Networks Coursework 2

Task 2:

a. Which command did you use?

show ip route

```
Hello, this is Quagga (version 1.1.1).
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router10# show ip route
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, P - PIM, A - Babel,
       > - selected route, * - FIB route

O>* 10.0.0.0/24 [110/50] via 10.0.10.1, eth0, 00:00:30
O>* 10.0.1.0/24 [110/40] via 10.0.10.1, eth0, 00:00:30
O>* 10.0.2.0/24 [110/40] via 10.0.10.1, eth0, 00:00:30
O>* 10.0.3.0/24 [110/40] via 10.0.10.1, eth0, 00:00:30
O>* 10.0.4.0/24 [110/40] via 10.0.10.1, eth0, 00:00:30
O>* 10.0.5.0/24 [110/40] via 10.0.10.1, eth0, 00:00:30
O>* 10.0.6.0/24 [110/30] via 10.0.10.1, eth0, 00:00:30
O>* 10.0.7.0/24 [110/30] via 10.0.10.1, eth0, 00:00:30
  *                     via 10.0.11.1, eth1, 00:00:30
O>* 10.0.8.0/24 [110/20] via 10.0.10.1, eth0, 00:00:30
O>* 10.0.9.0/24 [110/30] via 10.0.10.1, eth0, 00:00:30
O   10.0.10.0/24 [110/10] is directly connected, eth0, 00:01:20
C>* 10.0.10.0/24 is directly connected, eth0
O   10.0.11.0/24 [110/10] is directly connected, eth1, 00:01:20
C>* 10.0.11.0/24 is directly connected, eth1
O>* 10.0.12.0/24 [110/20] via 10.0.11.1, eth1, 00:00:30
O   10.0.13.0/24 [110/10] is directly connected, eth2, 00:01:19
C>* 10.0.13.0/24 is directly connected, eth2
O>* 10.0.14.0/24 [110/50] via 10.0.10.1, eth0, 00:00:30
C>* 127.0.0.0/8 is directly connected, lo
O>* 127.0.0.1/32 [110/0] is directly connected, lo, 00:01:20
router10#
```

b. What is the next hop to the IP of router4?

router 9 – 10.0.10.1

c. What is the cost of the path to the IP of router4?

30

d. Compare the path installation times for the path to the IP of router5, and the path to the IP of router9. Which path was installed first in the routing table? Explain why.

router5 – 10.0.4.2/24

router9 – 10.0.10.1/24

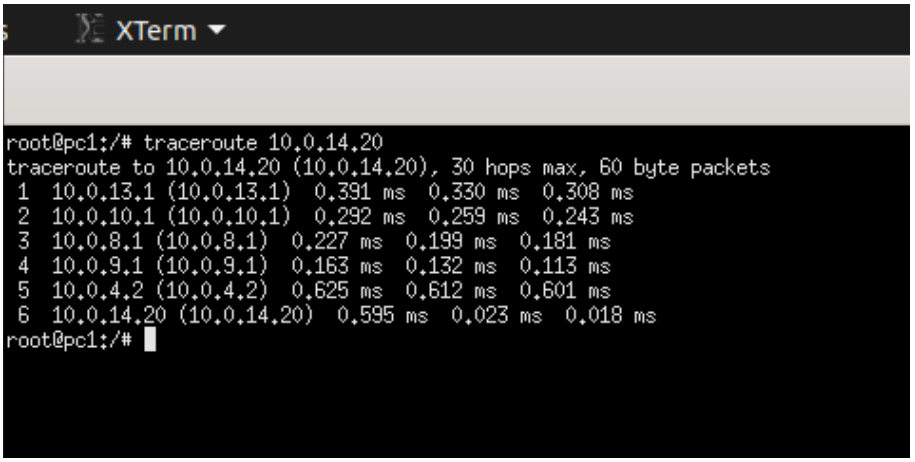
router 5 was last updated on: 00:00:30
router 9 was last updated on: 00:01:20

There is 50 seconds time difference between the time of installation of router 5 and the time of installation of router9, as router9 was installed first because it was discovered and inserted into the routing table of router10 1 minute and 20 seconds ago while router5 was discovered and inserted into the routing table of router10 30 seconds ago, and that means that router9 was installed first.

Task 3:

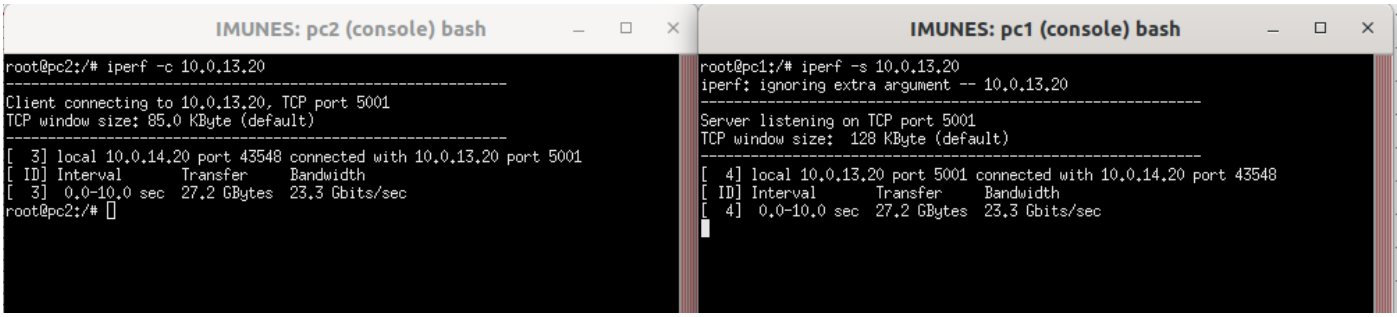
a. Which command did you use to measure the IP-level path? Post a screenshot of the result.

traceroute 10.0.14.20



b. Which command did you use to measure the bandwidth? Post a screenshot of the result.

on PC1: iperf -s 10.0.13.20
on PC2: iperf -c 10.0.13.20

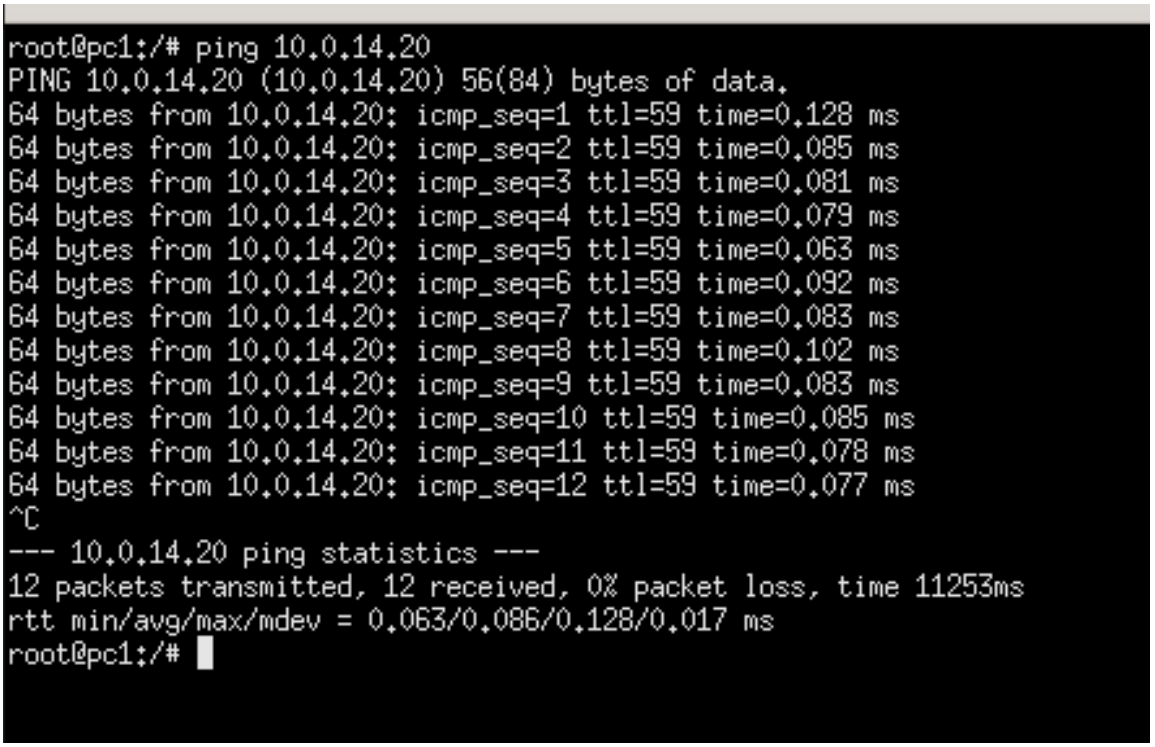


c. Write the sequence of routers for the path between pc1 and pc2

sequence: pc1 – router10 - router9 - router7 - router4 - router5 - pc2

d. What is the RTT between pc1 and pc2?

ping 10.0.14.20
rtt min = 0.063
rtt avg = 0.086
rtt max = 0.128
rtt mdev = 0.017 “standard deviation”



Task 5:

a. Which area is the backbone area of the topology?

the green area, because the green area contains the 2 backbone routers that connects all 3 areas and the backbone routers are router2 and router3

b. Query again the OSPF routing table of router10. Compare the next hop, and path cost with the values you found for Task 2.b and Task 2.c. Did any of the two values change and why? (you can also compare the IP-level paths to back your answer)

```
Hello, this is Quagga (version 1.1.1).
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router10# show ip route
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, P - PIM, A - Babel,
       > - selected route, * - FIB route

O>* 10.0.0.0/24 [110/50] via 10.0.10.1, eth0, 00:00:06
O>* 10.0.1.0/24 [110/40] via 10.0.10.1, eth0, 00:00:06
O>* 10.0.2.0/24 [110/40] via 10.0.10.1, eth0, 00:00:06
O>* 10.0.3.0/24 [110/50] via 10.0.10.1, eth0, 00:00:06
O>* 10.0.4.0/24 [110/60] via 10.0.10.1, eth0, 00:00:06
O>* 10.0.5.0/24 [110/60] via 10.0.10.1, eth0, 00:00:06
O>* 10.0.6.0/24 [110/30] via 10.0.10.1, eth0, 00:00:09
O>* 10.0.7.0/24 [110/30] via 10.0.10.1, eth0, 00:00:04
  *                        via 10.0.11.1, eth1, 00:00:04
O>* 10.0.8.0/24 [110/20] via 10.0.10.1, eth0, 00:00:09
O>* 10.0.9.0/24 [110/30] via 10.0.10.1, eth0, 00:00:09
O   10.0.10.0/24 [110/10] is directly connected, eth0, 00:00:58
C>* 10.0.10.0/24 is directly connected, eth0
O   10.0.11.0/24 [110/10] is directly connected, eth1, 00:00:58
C>* 10.0.11.0/24 is directly connected, eth1
O>* 10.0.12.0/24 [110/20] via 10.0.11.1, eth1, 00:00:04
O   10.0.13.0/24 [110/10] is directly connected, eth2, 00:00:57
C>* 10.0.13.0/24 is directly connected, eth2
O>* 10.0.14.0/24 [110/70] via 10.0.10.1, eth0, 00:00:06
C>* 127.0.0.0/8 is directly connected, lo
O>* 127.0.0.1/32 [110/0] is directly connected, lo, 00:00:58
router10# show ip route 10.0.9.1
Routing entry for 10.0.9.0/24
  Known via "ospf", distance 110, metric 30, tag 0, vrf 0, best, fib
  Last update 00:00:25 ago
  >* 10.0.10.1, via eth0

router10#
```

```
root@router10:/# traceroute 10.0.9.1
traceroute to 10.0.9.1 (10.0.9.1), 30 hops max, 60 byte packets
 1  10.0.10.1 (10.0.10.1)  0.457 ms  0.378 ms  0.361 ms
 2  10.0.8.1 (10.0.8.1)  0.347 ms  0.317 ms  0.301 ms
 3  10.0.9.1 (10.0.9.1)  0.285 ms  0.226 ms  0.206 ms
root@router10:/#
```

What is the next hop to the IP of router4?

2.b) router 9 – 10.0.10.1

5.b) router 9 - 10.0.10.1

the next hop for both tasks is the exact same, because there is a direct link from router 10 to router 9 and the cost between router 10 to router 9 has not been changed.

What is the cost of the path to the IP of router4?

2.b) cost – 30

5.b) cost – 30

the cost also for both tasks is the exact same, although router10 and router4 are in two different areas the cost has not changed because the traffic goes from router10 to router4 without passing through the backbones because a physical link exists between router7 and router4. Also, the IP-level paths are the exact same for 2.b and 5.b and this indicates that the cost is also the exact same.

c. Measure the following IP-level paths:

i. router4 to router7

path: router4 – router7

```
root@router4:/# traceroute 10.0.9.2
traceroute to 10.0.9.2 (10.0.9.2), 30 hops max, 60 byte packets
 1  10.0.9.2 (10.0.9.2)  0.333 ms  0.255 ms  0.234 ms
root@router4:/#
```

ii. From router7 to router9

path: router7 – router9

```
root@router7:/# traceroute 10.0.8.2
traceroute to 10.0.8.2 (10.0.8.2), 30 hops max, 60 byte packets
 1  10.0.8.2 (10.0.8.2)  0.337 ms  0.281 ms  0.265 ms
root@router7:/#
```

iii. From router4 to router9

path: router4 – router2 – router3 – router7 – router9

```
root@router4:/# traceroute 10.0.8.2
traceroute to 10.0.8.2 (10.0.8.2), 30 hops max, 60 byte packets
 1  10.0.3.1 (10.0.3.1)  0.468 ms  0.380 ms  0.362 ms
 2  10.0.2.2 (10.0.2.2)  0.341 ms  0.316 ms  0.302 ms
 3  10.0.6.2 (10.0.6.2)  0.286 ms  0.246 ms  0.227 ms
 4  10.0.8.2 (10.0.8.2)  0.208 ms  0.172 ms  0.150 ms
root@router4:/#
```

Is path (iii) the same as the concatenation of path (i) and path (ii)? Explain your answer.

No path (iii) is not the concatenation of path (i) and path (ii) because in path (i) there is a physical link between router4 and router7 so the traffic doesn't need to go through the backbones and in path (ii) there is a physical link between router7 and router9 and they are in the same area. But for (iii) there is no physical link from router4 to router9 and to send traffic from router4 to router9 the traffic needs to pass through the backbones because router4 and router9 are in two different areas.

Task 6:

b. Find the sequence of router hops for the following two paths

i. From router10 to router 5

Path: router10 – router11 – router8 – router7 – router3 – router2 – router4 – router 5

```
root@router10:/# traceroute 10.0.4.2
traceroute to 10.0.4.2 (10.0.4.2), 30 hops max, 60 byte packets
 1  10.0.11.1 (10.0.11.1)  0.460 ms  0.395 ms  0.380 ms
 2  10.0.12.1 (10.0.12.1)  0.366 ms  0.342 ms  0.326 ms
 3  10.0.8.1 (10.0.8.1)  0.308 ms  0.279 ms  0.261 ms
 4  10.0.6.1 (10.0.6.1)  0.244 ms  0.202 ms  0.181 ms
 5  10.0.2.1 (10.0.2.1)  0.161 ms  0.125 ms  0.105 ms
 6  10.0.3.2 (10.0.3.2)  0.082 ms  0.467 ms  0.415 ms
 7  10.0.4.2 (10.0.4.2)  0.392 ms  0.352 ms  0.327 ms
root@router10:/#
```

ii. From router5 to router10

Path: router5 – router4 – router2 – router3 – router7 – router9 – router10

```
root@router5:/# traceroute 10.0.11.2
traceroute to 10.0.11.2 (10.0.11.2), 30 hops max, 60 byte packets
 1  10.0.4.1 (10.0.4.1)  0.445 ms  0.396 ms  0.378 ms
 2  10.0.3.1 (10.0.3.1)  0.364 ms  0.339 ms  0.322 ms
 3  10.0.2.2 (10.0.2.2)  0.307 ms  0.276 ms  0.258 ms
 4  10.0.6.2 (10.0.6.2)  0.240 ms  0.205 ms  0.184 ms
 5  10.0.8.2 (10.0.8.2)  0.164 ms  0.130 ms  0.108 ms
 6  10.0.11.2 (10.0.11.2)  0.085 ms  0.076 ms  0.024 ms
root@router5:/#
```

Are these two paths symmetric? Specifically, do they traverse the same routers? Explain why.
No, the paths are not symmetric because a network is a directed graph so the cost from router10 to router9 can be very high, but at the same time the cost from router9 to router10 can be very low, and as we configured router10 to forward the traffic using router11 we didn't configure the costs of any other router

Task 7:

Coursework Specification: Two connected interfaces need to belong in the same subnet and to have the same MTU value in order to be able to exchange traffic directly.

Error #1: the IP address used by router6 and router2 had two different IP Prefixes which means they weren't able to communicate because they didn't belong to the same subnet and the solution for that is to use the same prefix for both routers

Error #2: the MTU (Maximum Transmission Unit) between any 2 routers had to be the same for them to be able to exchange traffic directly and the MTU value of router6 had an MTU of 500 while all other routers had an MTU of 1500. And the solution was to change the MTU of router6 to 1500.