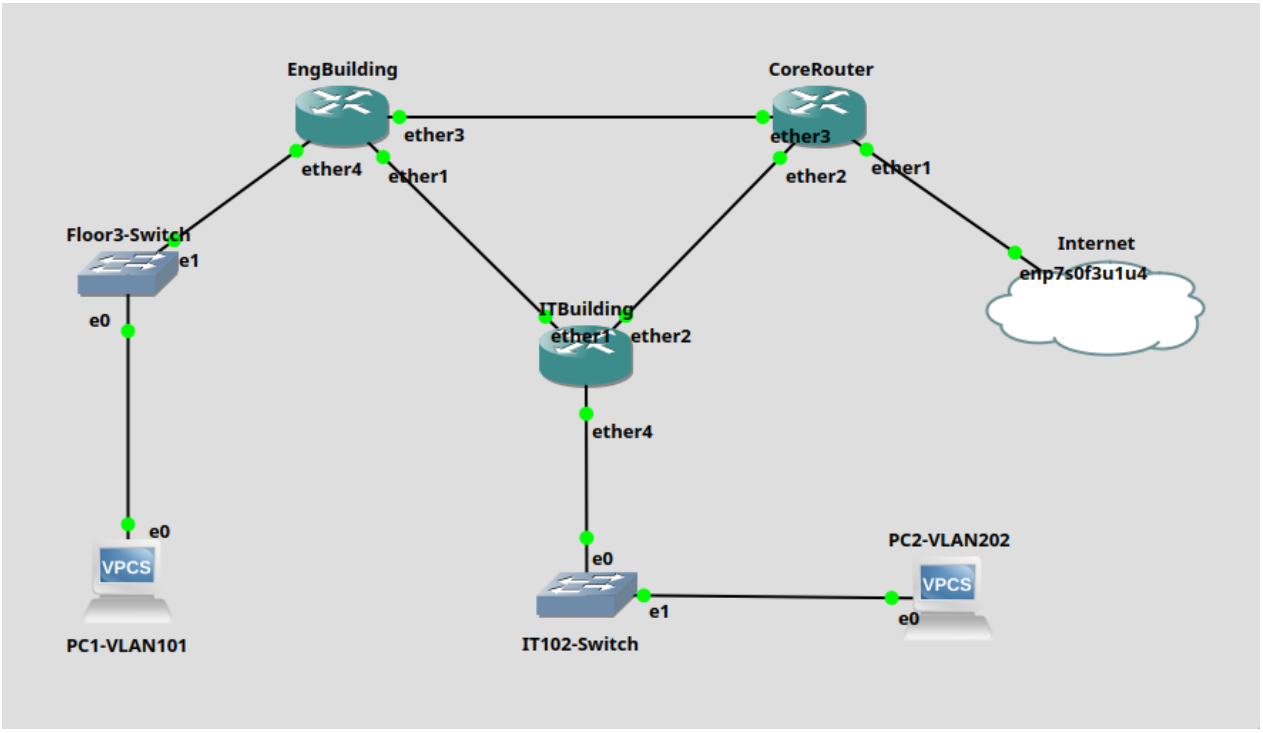

Figure 1: Network Topology

Note that the Internet device is linked to the CoreRouter device via the `enp7s0f3u1u4` interface. This is because I am running the simulation locally on my GNU/Linux laptop without any virtualisation – `enp7s0f3u1u4` is the name of the Ethernet interface on my laptop.

2 Routers Pinging Each Other

The following screenshots show each of the routers pinging each each router that they are directly linked to:

```
/ip dhcp-server network
add address=192.168.100.0/24 dns-server=8.8.8.8 gateway=192.168.100.1
/routing ospf interface
add dead-interval=5s hello-interval=1s interface=ether1
add dead-interval=5s hello-interval=1s interface=ether3
/routing ospf network
add area=backbone network=10.0.1.0/24
add area=backbone network=10.0.2.0/24
/system identity
set name=EngBuilding
[admin@EngBuilding] > ping 10.0.1.1
  SEQ HOST                                     SIZE TTL TIME  STATUS
    0 10.0.1.1                                   56  64 0ms
    1 10.0.1.1                                   56  64 0ms
    2 10.0.1.1                                   56  64 0ms
    3 10.0.1.1                                   56  64 0ms
    4 10.0.1.1                                   56  64 0ms
    sent=5 received=5 packet-loss=0% min-rtt=0ms avg-rtt=0ms max-rtt=0ms
[admin@EngBuilding] >
```

```
add action=masquerade chain=srcnat out-interface=ether1
/routing ospf interface
add dead-interval=5s hello-interval=1s interface=ether2
add dead-interval=5s hello-interval=1s interface=ether3
/routing ospf network
add area=backbone network=10.0.3.0/24
add area=backbone network=10.0.1.0/24
/system identity
set name=CoreRouter
[admin@CoreRouter] > ping 10.0.1.2
  SEQ HOST                                     SIZE TTL TIME  STATUS
    0 10.0.1.2                                   56  64 0ms
    1 10.0.1.2                                   56  64 0ms
    2 10.0.1.2                                   56  64 0ms
    3 10.0.1.2                                   56  64 0ms
    4 10.0.1.2                                   56  64 0ms
    sent=5 received=5 packet-loss=0% min-rtt=0ms avg-rtt=0ms max-rtt=0ms
[admin@CoreRouter] >
```

Figure 2: `EngBuilding` ↔ `CoreRouter`

```
/ip dhcp-server network
add address=192.168.100.0/24 dns-server=8.8.8.8 gateway=192.168.100.1
/routing ospf interface
add dead-interval=5s hello-interval=1s interface=ether1
add dead-interval=5s hello-interval=1s interface=ether3
/routing ospf network
add area=backbone network=10.0.1.0/24
add area=backbone network=10.0.2.0/24
/system identity
set name=EngBuilding
[admin@EngBuilding] > ping 10.0.2.1
  SEQ HOST                                     SIZE TTL TIME  STATUS
    0 10.0.2.1                                   56  64 0ms
    1 10.0.2.1                                   56  64 0ms
    2 10.0.2.1                                   56  64 0ms
    3 10.0.2.1                                   56  64 0ms
    4 10.0.2.1                                   56  64 0ms
    sent=5 received=5 packet-loss=0% min-rtt=0ms avg-rtt=0ms max-rtt=0ms

[admin@EngBuilding] >
```

```
add disabled=no interface=ether1
/ip dhcp-server network
add address=192.168.200.0/24 dns-server=8.8.8.8 gateway=192.168.200.1
/routing ospf interface
add dead-interval=5s hello-interval=1s interface=ether1
add dead-interval=5s hello-interval=1s interface=ether2
/routing ospf network
add area=backbone network=10.0.2.0/24
add area=backbone network=10.0.3.0/24
/system identity
set name=ITBuilding
[admin@ITBuilding] > ping 10.0.2.2
  SEQ HOST                                     SIZE TTL TIME  STATUS
    0 10.0.2.2                                   56  64 0ms
    1 10.0.2.2                                   56  64 0ms
    2 10.0.2.2                                   56  64 0ms
    3 10.0.2.2                                   56  64 0ms
    4 10.0.2.2                                   56  64 0ms
    sent=5 received=5 packet-loss=0% min-rtt=0ms avg-rtt=0ms max-rtt=0ms

[admin@ITBuilding] >
```

Figure 3: `EngBuilding` ↔ `ITBuilding`

```
/ip firewall nat
add action=masquerade chain=srcnat out-interface=ether1
add action=masquerade chain=srcnat out-interface=ether1
/routing ospf interface
add dead-interval=5s hello-interval=1s interface=ether2
add dead-interval=5s hello-interval=1s interface=ether3
/routing ospf network
add area=backbone network=10.0.3.0/24
add area=backbone network=10.0.1.0/24
/system identity
set name=CoreRouter
[admin@CoreRouter] > ping 10.0.3.2
  SEQ HOST                                     SIZE TTL TIME  STATUS
    0 10.0.3.2                                   56  64 0ms
    1 10.0.3.2                                   56  64 0ms
    2 10.0.3.2                                   56  64 0ms
    3 10.0.3.2                                   56  64 0ms
    4 10.0.3.2                                   56  64 0ms
    sent=5 received=5 packet-loss=0% min-rtt=0ms avg-rtt=0ms max-rtt=0ms

[admin@CoreRouter] >
```

```
add disabled=no interface=ether1
/ip dhcp-server network
add address=192.168.200.0/24 dns-server=8.8.8.8 gateway=192.168.200.1
/routing ospf interface
add dead-interval=5s hello-interval=1s interface=ether1
add dead-interval=5s hello-interval=1s interface=ether2
/routing ospf network
add area=backbone network=10.0.2.0/24
add area=backbone network=10.0.3.0/24
/system identity
set name=ITBuilding
[admin@ITBuilding] > ping 10.0.3.1
  SEQ HOST                                     SIZE TTL TIME  STATUS
    0 10.0.3.1                                   56  64 0ms
    1 10.0.3.1                                   56  64 0ms
    2 10.0.3.1                                   56  64 0ms
    3 10.0.3.1                                   56  64 0ms
    4 10.0.3.1                                   56  64 0ms
    sent=5 received=5 packet-loss=0% min-rtt=0ms avg-rtt=0ms max-rtt=0ms

[admin@ITBuilding] >
```

Figure 4: `CoreRouter` ↔ `ITBuilding`

3 Routers Pinging Each Other's Loopback Addresses

The following screenshots show each router pinging the loopback addresses of each of the other routers:

```
[admin@EngBuilding] > ping 10.10.10.3
  SEQ HOST                                     SIZE TTL TIME  STATUS
    0 10.10.10.3                                 56  64 0ms
    1 10.10.10.3                                 56  64 0ms
    2 10.10.10.3                                 56  64 0ms
    3 10.10.10.3                                 56  64 0ms
    sent=4 received=4 packet-loss=0% min-rtt=0ms avg-rtt=0ms max-rtt=0ms

[admin@EngBuilding] > ping 10.10.10.4
  SEQ HOST                                     SIZE TTL TIME  STATUS
    0 10.10.10.4                                 56  64 0ms
    1 10.10.10.4                                 56  64 0ms
    2 10.10.10.4                                 56  64 0ms
    3 10.10.10.4                                 56  64 0ms
    sent=4 received=4 packet-loss=0% min-rtt=0ms avg-rtt=0ms max-rtt=0ms

[admin@EngBuilding] >
```

```
[admin@CoreRouter] > ip address print
Flags: X - disabled, I - invalid, D - dynamic
 #   ADDRESS            NETWORK         INTERFACE
 0   10.10.10.3/32      10.10.10.3      Loopback
 1   10.0.3.2/24        10.0.3.0        ether2
 2   10.0.1.2/24        10.0.1.0        ether3
 3 D 10.226.144.201/20  10.226.144.0    ether1

[admin@CoreRouter] >
```

```
[admin@ITBuilding] > ip address print
Flags: X - disabled, I - invalid, D - dynamic
 #   ADDRESS            NETWORK         INTERFACE
 0   192.168.200.1/24   192.168.200.0   VLAN202
 1   10.10.10.4/32      10.10.10.4      Loopback
 2   10.0.3.1/24        10.0.3.0        ether2
 3   10.0.2.2/24        10.0.2.0        ether1

[admin@ITBuilding] >
```

Figure 5: `EngBuilding` Pinging the Loopback Addresses of the Other Routers

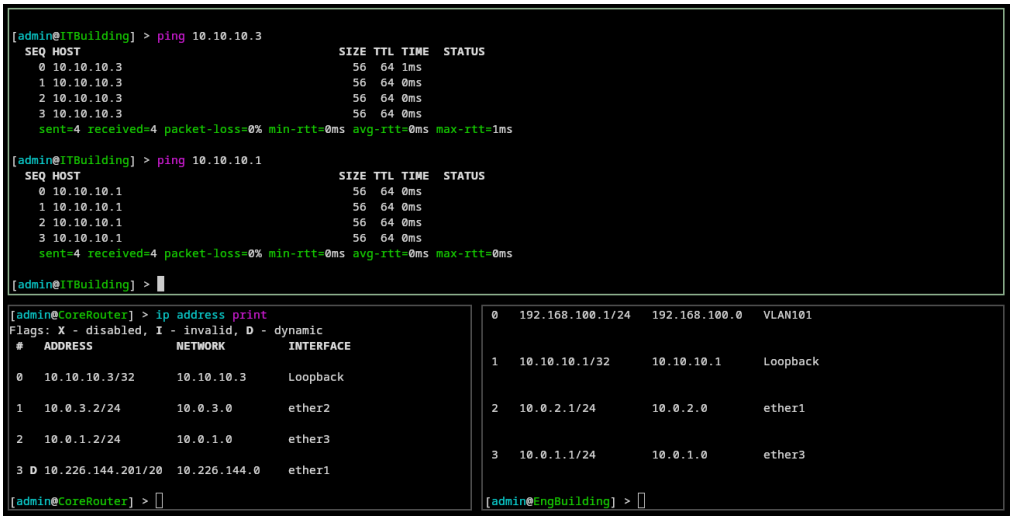

Figure 6: `ITBuilding` Pinging the Loopback Addresses of the Other Routers

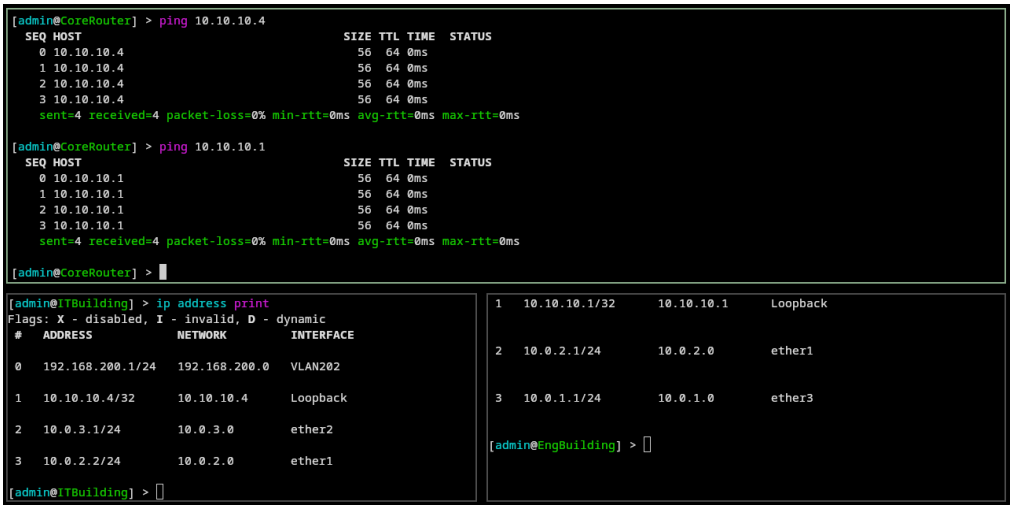

Figure 7: `CoreRouter` Pinging the Loopback Addresses of the Other Routers

4 VPCs Pinging Each Other

The following screenshot shows the two PCs pinging each other:

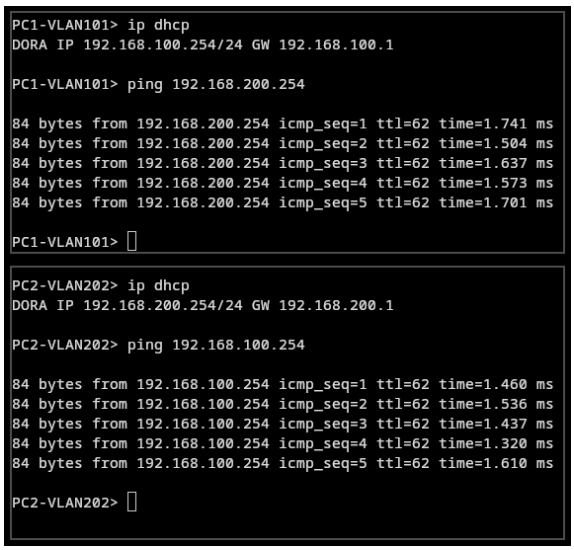

Figure 8: `PC1-VLAN101` ↔ `PC2-VLAN202`

5 Verify that the Internet is Reachable from All Devices

I encountered some difficulty reaching the Internet from my devices as I was running the simulations locally on my GNU/Linux laptop, and my packets were getting blocked at some point by the University's firewall, both from my simulated devices such as the VPCs & MikroTik routers, and when I ran a `traceroute` directly from my laptop. However, the traces from my routers & VPCs got stuck at the same IP address as the `traceroute` from my real laptop did, which indicates to me that the Internet was reachable and operational from my network simulation, at least to the same extent as it was reachable from my laptop.

```
PC1-VLAN101> trace 8.8.8.8
trace to 8.8.8.8, 8 hops max, press Ctrl+C to stop
 1   192.168.100.1   0.435 ms  0.368 ms  0.355 ms
 2   10.0.1.2   1.099 ms  0.656 ms  0.627 ms
 3   10.226.128.1   81.669 ms  125.263 ms  20.851 ms
 4   10.254.171.41   1.132 ms  1.095 ms  1.085 ms
 5   10.254.171.105   1.117 ms  1.107 ms  1.077 ms
 6     *  *  *
 7     *  *  *
 8     *  *  *
```

Figure 9: Trace to `8.8.8.8` from `PC1-VLAN101`

```
PC2-VLAN202> trace 8.8.8.8
trace to 8.8.8.8, 8 hops max, press Ctrl+C to stop
 1   192.168.200.1   0.712 ms  0.424 ms  0.322 ms
 2   10.0.3.2   0.697 ms  0.618 ms  0.594 ms
 3   10.226.128.1   39.126 ms  28.893 ms  24.383 ms
 4   10.254.171.41   1.384 ms  1.143 ms  1.128 ms
 5   10.254.171.105   1.138 ms  1.070 ms  1.047 ms
 6     *  *  *
 7     *  *  *
 8     *  *  *
```

Figure 10: Trace to `8.8.8.8` from `PC2-VLAN202`

```
[admin@CoreRouter] > tool traceroute 8.8.8.8
 # ADDRESS                          LOSS SENT    LAST     AVG    BEST   WORST STD-DEV STATUS
 1 10.226.128.1                      0%    6  42.5ms    30.4      17    42.5     7.6
 2 10.254.171.41                     0%    6   0.5ms     0.6     0.5     0.8     0.1
 3 10.254.171.105                    0%    6   0.5ms     0.6     0.5     0.6     0.1
 4                                 100%    6 timeout
 5                                 100%    6 timeout
 6                                 100%    6 timeout
 7                                 100%    6 timeout
 8                                 100%    5 timeout
```

Figure 11: Trace to `8.8.8.8` from `CoreRouter`

```
[admin@EngBuilding] > tool traceroute 8.8.8.8
 # ADDRESS                          LOSS SENT    LAST     AVG    BEST   WORST STD-DEV STATUS
 1 10.0.1.2                          0%    4   0.5ms     0.6     0.5     0.7     0.1
 # ADDRESS                          LOSS SENT    LAST     AVG    BEST   WORST STD-DEV STATUS
 1 10.0.1.2                          0%    6   0.6ms     0.6     0.5     0.8     0.1
 2 10.226.128.1                      0%    6  24.2ms    26.1    21.2    33.5     3.8
 3 10.254.171.41                     0%    6     1ms       1     0.9     1.2     0.1
 4 10.254.171.105                    0%    6   0.8ms       1     0.8     1.2     0.1
 5                                 100%    6 timeout
 6                                 100%    6 timeout
 7                                 100%    6 timeout
 8                                 100%    5 timeout
 9                                 100%    5 timeout
```

Figure 12: Trace to `8.8.8.8` from `EngBuilding`

```
[admin@ITBuilding] > tool traceroute 8.8.8.8
 # ADDRESS                          LOSS SENT    LAST     AVG    BEST   WORST STD-DEV STATUS
 1 10.0.3.2                          0%    6   0.6ms     0.8     0.6     1.1     0.2
 2 10.226.128.1                      0%    6  24.4ms    32.3    24.4    56.3    10.9
 3 10.254.171.41                     0%    6   1.1ms     1.2     1.1     1.2     0.1
 4 10.254.171.105                    0%    6   0.9ms       1     0.8     1.1     0.1
 5                                 100%    6 timeout
 6                                 100%    6 timeout
 7                                 100%    6 timeout
 8                                 100%    6 timeout
 9                                 100%    6 timeout
```

Figure 13: Trace to `8.8.8.8` from `ITBuilding`

```
[andrew@arch] ~
$ traceroute 8.8.8.8
traceroute to 8.8.8.8 (8.8.8.8), 30 hops max, 60 byte packets
 1  _gateway (10.226.128.1)  31.868 ms  31.826 ms  34.083 ms
 2  10.254.171.41 (10.254.171.41)  11.513 ms  11.503 ms  11.493 ms
 3  10.254.171.105 (10.254.171.105)  11.566 ms  11.556 ms  11.546 ms
 4  * * *
 5  * * *
 6  * * *
 7  * * *
 8  * * *
 9  * * *
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

Figure 14: Trace to `8.8.8.8` Directly from My Laptop

6 CoreRouter's Routing Table

```
[admin@CoreRouter] > ip route print
Flags: X - disabled, A - active, D - dynamic,
C - connect, S - static, r - rip, b - bgp, o - ospf, m - mme,
B - blackhole, U - unreachable, P - prohibit
 #      DST-ADDRESS        PREF-SRC        GATEWAY            DISTANCE
 0 ADS  0.0.0.0/0                          10.226.128.1              1
 1 ADC  10.0.1.0/24        10.0.1.2        ether3                    0
 2 ADo  10.0.2.0/24                        10.0.1.1                110
                                           10.0.3.1
 3 ADC  10.0.3.0/24        10.0.3.2        ether2                    0
 4 ADo  10.10.10.1/32                      10.0.1.1                110
 5 ADC  10.10.10.3/32      10.10.10.3      Loopback                  0
 6 ADo  10.10.10.4/32                      10.0.3.1                110
 7 ADC  10.226.128.0/20    10.226.130.218  ether1                    0
 8 ADo  192.168.100.0/24                   10.0.1.1                110
 9 ADo  192.168.200.0/24                   10.0.3.1                110
```

Figure 15: CoreRouter's Routing Table

Each entry in the routing table has a route number denoted #, a flag, a destination address denoted DST-ADDRESS, a preferred source denoted PREF-SRC, a gateway denoted GATEWAY, & an OSPF routing distance denoted DISTANCE.
The explanation of each entry is as follows:

0. This entry has a destination of 0.0.0.0/0, a gateway of 10.226.144.1, a flag of ADS meaning that it is **A**ctive, **D**ynamic (the route is dynamically learned through the routing protocol), & **S**tatic (the route is statically configured), & a distance of 1, which means that the route is highly preferred. It has no preferred source. This entry has the destination address of 0.0.0.0/0 which represents the default route – this is where any destination address that doesn't match a specific route in the routing table is sent. Any traffic that matches this default destination route will be forwarded to the gateway, which sends it out to the Internet.

1. This entry has a destination of 10.0.1.0/24, a preferred source of 10.0.1.2, a gateway of ether3, & a distance of 0. This destination address is that of the EngBuilding network, and the gateway is the link from CoreRouter to EngBuilding. Its preferred source is the IP of the gateway to the EngBuilding router on ether3. Its flag is ADC which means that it is **A**ctive, **D**ynamic, & **C**onnected, i.e. the route represents a directly connected network (that of EngBuilding). It has a cost of 1, which is quite low, showing that it is highly preferred.

2. This entry has a destination of 10.0.2.0/24, no preferred source, a gateway of 10.0.1.1 or 10.0.3.1, & a distance of 110. The destination is that of the ITBuilding network, and the two potential gateways are that of the EngBuilding router and the CoreRouter router, indicating that the network can be reached from either router. Its flag is ADo, where the "o" represents that the route was discovered through the **O**SPF protocol. It has a high cost of 110, which shows that it is not preferred.

3. This entry has a destination of 10.0.3.0/24, a preferred source of 10.0.3.2, a gateway of ether2, & a distance of 0. This is the route to the ITBuilding network and its preferred source is from within that network. Its flag is ADC meaning that it is active, dynamic, & connected and the distance of 0 indicates it is highly preferred, likely because it is directly connected to the router.

4. This entry has a destination of 10.10.10.1/32, no preferred source, a gateway of 10.0.1.1, & a distance of 110. The destination is the loopback address of the EngBuilding router and the gateway is that of the link that joins EngBuilding & CoreRouter. Its flag is ADo indicating that it was discovered via the OSPF protoocl and the distance of 110 indicates that it is not preferred.

5. This entry has a destination of 10.10.10.3/32, a preferred source of 10.10.10.3, a gateway of Loopback, & a distance of 0. The destination is the loopback address of the CoreRouter and the gateway is also the loopback address. Its flag is ADo indicating that it was discovered via the OSPF protoocl and the distance of 0 indicates that it is highly preferred, likely because it is literally the same device.

6. This entry has a destination of 10.10.10.4/32, no preferred source, a gateway of 10.0.3.1, & a distance of 110. The destination is the loopback address of the ITBuilding router and the gateway is that of the link that joins ITBuilding & CoreRouter. Its flag is ADo indicating that it was discovered via the OSPF protoocl and the distance of 110 indicates that it is not preferred.

7. This entry has a destination of 10.226.128.0/32, a preferred source of 10.226.130.218, a gateway of ether1, & a distance of 0. The destination address is the same IP as the gateway of route 0, as this is the address out onto the internet, via a

University router. Its flag is `ADC` indicating that it is directly connected to `CoreRouter` and the distance of 0 indicates that it is highly preferred, likely because it is directly connected.

8. This entry has a destination of `192.168.100.0/24`, no preferred source, a gateway of `10.0.1.1`, & a distance of 110. The destination address is that of `VLAN101`, and its gateway is the address of the link between `CoreRouter` & `EngBuilding`, as `VLAN101` is only accessible through `EngBuilding`. Its flag is `ADo` indicating that it was discovered via the OSPF protocol and the distance of 110 indicates that it is not preferred.

9. This entry has a destination of `192.168.200.0/24`, no preferred source, a gateway of `10.0.3.1`, & a distance of 110. The destination address is the IP of `VLAN202`, and its gateway is the address of the link between `CoreRouter` & `ITBuilding`, as `VLAN202` is only accessible through `ITBuilding`. Its flag is `ADo` indicating that it was discovered via the OSPF protocol and the distance of 110 indicates that it is not preferred.

7 What if Each Router Wasn't Set Up to Redistribute Connected Networks?

If each router was not set up to redistribute connected networks, the other routers would not be aware of the networks that were directly connected to the other routers, and therefore `ITBuilding` & `CoreRouter` would not be aware of the existence of `VLAN101`, and `EngBuilding` & `CoreRouter` would not be aware of the existence of `VLAN202`. This would mean that these networks would not be included in the routing tables of the routers that are not directly connected to them and therefore they would not be reachable from these routers using OSPF routing. This would prevent the VPCs from being able to ping each other: if `PC1-VLAN101` tried to ping `PC2-VLAN202`, `EngBuilding` would not know where to route the traffic next, as `ITBuilding` wouldn't have told `EngBuilding` that it was connected to `VLAN202`. The inverse would also be true if `PC2-VLAN202` tried to ping `PC1-VLAN101`.

8 Traceroute from `PC1-VLAN101` to `PC2-VLAN202`

```
PC1-VLAN101> trace 192.168.200.254 -P 1
trace to 192.168.200.254, 8 hops max (ICMP), press Ctrl+C to stop
 1   192.168.100.1   0.599 ms  0.405 ms  0.319 ms
 2   10.0.2.2   0.678 ms  0.636 ms  0.604 ms
 3   192.168.200.254   0.934 ms  0.873 ms  0.857 ms

PC1-VLAN101>
```

```
PC2-VLAN202> ip dhcp
DORA IP 192.168.200.254/24 GW 192.168.200.1

PC2-VLAN202>
```

Figure 16: Trace from `PC1-VLAN101` to `PC2-VLAN202`

8.1 Explanation of the Route Taken

The trace from `PC1-VLAN101` to `PC2-VLAN202` takes three hops:

1. `192.168.100.1`: the gateway to `VLAN101` on the `EngBuilding` router. Any traffic entering or exiting `VLAN101` must pass through this gateway.

2. `10.0.2.2`: the gateway to the `ITBuilding` router on its `ether1` interface, which links `EngBuilding` to `ITBuilding`.

3. `192.168.200.254`: the VPC `PC2-VLAN202` itself, which is naturally the final destination in a successful trace to this device.

9 Long Ping from `PC1-VLAN101` to `PC2-VLAN202`

Below is the output of a 30 seconds-long ping that was made from `PC1-VLAN101` to `PC2-VLAN202`. While this ping was running, the link from the `EngBuilding` router to the `ITBuilding` router was suspended.

```
PC1-VLAN101> ping 192.168.200.254 -c 30

84 bytes from 192.168.200.254 icmp_seq=1 ttl=62 time=1.814 ms
84 bytes from 192.168.200.254 icmp_seq=2 ttl=62 time=2.063 ms
84 bytes from 192.168.200.254 icmp_seq=3 ttl=62 time=2.075 ms
84 bytes from 192.168.200.254 icmp_seq=4 ttl=62 time=1.750 ms
84 bytes from 192.168.200.254 icmp_seq=5 ttl=62 time=1.796 ms
84 bytes from 192.168.200.254 icmp_seq=6 ttl=62 time=1.649 ms
84 bytes from 192.168.200.254 icmp_seq=7 ttl=62 time=1.750 ms
192.168.200.254 icmp_seq=8 timeout
84 bytes from 192.168.200.254 icmp_seq=9 ttl=61 time=2.002 ms
84 bytes from 192.168.200.254 icmp_seq=10 ttl=61 time=1.902 ms
84 bytes from 192.168.200.254 icmp_seq=11 ttl=61 time=1.598 ms
84 bytes from 192.168.200.254 icmp_seq=12 ttl=61 time=1.727 ms
84 bytes from 192.168.200.254 icmp_seq=13 ttl=61 time=1.728 ms
84 bytes from 192.168.200.254 icmp_seq=14 ttl=61 time=1.954 ms
84 bytes from 192.168.200.254 icmp_seq=15 ttl=61 time=1.732 ms
84 bytes from 192.168.200.254 icmp_seq=16 ttl=61 time=1.733 ms
84 bytes from 192.168.200.254 icmp_seq=17 ttl=61 time=1.879 ms
84 bytes from 192.168.200.254 icmp_seq=18 ttl=61 time=2.334 ms
84 bytes from 192.168.200.254 icmp_seq=19 ttl=61 time=1.475 ms
84 bytes from 192.168.200.254 icmp_seq=20 ttl=61 time=1.920 ms
84 bytes from 192.168.200.254 icmp_seq=21 ttl=61 time=1.960 ms
84 bytes from 192.168.200.254 icmp_seq=22 ttl=61 time=2.041 ms
84 bytes from 192.168.200.254 icmp_seq=23 ttl=61 time=2.043 ms
84 bytes from 192.168.200.254 icmp_seq=24 ttl=61 time=2.117 ms
84 bytes from 192.168.200.254 icmp_seq=25 ttl=61 time=1.867 ms
84 bytes from 192.168.200.254 icmp_seq=26 ttl=61 time=1.795 ms
84 bytes from 192.168.200.254 icmp_seq=27 ttl=61 time=2.011 ms
84 bytes from 192.168.200.254 icmp_seq=28 ttl=61 time=2.143 ms
84 bytes from 192.168.200.254 icmp_seq=29 ttl=61 time=2.053 ms
84 bytes from 192.168.200.254 icmp_seq=30 ttl=61 time=2.049 ms
```

Figure 17: Long Ping from `PC1-VLAN101` to `PC2-VLAN202`

The `EngBuilding` ↔ `ITBuilding` link was suspended just before the 8th packet was sent, resulting in this packet being dropped as it was sent along a route that no longer existed. OSPF kicked in very quickly and the traffic was re-routed after just one lost packet. It is quite obvious from looking at the network topology that the only other way the traffic could have been routed was from `EngBuilding` → `CoreRouter` → `ITBuilding`, which requires an extra hop. This path, being longer & not direct, would have not been preferred by OSPF when there was a link between `EngBuilding` & `ITBuilding`, but now that it's the best possible option, it will make use of it. We can see why this route was not preferred by the OSPF protocol, as it usually takes noticeably longer than the original route.

```
PC1-VLAN101> trace 192.168.200.254 -P 1
trace to 192.168.200.254, 8 hops max (ICMP), press Ctrl+C to stop
 1   192.168.100.1   0.624 ms  0.487 ms  0.352 ms
 2   10.0.1.2   0.813 ms  0.662 ms  0.665 ms
 3   10.0.3.1   1.079 ms  0.923 ms  0.968 ms
 4   192.168.200.254   1.225 ms  1.226 ms  1.207 ms
```

Figure 18: Trace from `PC1-VLAN101` to `PC2-VLAN202` After Suspending the `EngBuilding` ↔ `ITBuilding` Link

Comparing the above trace to the one ran previously, we can see that there is one extra hop now that the `EngBuilding` ↔ `ITBuilding` link has been suspended and that it does not go through the `10.0.2.2` gateway it did when we first ran the ping. That gateway was the one between `EngBuilding` & `ITBuilding`, which is of course now gone. Instead, the traffic travels over the link between `EngBuilding` & `CoreRouter` (`10.0.1.2`) and then over the link between `CoreRouter` & `ITBuilding` (`10.0.3.1`), as expected.

10 Packet Capture on Link from `EngBuilding` to `CoreRouter`

I ran a packet capture on the link from `EngBuilding` to `CoreRouter` and restored the link from `EngBuilding` to `CoreRouter`, then stopped the packet capture after around 30 seconds to ensure that OSPF had detected the topology changed and re-converged. Nine LSA packets were captured:

1. The first two packets are LS Update packets originating from `EngBuilding` & `ITBuilding`. The first originated from

`10.0.1.2` advertising `10.10.10.4` (`ITBuilding`) while the second originated from `10.0.10.1` advertising `10.10.10.1` (`EngBuilding`). This is the routers announcing that they can be reached over this new topology.

2. The next two packets are LS Acknowledgements, originating from the same two routers, each acknowledging the other router's update.

3. The next packet is an LS Update originating from `10.0.1.1` advertising `10.10.10.1` (`EngBuilding`) again. Another packet from the same origin then advertised `10.10.10.4` (`ITBuilding`). This being the IP address which originally advertised `EngBuilding` shows that it has learnt that `ITBuilding` is reachable to it from its advertisement. `10.0.1.2` then sent a packet advertising `ITBuilding` again.

4. `10.0.1.1` acknowledged `10.0.1.2`'s advertisement of `10.10.10.4`, and `10.0.1.2` acknowledged `10.0.1.1`'s advertisement of `EngBuilding`.

```
    30 14.004908    10.0.1.2          224.0.0.5         OSPF     110 LS Update
    31 14.005286    10.0.1.1          224.0.0.5         OSPF     110 LS Update
    32 14.015397    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    33 15.006820    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    34 15.006886    10.0.1.2          224.0.0.5         OSPF      78 LS Acknowledge
    35 15.007208    10.0.1.1          224.0.0.5         OSPF      78 LS Acknowledge
    36 15.017417    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    43 16.008981    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    44 16.009386    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    45 17.000961    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    46 17.011565    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    47 18.003021    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    48 18.013668    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    49 19.005219    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    50 19.015739    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    51 20.007249    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    52 20.017764    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    53 21.009251    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    54 21.009610    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    55 22.001081    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    56 22.011737    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    57 23.003215    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    58 23.013742    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    59 24.005241    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    60 24.015861    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    61 25.007315    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    62 25.017830    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    63 26.009323    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    64 26.009801    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    65 27.001263    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    66 27.011802    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    67 28.003393    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    68 28.014076    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    69 29.005702    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    70 29.017443    10.0.1.1          224.0.0.5         OSPF     110 LS Update
    71 29.017487    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    72 29.017990    10.0.1.1          224.0.0.5         OSPF     142 LS Update
    73 29.018094    10.0.1.2          224.0.0.5         OSPF     142 LS Update
    74 30.009596    10.0.1.2          224.0.0.5         OSPF      82 Hello Packet
    75 30.010002    10.0.1.1          224.0.0.5         OSPF      82 Hello Packet
    76 30.010038    10.0.1.1          224.0.0.5         OSPF      98 LS Acknowledge
    77 30.010287    10.0.1.2          224.0.0.5         OSPF      78 LS Acknowledge
```

Figure 19: OSPF Packets Captured on the `EngBuilding` ↔ `CoreRouter` Link