Summary:

The objective of this machine problem was to experiment with IP routing and OSPF. Some goals in the machine problem is to see how well recovery process in OSPF works and to see how it reacts when a link cost is change in the system.

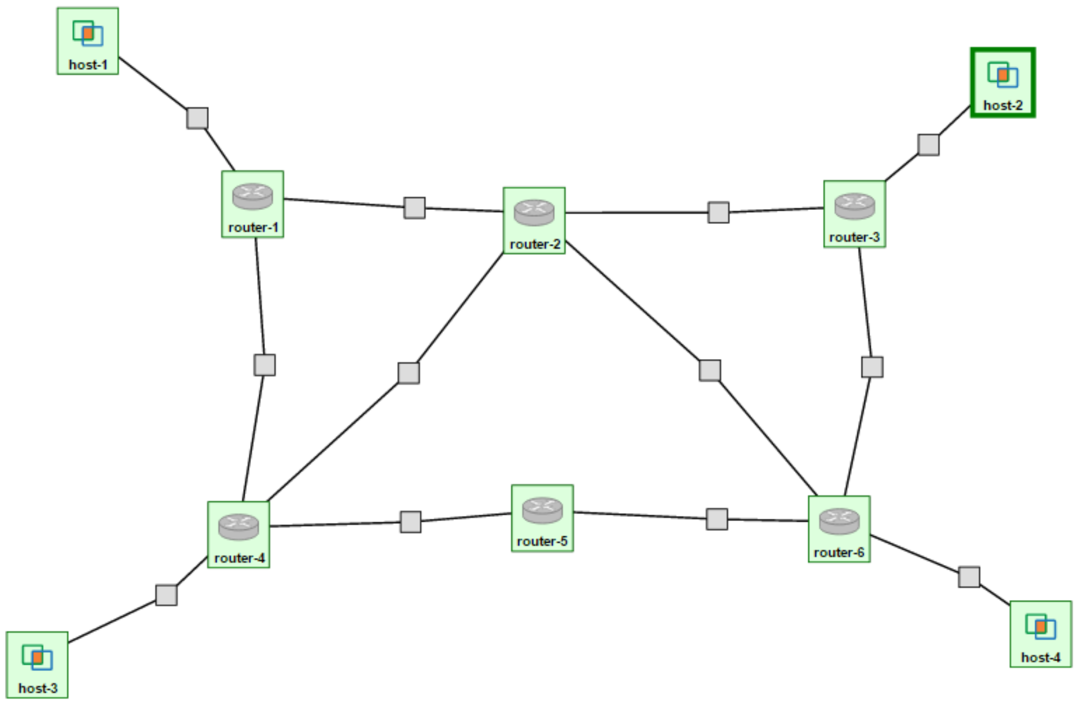

Figure 1: Routers and Host layout

Implementation:

The network was created using GENI resources from Wisconsin InstaGENI. Six VMs using the "OF OVS" image are used for the routers and four VMs using the "Xen VM" image for the hosts. The host VMs use the Ubuntu 14.04 LTS 64-bit disk image and they are attached to four different routers which can be seen in Figure 1. To find the IPs for each VM I use "ifconfig" and the addresses can be seen in Figure 2. Routeconfig.sh was downloaded on each router to configure them to use OSPF. A simple check using "show ip ospf neighbor" to make sure the routers were connected to the correct routers.

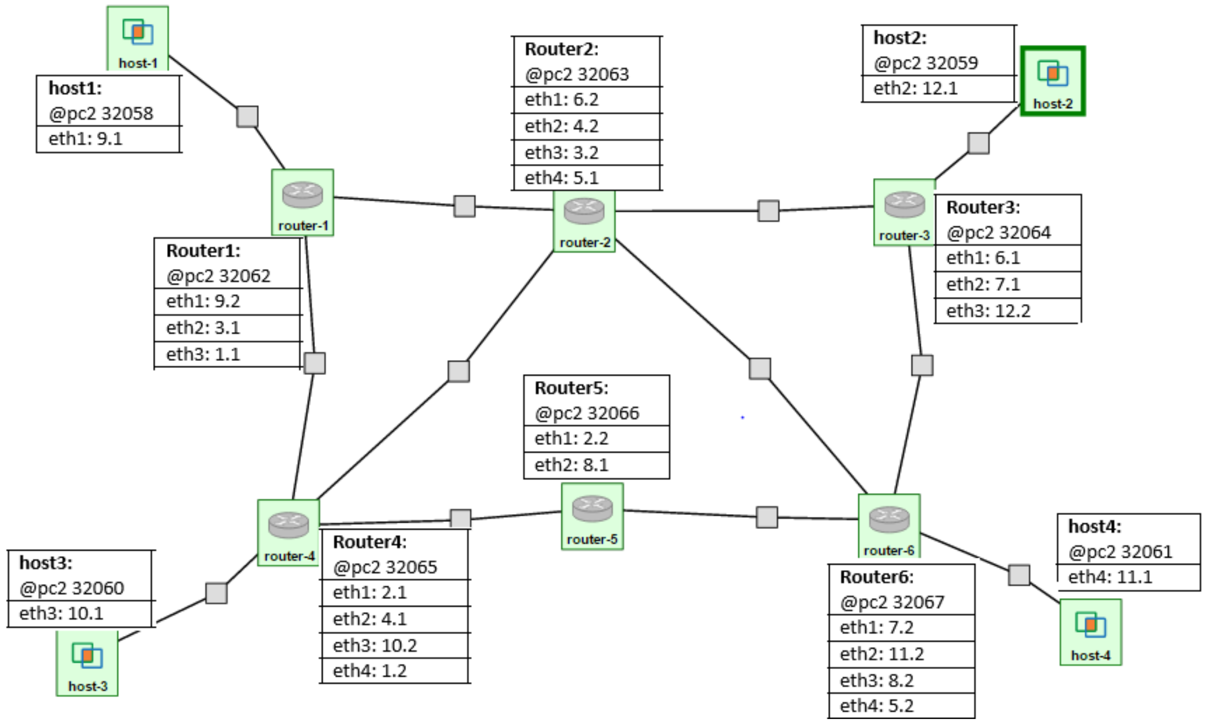

Figure 2: Routers and Host IP Addresses (prefix: 10.10._._)

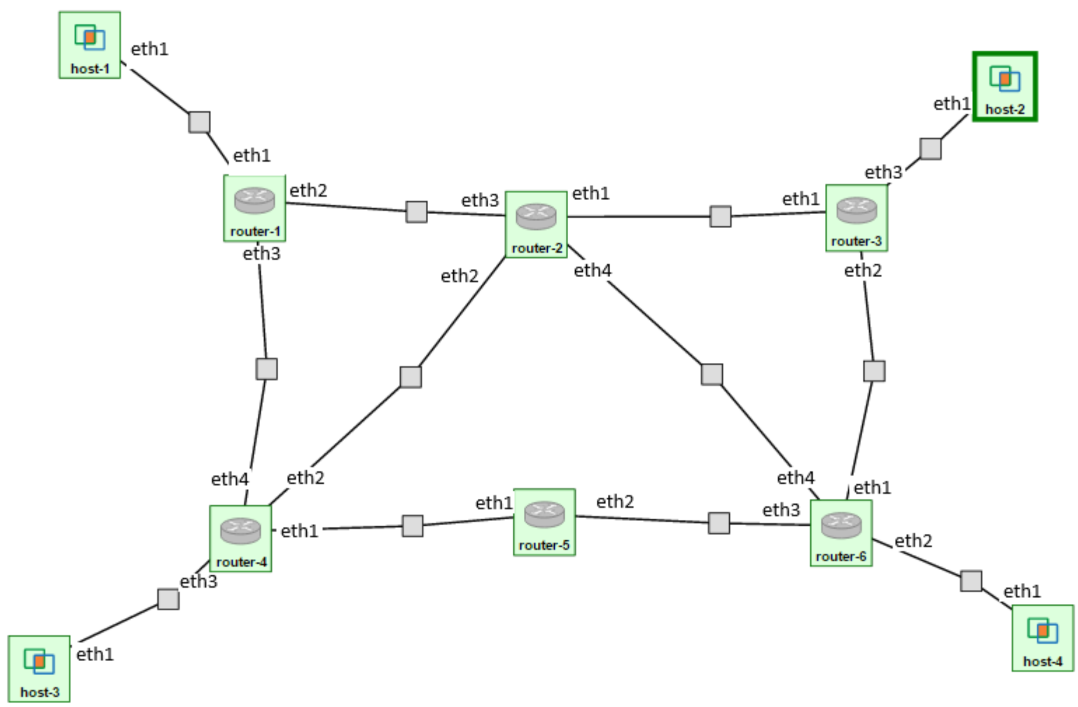

Figure 3: Ethernet links between Routers and Hosts

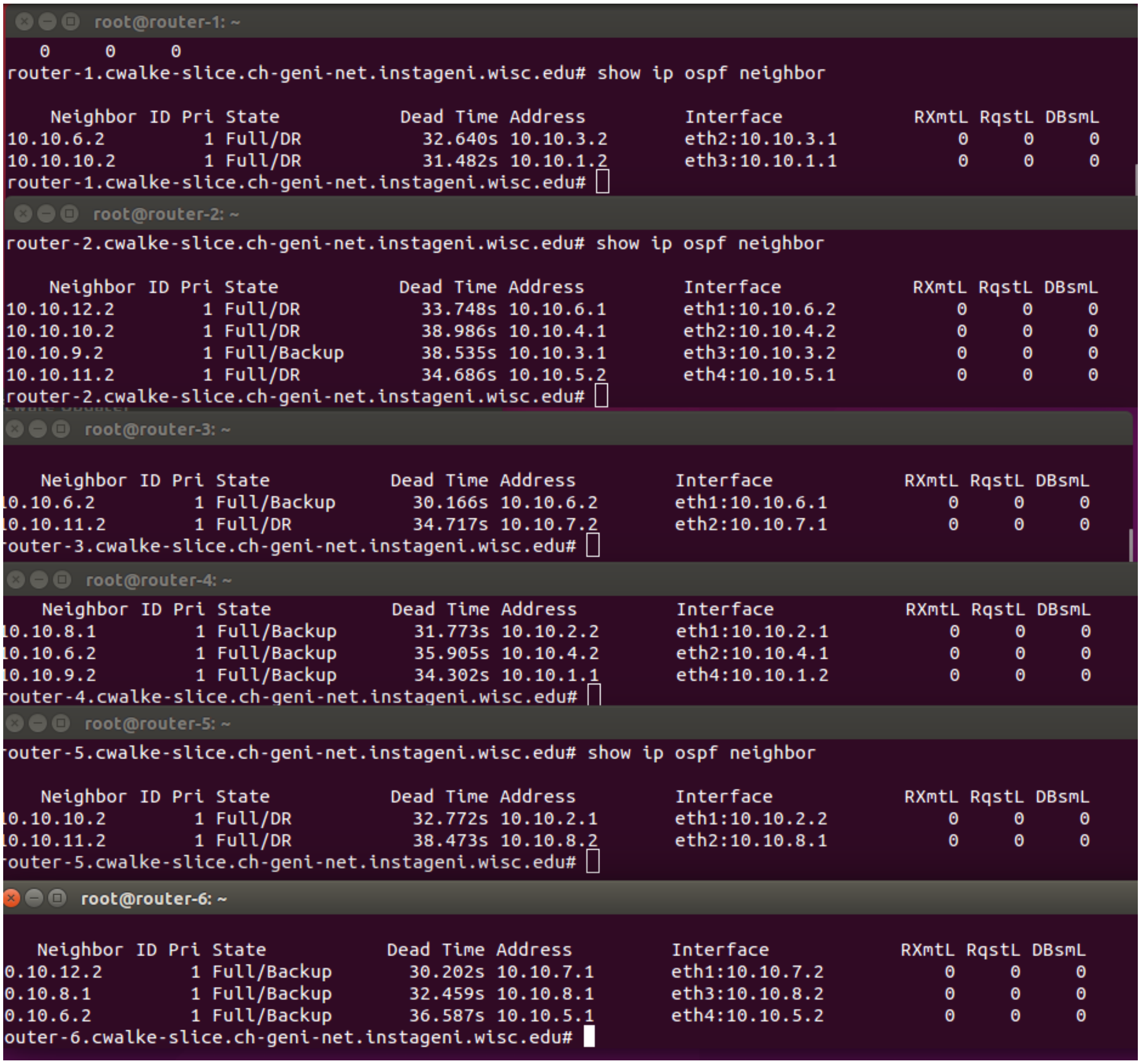

Figure 4: Router's Neighbors

Results:

Question 2: Link Failure and Recovery

To test link failure and recovery, I took down the link between router 1 and router 2. I check the new route from host 1 to host 2 using traceroute to see that new path is R1->R4->R2->R3 (Figure 5). I ping from host 1 to host 2 using IP address 10.10.12.1 and used tcpdump on router 2's eth 3 and eth 2 to listen for the ping packets from host 1. After turning the link on and off I notice when the link was taken down, the time to find a new route is almost instant and one packet is lost. But when the link is turn back on, it takes a few seconds find the original path and nine packets were lost.

```
traceroute to 10.10.12.1 (10.10.12.1), 30 hops max, 60 byte packets
 1  router-1-link-8 (10.10.9.2)  0.675 ms  0.620 ms  0.565 ms
 2  router-4-link-0 (10.10.1.2)  1.383 ms  1.380 ms  1.355 ms
 3  router-2-link-3 (10.10.4.2)  1.540 ms  1.459 ms  1.426 ms
 4  router-3-link-5 (10.10.6.1)  1.637 ms  1.557 ms  1.505 ms
 5  host-2-link-11 (10.10.12.1)  1.948 ms  1.872 ms  1.803 ms
chrsitw@host-1:~$
```

Figure 5: Traceroute from H1 to H4. Link between R1 and R2 is down

```
64 bytes from 10.10.12.1: icmp_seq=42 ttl=61 time=2.79 ms
64 bytes from 10.10.12.1: icmp_seq=43 ttl=60 time=3.29 ms
64 bytes from 10.10.12.1: icmp_seq=44 ttl=60 time=3.75 ms
```

Figure 6: Ping messages when link is down

```
64 bytes from 10.10.12.1: icmp_seq=11 ttl=60 time=3.16 ms
64 bytes from 10.10.12.1: icmp_seq=12 ttl=60 time=2.72 ms
64 bytes from 10.10.12.1: icmp_seq=13 ttl=60 time=2.79 ms
64 bytes from 10.10.12.1: icmp_seq=23 ttl=61 time=3.14 ms
64 bytes from 10.10.12.1: icmp_seq=24 ttl=61 time=2.21 ms
```

Figure 7: Ping messages with link turning on

```
--- 10.10.12.1 ping statistics ---
67 packets transmitted, 58 received, 13% packet loss, time
66094ms
rtt min/avg/max/mdev = 2.314/3.272/12.496/1.271 ms
```

Figure 8: Link turning ON packets lost

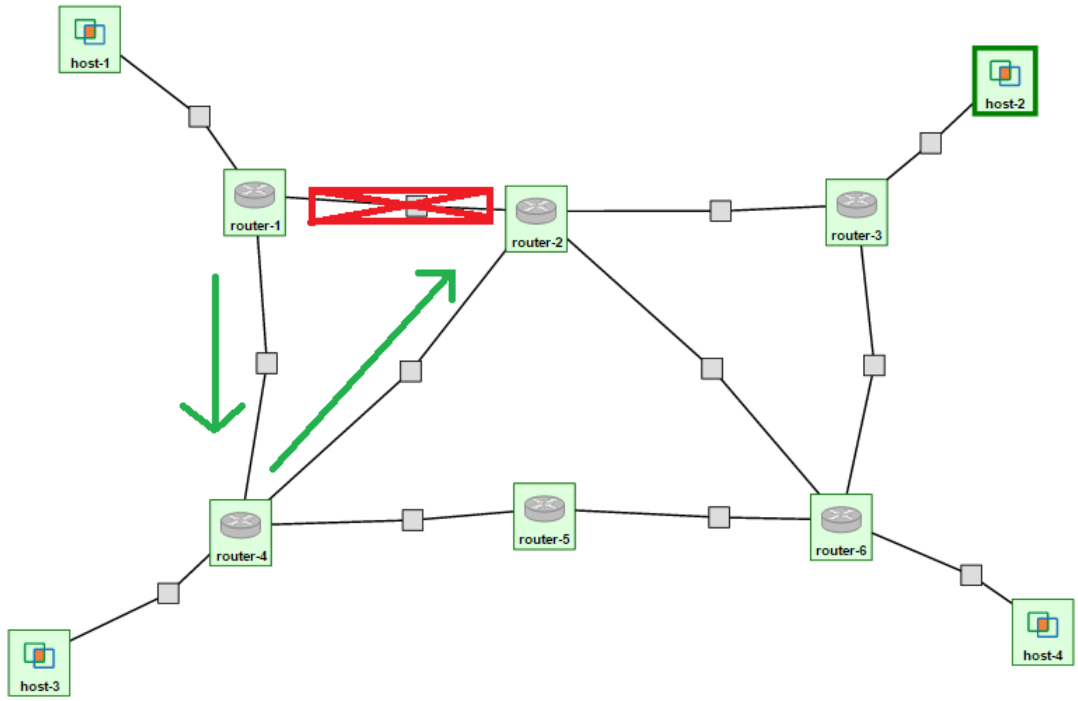

Figure 9: New route when link between R1 and R2 is down

Question 3: Change the cost of a link

The default router link cost is 10 for all the links. The cost to get from host 1 to host 4 would cost 20 taking a route of R1->R2->R6. In my implantation I change the link between router 2 and router 6 from 10 to 50. After using traceroute you can see that packets take two different paths to get to host 4 because both of their routes cost 30.

```
traceroute to 10.10.11.1 (10.10.11.1), 30 hops max, 60 byte packets
 1  router-1-link-8 (10.10.9.2)  0.735 ms  0.676 ms  0.704 ms
 2  router-2-link-2 (10.10.3.2)  1.116 ms  1.106 ms  1.124 ms
 3  router-6-link-4 (10.10.5.2)  1.575 ms  1.605 ms  1.556 ms
 4  host-4-link-10 (10.10.11.1)  2.251 ms  2.208 ms  2.183 ms
```

Figure 10: Traceroute from H1 to H4 with all links cost = 10

```
traceroute to 10.10.11.1 (10.10.11.1), 30 hops max, 60 byte packets
 1  router-1-link-8 (10.10.9.2)  0.646 ms  0.588 ms  0.529 ms
 2  router-2-link-2 (10.10.3.2)  0.995 ms router-4-link-0 (10.10.1.2)  1.025 ms router-2-link-2 (10.10.3.2)  0.942 ms
 3  router-5-link-1 (10.10.2.2)  1.319 ms router-3-link-5 (10.10.6.1)  1.372 ms router-5-link-1 (10.10.2.2)  1.284 ms
 4  router-6-link-6 (10.10.7.2)  1.642 ms  1.427 ms  1.486 ms
 5  host-4-link-10 (10.10.11.1)  2.078 ms  2.015 ms  1.997 ms
```

Figure 11: Traceroute from H1 to H4 with link change to 50

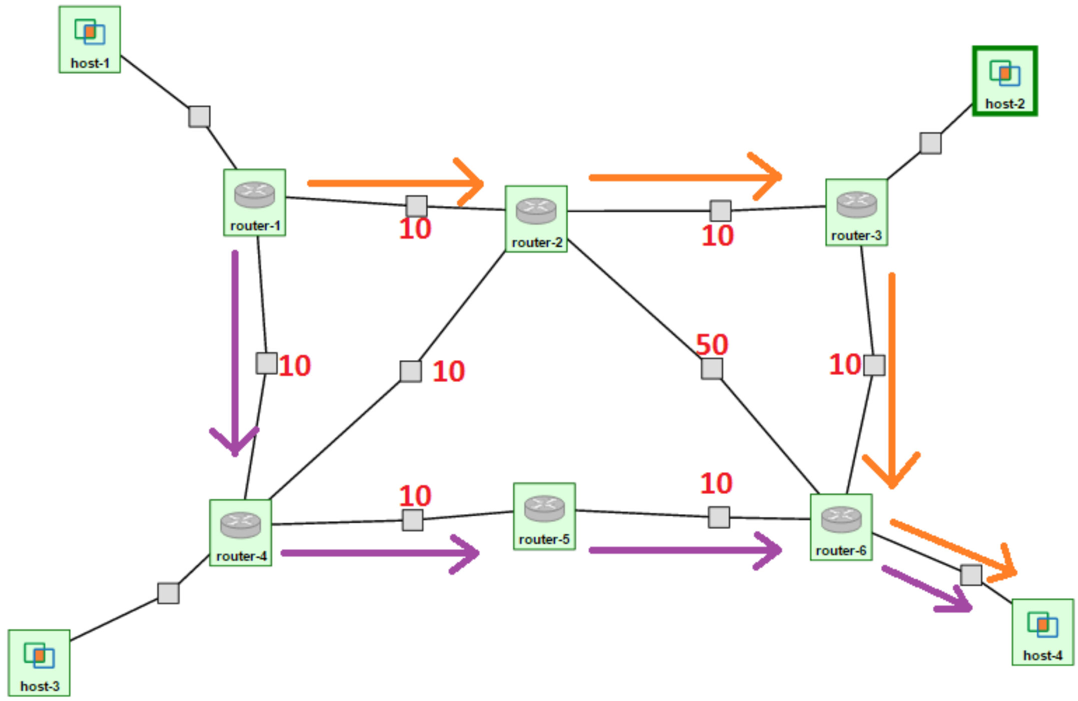

Figure 12: Routes of new paths after link cost change

Conclusion:

From experimenting with bringing down a link that OSPF recovers quickly and find a new path instantly while losing one packet. When the link is turn back on we notice that it takes about 8 seconds to find the original path and about 9 packets were lost. In our experiment with playing with link cost I learn that in the event of a tie, packets are sent down both paths.

After working on MP2, MP3 was very straight forward and I didn't run into much problems. I was find resources really soon not like in MP2. I did notice when just changing the link cost from one side of the link and running tracecount that I lose connection but after taking the tip to change the link from the other side, tracecount worked fine.