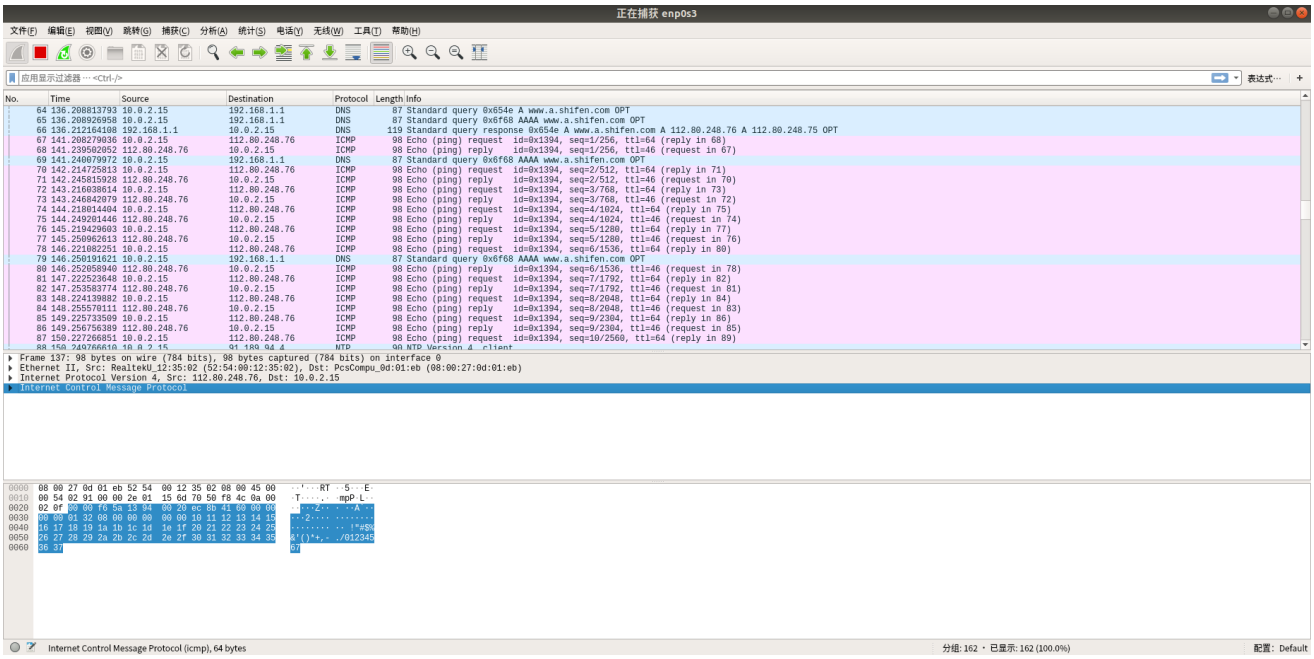
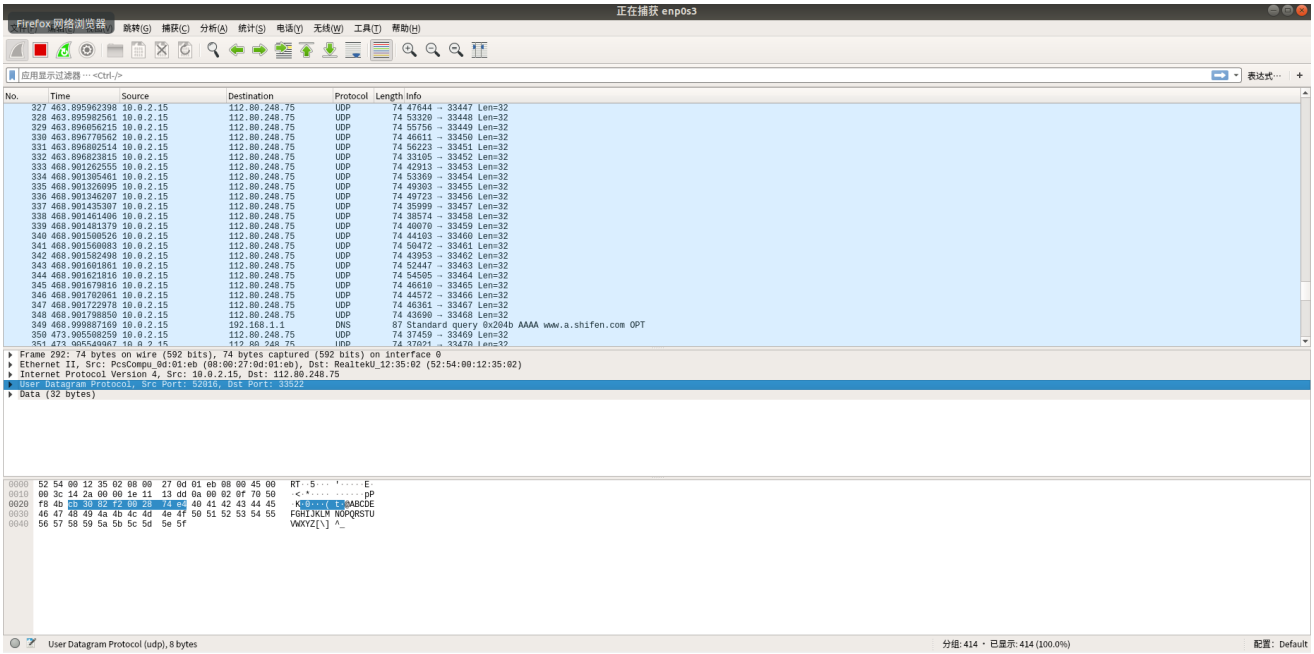
Lab1: Set up Environment and Test Basic Softwares

1. What protocol does "ping" and "traceroute" use?

"ping" uses Internet Control Message Protocol (ICMP)



"traceroute" uses User Datagram Protocol (UDP)



2. What is the IP address of www.sjtu.edu.cn?

The IP address of www.sjtu.edu.cn is 202.120.2.119

```
why@why-VirtualBox:~$ ping www.sjtu.edu.cn
PING www.sjtu.edu.cn (202.120.2.119) 56(84) bytes of data.
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=1 ttl=248 time=2.22 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=2 ttl=248 time=1.79 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=3 ttl=248 time=3.51 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=4 ttl=248 time=1.80 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=5 ttl=248 time=1.88 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=6 ttl=248 time=1.92 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=7 ttl=248 time=1.99 ms
```

3. What is the average round trip time (RTT) from your VM to www.sjtu.edu.cn and mit.edu. Analyze the reason for the difference of their RTTs.

   The average RTT to www.sjtu.edu.cn is 2.167 ms

```
why@why-VirtualBox:~$ ping -c 10 www.sjtu.edu.cn
PING www.sjtu.edu.cn (202.120.2.119) 56(84) bytes of data.
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=1 ttl=248 time=3.31 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=2 ttl=248 time=1.74 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=3 ttl=248 time=1.95 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=4 ttl=248 time=1.55 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=5 ttl=248 time=1.50 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=6 ttl=248 time=1.79 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=7 ttl=248 time=1.67 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=8 ttl=248 time=1.73 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=9 ttl=248 time=3.52 ms
64 bytes from 202.120.2.119 (202.120.2.119): icmp_seq=10 ttl=248 time=2.86 ms

--- www.sjtu.edu.cn ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9016ms
rtt min/avg/max/mdev = 1.507/2.167/3.522/0.724 ms
```

   The average RTT to mit.edu is 197.051 ms

```
why@why-VirtualBox:~$ ping -c 10 mit.edu
PING mit.edu (23.40.167.102) 56(84) bytes of data.
64 bytes from a23-40-167-102.deploy.static.akamaitechnologies.com (23.40.167.102): icmp_seq=1 ttl=40 time=196 ms
64 bytes from a23-40-167-102.deploy.static.akamaitechnologies.com (23.40.167.102): icmp_seq=2 ttl=40 time=196 ms
64 bytes from a23-40-167-102.deploy.static.akamaitechnologies.com (23.40.167.102): icmp_seq=3 ttl=40 time=196 ms
64 bytes from a23-40-167-102.deploy.static.akamaitechnologies.com (23.40.167.102): icmp_seq=4 ttl=40 time=199 ms
64 bytes from a23-40-167-102.deploy.static.akamaitechnologies.com (23.40.167.102): icmp_seq=5 ttl=40 time=197 ms
64 bytes from a23-40-167-102.deploy.static.akamaitechnologies.com (23.40.167.102): icmp_seq=6 ttl=40 time=199 ms
64 bytes from a23-40-167-102.deploy.static.akamaitechnologies.com (23.40.167.102): icmp_seq=7 ttl=40 time=196 ms
64 bytes from a23-40-167-102.deploy.static.akamaitechnologies.com (23.40.167.102): icmp_seq=8 ttl=40 time=196 ms
64 bytes from a23-40-167-102.deploy.static.akamaitechnologies.com (23.40.167.102): icmp_seq=9 ttl=40 time=195 ms
64 bytes from a23-40-167-102.deploy.static.akamaitechnologies.com (23.40.167.102): icmp_seq=10 ttl=40 time=196 ms

--- mit.edu ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9011ms
rtt min/avg/max/mdev = 195.963/197.051/199.769/1.458 ms
```

   The reason for the difference: the server of www.sjtu.edu.cn is closer to my location than the server of mit.edu, so packets go through fewer switches and routers from my VM to www.sjtu.edu.cn, resulting in less delay and smaller average RTT in packet transmission.

4. What is the TCP bandwidth between your two VMs?

   The TCP bandwidth is 35.5 Mbits/sec.

   On the host machine: use the command "iperf3 -l 16 -b 100m -t 30 -c 192.168.164.4 -i 1 -p 16000"

   "-t 30": the duration of date flow is 30s

   "-l 16": the size of packet is 16Bytes

"-b 100m": the bandwidth of data flow

```
why@why-VirtualBox:~$ iperf3 -l 16 -b 100m -t 30 -c 192.168.164.4 -i 1 -p 16000
Connecting to host 192.168.164.4, port 16000
[  4] local 192.168.164.3 port 60760 connected to 192.168.164.4 port 16000

[ ID] Interval           Transfer     Bandwidth       Retr  Cwnd
[  4]   0.00-1.00   sec  3.47 MBytes  29.1 Mbits/sec    0   25.5 KBytes
[  4]   1.00-2.00   sec  3.28 MBytes  27.6 Mbits/sec    0   25.5 KBytes
[  4]   2.00-3.00   sec  3.37 MBytes  28.2 Mbits/sec    0   25.5 KBytes
[  4]   3.00-4.00   sec  3.26 MBytes  27.4 Mbits/sec    0   25.5 KBytes
[  4]   4.00-5.00   sec  3.28 MBytes  27.5 Mbits/sec    0   25.5 KBytes
[  4]   5.00-6.00   sec  3.37 MBytes  28.2 Mbits/sec    0   26.9 KBytes
[  4]   6.00-7.00   sec  4.85 MBytes  40.7 Mbits/sec    0   28.3 KBytes
[  4]   7.00-8.00   sec  3.41 MBytes  28.6 Mbits/sec    0   29.7 KBytes
[  4]   8.00-9.00   sec  3.36 MBytes  28.2 Mbits/sec    0   29.7 KBytes
[  4]   9.00-10.00  sec  3.48 MBytes  29.2 Mbits/sec    0   29.7 KBytes
[  4]  10.00-11.00  sec  4.93 MBytes  41.4 Mbits/sec    0   29.7 KBytes
[  4]  11.00-12.00  sec  5.17 MBytes  43.3 Mbits/sec    0   29.7 KBytes
[  4]  12.00-13.00  sec  4.87 MBytes  40.9 Mbits/sec    0   29.7 KBytes
[  4]  13.00-14.00  sec  4.94 MBytes  41.4 Mbits/sec    0   29.7 KBytes
[  4]  14.00-15.00  sec  4.98 MBytes  41.8 Mbits/sec    0   29.7 KBytes
[  4]  15.00-16.00  sec  5.04 MBytes  42.2 Mbits/sec    0   29.7 KBytes
[  4]  16.00-17.00  sec  4.90 MBytes  41.1 Mbits/sec    0   29.7 KBytes
[  4]  17.00-18.00  sec  4.96 MBytes  41.6 Mbits/sec    0   29.7 KBytes
[  4]  18.00-19.00  sec  4.85 MBytes  40.7 Mbits/sec    0   29.7 KBytes
[  4]  19.00-20.00  sec  4.95 MBytes  41.5 Mbits/sec    0   29.7 KBytes
[  4]  20.00-21.00  sec  4.13 MBytes  34.7 Mbits/sec    0   29.7 KBytes
[  4]  21.00-22.00  sec  4.53 MBytes  38.0 Mbits/sec    0   29.7 KBytes
[  4]  22.00-23.00  sec  4.07 MBytes  34.2 Mbits/sec    0   45.2 KBytes
[  4]  23.00-24.00  sec  4.89 MBytes  41.0 Mbits/sec    0   45.2 KBytes
[  4]  24.00-25.00  sec  4.71 MBytes  39.5 Mbits/sec    0   45.2 KBytes
[  4]  25.00-26.00  sec  4.86 MBytes  40.8 Mbits/sec    0   45.2 KBytes
[  4]  26.00-27.00  sec  4.17 MBytes  35.0 Mbits/sec    0   45.2 KBytes
[  4]  27.00-28.00  sec  3.22 MBytes  27.0 Mbits/sec    0   45.2 KBytes
[  4]  28.00-29.00  sec  3.38 MBytes  28.3 Mbits/sec    0   45.2 KBytes
[  4]  29.00-30.00  sec  3.44 MBytes  28.9 Mbits/sec    0   45.2 KBytes
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Retr
[  4]   0.00-30.00  sec   126 MBytes  35.3 Mbits/sec    0             sender
[  4]   0.00-30.00  sec   126 MBytes  35.3 Mbits/sec                  receiver

iperf Done.
```

On the server machine: use command "iperf3 -s -i 1 -p 16000" to listen on port 16000

```
-----------------------------------------------------------
Server listening on 16000
-----------------------------------------------------------
Accepted connection from 192.168.164.3, port 60758
[  5] local 192.168.164.4 port 16000 connected to 192.168.164.3 port 60760
[ ID] Interval           Transfer     Bandwidth
[  5]   0.00-1.00   sec  3.41 MBytes  28.6 Mbits/sec
[  5]   1.00-2.00   sec  3.35 MBytes  28.1 Mbits/sec
[  5]   2.00-3.00   sec  3.37 MBytes  28.2 Mbits/sec
[  5]   3.00-4.00   sec  3.26 MBytes  27.4 Mbits/sec
[  5]   4.00-5.00   sec  3.28 MBytes  27.5 Mbits/sec
[  5]   5.00-6.00   sec  3.36 MBytes  28.2 Mbits/sec
[  5]   6.00-7.00   sec  4.78 MBytes  40.1 Mbits/sec
[  5]   7.00-8.00   sec  3.44 MBytes  28.9 Mbits/sec
[  5]   8.00-9.00   sec  3.41 MBytes  28.6 Mbits/sec
[  5]   9.00-10.00  sec  3.38 MBytes  28.4 Mbits/sec
[  5]  10.00-11.00  sec  4.94 MBytes  41.5 Mbits/sec
[  5]  11.00-12.00  sec  5.10 MBytes  42.8 Mbits/sec
[  5]  12.00-13.00  sec  4.86 MBytes  40.8 Mbits/sec
[  5]  13.00-14.00  sec  4.98 MBytes  41.7 Mbits/sec
[  5]  14.00-15.00  sec  4.96 MBytes  41.6 Mbits/sec
[  5]  15.00-16.00  sec  5.01 MBytes  42.1 Mbits/sec
[  5]  16.00-17.00  sec  4.90 MBytes  41.1 Mbits/sec
[  5]  17.00-18.00  sec  5.03 MBytes  42.2 Mbits/sec
[  5]  18.00-19.00  sec  4.85 MBytes  40.6 Mbits/sec
[  5]  19.00-20.00  sec  4.92 MBytes  41.3 Mbits/sec
[  5]  20.00-21.00  sec  4.19 MBytes  35.2 Mbits/sec
[  5]  21.00-22.00  sec  4.59 MBytes  38.5 Mbits/sec
[  5]  22.00-23.00  sec  3.91 MBytes  32.8 Mbits/sec
[  5]  23.00-24.00  sec  4.85 MBytes  40.7 Mbits/sec
[  5]  24.00-25.00  sec  4.74 MBytes  39.7 Mbits/sec
[  5]  25.00-26.00  sec  4.84 MBytes  40.6 Mbits/sec
[  5]  26.00-27.00  sec  4.39 MBytes  36.9 Mbits/sec
[  5]  27.00-28.00  sec  3.22 MBytes  27.0 Mbits/sec
[  5]  28.00-29.00  sec  3.38 MBytes  28.3 Mbits/sec
[  5]  29.00-30.00  sec  3.43 MBytes  28.9 Mbits/sec
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth
[  5]   0.00-30.00  sec  0.00 Bytes  0.00 bits/sec                  sender
[  5]   0.00-30.00  sec   126 MBytes  35.3 Mbits/sec                  receiver
-----------------------------------------------------------
Server listening on 16000
-----------------------------------------------------------
```

5. Select a VM as your host machine, and another VM as your server machine, then use ssh on your host to connect to the server.

   On the host machine:

```
why@why-VirtualBox:~$ ssh why@192.168.164.4
The authenticity of host '192.168.164.4 (192.168.164.4)' can't be established.
ECDSA key fingerprint is SHA256:sNsG4s47iOE1O0JySE2SoKQ7iPAGkHFpFH37qJU2I0Q.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '192.168.164.4' (ECDSA) to the list of known hosts.
why@192.168.164.4's password:
Welcome to Ubuntu 18.04.5 LTS (GNU/Linux 5.4.0-66-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage


 * Canonical Livepatch is available for installation.
   - Reduce system reboots and improve kernel security. Activate at:
     https://ubuntu.com/livepatch

80 个可升级软件包。
12 个安全更新。

Your Hardware Enablement Stack (HWE) is supported until April 2023.

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

why@why-VirtualBox:~$
```

On the server machine: first, start the ssh service and then we can check ssh connections using "ps -e | grep ssh" after the host machine have connected.

```
why@why-VirtualBox:~$ sudo service sshd start
why@why-VirtualBox:~$ sudo service sshd status
● ssh.service - OpenBSD Secure Shell server
   Loaded: loaded (/lib/systemd/system/ssh.service; enabled; vendor preset: enabled)
   Active: active (running) since Fri 2021-03-05 09:57:39 CST; 44min ago
  Process: 976 ExecReload=/bin/kill -HUP $MAINPID (code=exited, status=0/SUCCESS)
  Process: 970 ExecReload=/usr/sbin/sshd -t (code=exited, status=0/SUCCESS)
  Process: 693 ExecStartPre=/usr/sbin/sshd -t (code=exited, status=0/SUCCESS)
 Main PID: 704 (sshd)
    Tasks: 1 (limit: 2328)
   CGroup: /system.slice/ssh.service
           └─704 /usr/sbin/sshd -D

3月 05 09:57:40 why-VirtualBox systemd[1]: Reloaded OpenBSD Secure Shell server.
3月 05 09:57:40 why-VirtualBox sshd[704]: Server listening on 0.0.0.0 port 22.
3月 05 09:57:40 why-VirtualBox sshd[704]: Server listening on :: port 22.
3月 05 09:57:40 why-VirtualBox systemd[1]: Reloading OpenBSD Secure Shell server.
3月 05 09:57:40 why-VirtualBox sshd[704]: Received SIGHUP; restarting.
3月 05 09:57:40 why-VirtualBox sshd[704]: Server listening on 0.0.0.0 port 22.
3月 05 09:57:40 why-VirtualBox systemd[1]: Reloaded OpenBSD Secure Shell server.
3月 05 09:57:40 why-VirtualBox sshd[704]: Server listening on :: port 22.
3月 05 10:36:44 why-VirtualBox sshd[2198]: Accepted password for why from 192.168.164.3 port 551
3月 05 10:36:44 why-VirtualBox sshd[2198]: pam_unix(sshd:session): session opened for user why b
lines 1-21/21 (END)
why@why-VirtualBox:~$ ps -e | grep ssh
  704 ?        00:00:00 sshd
 1173 ?        00:00:00 ssh-agent
why@why-VirtualBox:~$ ps -e | grep ssh
  704 ?        00:00:00 sshd
 1173 ?        00:00:00 ssh-agent
 2412 ?        00:00:00 sshd
 2478 ?        00:00:00 sshd
why@why-VirtualBox:~$
```

6. Use scp to copy a file from your host to the server.

In the server machine, create a folder "test" in the "/home" directory and modify the write permission.

```
root@why-VirtualBox:/home# mkdir test
root@why-VirtualBox:/home# chmod 777 test
root@why-VirtualBox:/home# ls
test  why
```

In the host machine, create "a.txt" and copy it to the “/home/test” directory of the server machine.

```
why@why-VirtualBox:~$ vi a.txt
why@why-VirtualBox:~$ scp a.txt why@192.168.164.4:/home/test
why@192.168.164.4's password:
a.txt                                         100%    0     0.0KB/s   00:00
why@why-VirtualBox:~$
```

we can see that in the server machine, "a.txt" appears under the "home/test" directory.

```
root@why-VirtualBox:/home# cd test
root@why-VirtualBox:/home/test# ls
a.txt
root@why-VirtualBox:/home/test#
```