

LAPORAN

TUGAS BESAR

Disusun untuk memenuhi tugas

Mata Kuliah: Jaringan Komputer

Dosen Pengampu: Dita Oktaria, S.Kom, M.T.



Oleh:

M NAUFAL RIFQI RAMDHANI (1301201572)

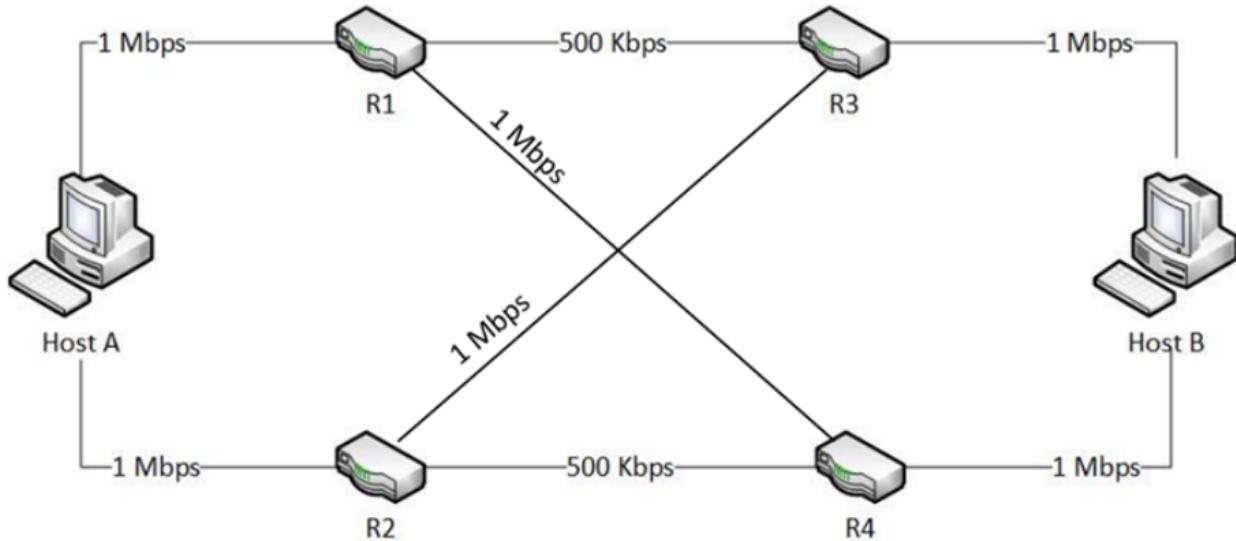
**KELAS IF-44-01
JURUSAN S1 INFORMATIKA
FAKULTAS INFORMATIKA
UNIVERSITAS TELKOM**

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DESKRIPSI TUGAS

Pada tugas besar mata kuliah jaringan komputer kali ini kita diminta untuk membangun topologi dengan spesifikasi sebagai berikut :



Setelah membangun topologi seperti gambar diatas, kita juga diminta untuk memenuhi beberapa CLO, diantaranya :

- CLO 1 (Subnet + bangun topologi)

Pada CLO 1, kita diminta untuk mendesain subnet masing-masing network, assign IP sesuai subnet dan menguji koneksi antara 2 host yang berada dalam 1 network.

- CLO 2 (Static Routing)

Pada CLO 2, kita diminta untuk mengimplementasikan mekanisme Routing pada topologi yang sudah dibuat, menguji koneksi menggunakan ping, membuat tabel routing di semua host, dibuktikan dengan ping antar host dan menganalisis routing yang digunakan menggunakan traceroute.

- CLO 3 (Capture traffic TCP)

Pada CLO 3, kita diminta untuk membuktikan bahwa TCP telah diimplementasikan dengan benar pada topologi, mengenerate traffic menggunakan iPerf, mengcapture trafik menggunakan custom script atau Wireshark untuk diinspeksi, dibuktikan dengan trafik di Wireshark/tcpdump.

- CLO 4 (Buffer)

Pada CLO 4, kita diminta untuk menginspeksi penggunaan queue pada router jaringan, mengenerate traffic menggunakan iPerf, mengatur ukuran buffer pada router : 20, 40, 60 dan 100, mengcapture pengaruh ukuran buffer terhadap delay, menganalisis eksperimen hasil variasi ukuran buffer dan memahami caranya mengubah buffer dan mengenai pengaruh besar buffer.

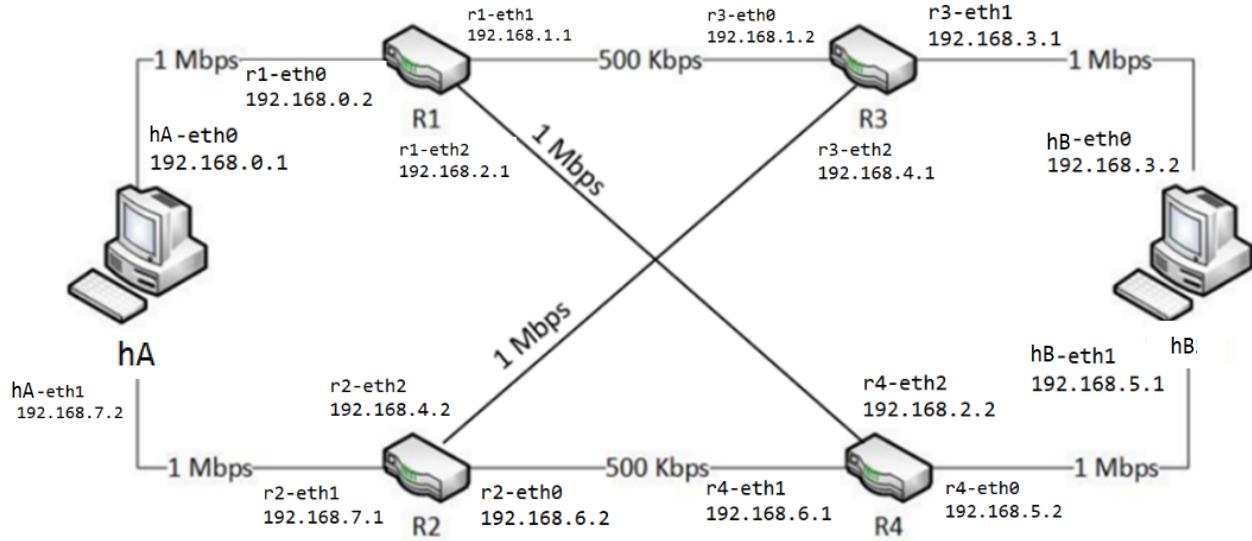
PEMBAHASAN

1. CLO 1

1.1. Tabel Subnetting

Nama	Needs	Alokasi	Network ID	Host Range	Broadcast	Prefix	Subnet Mask
Net 1	2	254	192.168.0.0	192.168.0.1 - 192.168.0.254	192.168.0.255	/24	255.255.255.0
Net 2	2	254	192.168.1.0	192.168.1.1 - 192.168.1.254	192.168.1.255	/24	255.255.255.0
Net 3	2	254	192.168.2.0	192.168.2.1 - 192.168.2.254	192.168.2.255	/24	255.255.255.0
Net 4	2	254	192.168.3.0	192.168.3.1 - 192.168.3.254	192.168.3.255	/24	255.255.255.0
Net 5	2	254	192.168.4.0	192.168.4.1 - 192.168.4.254	192.168.4.255	/24	255.255.255.0
Net 6	2	254	192.168.5.0	192.168.5.1 - 192.168.5.254	192.168.5.255	/24	255.255.255.0
Net 7	2	254	192.168.6.0	192.168.6.1 - 192.168.6.254	192.168.6.255	/24	255.255.255.0
Net 8	2	254	192.168.7.0	192.168.7.1 - 192.168.7.254	192.168.7.255	/24	255.255.255.0

1.2. Desain Topologi



1.3. Source Code

Berikut adalah source code untuk membangun topologi dan mengassign kan IP kedalamnya.

```
*Tubes.py
-/TUBES_Jarkom
Open Save
1 from mininet.net import Mininet
2 from mininet.cli import CLI
3 from mininet.link import Link, TCLink, Intf
4 from subprocess import Popen, PIPE
5 from mininet.log import setLogLevel
6
7 if '__main__' == __name__:
8     setLogLevel('Info')
9     net = Mininet(link=TCLink)
10    value = 0
11
12    #Add Host
13    hA = net.addHost('hA')
14    hB = net.addHost('hB')
15
16    #Add Router
17    r1 = net.addHost('r1')
18    r2 = net.addHost('r2')
19    r3 = net.addHost('r3')
20    r4 = net.addHost('r4')
21
22    #Add Link
23    net.addLink(r1, hA, intfName1 = 'r1-eth0', intfName2 = 'hA-eth0', cls=TCLink, bw=1)
24    net.addLink(r1, r3, intfName1 = 'r1-eth1', intfName2 = 'r3-eth0', cls=TCLink, bw=0.5)
25    net.addLink(r3, hB, intfName1 = 'r3-eth1', intfName2 = 'hB-eth0', cls=TCLink, bw=1)
26    net.addLink(hB, r4, intfName1 = 'hB-eth1', intfName2 = 'r4-eth0', cls=TCLink, bw=1)
27    net.addLink(r4, r2, intfName1 = 'r4-eth1', intfName2 = 'r2-eth0', cls=TCLink, bw=0.5)
28    net.addLink(r2, hA, intfName1 = 'r2-eth1', intfName2 = 'hA-eth1', cls=TCLink, bw=1)
29    net.addLink(r1, r4, intfName1 = 'r1-eth2', intfName2 = 'r4-eth2', cls=TCLink, bw=1)
30    net.addLink(r2, r3, intfName1 = 'r2-eth2', intfName2 = 'r3-eth2', cls=TCLink, bw=1)
31    net.build()
32
33    #Config Host
34    hA.cmd("ifconfig hA-eth0 0")
35    hA.cmd("ifconfig hA-eth1 0")
36    hA.cmd("ifconfig hA-eth0 192.168.0.1 netmask 255.255.255.0")
37    hA.cmd("ifconfig hA-eth1 192.168.7.2 netmask 255.255.255.0")
```

```

38     hB.cmd("ifconfig hB-eth0 0")
39     hB.cmd("ifconfig hB-eth1 0")
40     hB.cmd("ifconfig hB-eth0 192.168.3.2 netmask 255.255.255.0")
41     hB.cmd("ifconfig hB-eth1 192.168.5.1 netmask 255.255.255.0")
42
43     #Config Router
44     r1.cmd("echo 1 > /proc/sys/net/ipv4/ip_forward")
45     r2.cmd("echo 2 > /proc/sys/net/ipv4/ip_forward")
46     r3.cmd("echo 3 > /proc/sys/net/ipv4/ip_forward")
47     r4.cmd("echo 4 > /proc/sys/net/ipv4/ip_forward")
48
49     r1.cmd("ifconfig r1-eth0 0")
50     r1.cmd("ifconfig r1-eth1 0")
51     r1.cmd("ifconfig r1-eth2 0")
52     r1.cmd("ifconfig r1-eth0 192.168.0.2 netmask 255.255.255.0")
53     r1.cmd("ifconfig r1-eth1 192.168.1.1 netmask 255.255.255.0")
54     r1.cmd("ifconfig r1-eth2 192.168.2.1 netmask 255.255.255.0")
55
56     r2.cmd("ifconfig r2-eth0 0")
57     r2.cmd("ifconfig r2-eth1 0")
58     r2.cmd("ifconfig r2-eth2 0")
59     r2.cmd("ifconfig r2-eth0 192.168.6.2 netmask 255.255.255.0")
60     r2.cmd("ifconfig r2-eth1 192.168.7.1 netmask 255.255.255.0")
61     r2.cmd("ifconfig r2-eth2 192.168.4.2 netmask 255.255.255.0")
62
63     r3.cmd("ifconfig r3-eth0 0")
64     r3.cmd("ifconfig r3-eth1 0")
65     r3.cmd("ifconfig r3-eth2 0")
66     r3.cmd("ifconfig r3-eth0 192.168.1.2 netmask 255.255.255.0")
67     r3.cmd("ifconfig r3-eth1 192.168.3.1 netmask 255.255.255.0")
68     r3.cmd("ifconfig r3-eth2 192.168.4.1 netmask 255.255.255.0")
69
70     r4.cmd("ifconfig r4-eth0 0")
71     r4.cmd("ifconfig r4-eth1 0")
72     r4.cmd("ifconfig r4-eth2 0")
73     r4.cmd("ifconfig r4-eth0 192.168.5.2 netmask 255.255.255.0")
74     r4.cmd("ifconfig r4-eth1 192.168.6.1 netmask 255.255.255.0")
75
76     r4.cmd("ifconfig r4-eth2 192.168.2.2 netmask 255.255.255.0")
77
78     CLI(net)
79     net.stop()

```

1.4. Konfigurasi Topologi Jaringan

```

mininet> net
hA hA-eth0:r1-eth0 hA-eth1:r2-eth1
hB hB-eth0:r3-eth1 hB-eth1:r4-eth0
r1 r1-eth0:hA-eth0 r1-eth1:r3-eth0 r1-eth2:r4-eth2
r2 r2-eth0:r4-eth1 r2-eth1:hA-eth1 r2-eth2:r3-eth2
r3 r3-eth0:r1-eth1 r3-eth1:hB-eth0 r3-eth2:r2-eth2
r4 r4-eth0:hB-eth1 r4-eth1:r2-eth0 r4-eth2:r1-eth2

```

1.5. Uji Konektivitas yang berada pada satuan jaringan

```

naufal@NaufalRifqi:~/TUBES_Jarkom$ sudo su
root@NaufalRifqi:/home/naufal/TUBES_Jarkom# python3 Tubes.py
(1.00Mbit) (1.00Mbit) (0.50Mbit) (0.50Mbit) (1.00Mbit) (1.00Mbit) (1.00Mbit) (0.50Mbit) (0.50Mbit) (1.00Mbit) (1.00Mbit) *** configuring hosts
hA hB r1 r2 r3 r4
*** Starting CLI:
mininet> hA ping r1 -c 1
PING 192.168.0.2 (192.168.0.2) 56(84) bytes of data.
64 bytes from 192.168.0.2: icmp_seq=1 ttl=64 time=0.060 ms

--- 192.168.0.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.060/0.060/0.060/0.000 ms
mininet> r1 ping r3 -c 1
PING 192.168.1.2 (192.168.1.2) 56(84) bytes of data.
64 bytes from 192.168.1.2: icmp_seq=1 ttl=64 time=0.088 ms

--- 192.168.1.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.088/0.088/0.088/0.000 ms
mininet> r3 ping hB -c 1
PING 192.168.3.2 (192.168.3.2) 56(84) bytes of data.
64 bytes from 192.168.3.2: icmp_seq=1 ttl=64 time=0.053 ms

--- 192.168.3.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.053/0.053/0.053/0.000 ms
mininet> hB ping r4 -c 1
PING 192.168.5.2 (192.168.5.2) 56(84) bytes of data.
64 bytes from 192.168.5.2: icmp_seq=1 ttl=64 time=0.063 ms

--- 192.168.5.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.063/0.063/0.063/0.000 ms
mininet> r4 ping r2 -c 1
PING 192.168.6.2 (192.168.6.2) 56(84) bytes of data.
64 bytes from 192.168.6.2: icmp_seq=1 ttl=64 time=0.073 ms

```

```

--- 192.168.6.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.073/0.073/0.073/0.000 ms
mininet> r2 ping 192.168.7.2 -c 1
PING 192.168.7.2 (192.168.7.2) 56(84) bytes of data.
64 bytes from 192.168.7.2: icmp_seq=1 ttl=64 time=0.075 ms

--- 192.168.7.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.075/0.075/0.075/0.000 ms
mininet> r1 ping 192.168.2.2
PING 192.168.2.2 (192.168.2.2) 56(84) bytes of data.
64 bytes from 192.168.2.2: icmp_seq=1 ttl=64 time=0.083 ms
64 bytes from 192.168.2.2: icmp_seq=2 ttl=64 time=0.118 ms
64 bytes from 192.168.2.2: icmp_seq=3 ttl=64 time=0.194 ms
^C
--- 192.168.2.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2031ms
rtt min/avg/max/mdev = 0.083/0.131/0.194/0.046 ms
mininet> r2 ping 192.168.4.1 -c 1
PING 192.168.4.1 (192.168.4.1) 56(84) bytes of data.
64 bytes from 192.168.4.1: icmp_seq=1 ttl=64 time=0.065 ms

--- 192.168.4.1 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.065/0.065/0.065/0.000 ms
mininet>

```

1.6. Uji Konektivitas yang berada pada area berbeda

```

mininet> hA ping hB
ping: connect: Network is unreachable
mininet> r1 ping r2
ping: connect: Network is unreachable
mininet> r3 ping r4
ping: connect: Network is unreachable

```

2. CLO 2

2.1. Source Code

Source code ini melanjutkan source code yang sudah dibuat di CLO 1. Berikut adalah source code untuk melakukan routing pada topologi yang sudah dibuat.

```

77      #Routing Host
78      hA.cmd("ip rule add from 192.168.0.1 table 1")
79      hA.cmd("ip rule add from 192.168.7.2 table 2")
80      hA.cmd("ip route add 192.168.0.0/24 dev hA-eth0 scope link table 1")
81      hA.cmd("ip route add default via 192.168.0.2 dev hA-eth0 table 1")
82      hA.cmd("ip route add 192.168.7.0/24 dev hA-eth1 scope link table 2")
83      hA.cmd("ip route add default via 192.168.7.1 dev hA-eth1 table 2")
84      hA.cmd("ip route add default scope global nexthop via 192.168.0.2 dev hA-eth0")
85      hA.cmd("ip route add default scope global nexthop via 192.168.7.1 dev hA-eth1")
86
87      hB.cmd("ip rule add from 192.168.3.2 table 3")
88      hB.cmd("ip rule add from 192.168.5.1 table 4")
89      hB.cmd("ip route add 192.168.3.0/24 dev hB-eth0 scope link table 1")
90      hB.cmd("ip route add default via 192.168.3.1 dev hB-eth0 table 1")
91      hB.cmd("ip route add 192.168.5.0/24 dev hB-eth1 scope link table 2")
92      hB.cmd("ip route add default via 192.168.5.2 dev hB-eth1 table 2")
93      hB.cmd("ip route add default scope global nexthop via 192.168.3.1 dev hB-eth0")
94      hB.cmd("ip route add default scope global nexthop via 192.168.5.2 dev hB-eth1")
95
96      #Routing Router
97      r1.cmd("route add -net 192.168.3.0/24 gw 192.168.1.2")
98      r1.cmd("route add -net 192.168.5.0/24 gw 192.168.2.2")
99      r1.cmd("route add -net 192.168.6.0/24 gw 192.168.2.2")
100     r1.cmd("route add -net 192.168.7.0/24 gw 192.168.1.2")
101     r1.cmd("route add -net 192.168.4.0/24 gw 192.168.1.2")
102
103     r2.cmd("route add -net 192.168.0.0/24 gw 192.168.4.1")
104     r2.cmd("route add -net 192.168.1.0/24 gw 192.168.4.1")
105     r2.cmd("route add -net 192.168.3.0/24 gw 192.168.4.1")
106     r2.cmd("route add -net 192.168.5.0/24 gw 192.168.6.1")
107     r2.cmd("route add -net 192.168.2.0/24 gw 192.168.6.1")
108
109     r3.cmd("route add -net 192.168.5.0/24 gw 192.168.4.2")
110     r3.cmd("route add -net 192.168.6.0/24 gw 192.168.4.2")
111     r3.cmd("route add -net 192.168.7.0/24 gw 192.168.4.2")
112     r3.cmd("route add -net 192.168.0.0/24 gw 192.168.1.1")
113     r3.cmd("route add -net 192.168.2.0/24 gw 192.168.1.1")
114
115     r4.cmd("route add -net 192.168.7.0/24 gw 192.168.6.2")
116     r4.cmd("route add -net 192.168.0.0/24 gw 192.168.2.1")
117     r4.cmd("route add -net 192.168.1.0/24 gw 192.168.2.1")
118     r4.cmd("route add -net 192.168.3.0/24 gw 192.168.2.1")
119     r4.cmd("route add -net 192.168.4.0/24 gw 192.168.6.2")
120

```

2.2. Uji Konektivitas Menggunakan Ping pada Setiap Host

```

naufal@NaufalRifqi:~/TUBES_Jarkom$ sudo python3 Tubes.py
(1.00Mbit) (1.00Mbit) (0.50Mbit) (0.50Mbit) (1.00Mbit) (1.00Mbit) (1.00Mbit) (0.50Mbit)
(1.00Mbit) (1.00Mbit) (1.00Mbit) (1.00Mbit) (1.00Mbit) *** Configuring hosts
hA hB r1 r2 r3 r4
*** Starting CLI:
mininet> hA ping hB
PING 192.168.3.2 (192.168.3.2) 56(84) bytes of data.
64 bytes from 192.168.3.2: icmp_seq=1 ttl=62 time=0.135 ms
64 bytes from 192.168.3.2: icmp_seq=2 ttl=62 time=0.226 ms
^C
--- 192.168.3.2 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1017ms
rtt min/avg/max/mdev = 0.135/0.180/0.226/0.045 ms
mininet> hA ping r1 -c 1
PING 192.168.0.2 (192.168.0.2) 56(84) bytes of data.
64 bytes from 192.168.0.2: icmp_seq=1 ttl=64 time=0.051 ms
--- 192.168.0.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.051/0.051/0.051/0.000 ms
mininet> hA ping r2 -c 1
PING 192.168.6.2 (192.168.6.2) 56(84) bytes of data.
64 bytes from 192.168.6.2: icmp_seq=1 ttl=62 time=0.092 ms
--- 192.168.6.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.092/0.092/0.092/0.000 ms
mininet> hA ping r3 -c 1
PING 192.168.1.2 (192.168.1.2) 56(84) bytes of data.
64 bytes from 192.168.1.2: icmp_seq=1 ttl=63 time=0.079 ms
--- 192.168.1.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.079/0.079/0.079/0.000 ms
mininet> hA ping r4 -c 1
PING 192.168.5.2 (192.168.5.2) 56(84) bytes of data.
64 bytes from 192.168.5.2: icmp_seq=1 ttl=63 time=0.068 ms
--- 192.168.5.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.068/0.068/0.068/0.000 ms
mininet> hB ping hA -c 1
PING 192.168.0.1 (192.168.0.1) 56(84) bytes of data.
64 bytes from 192.168.0.1: icmp_seq=1 ttl=62 time=0.078 ms
--- 192.168.0.1 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.078/0.078/0.078/0.000 ms

```

- Hasil Pingall

```

mininet> pingall
*** Ping: testing ping reachability
hA -> hB r1 r2 r3 r4
hB -> hA r1 r2 r3 r4
r1 -> hA hB r2 r3 r4
r2 -> hA hB r1 r3 r4
r3 -> hA hB r1 r2 r4
r4 -> hA hB r1 r2 r3
*** Results: 0% dropped (30/30 received)

```

2.3. Routing Table Setiap Host

- hA

Destination	Gateway	Genmask	Flags	MSS	Window	irtt	Iface
0.0.0.0	192.168.7.1	0.0.0.0	UG	0	0		0 hA-eth1
0.0.0.0	192.168.0.2	0.0.0.0	UG	0	0		0 hA-eth0
192.168.0.0	0.0.0.0	255.255.255.0	U	0	0		0 hA-eth0
192.168.7.0	0.0.0.0	255.255.255.0	U	0	0		0 hA-eth1

- hB

Destination	Gateway	Genmask	Flags	MSS	Window	irtt	Iface
0.0.0.0	192.168.5.2	0.0.0.0	UG	0	0		0 hB-eth1
0.0.0.0	192.168.3.1	0.0.0.0	UG	0	0		0 hB-eth0
192.168.3.0	0.0.0.0	255.255.255.0	U	0	0		0 hB-eth0
192.168.5.0	0.0.0.0	255.255.255.0	U	0	0		0 hB-eth1

- R1

```
mininet> r1 netstat -rn
Kernel IP routing table
Destination     Gateway         Genmask        Flags   MSS Window irtt Iface
192.168.0.0     0.0.0.0       255.255.255.0 U        0 0          0 r1-eth0
192.168.1.0     0.0.0.0       255.255.255.0 U        0 0          0 r1-eth1
192.168.2.0     0.0.0.0       255.255.255.0 U        0 0          0 r1-eth2
192.168.3.0     192.168.1.2  255.255.255.0 UG       0 0          0 r1-eth1
192.168.4.0     192.168.1.2  255.255.255.0 UG       0 0          0 r1-eth1
192.168.5.0     192.168.2.2  255.255.255.0 UG       0 0          0 r1-eth2
192.168.6.0     192.168.2.2  255.255.255.0 UG       0 0          0 r1-eth2
192.168.7.0     192.168.1.2  255.255.255.0 UG       0 0          0 r1-eth1
```

- R2

```
mininet> r2 netstat -rn
Kernel IP routing table
Destination     Gateway         Genmask        Flags   MSS Window irtt Iface
192.168.0.0     192.168.4.1  255.255.255.0 UG       0 0          0 r2-eth2
192.168.1.0     192.168.4.1  255.255.255.0 UG       0 0          0 r2-eth2
192.168.2.0     192.168.6.1  255.255.255.0 UG       0 0          0 r2-eth0
192.168.3.0     192.168.4.1  255.255.255.0 UG       0 0          0 r2-eth2
192.168.4.0     0.0.0.0       255.255.255.0 U        0 0          0 r2-eth2
192.168.5.0     192.168.6.1  255.255.255.0 UG       0 0          0 r2-eth0
192.168.6.0     0.0.0.0       255.255.255.0 U        0 0          0 r2-eth0
192.168.7.0     0.0.0.0       255.255.255.0 U        0 0          0 r2-eth1
```

- R3

```
mininet> r3 netstat -rn
Kernel IP routing table
Destination     Gateway         Genmask        Flags   MSS Window irtt Iface
192.168.0.0     192.168.1.1  255.255.255.0 UG       0 0          0 r3-eth0
192.168.1.0     0.0.0.0       255.255.255.0 U        0 0          0 r3-eth0
192.168.2.0     192.168.1.1  255.255.255.0 UG       0 0          0 r3-eth0
192.168.3.0     0.0.0.0       255.255.255.0 U        0 0          0 r3-eth1
192.168.4.0     0.0.0.0       255.255.255.0 U        0 0          0 r3-eth2
192.168.5.0     192.168.4.2  255.255.255.0 UG       0 0          0 r3-eth0
192.168.6.0     192.168.4.2  255.255.255.0 UG       0 0          0 r3-eth2
192.168.7.0     192.168.4.2  255.255.255.0 UG       0 0          0 r3-eth2
```

- R4

```
mininet> r4 netstat -rn
Kernel IP routing table
Destination     Gateway         Genmask        Flags   MSS Window irtt Iface
192.168.0.0     192.168.2.1  255.255.255.0 UG       0 0          0 r4-eth2
192.168.1.0     192.168.2.1  255.255.255.0 UG       0 0          0 r4-eth2
192.168.2.0     0.0.0.0       255.255.255.0 U        0 0          0 r4-eth2
192.168.3.0     192.168.2.1  255.255.255.0 UG       0 0          0 r4-eth2
192.168.4.0     192.168.6.2  255.255.255.0 UG       0 0          0 r4-eth1
192.168.5.0     0.0.0.0       255.255.255.0 U        0 0          0 r4-eth0
192.168.6.0     0.0.0.0       255.255.255.0 U        0 0          0 r4-eth1
192.168.7.0     192.168.6.2  255.255.255.0 UG       0 0          0 r4-eth1
```

2.4. Traceroute

- hA

```
mininet> hA traceroute -n r1
traceroute to 192.168.0.2 (192.168.0.2), 30 hops max, 60 byte packets
 1  192.168.0.2  0.078 ms  0.006 ms  0.005 ms
mininet> hA traceroute -n r2
traceroute to 192.168.6.2 (192.168.6.2), 30 hops max, 60 byte packets
 1  192.168.0.2  0.051 ms  0.012 ms  0.010 ms
 2  192.168.2.2  0.029 ms  0.019 ms  0.016 ms
 3  192.168.6.2  0.037 ms  0.023 ms  0.021 ms
mininet> hA traceroute -n r3
traceroute to 192.168.1.2 (192.168.1.2), 30 hops max, 60 byte packets
 1  192.168.0.2  0.074 ms  0.014 ms  0.010 ms
 2  192.168.1.2  0.029 ms  0.017 ms  0.019 ms
mininet> hA traceroute -n r4
traceroute to 192.168.5.2 (192.168.5.2), 30 hops max, 60 byte packets
 1  192.168.0.2  0.046 ms  0.012 ms  0.010 ms
 2  192.168.5.2  0.028 ms  0.017 ms  0.016 ms
mininet> hA traceroute -n hB
traceroute to 192.168.3.2 (192.168.3.2), 30 hops max, 60 byte packets
 1  192.168.0.2  0.040 ms  0.009 ms  0.008 ms
 2  192.168.1.2  0.022 ms  0.013 ms  0.012 ms
 3  192.168.3.2  0.026 ms  0.017 ms  0.016 ms
```

- hB

```
mininet> hB traceroute -n r1
traceroute to 192.168.0.2 (192.168.0.2), 30 hops max, 60 byte packets
 1  192.168.3.1  0.050 ms  0.012 ms  0.011 ms
 2  192.168.0.2  0.026 ms  0.017 ms  0.016 ms
mininet> hB traceroute -n r2
traceroute to 192.168.6.2 (192.168.6.2), 30 hops max, 60 byte packets
 1  192.168.3.1  0.051 ms  0.052 ms  0.012 ms
 2  192.168.6.2  0.028 ms  0.017 ms  0.016 ms
mininet> hB traceroute -n r3
traceroute to 192.168.1.2 (192.168.1.2), 30 hops max, 60 byte packets
 1  192.168.1.2  0.050 ms  0.013 ms  0.012 ms
mininet> hB traceroute -n r4
traceroute to 192.168.5.2 (192.168.5.2), 30 hops max, 60 byte packets
 1  192.168.5.2  0.065 ms  0.014 ms  0.011 ms
mininet> hB traceroute -n hA
traceroute to 192.168.0.1 (192.168.0.1), 30 hops max, 60 byte packets
 1  192.168.3.1  0.047 ms  0.013 ms  0.011 ms
 2  192.168.1.1  0.025 ms  0.018 ms  0.019 ms
 3  192.168.0.1  0.033 ms  0.023 ms  0.025 ms
```

- R1 ke R2

```
mininet> r1 traceroute -n r2
traceroute to 192.168.6.2 (192.168.6.2), 30 hops max, 60 byte packets
 1  192.168.2.2  0.115 ms  0.016 ms  0.009 ms
 2  192.168.6.2  0.025 ms  0.020 ms  0.016 ms
```

- R3 ke R4

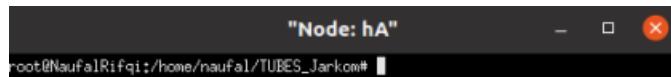
```
mininet> r3 traceroute r4
traceroute to 192.168.5.2 (192.168.5.2), 30 hops max, 60 byte packets
 1  192.168.4.2 (192.168.4.2)  0.084 ms  0.014 ms  0.010 ms
 2  192.168.5.2 (192.168.5.2)  0.025 ms  0.017 ms  0.017 ms
```

3. CLO 3

3.1. Langkah-langkah membuat *traffic* dan meng-capture *traffic*

- Lakukan pembukaan terminal node hA.

```
mininet> xterm hA
```



- Setelah terminal node hA terbuka, ketikkan perintah dibawah ini. Untuk membuat file paket dengan nama “tcpdump.pcap” yang berisikan protokol TCP dengan jumlah 100 paket.

```
"Node: hA"
-
root@NaufalRifqi:/home/naufal/TUBES_Jarkom# tcpdump -w tcpdump.pcap -c 100
tcpdump: listening on hA-eth0, link-type EN10MB (Ethernet), capture size 262144
bytes
```

- Kembali ke terminal mininet, dan ketikkan perintah dibawah ini.

```
mininet> iperf hB hA
*** Iperf: testing TCP bandwidth between hB and hA
*** Results: ['478 Kbits/sec', '1.06 Mbits/sec']
```

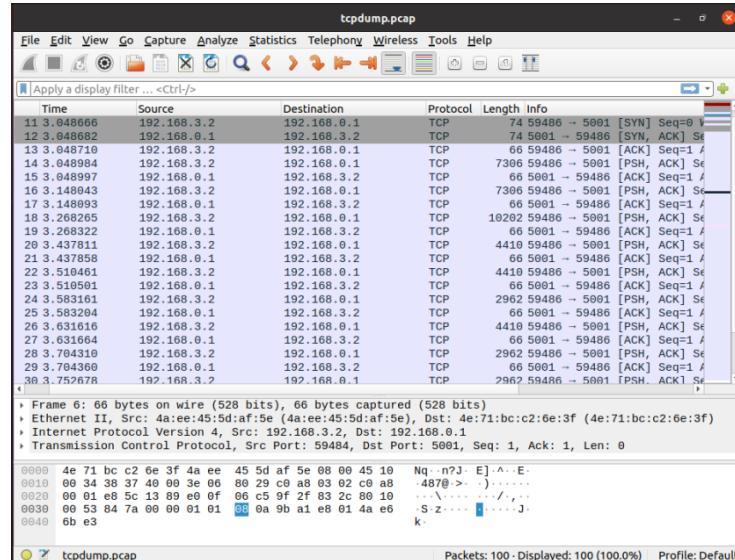
Maka terminal node hA akan berubah menjadi seperti dibawah.

```
root@NaufalRifqi:/home/naufal/TUBES_Jarkom# tcpdump -w tcpdump.pcap -c 100
tcpdump: listening on hA-eth0, link-type EN10MB (Ethernet), capture size 262144
bytes
100 packets captured
130 packets received by filter
0 packets dropped by kernel
root@NaufalRifqi:/home/naufal/TUBES_Jarkom#
```

- Buka terminal baru dan ketikkan perintah dibawah untuk membuka file yang sudah dibuat menggunakan wireshark

```
naufal@NaufalRifql:~/TUBES_Jarkom$ wireshark -r tcpdump.pcap
```

- Hasil dari tcpdump yang tadi sudah dilakukan, terbukti bahwa seluruh paket yang tercapture memiliki protokol TCP. Yang membedakan antara TCP dan UDP yaitu pada protokol TCP terdapat yang namanya three way handshake, seperti contohnya bisa kita lihat pada paket no 11 hingga 13. Cirinya dapat dilihat dari flag yang dimilikinya, yaitu [SYN] lalu [SYN, ACK] dan yang terakhir [ACK].



4. CLO 4

4.1. Source Code

Untuk CLO 4, terdapat beberapa source code yang perlu ditambahkan diantaranya :

4.1.1. iPerf

```
121      #iperf
122      hB.cmd('iperf -s &')
123      hA.cmd('iperf -t 10 -B 192.168.0.1 -c 192.168.3.2 &')
124      hA.cmd('iperf -t 10 -B 192.168.7.2 -c 192.168.3.2 &')
```

4.1.2. Pada routing host

```
86      #Tambahkan untuk clo4
87      hA.cmd('route add default gw 192.168.0.2 dev hA-eth0')
88      hA.cmd('route add default gw 192.168.7.1 dev hA-eth1')
89
90      #Tambahkan untuk clo4
91      hB.cmd('route add default gw 192.168.3.1 dev hB-eth0')
92      hB.cmd('route add default gw 192.168.5.2 dev hB-eth1')
```

4.1.3. Pada addlink untuk mengatur buffer nya

```
22      #Add Link
23      #Tambahkan max_queue_size dan use_htb = True untuk CLO4
24      net.addLink(r1, hA, max_queue_size = 20, use_htb = True, intfName1 = 'r1-eth0', intfName2 =
25          'hA-eth0', cls=TCLink, bw=1)
26      net.addLink(r1, r3, max_queue_size = 20, use_htb = True, intfName1 = 'r1-eth1', intfName2 =
27          'r3-eth0', cls=TCLink, bw=0.5)
28      net.addLink(r3, hB, max_queue_size = 20, use_htb = True, intfName1 = 'r3-eth1', intfName2 =
29          'hB-eth0', cls=TCLink, bw=1)
30      net.addLink(hB, r4, max_queue_size = 20, use_htb = True, intfName1 = 'hB-eth1', intfName2 =
31          'r4-eth0', cls=TCLink, bw=1)
32      net.addLink(r4, r2, max_queue_size = 20, use_htb = True, intfName1 = 'r4-eth1', intfName2 =
33          'r2-eth0', cls=TCLink, bw=0.5)
34      net.addLink(r2, hA, max_queue_size = 20, use_htb = True, intfName1 = 'r2-eth1', intfName2 =
35          'hA-eth1', cls=TCLink, bw=1)
36      net.addLink(r1, r4, max_queue_size = 20, use_htb = True, intfName1 = 'r1-eth2', intfName2 =
37          'r4-eth2', cls=TCLink, bw=1)
38      net.addLink(r2, r3, max_queue_size = 20, use_htb = True, intfName1 = 'r2-eth2', intfName2 =
39          'r3-eth2', cls=TCLink, bw=1)
40      net.build()
```

4.2. Uji dengan buffer : 20

```
22      #Add Link
23      #Tambahkan max_queue_size dan use_htb = True untuk CL04
24      net.addLink(r1, h4, max_queue_size = 20, use_htb = True, intfName1 = 'r1-eth0', intfName2 =
25          'h4-eth0', cls=TCLink, bw=1)
26      net.addLink(r1, r3, max_queue_size = 20, use_htb = True, intfName1 = 'r1-eth1', intfName2 =
27          'r3-eth0', cls=TCLink, bw=0.5)
28      net.addLink(r3, h4, max_queue_size = 20, use_htb = True, intfName1 = 'r3-eth1', intfName2 =
29          'h4-eth0', cls=TCLink, bw=1)
30      net.addLink(h4, r4, max_queue_size = 20, use_htb = True, intfName1 = 'h4-eth1', intfName2 =
31          'r4-eth0', cls=TCLink, bw=1)
32      net.addLink(r4, r2, max_queue_size = 20, use_htb = True, intfName1 = 'r4-eth1', intfName2 =
33          'r2-eth0', cls=TCLink, bw=0.5)
34      net.addLink(r2, h4, max_queue_size = 20, use_htb = True, intfName1 = 'r2-eth1', intfName2 =
35          'h4-eth0', cls=TCLink, bw=1)
36      net.addLink(r1, r4, max_queue_size = 20, use_htb = True, intfName1 = 'r1-eth2', intfName2 =
37          'r4-eth2', cls=TCLink, bw=1)
38      net.addLink(r2, r3, max_queue_size = 20, use_htb = True, intfName1 = 'r2-eth2', intfName2 =
39          'r3-eth2', cls=TCLink, bw=1)
40      net.build()
```

- Test ping hA ke hB

```
naufal@NaufalRifqi:~/TUBES_Jarkom$ sudo python3 Tubes.py
(1.00Mbit) (1.00Mbit) (0.50Mbit) (0.50Mbit) (1.00Mbit) (1.00Mbit) (1.00Mbit) (0.50Mbit) (0.50Mbit) (1.00Mbit) (1.00Mbit) (1.00Mbit) (1.00Mbit) *** Configuring hosts
hA hB r1 r2 r3 r4
*** Starting CLI:
mininet> hA ping hB
connect failed: Connection refused
-----
Client connecting to 192.168.3.2, TCP port 5001
Binding to local address 192.168.7.2
TCP window size: 85.3 KByte (default)
-----
[ 3] local 192.168.7.2 port 40359 connected with 192.168.3.2 port 5001
PING 192.168.3.2 (192.168.3.2) 56(84) bytes of data.
64 bytes from 192.168.3.2: icmp_seq=1 ttl=62 time=0.26 ms
64 bytes from 192.168.3.2: icmp_seq=2 ttl=62 time=0.0 ms
64 bytes from 192.168.3.2: icmp_seq=3 ttl=62 time=0.19 ms
64 bytes from 192.168.3.2: icmp_seq=4 ttl=62 time=0.0 ms
64 bytes from 192.168.3.2: icmp_seq=5 ttl=62 time=0.19 ms
64 bytes from 192.168.3.2: icmp_seq=6 ttl=62 time=0.74 ms
64 bytes from 192.168.3.2: icmp_seq=7 ttl=62 time=0.05 ms
[ ID] Interval           Transfer          Bandwidth
[ 3] 0.0-10.8 sec   1.50 MBytes  1.16 Mbps/sec
64 bytes from 192.168.3.2: icmp_seq=8 ttl=62 time=66.3 ms
64 bytes from 192.168.3.2: icmp_seq=9 ttl=62 time=59.9 ms
64 bytes from 192.168.3.2: icmp_seq=10 ttl=62 time=65.0 ms
64 bytes from 192.168.3.2: icmp_seq=11 ttl=62 time=0.102 ms
64 bytes from 192.168.3.2: icmp_seq=12 ttl=62 time=0.111 ms
64 bytes from 192.168.3.2: icmp_seq=13 ttl=62 time=0.098 ms
64 bytes from 192.168.3.2: icmp_seq=14 ttl=62 time=0.114 ms
64 bytes from 192.168.3.2: icmp_seq=15 ttl=62 time=0.066 ms
64 bytes from 192.168.3.2: icmp_seq=16 ttl=62 time=0.082 ms
^C
--- 192.168.3.2 ping statistics ---
16 packets transmitted, 16 received, 0% packet loss, time 15106ms
rtt min/avg/max/ddev = 0.060/0.40/126/68.043/31.099 ms
# Show Applications
```

4.3. Uji dengan buffer : 40

```
22      #Add Link
23      #Tambahkan max_queue_size dan use_htb = True untuk CL04
24      net.addLink(r1, h4, max_queue_size = 40, use_htb = True, intfName1 = 'r1-eth0', intfName2 =
25          'h4-eth0', cls=TCLink, bw=1)
26      net.addLink(r1, r3, max_queue_size = 40, use_htb = True, intfName1 = 'r1-eth1', intfName2 =
27          'r3-eth0', cls=TCLink, bw=0.5)
28      net.addLink(r3, h4, max_queue_size = 40, use_htb = True, intfName1 = 'r3-eth1', intfName2 =
29          'h4-eth0', cls=TCLink, bw=1)
30      net.addLink(h4, r4, max_queue_size = 40, use_htb = True, intfName1 = 'h4-eth1', intfName2 =
31          'r4-eth0', cls=TCLink, bw=1)
32      net.addLink(r4, r2, max_queue_size = 40, use_htb = True, intfName1 = 'r4-eth1', intfName2 =
33          'r2-eth0', cls=TCLink, bw=0.5)
34      net.addLink(r2, h4, max_queue_size = 40, use_htb = True, intfName1 = 'r2-eth1', intfName2 =
35          'h4-eth0', cls=TCLink, bw=1)
36      net.addLink(r1, r4, max_queue_size = 40, use_htb = True, intfName1 = 'r1-eth2', intfName2 =
37          'r4-eth2', cls=TCLink, bw=1)
38      net.addLink(r2, r3, max_queue_size = 40, use_htb = True, intfName1 = 'r2-eth2', intfName2 =
39          'r3-eth2', cls=TCLink, bw=1)
40      net.build()
```

- Test ping hA ke hB

```
naufal@NaufalRtfqt:~/TUBES_Jarkom$ sudo python3 Tubes.py
[sudo] password for naufal:
(1.00Mbit) (1.00Mbit) (0.50Mbit) (0.50Mbit) (1.00Mbit) (1.00Mbit) (1.00Mbit) (0.50Mbit) (0.50Mbit) (1.00Mbit) (1.00Mbit) *** Configuring hosts
hA hB r1 r2 r3 r4
*** Starting CLI:
mininet> hA ping hB
-----
Client connecting to 192.168.3.2, TCP port 5001
Binding to local address 192.168.7.2
TCP window size: 85.3 KByte (default)
-----
[ 3] local 192.168.7.2 port 38575 connected with 192.168.3.2 port 5001
Client connecting to 192.168.3.2, TCP port 5001
Binding to local address 192.168.0.1
TCP window size: 85.3 KByte (default)
-----
[ 3] local 192.168.0.1 port 34637 connected with 192.168.3.2 port 5001
PING 192.168.3.2 (192.168.3.2) 56(84) bytes of data.
64 bytes from 192.168.3.2: icmp_seq=1 ttl=62 time=616 ns
64 bytes from 192.168.3.2: icmp_seq=2 ttl=62 time=537 ns
64 bytes from 192.168.3.2: icmp_seq=3 ttl=62 time=543 ns
64 bytes from 192.168.3.2: icmp_seq=4 ttl=62 time=561 ns
64 bytes from 192.168.3.2: icmp_seq=5 ttl=62 time=598 ns
64 bytes from 192.168.3.2: icmp_seq=6 ttl=62 time=606 ns
64 bytes from 192.168.3.2: icmp_seq=7 ttl=62 time=636 ns
[ ID] Interval Transfer Bandwidth
[ 3] 0.0-11.6 sec  896 KBytes  635 Kbits/sec
64 bytes from 192.168.3.2: icmp_seq=8 ttl=62 time=750 ns
[ ID] Interval Transfer Bandwidth
[ 3] 0.0-12.1 sec  1.25 MBytes  864 Kbits/sec
64 bytes from 192.168.3.2: icmp_seq=9 ttl=62 time=877 ms
64 bytes from 192.168.3.2: icmp_seq=10 ttl=62 time=906 ms
^C
--- 192.168.3.2 ping statistics ---
11 packets transmitted, 10 received, 9.09091% packet loss, time 10008ms
rtt min/avg/max/mdev = 537.490/662.196/906.326/128.329 ms
```

4.4. Uji dengan buffer : 60

```
22      #Add Link
23      #Tambahkan max_queue_size dan use_htb = True untuk CLO4
24      net.addLink(r1, hA, max_queue_size = 60, use_htb = True, intfName1 = 'r1-eth0', intfName2 =
25          'hA-eth0', cls=TCLink, bw=1)
26      net.addLink(r1, r3, max_queue_size = 60, use_htb = True, intfName1 = 'r1-eth1', intfName2 =
27          'r3-eth0', cls=TCLink, bw=0.5)
28      net.addLink(r3, hB, max_queue_size = 60, use_htb = True, intfName1 = 'r3-eth1', intfName2 =
29          'hB-eth0', cls=TCLink, bw=1)
30      net.addLink(hB, r4, max_queue_size = 60, use_htb = True, intfName1 = 'hB-eth1', intfName2 =
31          'r4-eth0', cls=TCLink, bw=0.5)
32      net.addLink(r4, r2, max_queue_size = 60, use_htb = True, intfName1 = 'r4-eth1', intfName2 =
33          'r2-eth0', cls=TCLink, bw=1)
34      net.addLink(r2, hA, max_queue_size = 60, use_htb = True, intfName1 = 'r2-eth1', intfName2 =
35          'hA-eth1', cls=TCLink, bw=1)
36      net.addLink(r1, r4, max_queue_size = 60, use_htb = True, intfName1 = 'r1-eth2', intfName2 =
37          'r4-eth2', cls=TCLink, bw=1)
38      net.addLink(r2, r3, max_queue_size = 60, use_htb = True, intfName1 = 'r2-eth2', intfName2 =
39          'r3-eth2', cls=TCLink, bw=1)
40      net.build()
```

- Test ping hA ke hB

```
naufal@NaufalRtfqt:~/TUBES_Jarkom$ sudo python3 Tubes.py
[sudo] password for naufal:
(1.00Mbit) (1.00Mbit) (0.50Mbit) (0.50Mbit) (1.00Mbit) (1.00Mbit) (1.00Mbit) (0.50Mbit) (0.50Mbit) (1.00Mbit) (1.00Mbit) *** Configuring hosts
hA hB r1 r2 r3 r4
*** Starting CLI:
mininet> hA ping hB
-----
Client connecting to 192.168.3.2, TCP port 5001
Binding to local address 192.168.7.2
TCP window size: 128 Kbyte (default)
-----
[ 3] local 192.168.7.2 port 38257 connected with 192.168.3.2 port 5001
PING 192.168.3.2 (192.168.3.2) 56(84) bytes of data.
64 bytes from 192.168.3.2: icmp_seq=1 ttl=62 time=63.2 ms
64 bytes from 192.168.3.2: icmp_seq=2 ttl=62 time=69.0 ms
64 bytes from 192.168.3.2: icmp_seq=3 ttl=62 time=62.7 ms
64 bytes from 192.168.3.2: icmp_seq=4 ttl=62 time=67.1 ms
64 bytes from 192.168.3.2: icmp_seq=5 ttl=62 time=60.5 ms
64 bytes from 192.168.3.2: icmp_seq=6 ttl=62 time=65.1 ms
[ ID] Interval Transfer Bandwidth
[ 3] 0.0-10.2 sec  1.38 MBytes  1.13 Mbits/sec
64 bytes from 192.168.3.2: icmp_seq=7 ttl=62 time=58.9 ms
64 bytes from 192.168.3.2: icmp_seq=8 ttl=62 time=62.9 ms
64 bytes from 192.168.3.2: icmp_seq=9 ttl=62 time=0.083 ms
64 bytes from 192.168.3.2: icmp_seq=10 ttl=62 time=0.088 ms
64 bytes from 192.168.3.2: icmp_seq=11 ttl=62 time=0.068 ms
64 bytes from 192.168.3.2: icmp_seq=12 ttl=62 time=0.094 ms
64 bytes from 192.168.3.2: icmp_seq=13 ttl=62 time=0.086 ms
64 bytes from 192.168.3.2: icmp_seq=14 ttl=62 time=0.071 ms
64 bytes from 192.168.3.2: icmp_seq=15 ttl=62 time=0.080 ms
64 bytes from 192.168.3.2: icmp_seq=16 ttl=62 time=0.082 ms
64 bytes from 192.168.3.2: icmp_seq=17 ttl=62 time=0.068 ms
64 bytes from 192.168.3.2: icmp_seq=18 ttl=62 time=0.085 ms
64 bytes from 192.168.3.2: icmp_seq=19 ttl=62 time=0.081 ms
64 bytes from 192.168.3.2: icmp_seq=20 ttl=62 time=0.086 ms
64 bytes from 192.168.3.2: icmp_seq=21 ttl=62 time=0.099 ms
^C
```

4.5. Uji dengan buffer : 100

```
22     #Add LInk
23     #Tambahkan max_queue_size dan use_htb = True untuk CLO4
24     net.addLink(r1, hA, max_queue_size = 100, use_htb = True, intfName1 = 'r1-eth0', intfName2
= 'hA-eth0', cls=TCLink, bw=1)
25     net.addLink(r1, r3, max_queue_size = 100, use_htb = True, intfName1 = 'r1-eth1', intfName2
= 'r3-eth0', cls=TCLink, bw=0.5)
26     net.addLink(r3, hB, max_queue_size = 100, use_htb = True, intfName1 = 'r3-eth1', intfName2
= 'hB-eth0', cls=TCLink, bw=1)
27     net.addLink(hB, r4, max_queue_size = 100, use_htb = True, intfName1 = 'hB-eth1', intfName2
= 'r4-eth0', cls=TCLink, bw=1)
28     net.addLink(r4, r2, max_queue_size = 100, use_htb = True, intfName1 = 'r4-eth1', intfName2
= 'r2-eth0', cls=TCLink, bw=0.5)
29     net.addLink(r2, hA, max_queue_size = 100, use_htb = True, intfName1 = 'r2-eth1', intfName2
= 'hA-eth2', cls=TCLink, bw=1)
30     net.addLink(r1, r4, max_queue_size = 100, use_htb = True, intfName1 = 'r1-eth2', intfName2
= 'r4-eth2', cls=TCLink, bw=1)
31     net.addLink(r2, r3, max_queue_size = 100, use_htb = True, intfName1 = 'r2-eth2', intfName2
= 'r3-eth2', cls=TCLink, bw=1)
32     net.build()
```

- Test ping hA ke hB

```
naufal@NaufalRifqi:~/TUBES_Jarkom$ sudo python3 Tubes.py
[sudo] password for naufal:
(1.00Mbit) (1.00Mbit) (0.50Mbit) (0.50Mbit) (1.00Mbit) (1.00Mbit) (1.00Mbit) (0.50
Mbit) (1.00Mbit) (1.00Mbit) (1.00Mbit) (1.00Mbit) *** Configuring hosts
hA hB r1 r2 r3 r4
*** Starting CLI:
mininet> hA ping hB
-----
Client connecting to 192.168.3.2, TCP port 5001
Binding to local address 192.168.7.2
TCP window size: 128 KByte (default)
[ 3] local 192.168.7.2 port 59895 connected with 192.168.3.2 port 5001
-----
Client connecting to 192.168.3.2, TCP port 5001
Binding to local address 192.168.0.1
TCP window size: 85.3 KByte (default)
-----
[ 3] local 192.168.0.1 port 33295 connected with 192.168.3.2 port 5001
PING 192.168.3.2 (192.168.3.2) 56(84) bytes of data.
64 bytes from 192.168.3.2: icmp_seq=1 ttl=62 time=1249 ms
64 bytes from 192.168.3.2: icmp_seq=2 ttl=62 time=1394 ms
64 bytes from 192.168.3.2: icmp_seq=3 ttl=62 time=1484 ms
64 bytes from 192.168.3.2: icmp_seq=4 ttl=62 time=1659 ms
64 bytes from 192.168.3.2: icmp_seq=5 ttl=62 time=1870 ms
64 bytes from 192.168.3.2: icmp_seq=6 ttl=62 time=2241 ms
64 bytes from 192.168.3.2: icmp_seq=7 ttl=62 time=2331 ms
64 bytes from 192.168.3.2: icmp_seq=8 ttl=62 time=2323 ms
[ ID] Interval      Transfer     Bandwidth
[ 3] 0.0-12.6 sec  1.12 MBytes  752 Kbytes/sec
[ ID] Interval      Transfer     Bandwidth
[ 3] 0.0-14.2 sec  1.76 MBytes  1.04 Mbytes/sec
64 bytes from 192.168.3.2: icmp_seq=12 ttl=62 time=1829 ms
64 bytes from 192.168.3.2: icmp_seq=13 ttl=62 time=1290 ms
^C
--- 192.168.3.2 ping statistics ---
14 packets transmitted, 10 received, 28,5714% packet loss, time 13078ms
rtt min/avg/max/mdev = 1249.450/1767.046/2331.109/398.973 ms, pipe 3
```

4.6. Hasil analisis

Dari ke empat kasus diatas yaitu uji dengan buffer : 20, 40, 60, dan 100. Dapat kita simpulkan bahwa nilai buffer mempengaruhi waktu pengiriman paket, semakin besar nilai buffer maka semakin lama waktu yang dibutuhkan, sebagai contoh kita ambil pada saat uji dengan nilai buffer 20, mendapatkan nilai time kurang lebih 60ms, dan pada saat nilai buffer nya 100 nilai time yang didapatkan adalah lebih dari 1200ms.

5. Link Video

<https://youtu.be/1Kxntp8pxog>