2. [30 pts] Save a screenshot of *dump* and *pingall* output. Explain what is being shown in the screenshot.

```
mininet> dump
<Host h1: h1-eth0:10.0.0.1 pid=1813>
<Host h2: h2-eth0:10.0.0.2 pid=1817>
<Host h3: h3-eth0:10.0.0.3 pid=1819>
<Host h4: h4-eth0:10.0.0.4 pid=1821>
<Host h5: h5-eth0:10.0.0.5 pid=1823>
<Host h6: h6-eth0:10.0.0.6 pid=1825>
<OVSSwitch s1: lo:127.0.0.1,s1-eth1:None,s1-eth2:None,s1-eth3:None pid=1830>
<OVSSwitch s2: lo:127.0.0.1,s2-eth1:None,s2-eth2:None,s2-eth3:None pid=1833>
<OVSSwitch s3: lo:127.0.0.1,s3-eth1:None,s3-eth2:None,s3-eth3:None,s3-eth4:None
pid=1836>
<Controller c0: 127.0.0.1:6633 pid=1806>
```

```
mininet> pingall
*** Ping: testing ping reachability
h1 -> h2 h3 h4 h5 h6
h2 -> h1 h3 h4 h5 h6
h3 -> h1 h2 h4 h5 h6
h4 -> h1 h2 h3 h5 h6
h5 -> h1 h2 h3 h4 h6
h6 -> h1 h2 h3 h4 h5
*** Results: 0% dropped (30/30 received)
```

“dump” command displays information about all devices including host h1 - h6, switch s1 - s3, and controller c0. It lists their interfaces, the IP addresses, and the pids.

“pingall” command does all-pairs “ping” to test connectivity between hosts. For example, host h1 can connect to host h6 through a bunch of hosts h2, h3, h4, h5.

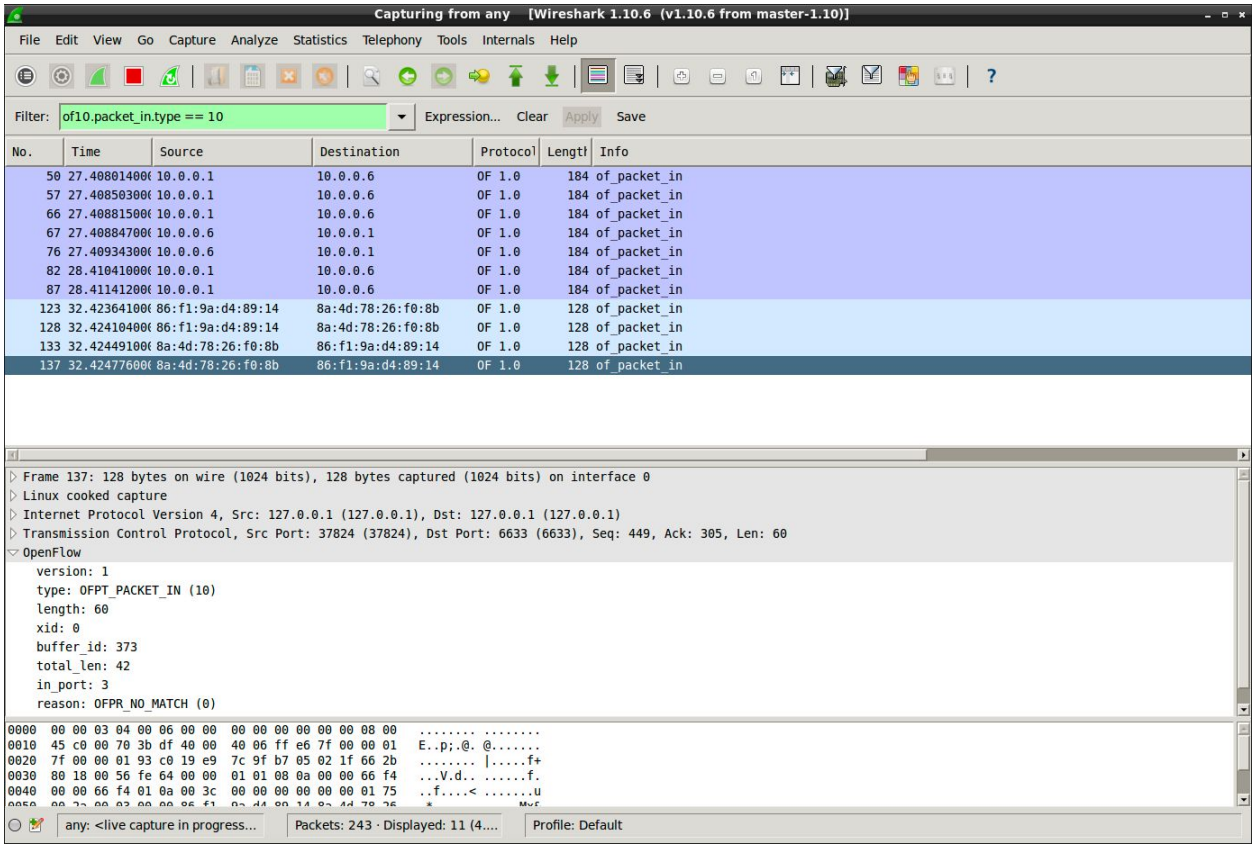
3. [10 pts] Run the *iperf* command as well, and screenshot the output, how fast is the connect?

“iperf” command runs on host h1 and client h6 to analyze the bandwidth between them. The connection between them is around 43 Gbits/sec.

4.a) [20 pts] Run ping from a host to any other host using *hX ping -c 5 hY*. How many *of_packet_in* messages show up? Take a screenshot of your results.

```
mininet> h1 ping -c 5 h6
PING 10.0.0.6 (10.0.0.6) 56(84) bytes of data.
64 bytes from 10.0.0.6: icmp_seq=1 ttl=64 time=1.78 ms
64 bytes from 10.0.0.6: icmp_seq=2 ttl=64 time=1.77 ms
64 bytes from 10.0.0.6: icmp_seq=3 ttl=64 time=0.363 ms
64 bytes from 10.0.0.6: icmp_seq=4 ttl=64 time=0.081 ms
64 bytes from 10.0.0.6: icmp_seq=5 ttl=64 time=0.061 ms

--- 10.0.0.6 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4004ms
rtt min/avg/max/mdev = 0.061/0.811/1.780/0.796 ms
```

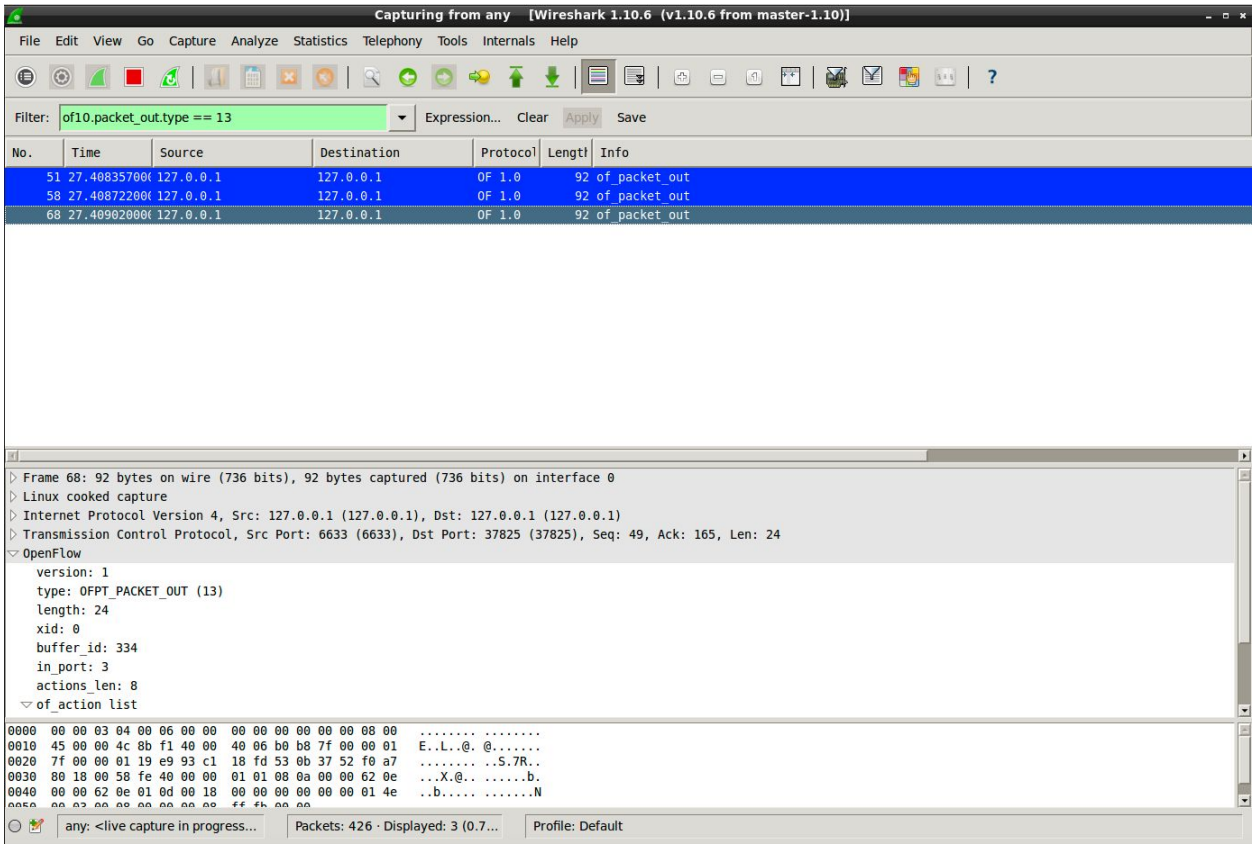


There are 11 *of_packet_in* messages ping from host1 to host6.

b). [20 pts] What is the source and destination IP addresses for these entries? Find another packet that matches the “of” filter with the OpenFlow typefield set to *OFPT_PACKET_OUT*. What is the source and destination IP address for this entry? Take screenshots showing your results.

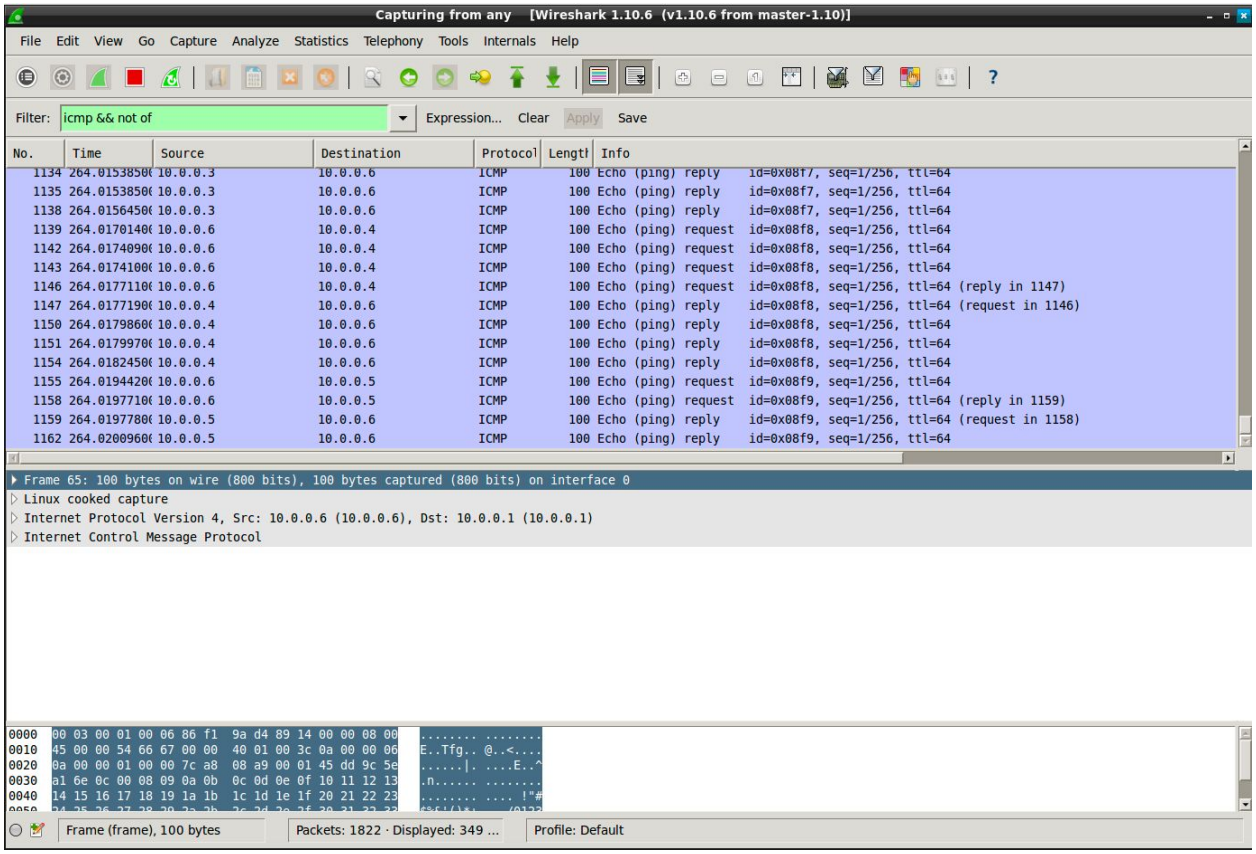
The source and destination IP addresses for these entries are displayed below.

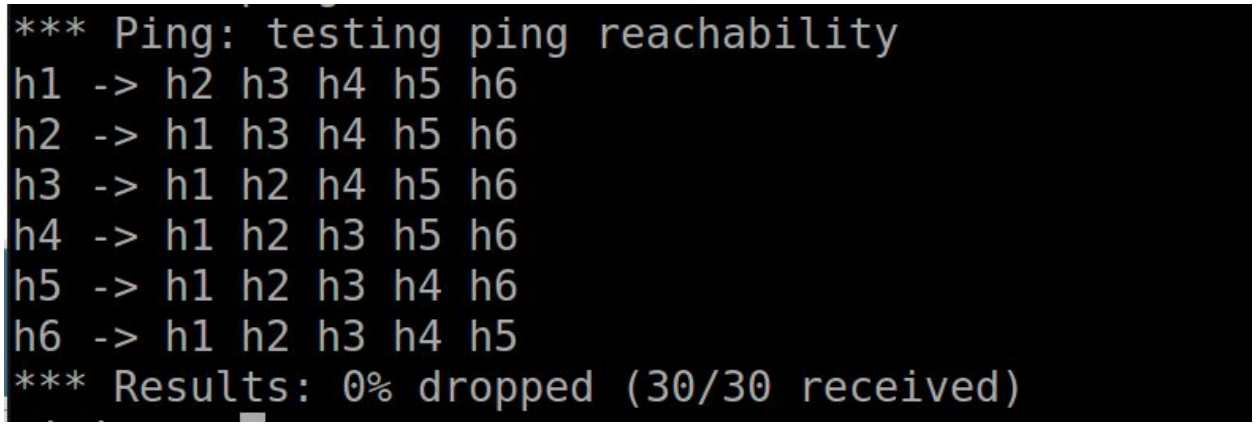
No.	Time	Source	Destination	Protocol	Length	Info
69	34.52176700(	10.0.0.1	10.0.0.6	OF 1.0	184	of_packet_in
76	34.52246000(	10.0.0.1	10.0.0.6	OF 1.0	184	of_packet_in
85	34.52302700(	10.0.0.1	10.0.0.6	OF 1.0	184	of_packet_in
86	34.52306300(	10.0.0.6	10.0.0.1	OF 1.0	184	of_packet_in
95	34.52363300(	10.0.0.6	10.0.0.1	OF 1.0	184	of_packet_in
101	35.52454000(	10.0.0.1	10.0.0.6	OF 1.0	184	of_packet_in
106	35.52510400(	10.0.0.1	10.0.0.6	OF 1.0	184	of_packet_in
142	39.53178900(	52:77:3f:e9:c9:ac	ca:7e:cd:68:00:8f	OF 1.0	128	of_packet_in
147	39.53251000(	52:77:3f:e9:c9:ac	ca:7e:cd:68:00:8f	OF 1.0	128	of_packet_in
152	39.53322500(	ca:7e:cd:68:00:8f	52:77:3f:e9:c9:ac	OF 1.0	128	of_packet_in
156	39.53368600(	ca:7e:cd:68:00:8f	52:77:3f:e9:c9:ac	OF 1.0	128	of_packet_in



There are 3 entries with the source ip address 127.0.0.1 to the destination ip address 127.0.0.1

c). [20 pts] Replace the display filter for “of” to “icmp && not of”. Run *pingall* again, how many entries are generated in wireshark? What types of icmp entries show up? Take a screenshot of your results.





There are 349 entries generated when running *pingall*. ICMP provides two types of query messages, Echo (ping) request and Echo (ping) reply.