

## Part1:

Time	Source	Destination	Protocol	Length	Info
1 0.000000000	c6:15:db:7b:55:da	Broadcast	ARP	42	Who has 10.0.0.2? Tell 10.0.0.1
2 0.001595390	9a:46:cf:1c:a4:5c	c6:15:db:7b:55:da	ARP	42	10.0.0.2 is at 9a:46:cf:1c:a4:5c
3 0.001598956	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=1/256, ttl=64 (reply in 4)
4 0.001363825	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=1/256, ttl=64 (request in 3)
5 1.001848203	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=2/512, ttl=64 (reply in 6)
6 1.001880518	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=2/512, ttl=64 (request in 5)
7 2.009910564	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=3/768, ttl=64 (reply in 8)
8 2.009943820	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=3/768, ttl=64 (request in 7)
9 3.035512073	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=4/1024, ttl=64 (reply in 10)
10 3.035543202	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=4/1024, ttl=64 (request in 9)
11 4.061269377	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=5/1280, ttl=64 (reply in 12)
12 4.061302847	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=5/1280, ttl=64 (request in 11)
13 5.080982817	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=6/1536, ttl=64 (reply in 14)
14 5.081014763	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=6/1536, ttl=64 (request in 13)
15 5.218575748	9a:46:cf:1c:a4:5c	c6:15:db:7b:55:da	ARP	42	Who has 10.0.0.1? Tell 10.0.0.2
16 5.218587647	c6:15:db:7b:55:da	9a:46:cf:1c:a4:5c	ARP	42	10.0.0.1 is at c6:15:db:7b:55:da
17 6.128098263	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=7/1792, ttl=64 (reply in 18)
18 6.128131417	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=7/1792, ttl=64 (request in 17)
19 7.133791585	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=8/2048, ttl=64 (reply in 20)
20 7.133821417	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=8/2048, ttl=64 (request in 19)
21 8.153946987	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=9/2304, ttl=64 (reply in 22)
22 8.153975182	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=9/2304, ttl=64 (request in 21)
23 9.180770441	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=10/2560, ttl=64 (reply in 24)
24 9.180804362	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=10/2560, ttl=64 (request in 23)
25 10.204601906	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=11/2816, ttl=64 (reply in 26)
26 10.204738955	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=11/2816, ttl=64 (request in 25)
27 11.225714176	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=12/3072, ttl=64 (reply in 28)
28 11.225745667	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=12/3072, ttl=64 (request in 27)
29 12.250236279	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=13/3328, ttl=64 (reply in 30)
30 12.250267924	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=13/3328, ttl=64 (request in 29)
31 13.273302805	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=14/3584, ttl=64 (reply in 32)
32 13.273391924	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=14/3584, ttl=64 (request in 31)
33 14.317185560	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=15/3840, ttl=64 (reply in 34)
34 14.317210798	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=15/3840, ttl=64 (request in 33)
35 14.425004396	fe80::4a81:e6ff:fe2::2	ff02::2	ICMPv6	70	Router Solicitation from 46:81:e6:2b:3c:c0
36 15.322512372	10.0.0.1	10.0.0.2	ICMP	98	Echo (ping) request id=0x099b, seq=16/4096, ttl=64 (reply in 37)
37 15.322543042	10.0.0.2	10.0.0.1	ICMP	98	Echo (ping) reply id=0x099b, seq=16/4096, ttl=64 (request in 36)

Frame 1: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on interface sl-eth1, id 1  
Ethernet II, Src: c6:15:db:7b:55:da (c6:15:db:7b:55:da), Dst: Broadcast (ff:ff:ff:ff:ff:ff)  
Address Resolution Protocol (request)

## Part2:

### 1. tshark

sudo tshark -f 'icmp and src or dst host 8.8.8.8' -w 'packet01.pcapng'

```
cindy@cindy-VirtualBox:~/TCP/IP/TCP/IP_HW2$ sudo tshark -f 'icmp and src or dst host 8.8.8.8' -w 'packet01.pcapng'
Running as user "root" and group "root". This could be dangerous.
Capturing on 'enp0s3'
** (tshark:3660) 14:05:27.141603 [Main MESSAGE] -- Capture started.
** (tshark:3660) 14:05:27.141817 [Main MESSAGE] -- File: "packet01.pcapng"
20 ^C
```

ping 8.8.8.8 ping 208.67.220.220

```
cindy@cindy-VirtualBox:~$ ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8) 56(84) bytes of data.
64 bytes from 8.8.8.8: icmp_seq=1 ttl=115 time=8.19 ms
64 bytes from 8.8.8.8: icmp_seq=2 ttl=115 time=13.4 ms
64 bytes from 8.8.8.8: icmp_seq=3 ttl=115 time=8.22 ms
64 bytes from 8.8.8.8: icmp_seq=4 ttl=115 time=8.39 ms
64 bytes from 8.8.8.8: icmp_seq=5 ttl=115 time=7.80 ms
64 bytes from 8.8.8.8: icmp_seq=6 ttl=115 time=17.4 ms
64 bytes from 8.8.8.8: icmp_seq=7 ttl=115 time=8.66 ms
64 bytes from 8.8.8.8: icmp_seq=8 ttl=115 time=7.39 ms
64 bytes from 8.8.8.8: icmp_seq=9 ttl=115 time=19.3 ms
64 bytes from 8.8.8.8: icmp_seq=10 ttl=115 time=7.26 ms
^C
--- 8.8.8.8 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9029ms
rtt min/avg/max/mdev = 7.256/10.612/19.346/4.251 ms
cindy@cindy-VirtualBox:~$ ping 208.67.220.220
PING 208.67.220.220 (208.67.220.220) 56(84) bytes of data.
64 bytes from 208.67.220.220: icmp_seq=1 ttl=47 time=39.2 ms
64 bytes from 208.67.220.220: icmp_seq=2 ttl=47 time=35.0 ms
64 bytes from 208.67.220.220: icmp_seq=3 ttl=47 time=34.7 ms
64 bytes from 208.67.220.220: icmp_seq=4 ttl=47 time=34.9 ms
64 bytes from 208.67.220.220: icmp_seq=5 ttl=47 time=35.8 ms
64 bytes from 208.67.220.220: icmp_seq=6 ttl=47 time=35.6 ms
64 bytes from 208.67.220.220: icmp_seq=7 ttl=47 time=34.8 ms
64 bytes from 208.67.220.220: icmp_seq=8 ttl=47 time=48.4 ms
64 bytes from 208.67.220.220: icmp_seq=9 ttl=47 time=71.0 ms
64 bytes from 208.67.220.220: icmp_seq=10 ttl=47 time=34.8 ms
^C
--- 208.67.220.220 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9038ms
rtt min/avg/max/mdev = 34.726/40.424/71.040/10.972 ms
```

sudo tshark -r packet01.pcapng

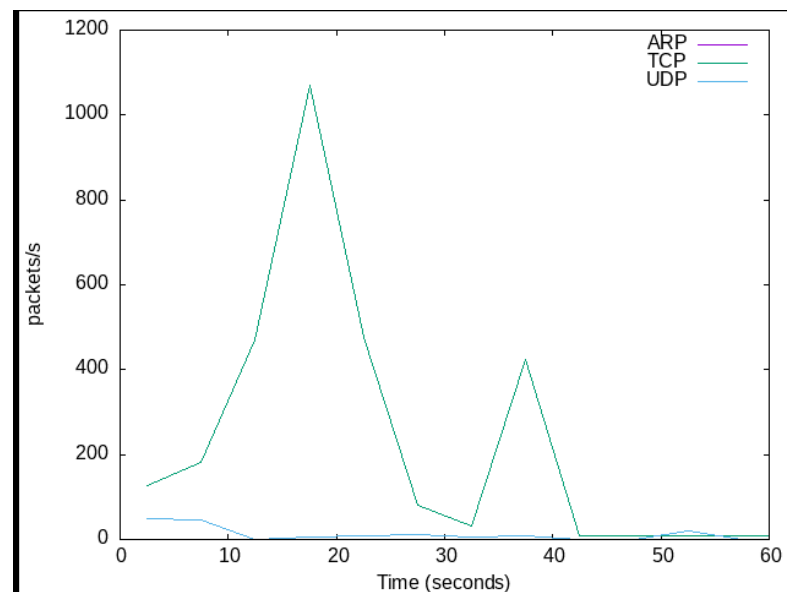
```
cindy@cindy-VirtualBox: ~/TCPIP/TCPIP_HW2$ sudo tshark -r packet01.pcapng
Running as user "root" and group "root". This could be dangerous.
 1 0.000000000 10.0.2.15 → 8.8.8.8 ICMP 98 Echo (ping) request id=0x0004, seq=1/256, ttl=64
 2 0.008162754 8.8.8.8 → 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0004, seq=1/256, ttl=115 (request in 1)
 3 1.002134536 10.0.2.15 → 8.8.8.8 ICMP 98 Echo (ping) request id=0x0004, seq=2/512, ttl=64
 4 1.015532145 8.8.8.8 → 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0004, seq=2/512, ttl=115 (request in 3)
 5 2.003291215 10.0.2.15 → 8.8.8.8 ICMP 98 Echo (ping) request id=0x0004, seq=3/768, ttl=64
 6 2.011486466 8.8.8.8 → 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0004, seq=3/768, ttl=115 (request in 5)
 7 3.010641432 10.0.2.15 → 8.8.8.8 ICMP 98 Echo (ping) request id=0x0004, seq=4/1024, ttl=64
 8 3.019000053 8.8.8.8 → 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0004, seq=4/1024, ttl=115 (request in 7)
 9 4.011760455 10.0.2.15 → 8.8.8.8 ICMP 98 Echo (ping) request id=0x0004, seq=5/1280, ttl=64
10 4.019510740 8.8.8.8 → 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0004, seq=5/1280, ttl=115 (request in 9)
11 5.018522495 10.0.2.15 → 8.8.8.8 ICMP 98 Echo (ping) request id=0x0004, seq=6/1536, ttl=64
12 5.035887481 8.8.8.8 → 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0004, seq=6/1536, ttl=115 (request in 11)
13 6.020459448 10.0.2.15 → 8.8.8.8 ICMP 98 Echo (ping) request id=0x0004, seq=7/1792, ttl=64
14 6.029090358 8.8.8.8 → 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0004, seq=7/1792, ttl=115 (request in 13)
15 7.028234267 10.0.2.15 → 8.8.8.8 ICMP 98 Echo (ping) request id=0x0004, seq=8/2048, ttl=64
16 7.035593157 8.8.8.8 → 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0004, seq=8/2048, ttl=115 (request in 15)
17 8.030924223 10.0.2.15 → 8.8.8.8 ICMP 98 Echo (ping) request id=0x0004, seq=9/2304, ttl=64
18 8.050239606 8.8.8.8 → 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0004, seq=9/2304, ttl=115 (request in 17)
19 9.033035157 10.0.2.15 → 8.8.8.8 ICMP 98 Echo (ping) request id=0x0004, seq=10/2560, ttl=64
20 9.040266698 8.8.8.8 → 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0004, seq=10/2560, ttl=115 (request in 19)
```

## 2. tcpstat

sudo tcpstat -f 'icmp'

```
cindy@cindy-VirtualBox: ~/TCPIP/TCPIP_HW2$ sudo tcpstat -f 'icmp'
[sudo] password for cindy:
Listening on enp0s3
Time:1663569361 n=10 avg=84.00 stddev=0.00 bps=1344.00
Time:1663569366 n=10 avg=84.00 stddev=0.00 bps=1344.00
^CTime:1663569371 n=6 avg=84.00 stddev=0.00 bps=806.40
```

## 3. tcpdump & tcpstat & gnuplot



## 4. mininet & iperf & gnuplot

### 4-1.

Iperf 是網絡性能測試工具，它可以用來測量網絡 bandwidth，也可以顯示網絡延遲抖動、丟包率等訊息。當網路出現問題時，可以利用它來測試，來了解問題出在哪裡。

## 4-2.

sudo mn

TCP(1hop)

```
"Node: h1"
root@cindy-VirtualBox:/home/cindy# iperf3 -s
server listening on 5201
Accepted connection from 10.0.0.2, port 43398
[ 7] local 10.0.0.1 port 5201 connected to 10.0.0.2 port 43402
[ ID] Interval      Transfer      Bitrate
[ 7] 0.00-1.00 sec  2.31 GBytes  19.8 Gbits/sec
[ 7] 1.00-2.00 sec  2.68 GBytes  23.0 Gbits/sec
[ 7] 2.00-3.00 sec  2.45 GBytes  21.1 Gbits/sec
[ 7] 3.00-4.00 sec  2.52 GBytes  21.6 Gbits/sec
[ 7] 4.00-5.00 sec  2.64 GBytes  22.7 Gbits/sec
[ 7] 5.00-6.00 sec  2.45 GBytes  21.0 Gbits/sec
[ 7] 6.00-7.02 sec  2.23 GBytes  18.7 Gbits/sec
[ 7] 7.02-8.00 sec  1.95 GBytes  17.1 Gbits/sec
[ 7] 8.00-9.00 sec  2.37 GBytes  20.4 Gbits/sec
[ 7] 9.00-10.00 sec 2.59 GBytes  23.1 Gbits/sec
[ 7] 10.00-10.00 sec 256 KBytes   9.80 Gbits/sec
-----
[ ID] Interval      Transfer      Bitrate
[ 7] 0.00-10.00 sec 24.3 GBytes  20.9 Gbits/sec
receiver
Server listening on 5201

"Node: h2"
root@cindy-VirtualBox:/home/cindy# iperf3 -c 10.0.0.1 > "TCP1hop"
root@cindy-VirtualBox:/home/cindy#
```

UCP(1hop)

```
"Node: h1"
Accepted connection from 10.0.0.2, port 42004
[ 7] local 10.0.0.1 port 5201 connected to 10.0.0.2 port 59579
[ ID] Interval      Transfer      Bitrate      Jitter    Lost/Totl  Datag
[ 7] 0.00-1.00 sec  11.4 MBytes  95.4 Mbits/sec  0.019 ms  381/8620 (4.4%)
[ 7] 1.00-2.00 sec  11.8 MBytes  99.3 Mbits/sec  0.017 ms  0/8576 (0%)
[ 7] 2.00-3.00 sec  11.9 MBytes  99.2 Mbits/sec  0.003 ms  93/8686 (1.1%)
[ 7] 3.00-4.00 sec  11.9 MBytes  99.8 Mbits/sec  0.307 ms  0/8501 (0%)
[ 7] 4.00-5.00 sec  11.3 MBytes  100 Mbits/sec  0.000 ms  0/8553 (0%)
[ 7] 5.00-6.00 sec  12.0 MBytes  101 Mbits/sec  0.015 ms  0/8554 (0%)
[ 7] 6.00-7.00 sec  10.1 MBytes  84.8 Mbits/sec  0.237 ms  1232/8619 (15%)
[ 7] 7.00-8.00 sec  11.4 MBytes  95.7 Mbits/sec  0.011 ms  404/8650 (4.7%)
[ 7] 8.00-9.00 sec  10.5 MBytes  88.0 Mbits/sec  0.035 ms  1032/8630 (12%)
[ 7] 9.00-10.00 sec 11.6 MBytes  97.4 Mbits/sec  0.004 ms  213/8626 (2.5%)
-----
[ ID] Interval      Transfer      Bitrate      Jitter    Lost/Totl  Datag
[SUM] 0.0-10.0 sec 30 datagrams received out-of-order
[ 7] 0.00-10.00 sec 114 MBytes  96.0 Mbits/sec  0.004 ms  3421/86315 (4%)
receiver
Server listening on 5201

"Node: h2"
root@cindy-VirtualBox:/home/cindy# iperf3 -u -c 10.0.0.1 -b 100m > "UCP1hop"
-f3: error - unable to send control message: Bad file descriptor
root@cindy-VirtualBox:/home/cindy# iperf3 -u -c 10.0.0.1 -b 100m > "UCP1hop"
root@cindy-VirtualBox:/home/cindy#
```

sudo mn -topo=linear,3

TCP(3hop)

```
"Node: h1"
root@cindy-VirtualBox:/home/cindy# iperf3 -s
Server listening on 5201
Accepted connection from 10.0.0.3, port 34952
[ 7] local 10.0.0.1 port 5201 connected to 10.0.0.3 port 34954
[ ID] Interval      Transfer      Bitrate
[ 7] 0.00-1.00 sec  2.27 GBytes  19.5 Gbits/sec
[ 7] 1.00-2.00 sec  2.50 GBytes  22.1 Gbits/sec
[ 7] 2.00-3.00 sec  2.28 GBytes  19.6 Gbits/sec
[ 7] 3.00-4.00 sec  2.66 GBytes  22.8 Gbits/sec
[ 7] 4.00-5.00 sec  2.48 GBytes  21.3 Gbits/sec
[ 7] 5.00-6.00 sec  2.50 GBytes  21.5 Gbits/sec
[ 7] 6.00-7.00 sec  2.56 GBytes  22.0 Gbits/sec
[ 7] 7.00-8.00 sec  2.35 GBytes  20.2 Gbits/sec
[ 7] 8.00-9.00 sec  2.11 GBytes  18.2 Gbits/sec
[ 7] 9.00-10.00 sec 2.49 GBytes  21.4 Gbits/sec
-----
[ ID] Interval      Transfer      Bitrate
[ 7] 0.00-10.00 sec 24.3 GBytes  20.9 Gbits/sec
receiver
Server listening on 5201

"Node: h3"
root@cindy-VirtualBox:/home/cindy# iperf3 -c 10.0.0.1 > "TCP3hop"
root@cindy-VirtualBox:/home/cindy#
```

UCP(3hop)

"Node: h1"  
root@cindy-VirtualBox:/home/cindy# iperf3 -s  
Server listening on 5201  
Accepted connection from 10.0.0.3, port 46366  
[ 7] local 10.0.0.1 port 5201 connected to 10.0.0.3 port 55181  
[ ID] Interval Transfer Bitrate Jitter Lost/Totals Data  
rans  
[ 7] 0.00-1.00 sec 10.7 MBytes 89.7 Mbits/sec 0.041 ms 874/8621 (10%)  
[ 7] 1.00-2.00 sec 11.6 MBytes 96.9 Mbits/sec 0.035 ms 233/8616 (2.7%)  
[ 7] 2.00-3.00 sec 11.2 MBytes 94.0 Mbits/sec 0.026 ms 553/8653 (6.4%)  
[ 7] 3.00-4.00 sec 11.5 MBytes 96.8 Mbits/sec 0.034 ms 275/8636 (3.2%)  
[ 7] 4.00-5.00 sec 11.9 MBytes 99.5 Mbits/sec 0.002 ms 29/8630 (0.34%)  
[ 7] 5.00-6.00 sec 11.9 MBytes 100 Mbits/sec 0.039 ms 0/8635 (0%)  
[ 7] 6.00-7.00 sec 11.8 MBytes 98.8 Mbits/sec 0.068 ms 99/8624 (1.1%)  
[ 7] 7.00-8.00 sec 11.9 MBytes 99.6 Mbits/sec 0.015 ms 41/8640 (0.47%)  
[ 7] 8.00-9.00 sec 11.8 MBytes 98.9 Mbits/sec 0.051 ms 96/8635 (1.1%)  
[ 7] 9.00-10.00 sec 11.3 MBytes 94.8 Mbits/sec 0.036 ms 449/8632 (5.2%)  
[ ID] Interval Transfer Bitrate Jitter Lost/Totals Data  
rans  
[ 7] 0.00-10.00 sec 116 MBytes 96.9 Mbits/sec 0.036 ms 2649/86322 (3.1%)  
Adding switches:  
s1 s2 s3  
\*\*\* Adding links:

"Node: h3"  
root@cindy-VirtualBox:/home/cindy# iperf3 -u -c 10.0.0.1 -b 100m > "UCP3hop"  
root@cindy-VirtualBox:/home/cindy#

sudo mn -topo=linear,5

TCP(5hop)

"Node: h1"  
root@cindy-VirtualBox:/home/cindy# iperf3 -s  
Server listening on 5201  
Accepted connection from 10.0.0.5, port 47322  
[ 7] local 10.0.0.1 port 5201 connected to 10.0.0.5 port 47336  
[ ID] Interval Transfer Bitrate  
[ 7] 0.00-1.00 sec 1.86 GBytes 16.0 Gbits/sec  
[ 7] 1.00-2.00 sec 2.08 GBytes 17.9 Gbits/sec  
[ 7] 2.00-3.00 sec 2.08 GBytes 17.8 Gbits/sec  
[ 7] 3.00-4.00 sec 1.92 GBytes 16.5 Gbits/sec  
[ 7] 4.00-5.00 sec 2.33 GBytes 20.0 Gbits/sec  
[ 7] 5.00-6.00 sec 2.26 GBytes 19.4 Gbits/sec  
[ 7] 6.00-7.00 sec 2.19 GBytes 18.8 Gbits/sec  
[ 7] 7.00-8.00 sec 2.26 GBytes 19.4 Gbits/sec  
[ 7] 8.00-9.00 sec 2.14 GBytes 18.4 Gbits/sec  
[ 7] 9.00-10.00 sec 1.96 GBytes 16.9 Gbits/sec  
[ 7] 10.00-10.00 sec 4.50 MBytes 17.2 Gbits/sec  
[ ID] Interval Transfer Bitrate  
[ 7] 0.00-10.00 sec 21.1 GBytes 18.1 Gbits/sec  
receiver  
Server listening on 5201

"Node: h5"  
root@cindy-VirtualBox:/home/cindy# iperf3 -c 10.0.0.1 > "TCP5hop"  
iperf3: error - unable to send control message: Bad file descriptor  
root@cindy-VirtualBox:/home/cindy#  
root@cindy-VirtualBox:/home/cindy# iperf3 -c 10.0.0.1 > "TCP5hop"  
root@cindy-VirtualBox:/home/cindy#

UCP(5hop)

"Node: h1"  
Server listening on 5201  
iperf3: interrupt - the server has terminated  
root@cindy-VirtualBox:/home/cindy# iperf3 -s  
Server listening on 5201  
Accepted connection from 10.0.0.5, port 39578  
[ 7] local 10.0.0.1 port 5201 connected to 10.0.0.5 port 35717  
[ ID] Interval Transfer Bitrate Jitter Lost/Totals Data  
rans  
[ 7] 0.00-1.00 sec 11.5 MBytes 96.1 Mbits/sec 0.089 ms 329/8624 (3.8%)  
[ 7] 1.00-2.00 sec 11.2 MBytes 94.3 Mbits/sec 0.106 ms 476/8621 (5.5%)  
[ 7] 2.00-3.00 sec 11.8 MBytes 99.0 Mbits/sec 0.003 ms 86/8632 (1%)  
[ 7] 3.00-4.00 sec 11.6 MBytes 97.1 Mbits/sec 0.049 ms 263/8643 (3%)  
[ 7] 4.00-5.00 sec 11.7 MBytes 97.7 Mbits/sec 0.043 ms 192/8631 (2.2%)  
[ 7] 5.00-6.00 sec 11.9 MBytes 99.4 Mbits/sec 0.043 ms 0/8606 (0%)  
[ 7] 6.00-7.00 sec 11.9 MBytes 100 Mbits/sec 0.010 ms 0/8639 (0%)  
[ 7] 7.00-8.00 sec 11.9 MBytes 99.5 Mbits/sec 0.005 ms 0/8615 (0%)  
[ 7] 8.00-9.00 sec 11.3 MBytes 94.7 Mbits/sec 0.024 ms 516/8673 (5.9%)  
[ 7] 9.00-10.00 sec 11.8 MBytes 99.3 Mbits/sec 0.010 ms 60/8637 (0.68%)  
[ ID] Interval Transfer Bitrate Jitter Lost/Totals Data  
rans  
[ 7] 0.00-10.00 sec 117 MBytes 97.7 Mbits/sec 0.010 ms 1922/86321 (2.2%)

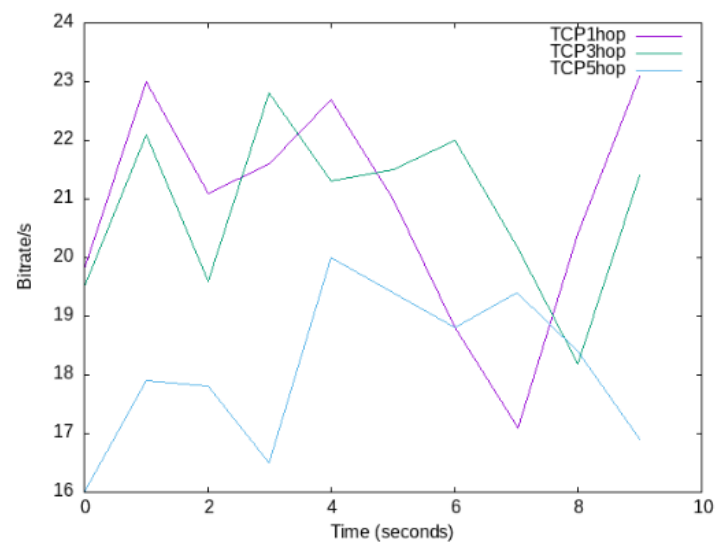
"Node: h5"  
root@cindy-VirtualBox:/home/cindy# iperf3 -c 10.0.0.1 > "TCP5hop"  
iperf3: error - unable to send control message: Bad file descriptor  
root@cindy-VirtualBox:/home/cindy#  
root@cindy-VirtualBox:/home/cindy# iperf3 -c 10.0.0.1 > "TCP5hop"  
root@cindy-VirtualBox:/home/cindy# iperf3 -u -c 10.0.0.1 -b 100m > "UCP5hop"  
root@cindy-VirtualBox:/home/cindy#  
"UCP1hop" selected (1.1 kB)

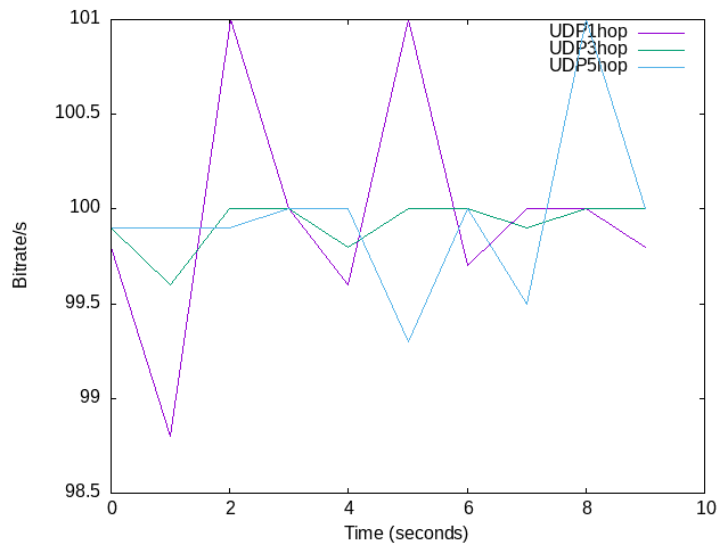
### 4-3.

```
cindy@cindy-VirtualBox:~/TCPIP/TCPIP_HW2$ cat TCP1hop | grep Gbits | tr - " " |h
ead -10 | awk {'print $3,$8'} > TCP1hopf
cindy@cindy-VirtualBox:~/TCPIP/TCPIP_HW2$ cat TCP3hop | grep Gbits | tr - " " |h
ead -10 | awk {'print $3,$8'} > TCP3hopf
cindy@cindy-VirtualBox:~/TCPIP/TCPIP_HW2$ cat TCP5hop | grep Gbits | tr - " " |h
ead -10 | awk {'print $3,$8'} > TCP5hopf
cindy@cindy-VirtualBox:~/TCPIP/TCPIP_HW2$ cat UDP5hop | grep Mbits | tr - " " |h
ead -10 | awk {'print $3,$8'} > UDP5hopf
cindy@cindy-VirtualBox:~/TCPIP/TCPIP_HW2$ cat UDP3hop | grep Mbits | tr - " " |h
ead -10 | awk {'print $3,$8'} > UDP3hopf
cindy@cindy-VirtualBox:~/TCPIP/TCPIP_HW2$ cat UDP1hop | grep Mbits | tr - " " |h
ead -10 | awk {'print $3,$8'} > UDP1hopf
```

```
script2
~/TCPIP/TCPIP_HW2
1 set terminal png
2 set style data lines
3 set xlabel "Time (seconds)"
4 set ylabel "Bitrate/s"
5 plot [00:10] "TCP1hopf" using 1:2 title "TCP1hop", \
6      "TCP3hopf" using 1:2 title "TCP3hop", \
7      "TCP5hopf" using 1:2 title "TCP5hop"
```

```
script3
~/TCPIP/TCPIP_HW2
1 set terminal png
2 set style data lines
3 set xlabel "Time (seconds)"
4 set ylabel "Bitrate/s"
5 plot [00:10] "UDP1hopf" using 1:2 title "UDP1hop", \
6      "UDP3hopf" using 1:2 title "UDP3hop", \
7      "UDP5hopf" using 1:2 title "UDP5hop"
```





#### 4-4.

TCP 1、3、5node 的 bitrate 差異很比較大，而 UDP 差異比較小，TCP 要經過三方交握，會有延遲、封包掉了又要重傳，而 UDP 能傳多快就傳多快，不管封包有沒有準確送達，就繼續傳下一個封包，所以差異比較小。

#### 5.

```

root@cindy-VirtualBox:/home/cindy/TCP/IP/TCP_IP_HW2# netperf -t TCP_STREAM -H 10.0.0.1 -l 60
MIGRATED TCP STREAM TEST from 0.0.0.0 (0.0.0.0) port 0 AF_INET to 10.0.0.1 () port 0 AF_INET : demo
Recv Send Send
Socket Socket Message Elapsed
Size Size Size Time Throughput
bytes bytes bytes secs. 10^6bits/sec
87380 87380 87380 60.03 14916.69

root@cindy-VirtualBox:/home/cindy/TCP/IP/TCP_IP_HW2# netperf -t UDP_STREAM -H 10.0.0.1 -l 60
MIGRATED UDP STREAM TEST from 0.0.0.0 (0.0.0.0) port 0 AF_INET to 10.0.0.1 () port 0 AF_INET : demo
Socket Message Elapsed Messages
Size Size Time Okay Errors Throughput
bytes bytes secs # # 10^6bits/sec
212992 65507 60.01 402616 0 3515.88
212992 65507 60.01 394468 0 3444.72

```