HY-335

Project Phase-A

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Question 1.1

Group Number is 65

Default IP: 65.200.0.0

Default IP in binary : 00100001.11001000.00000000.00000000

Mask : 11111111. 11111111. 11111110.00000000

IPs range : 65.200.0.1 - 65.200.0.254

Ip addresses for students and staff :

Student_1 : 65.200.0.3/24

```
root@student_1:~# ip address add 65.200.0.3/23 dev 65-CERN
root@student_1:~# ifconfig
65-CERN: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 65.200.0.3  netmask 255.255.254.0  broadcast 0.0.0.0
        ether 3a:02:8d:ab:9b:c4  txqueuelen 1000  (Ethernet)
        RX packets 360  bytes 25296 (24.7 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

```
root@student_1:~# netstat -rn
Kernel IP routing table
Destination     Gateway         Genmask         Flags   MSS Window  irtt Iface
0.0.0.0         65.200.0.1      0.0.0.0         UG        0 0          0 65-CERN
65.200.0.0      0.0.0.0         255.255.254.0   U         0 0          0 65-CERN
158.65.0.0      0.0.0.0         255.255.0.0     U         0 0          0 ssh
```

Staff_1 : 65.200.0.4/24

```
root@staff_1:~# ifconfig
65-CERN: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 65.200.0.4  netmask 255.255.255.255  broadcast 0.0.0.0
        ether ae:45:f2:31:fd:fc  txqueuelen 1000  (Ethernet)
        RX packets 359  bytes 25226 (24.6 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 27  bytes 1134 (1.1 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

```
root@staff_1:~# netstat -rn
Kernel IP routing table
Destination     Gateway         Genmask         Flags   MSS Window  irtt Ifa
ce
0.0.0.0         65.200.0.1      0.0.0.0         UG        0 0          0 65-
CERN
65.200.0.0      0.0.0.0         255.255.254.0   U         0 0          0 65-
CERN
158.65.0.0      0.0.0.0         255.255.0.0     U         0 0          0 ssh
```

Student_2 : 65.200.0.5/24

```
root@student_2:~# ifconfig
65-ETHZ: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 65.200.0.5  netmask 255.255.254.0  broadcast 0.0.0.0
        ether a2:56:00:f0:b6:72  txqueuelen 1000  (Ethernet)
        RX packets 362  bytes 25436 (24.8 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

```
Kernel IP routing table
Destination     Gateway         Genmask         Flags   MSS Window  irtt Iface
0.0.0.0         65.200.0.2      0.0.0.0         UG        0 0          0 65-ETHZ
65.200.0.0      0.0.0.0         255.255.254.0   U         0 0          0 65-ETHZ
158.65.0.0      0.0.0.0         255.255.0.0     U         0 0          0 ssh
```

Staff_2 : 65.200.0.6/24

```
root@staff_2:~# ifconfig
65-ETHZ: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 65.200.0.6  netmask 255.255.254.0  broadcast 0.0.0.0
        ether ba:a6:25:a7:6c:a1  txqueuelen 1000  (Ethernet)
        RX packets 360  bytes 25296 (24.7 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 15  bytes 630 (630.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

```
root@staff_2:~# netstat -rn
Kernel IP routing table
Destination     Gateway         Genmask         Flags   MSS Window  irtt Iface
0.0.0.0         65.200.0.2      0.0.0.0         UG        0 0          0 65-ETHZ
65.200.0.0      0.0.0.0         255.255.254.0   U         0 0          0 65-ETHZ
158.65.0.0      0.0.0.0         255.255.0.0     U         0 0          0 ssh
```

Student_3 : 65.200.0.7/24

```
root@student_3:~# ifconfig
65-EPFL: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 65.200.0.7  netmask 255.255.254.0  broadcast 0.0.0.0
        ether 52:38:cf:0f:ce:ef  txqueuelen 1000  (Ethernet)
        RX packets 361  bytes 25366 (24.7 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

```
root@student_3:~# route add default gw 65.200.0.1 65-EPFL
root@student_3:~# netstat -rn
Kernel IP routing table
Destination     Gateway         Genmask         Flags   MSS Window  irtt Iface
0.0.0.0         65.200.0.1      0.0.0.0         UG        0 0          0 65-EPFL
65.200.0.0      0.0.0.0         255.255.254.0   U         0 0          0 65-EPFL
158.65.0.0      0.0.0.0         255.255.0.0     U         0 0          0 ssh
```

Staff_3 : 65.200.0.8/24

```
root@staff_3:~# ifconfig
65-EPFL: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 65.200.0.8  netmask 255.255.254.0  broadcast 0.0.0.0
        ether 8a:3d:f5:92:9f:e3  txqueuelen 1000  (Ethernet)
        RX packets 359  bytes 25226 (24.6 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

```
root@staff_3:~# netstat -rn
Kernel IP routing table
Destination     Gateway         Genmask         Flags   MSS Window  irtt Iface
0.0.0.0         65.200.0.1      0.0.0.0         UG        0 0          0 65-EPFL
65.200.0.0      0.0.0.0         255.255.254.0   U         0 0          0 65-EPFL
158.65.0.0      0.0.0.0         255.255.0.0     U         0 0          0 ssh
```

(στα παρακατω screenshot τα addresses φαινονται assigned με /23 αλλα να θεωρηθεί /24 απλά δεν γινόταν μετά να τα αλλάξουμε επειδή ειχαν γίνει unconfigured και δεν θέλαμε μπερδέματα)

GENE IP : 65.200.0.1/24

```
GENE_router# show interface brief
Interface       Status  VRF             Addresses
---------       ------  ---             ---------
GENE-L2         up      default         65.200.0.1/23
GENE-L2.10      down    default
GENE-L2.20      up      default
GENE-L2.30      down    default
ext_67_LOND     up      default
lo              up      default
port_MIAM       up      default
port_PARI       up      default
ssh             up      default         158.65.13.1/16
```

ZURI IP : 65.200.0.2/24

```
ZURI_router# show interface brief
Interface       Status  VRF             Addresses
---------       ------  ---             ---------
ZURI-L2         up      default         65.200.0.2/23
ZURI-L2.10      down    default
ZURI-L2.20      down    default
ZURI-L2.30      down    default
ext_64_ATLA     up      default
lo              up      default
measurement_65  up      default         65.0.199.1/24
port_LOND       up      default
port_PARI       up      default
ssh             up      default         158.65.11.1/16
```

Ping from student#1 to GENE router :

(we need to login to student and then ping the address of the router which is GENE with the following commands)
./goto.sh UNIV student_1

ping 65.200.0.1

Ping from staff#2 to ZURI router :

(similar to previous example we login to staff_2 and ping the address of ZURI)

./goto.sh UNIV staff_2

ping 65.200.0.2

Question 1.2

During this phase we need to reconfigure most IP addresses .

Thew new IP addresses are :

Student_1 : 65.200.0.3/24	Staff_1 : 65.200.1.3/24
Student_2 : 65.200.0.4/24	Staff_2: 65.200.1.4/24
Student_3 : 65.200.0.5/24	Staff_3 : 65.200.1.5/24

Gene-L2.10 : 65.200.1.1/24	Gene-L2.20 : 65.200.0.1/24
Zuri-L2.10: 65.200.1.2/24	Zuri-L2.20: 65.200.0.2/24

We used a different subnet for students and a different subnet for staff .

(Screenshots are not included , process is the same as 1.1 so far)

To configure the switches we need to set up the VLAN. For the students of our network we used the tag = 20 and for our staff the tag = 10. After that we need to set up the trunks as well , so the staff(tag = 10) and the students (tag=20) can communicate through layer-3 connectivity(router). In the switches interfaces we used the trunks 10 and 20.

To set up the tags we used the command:

For the students i = 1,2,3

ovs-vsctl set port 65-student_i tag=20

And for the staff j = 1,2,3

ovs-vsctl set port 65-staff_i tag=10

Now to set up the trunks in the interfaces we used the commands:

switch_name = CERN,EPFL,ETHZ

ovs-vsctl set port 65-[switch_name] trunk=10,20

CERN overview:

```
root@CERN:~# ovs-vsctl show
c40f41be-4e42-4ddd-995f-cab695f65cd4
    Bridge "br0"
        fail_mode: standalone
        Port "65-vpn_1"
            Interface "65-vpn_1"
        Port "br0"
            Interface "br0"
                type: internal
        Port "65-ETHZ"
            trunks: [10, 20]
            Interface "65-ETHZ"
        Port GENErouter
            Interface GENErouter
        Port "65-EPFL"
            trunks: [10, 20]
            Interface "65-EPFL"
        Port "65-staff_1"
            tag: 10
            Interface "65-staff_1"
        Port "65-student_1"
            tag: 20
            Interface "65-student_1"
    ovs_version: "2.6.2"
```

ETHZ overview:

```
root@ETHZ:~# ovs-vsctl show
b1df4c89-6eb8-4aa3-921d-a267dfaf8ba5
    Bridge "br0"
        fail_mode: standalone
        Port "65-EPFL"
            trunks: [10, 20]
            Interface "65-EPFL"
        Port ZURIrouter
            Interface ZURIrouter
        Port "65-student_2"
            tag: 20
            Interface "65-student_2"
        Port "65-staff_2"
            tag: 10
            Interface "65-staff_2"
        Port "br0"
            Interface "br0"
                type: internal
        Port "65-CERN"
            trunks: [10, 20]
            Interface "65-CERN"
    ovs_version: "2.6.2"
```

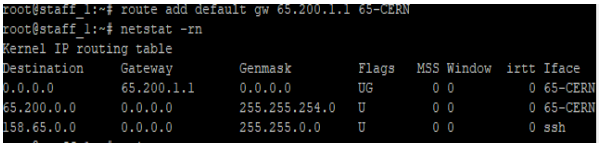
EPFL overview:

```
root@EPFL:~# ovs-vsctl show
36622e42-077a-431a-bd4d-28ee1264f4be
    Bridge "br0"
        fail_mode: standalone
        Port "65-vpn_3"
            Interface "65-vpn_3"
        Port "65-ETHZ"
            trunks: [10, 20]
            Interface "65-ETHZ"
        Port "br0"
            Interface "br0"
                type: internal
        Port "65-CERN"
            trunks: [10, 20]
            Interface "65-CERN"
        Port "65-staff_3"
            tag: 10
            Interface "65-staff_3"
        Port "65-student_3"
            tag: 20
            Interface "65-student_3"
    ovs_version: "2.6.2"
```

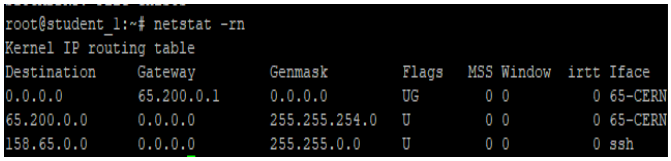
Now we have to set the default gateways of each host to the corresponding interface of the router. For student_1, student_3 the default gateway must be

the address of the GENE.L2.20 interface which is 65.200.0.1.
For staff_1, staff_ 3 the default gateway must be the address of the GENE.L2.10 interface which is 65.200.1.1. The same goes for student_2 and staff_2 but now it must be for the ZURI router, the student_2 will go to the ZURI.L2.20 which is 65.200.0.2 and the staff_2 will go to the ZURI.L2.10 which is 65.200.1.2.

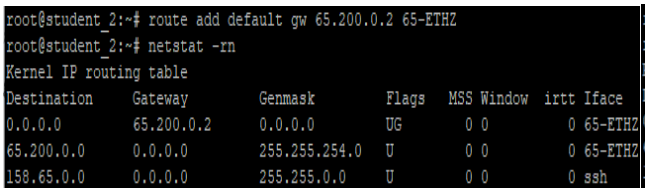
STAFF_1



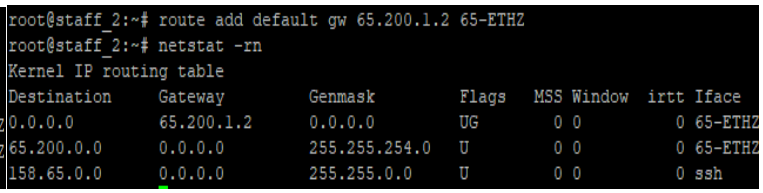
STUDENT_1



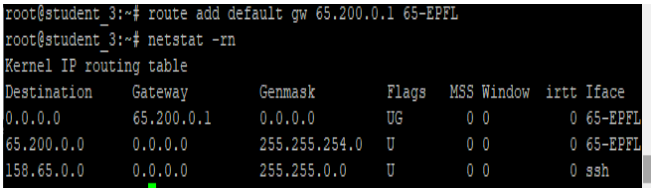
STUDENT_2



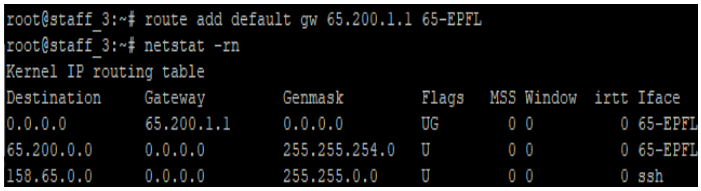
STAFF_2



STUDENT_3



STAFF_3



Question 1.3

For the first part of this question we need to set up all the host and the routers of the layer-3 (before OSPF) . For example, for the BOST router and host we need to set-up the addresses and the loopback interface in the router.

BOST_HOST IP:

```
root@BOST_host:~# ifconfig
BOSTrouter: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 65.106.0.1  netmask 255.255.255.0  broadcast 0.0.0.0
        ether 7e:0e:03:3f:c2:b8  txqueuelen 1000  (Ethernet)
        RX packets 500  bytes 35488 (34.6 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 22  bytes 1932 (1.8 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

ssh: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 158.65.15.2  netmask 255.255.0.0  broadcast 0.0.0.0
        ether 7e:10:20:78:2a:fd  txqueuelen 1000  (Ethernet)
        RX packets 2773  bytes 343278 (335.2 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 469  bytes 66881 (65.3 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

BOST_HOST GATEWAY:

```
root@BOST_host:~# netstat -rn
Kernel IP routing table
Destination     Gateway         Genmask         Flags   MSS Window  irtt Iface
0.0.0.0         65.106.0.2      0.0.0.0         UG        0 0          0 BOSTrouter
65.106.0.0      0.0.0.0         255.255.255.0   U         0 0          0 BOSTrouter
158.65.0.0      0.0.0.0         255.255.0.0     U         0 0          0 ssh
```

BOST_ROUTER IP:

```
BOST_router# show interface brief
Interface       Status  VRF             Addresses
---------       ------  ---             ---------
ext_63_MIAM     up      default
host            up      default         65.106.0.2/24
lo              up      default         65.156.0.1/24
port_LOND       up      default
port_NEWY       up      default
ssh             up      default         158.65.15.1/16
```

After that we need to connect every single router to the neighboring router. For example, in the BOST router we have the ports : port_LOND and port_NEWY we have to set some addresses so that there is connectivity between the routers.

```
BOST_router# show interface brief
Interface       Status  VRF             Addresses
---------       ------  ---             ---------
ext_63_MIAM     up      default
host            up      default         65.106.0.2/24
lo              up      default         65.156.0.1/24
port_LOND       up      default         65.0.7.2/24
port_NEWY       up      default         65.0.10.2/24
ssh             up      default         158.65.15.1/16
```

Then if you configure the OSPF for every port of the BOST_Router and configure the whole layer-3 network you must have something like this. That means that all the routers are connected to each other.

```
BOST_router# show ip route
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, D - SHARP,
       F - PBR, f - OpenFabric,
       > - selected route, * - FIB route, q - queued route, r - rejected route

O>* 65.0.1.0/24 [110/30] via 65.0.7.1, port_LOND, 00:22:36
  *                      via 65.0.10.1, port_NEWY, 00:22:36
O>* 65.0.2.0/24 [110/20] via 65.0.7.1, port_LOND, 00:26:37
O>* 65.0.3.0/24 [110/30] via 65.0.7.1, port_LOND, 00:22:36
  *                      via 65.0.10.1, port_NEWY, 00:22:36
O>* 65.0.4.0/24 [110/20] via 65.0.7.1, port_LOND, 00:26:37
O>* 65.0.5.0/24 [110/20] via 65.0.10.1, port_NEWY, 00:32:24
O>* 65.0.6.0/24 [110/30] via 65.0.7.1, port_LOND, 00:22:22
  *                      via 65.0.10.1, port_NEWY, 00:22:22
```

```
O   65.0.7.0/24 [110/10] is directly connected, port_LOND, 00:32:50
C>* 65.0.7.0/24 is directly connected, port_LOND, 00:45:55
O>* 65.0.8.0/24 [110/20] via 65.0.7.1, port_LOND, 00:26:25
  *                      via 65.0.10.1, port_NEWY, 00:26:25
O>* 65.0.9.0/24 [110/30] via 65.0.10.1, port_NEWY, 00:12:56
O   65.0.10.0/24 [110/10] is directly connected, port_NEWY, 00:32:34
C>* 65.0.10.0/24 is directly connected, port_NEWY, 00:44:07
O>* 65.0.11.0/24 [110/20] via 65.0.10.1, port_NEWY, 00:32:24
O>* 65.0.12.0/24 [110/20] via 65.0.10.1, port_NEWY, 00:32:24
O>* 65.0.13.0/24 [110/30] via 65.0.10.1, port_NEWY, 00:31:16
O>* 65.0.198.0/24 [110/30] via 65.0.7.1, port_LOND, 00:22:36
  *                        via 65.0.10.1, port_NEWY, 00:22:36
O>* 65.0.199.0/24 [110/30] via 65.0.7.1, port_LOND, 00:08:56
O>* 65.101.0.0/24 [110/20] via 65.0.7.1, port_LOND, 00:26:24
O>* 65.103.0.0/24 [110/30] via 65.0.7.1, port_LOND, 00:22:16
  *                        via 65.0.10.1, port_NEWY, 00:22:16
O>* 65.105.0.0/24 [110/20] via 65.0.10.1, port_NEWY, 00:32:24
O   65.106.0.0/24 [110/10] is directly connected, host, 00:32:35
C>* 65.106.0.0/24 is directly connected, host, 02:09:08
O>* 65.107.0.0/24 [110/30] via 65.0.10.1, port_NEWY, 00:31:16
O>* 65.108.0.0/24 [110/30] via 65.0.10.1, port_NEWY, 00:12:56
C>* 65.156.0.0/24 is directly connected, lo, 02:08:38
O>* 65.200.0.0/23 [110/30] via 65.0.7.1, port_LOND, 00:08:47
C>* 158.65.0.0/16 is directly connected, ssh, 02w5d05h
O>* 198.0.0.0/24 [110/20] via 65.0.7.1, port_LOND, 00:26:37
```

At last, we have to do a traceroute from the host of ATLA to host of PARI.

```
root@PARI_host:~# traceroute 65.107.0.1
traceroute to 65.107.0.1 (65.107.0.1), 30 hops max, 60 byte packets
 1  PARI-host.group65 (65.103.0.2)  0.122 ms  0.015 ms  0.016 ms
 2  NEWY-PARI.group65 (65.0.5.2)  2.152 ms MIAM-PARI.group65 (65.0.6.2)  0.209 ms NEWY-PARI.group65 (65.0.5.2)  2.068 ms
 3  ATLA-MIAM.group65 (65.0.13.1)  0.585 ms ATLA-NEWY.group65 (65.0.11.2)  2.405 ms  2.324 ms
 4  host-ATLA.group65 (65.107.0.1)  1.480 ms  2.345 ms  1.416 ms
```

As we can see there is connectivity between the two hosts.

Question 1.4

Firstly we need to identify which configuration our AS has .

First ping is from LOND to NEWY and BW is high (> 25Mbps)

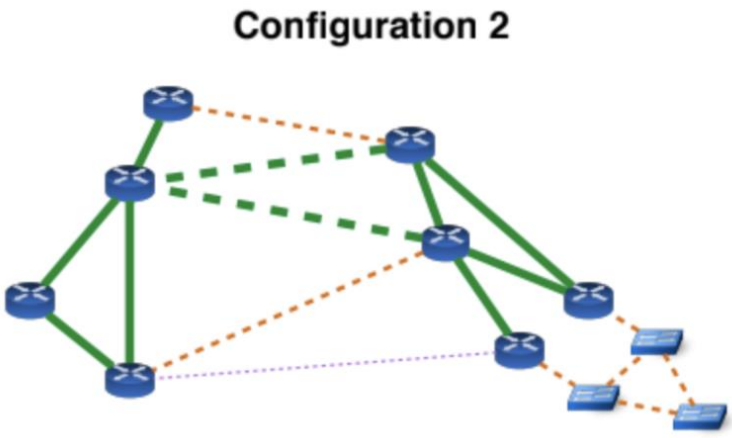
So we have configuration 2 or 3.

```
root@LOND_host:~# iperf3 -c 65.105.0.1 -t 10
Connecting to host 65.105.0.1, port 5201
[  4] local 65.101.0.1 port 49278 connected to 65.105.0.1 port 5201
[ ID] Interval           Transfer     Bandwidth       Retr  Cwnd
[  4]   0.00-1.00   sec  7.17 MBytes  60.1 Mbits/sec  435   17.0 KBytes
[  4]   1.00-2.00   sec  5.65 MBytes  47.4 Mbits/sec  348   14.1 KBytes
[  4]   2.00-3.00   sec  7.52 MBytes  63.1 Mbits/sec  467   11.3 KBytes
[  4]   3.00-4.00   sec  6.15 MBytes  51.6 Mbits/sec  387   9.90 KBytes
[  4]   4.00-5.00   sec  6.34 MBytes  53.2 Mbits/sec  376   7.07 KBytes
[  4]   5.00-6.00   sec  5.90 MBytes  49.5 Mbits/sec  330   14.1 KBytes
[  4]   6.00-7.00   sec  6.65 MBytes  55.8 Mbits/sec  493   26.9 KBytes
[  4]   7.00-8.00   sec  5.16 MBytes  43.3 Mbits/sec  361   7.07 KBytes
[  4]   8.00-9.00   sec  5.84 MBytes  49.0 Mbits/sec  375   9.90 KBytes
[  4]   9.00-10.00  sec  7.71 MBytes  64.6 Mbits/sec  660   29.7 KBytes
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Retr
[  4]   0.00-10.00  sec  64.1 MBytes  53.8 Mbits/sec  4232             sender
[  4]   0.00-10.00  sec  63.2 MBytes  53.0 Mbits/sec                   receiver

iperf Done.
```

We need to check one more and its going to be BOST – LOND .

```
root@LOND_host:~# iperf3 -c 65.106.0.1 -t 10
Connecting to host 65.106.0.1, port 5201
[  4] local 65.101.0.1 port 59928 connected to 65.106.0.1 port 5201
[ ID] Interval           Transfer     Bandwidth       Retr  Cwnd
[  4]   0.00-1.00   sec  5.97 MBytes  50.0 Mbits/sec  1171   24.0 KBytes
[  4]   1.00-2.00   sec  1.24 MBytes  10.4 Mbits/sec  932   39.6 KBytes
[  4]   2.00-3.00   sec  1.18 MBytes  9.91 Mbits/sec  359   21.2 KBytes
[  4]   3.00-4.00   sec  1.18 MBytes  9.90 Mbits/sec   14   19.8 KBytes
[  4]   4.00-5.00   sec  1.12 MBytes  9.39 Mbits/sec   11   29.7 KBytes
[  4]   5.00-6.00   sec  1.18 MBytes  9.90 Mbits/sec   12   28.3 KBytes
[  4]   6.00-7.00   sec  1.18 MBytes  9.90 Mbits/sec   16   28.3 KBytes
[  4]   7.00-8.00   sec  1.18 MBytes  9.91 Mbits/sec   15   28.3 KBytes
[  4]   8.00-9.00   sec  1.18 MBytes  9.90 Mbits/sec    6   29.7 KBytes
[  4]   9.00-10.00  sec  1.18 MBytes  9.91 Mbits/sec   13   28.3 KBytes
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Retr
[  4]   0.00-10.00  sec  16.6 MBytes  13.9 Mbits/sec  2549             sender
[  4]   0.00-10.00  sec  12.7 MBytes  10.6 Mbits/sec                   receiver

iperf Done.
```

The BW is medium (close to 10Mbps) so we have configuration 2 .



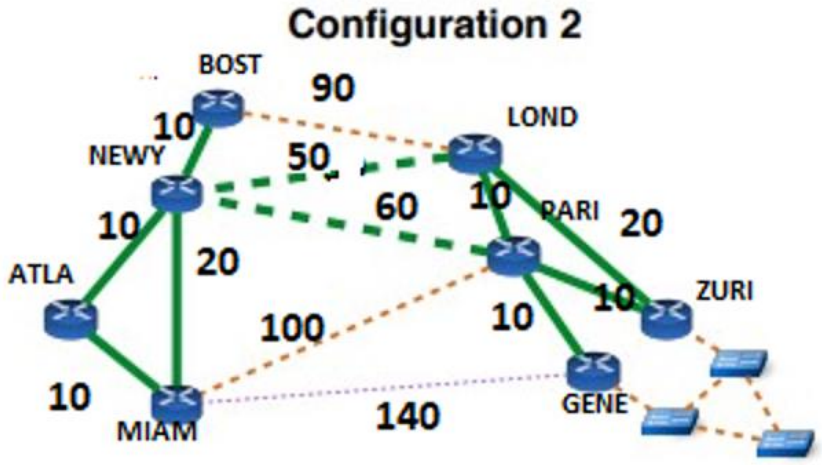
Next step :

We need to set the weights so that the two paths MIAM-NEWY(20) and MIAM-ATLA-NEWY(10+10) are load balanced and the two paths ZURI-LOND(20) AND ZURI-PARI-LOND(10+10) .

As a final requirement we need to load balance the traffic between ATLA – ZURI across the two submarine links with the higher bandwidth .

Thats why we have selected values 50-60 on the two lines to even out the difference from PARI to ZURI and from LOND to ZURI .

The rest of the values were assigned to make sense and be slower paths .



Lastly we can use traceroute from ATLA-host to ZURI – loopback .

```
root@ATLA_host:~# traceroute 65.152.0.1
traceroute to 65.152.0.1 (65.152.0.1), 30 hops max, 60 byte packets
 1  ATLA-host.group65 (65.107.0.2)  0.433 ms  0.299 ms  0.338 ms
 2  NEWY-ATLA.group65 (65.0.11.1)  0.813 ms  0.631 ms  0.769 ms
 3  LOND-NEWY.group65 (65.0.8.1)  1.063 ms  1.045 ms PARI-LOND.group65 (65.0.4.1)  1.941 ms
 4  65.152.0.1 (65.152.0.1)  2.375 ms  2.410 ms PARI-NEWY.group65 (65.0.5.1)  1.659 ms
root@ATLA_host:~#
```

We see what we expected exactly by following the route we set for it to follow from ATLA to NEWY to then either LOND or PARI , in this case LOND , then PARI from LOND to ZURI.

Question 1.5

Before static route : (ATLA -> NEWY to host directly and same thing happened for NEWY->ATLA)

```
root@ATLA_host:~# traceroute 65.105.0.1
traceroute to 65.105.0.1 (65.105.0.1), 30 hops max, 60 byte packets
 1  ATLA-host.group65 (65.107.0.2)  0.383 ms  0.295 ms  0.081 ms
 2  NEWY-ATLA.group65 (65.0.11.1)  0.367 ms  0.310 ms  0.288 ms
 3  host-NEWY.group65 (65.105.0.1)  0.478 ms  0.293 ms  0.307 ms
```

We set up static routes so that traffic is first sent to MIAM and then NEWY .

After static route : (ATLA -> MIAM -> NEWY)

```
root@ATLA_host:~# traceroute 65.105.0.1
traceroute to 65.105.0.1 (65.105.0.1), 30 hops max, 60 byte packets
 1  ATLA-host.group65 (65.107.0.2)  0.715 ms  0.472 ms  0.472 ms
 2  MIAM-ATLA.group65 (65.0.13.2)  0.882 ms  0.803 ms  0.534 ms
 3  NEWY-MIAM.group65 (65.0.12.1)  0.759 ms  0.613 ms  0.514 ms
 4  host-NEWY.group65 (65.105.0.1)  0.932 ms  0.783 ms  0.565 ms
root@ATLA_host:~#
```

From NEWY to ATLA : (NEWY -> MIAM -> ATLA)

```
root@NEWY_host:~# traceroute 65.107.0.1
traceroute to 65.107.0.1 (65.107.0.1), 30 hops max, 60 byte packets
 1  NEWY-host.group65 (65.105.0.2)  0.118 ms  0.016 ms  0.013 ms
 2  MIAM-NEWY.group65 (65.0.12.2)  0.135 ms  0.057 ms  0.058 ms
 3  ATLA-MIAM.group65 (65.0.13.1)  0.378 ms  0.364 ms  0.331 ms
 4  host-ATLA.group65 (65.107.0.1)  0.349 ms  0.308 ms  0.331 ms
root@NEWY_host:~# exit
```

MIAM router ‘show ip route’ :

```
MIAM_router# show ip route
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, D - SHARP,
       F - PBR, f - OpenFabric,
       > - selected route, * - FIB route, q - queued route, r - rejected route

O>* 65.0.1.0/24 [110/90] via 65.0.12.1, port_NEWY, 1d00h15m
  *                      via 65.0.13.1, port_ATLA, 1d00h15m
O>* 65.0.2.0/24 [110/90] via 65.0.12.1, port_NEWY, 1d00h11m
  *                      via 65.0.13.1, port_ATLA, 1d00h11m
O>* 65.0.3.0/24 [110/90] via 65.0.12.1, port_NEWY, 1d00h15m
  *                      via 65.0.13.1, port_ATLA, 1d00h15m
O>* 65.0.4.0/24 [110/80] via 65.0.12.1, port_NEWY, 1d00h15m
  *                      via 65.0.13.1, port_ATLA, 1d00h15m
O>* 65.0.5.0/24 [110/80] via 65.0.12.1, port_NEWY, 1d00h15m
  *                      via 65.0.13.1, port_ATLA, 1d00h15m
O   65.0.6.0/24 [110/100] is directly connected, port_PARI, 1d00h13m
C>* 65.0.6.0/24 is directly connected, port_PARI, 1d22h04m
O>* 65.0.7.0/24 [110/120] via 65.0.12.1, port_NEWY, 1d00h12m
  *                      via 65.0.13.1, port_ATLA, 1d00h12m
O>* 65.0.8.0/24 [110/70] via 65.0.12.1, port_NEWY, 1d00h15m
  *                      via 65.0.13.1, port_ATLA, 1d00h15m
O   65.0.9.0/24 [110/140] is directly connected, port_GENE, 1d00h19m
C>* 65.0.9.0/24 is directly connected, port_GENE, 1d22h06m
O>* 65.0.10.0/24 [110/30] via 65.0.12.1, port_NEWY, 1d00h22m
  *                      via 65.0.13.1, port_ATLA, 1d00h22m
O>* 65.0.11.0/24 [110/20] via 65.0.13.1, port_ATLA, 1d00h23m
O   65.0.12.0/24 [110/20] is directly connected, port_NEWY, 1d00h23m
C>* 65.0.12.0/24 is directly connected, port_NEWY, 1d22h04m
O   65.0.13.0/24 [110/10] is directly connected, port_ATLA, 1d21h58m
C>* 65.0.13.0/24 is directly connected, port_ATLA, 1d22h07m
O>* 65.0.198.0/24 [110/90] via 65.0.12.1, port_NEWY, 1d00h15m
  *                      via 65.0.13.1, port_ATLA, 1d00h15m
O>* 65.0.199.0/24 [110/100] via 65.0.12.1, port_NEWY, 1d00h11m
  *                       via 65.0.13.1, port_ATLA, 1d00h11m
O>* 65.101.0.0/24 [110/80] via 65.0.12.1, port_NEWY, 1d00h15m
  *                      via 65.0.13.1, port_ATLA, 1d00h15m
O>* 65.103.0.0/24 [110/90] via 65.0.12.1, port_NEWY, 1d00h15m
  *                      via 65.0.13.1, port_ATLA, 1d00h15m
S>* 65.105.0.0/24 [1/0] via 65.0.12.1, port_NEWY, 00:01:47
O   65.105.0.0/24 [110/30] via 65.0.12.1, port_NEWY, 1d00h22m
                       via 65.0.13.1, port_ATLA, 1d00h22m
O>* 65.106.0.0/24 [110/40] via 65.0.12.1, port_NEWY, 1d00h22m
  *                      via 65.0.13.1, port_ATLA, 1d00h22m
O>* 65.107.0.0/24 [110/20] via 65.0.13.1, port_ATLA, 1d21h58m
O   65.108.0.0/24 [110/10] is directly connected, host, 1d21h58m
C>* 65.108.0.0/24 is directly connected, host, 1d23h17m
O>* 65.152.0.1/32 [110/90] via 65.0.12.1, port_NEWY, 1d00h11m
  *                      via 65.0.13.1, port_ATLA, 1d00h11m
C>* 65.158.0.0/24 is directly connected, lo, 1d23h16m
O>* 65.200.0.0/23 [110/100] via 65.0.12.1, port_NEWY, 1d00h11m
  *                       via 65.0.13.1, port_ATLA, 1d00h11m
C>* 158.65.0.0/16 is directly connected, ssh, 03w0d03h
O>* 198.0.0.0/24 [110/80] via 65.0.12.1, port_NEWY, 1d00h15m
  *                      via 65.0.13.1, port_ATLA, 1d00h15m
MIAM_router#
```