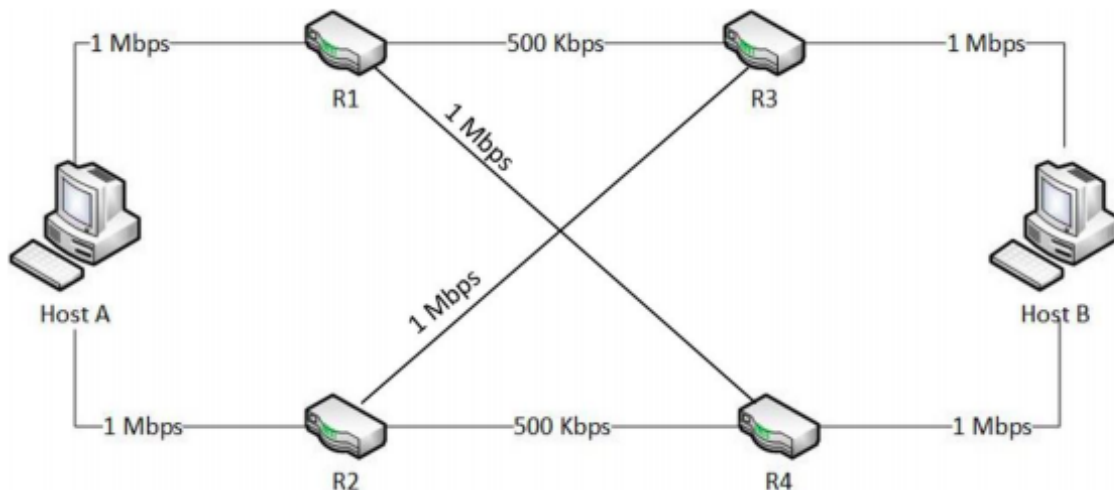# LAPORAN TUGAS BESAR JARINGAN KOMPUTER

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IF-43-10 S-1 Informatika

1. Membangun Topologi

Topologi yang akan dibangun adalah topologi dengan 2 Host dan 4 Router. Topologi ini membutuhkan 8 jaringan. Di sini saya menggunakan IP Private 10.0.0.0/24. Penggunaan prefix /24 hanya untuk memudahkan saja dalam pembangunan topologi, disamping dengan alokasi yang seharusnya.

1.1 Tabel Subnet dan Ilustrasi Topologi yang Dibangun

	Butuh	Alokasi	Net ID	Host Range		Broadcast	Prefix	Subnet Mask
Net 1	2	256	10.0.0.0	10.0.0.1	10.0.0.254	10.0.0.255	/24	255.255.255.0
Net 2	2	256	10.0.1.0	10.0.1.1	10.0.1.254	10.0.1.255	/24	255.255.255.0
Net 3	2	256	10.0.2.0	10.0.2.1	10.0.2.254	10.0.2.255	/24	255.255.255.0
Net 4	2	256	10.0.3.0	10.0.3.1	10.0.3.254	10.0.3.255	/24	255.255.255.0
Net 5	2	256	10.0.4.0	10.0.4.1	10.0.4.254	10.0.4.255	/24	255.255.255.0
Net 6	2	256	10.0.5.0	10.0.5.1	10.0.5.254	10.0.5.255	/24	255.255.255.0
Net 7	2	256	10.0.6.0	10.0.6.1	10.0.6.254	10.0.6.255	/24	255.255.255.0
Net 8	2	256	10.0.7.0	10.0.7.1	10.0.7.254	10.0.7.255	/24	255.255.255.0
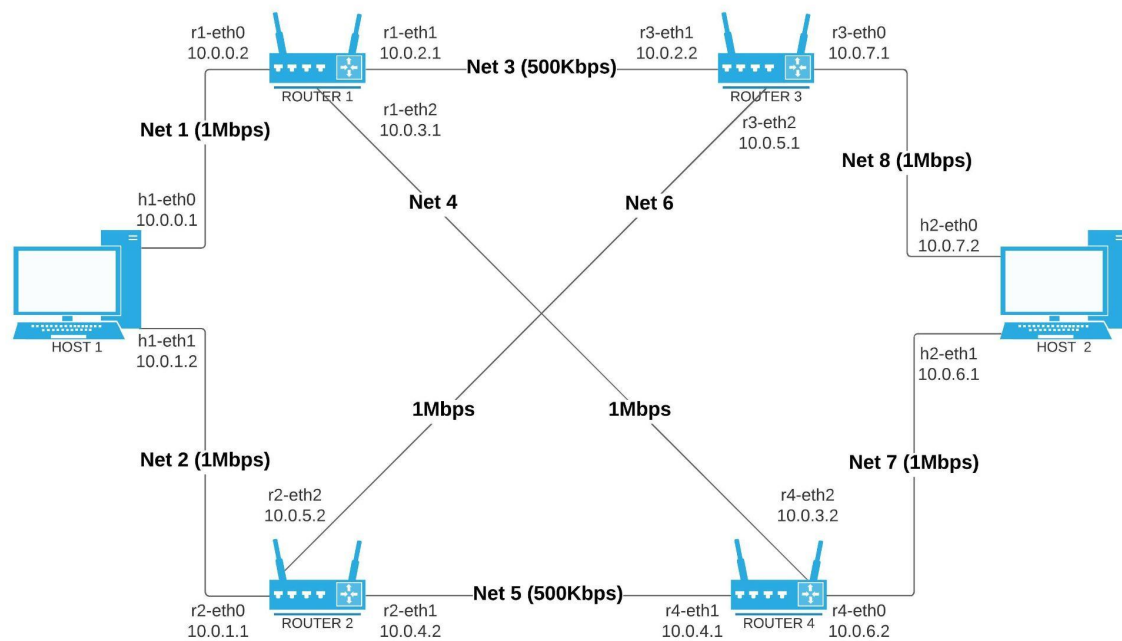
1.2 Uji Konektivitas dari Topologi yang Dibangun

Berikut sampel kode mininet dari topologi yang dibangun:

Uji konektivitas dilakukan dengan melakukan ping antar node yang ada dalam satu jaringan. Misal, untuk menguji koneksi antar Host 1 dan Router 1 dilakukan ping pada h1 dengan: self.h1.cmdPrint('ping -c 3 10.0.0.2'). Hal ini dilakukan pada semua jaringan yang ada. Hasilnya adalah semuanya terkoneksi dengan baik. Untuk hasil selengkapnya, terdapat pada Lampiran 1.

Kita juga dapat mengecek dan mencocokkan keterhubungan topologi yang dibangun di mininet dengan topologi yang diharapkan dengan mengetikkan links di mininet CLI.
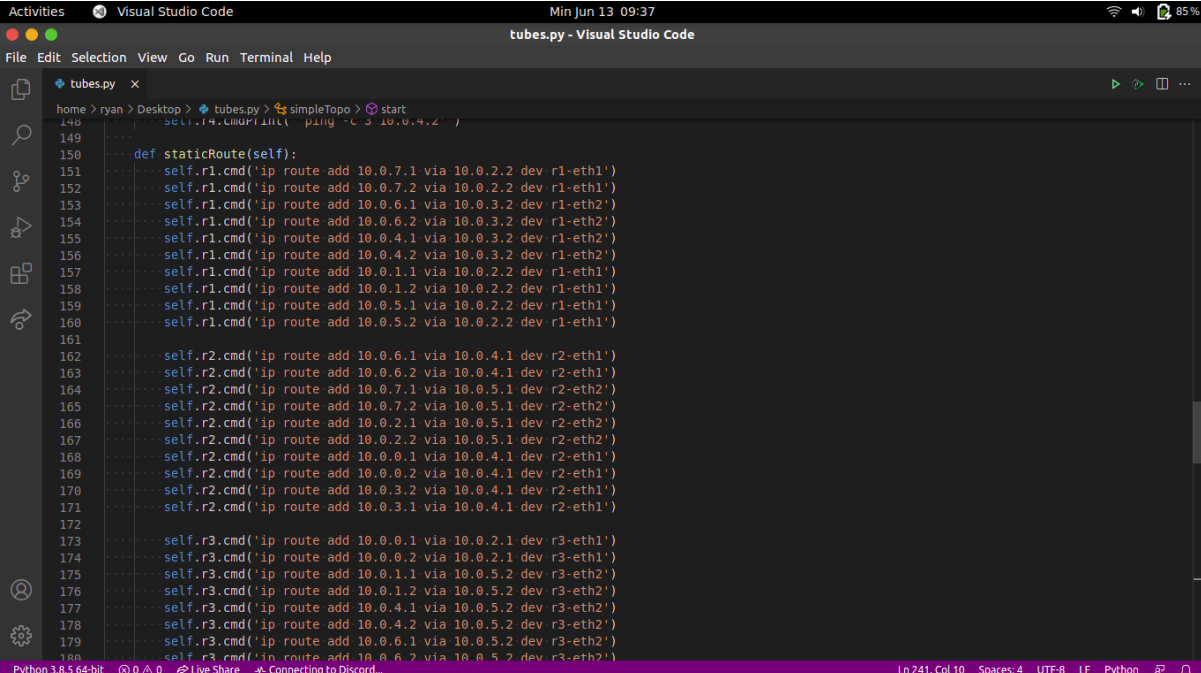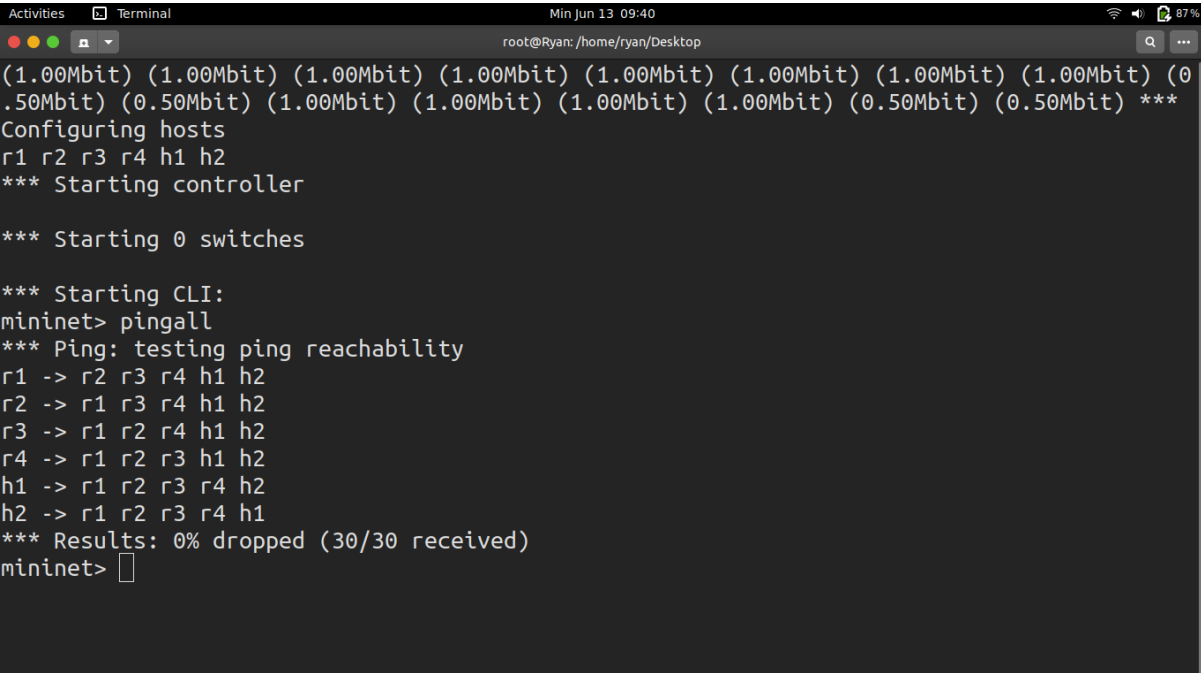
2. Implementasi Mekanisme Routing

Saya menggunakan mekanisme Static Routing yaitu mengetikkan secara manual tabel routing dari topologi yang ada. Berikut sampel kode di mininet:

2.1 Uji Konektivitas

Uji konektivitas dilakukan dengan menuliskan perintah pingall pada mininet CLI. Terlihat bahwa semua node telah terhubung sepenuhnya.

2.2 Traceroute

Pada traceroute, paket akan dikirimkan dari node pengirim ke penerima, namun paket tersebut akan melakukan mekanisme penambahan TTL pada setiap hop yang dilewati. Kita bisa melihat hop mana saja yang dilewati untuk ketika paket dikirimkan ke tujuan.

Misal, kita bisa mengecek hop mana saja yang dilewati ketika paket dikirimkan dari h1 ke h2. Bisa kita lihat bahwa hop yang dilewati antara lain router 2 dan router 3 lalu sampai pada akhirnya ke host 2 (10.0.7.2). Traceroute akan berhenti jika sudah mencapai tujuan, atau telah mencapai maksimum hop yaitu 30.

mininet> h1 traceroute h2
traceroute to 10.0.7.2 (10.0.7.2), 30 hops max, 60 byte packets
 1 10.0.1.1 (10.0.1.1) 0.511 ms 0.440 ms 0.423 ms
 2 10.0.5.1 (10.0.5.1) 0.405 ms 0.371 ms 0.348 ms
 3 10.0.7.2 (10.0.7.2) 0.325 ms 0.287 ms 0.259 ms

3. Membuktikan bahwa TCP telah diimplementasikan dengan Benar

Pertama, kita bisa mengetikkan xterm h1 (pada kasus ini node h1/host 1) untuk membuka terminal pada host 1 di mininet CLI.
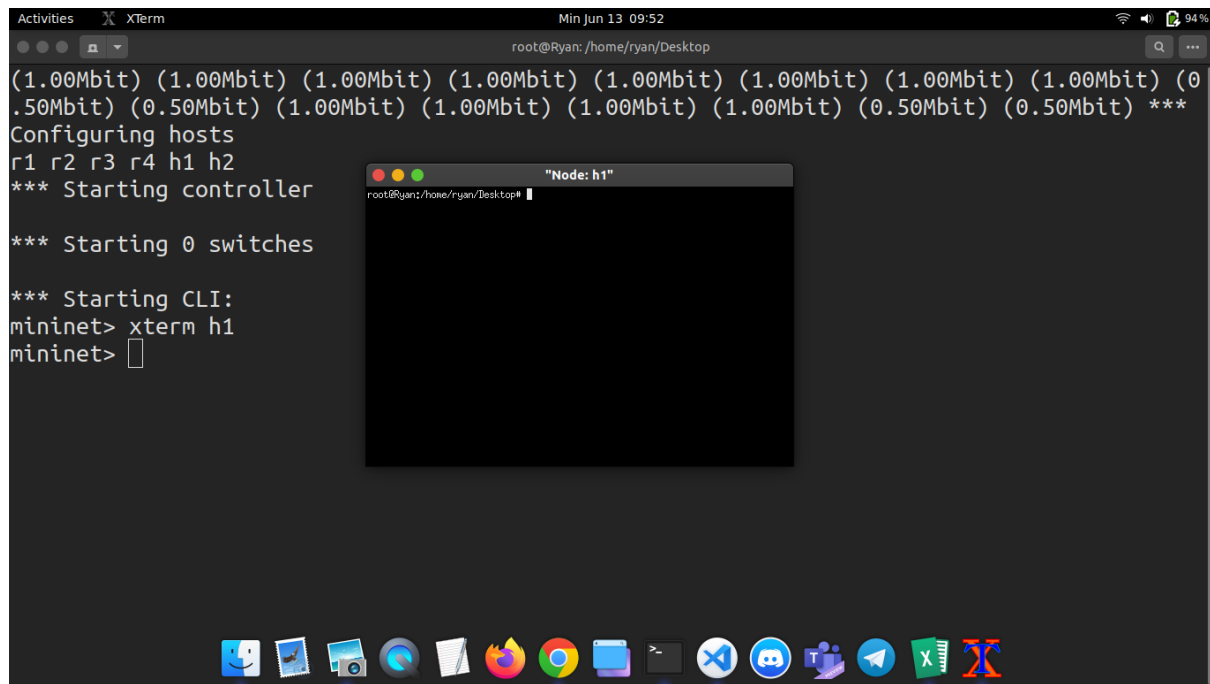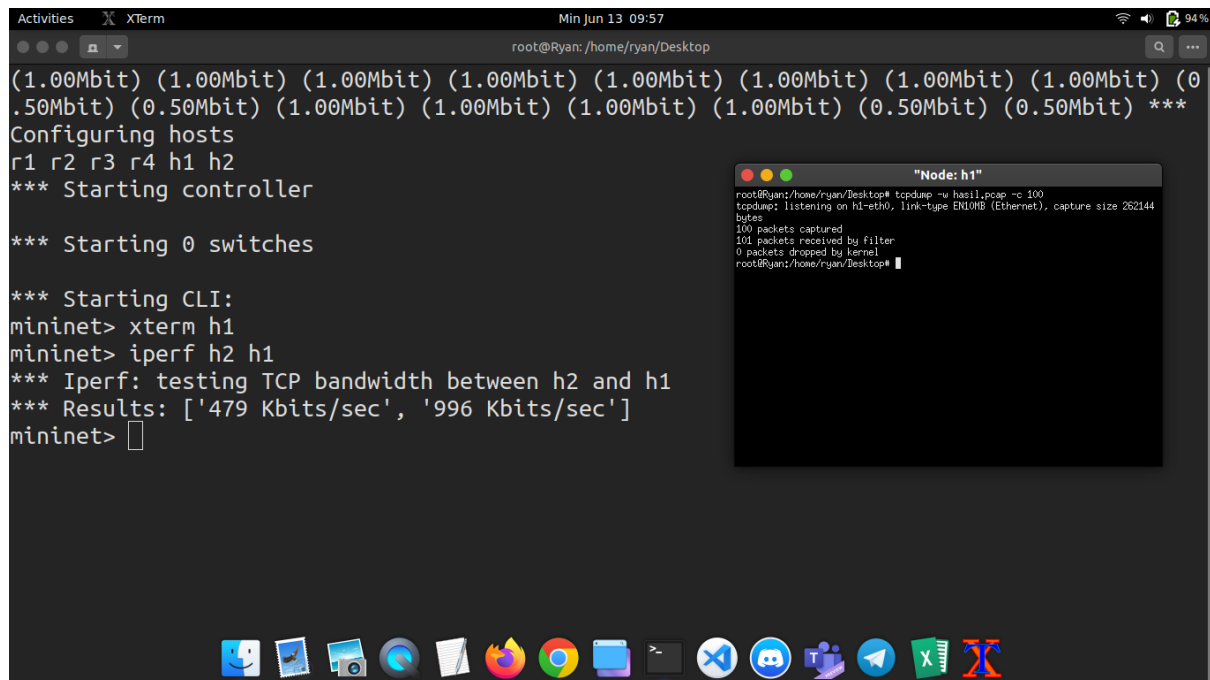
Kedua, pada xterm, kita akan mengetikkan perintah untuk meng-capture paket menggunakan tcpdump. Paket yang akan dicapture sebanyak 100 paket. Maka command yang digunakan:

tcpdump -w hasil.pcap -c 100
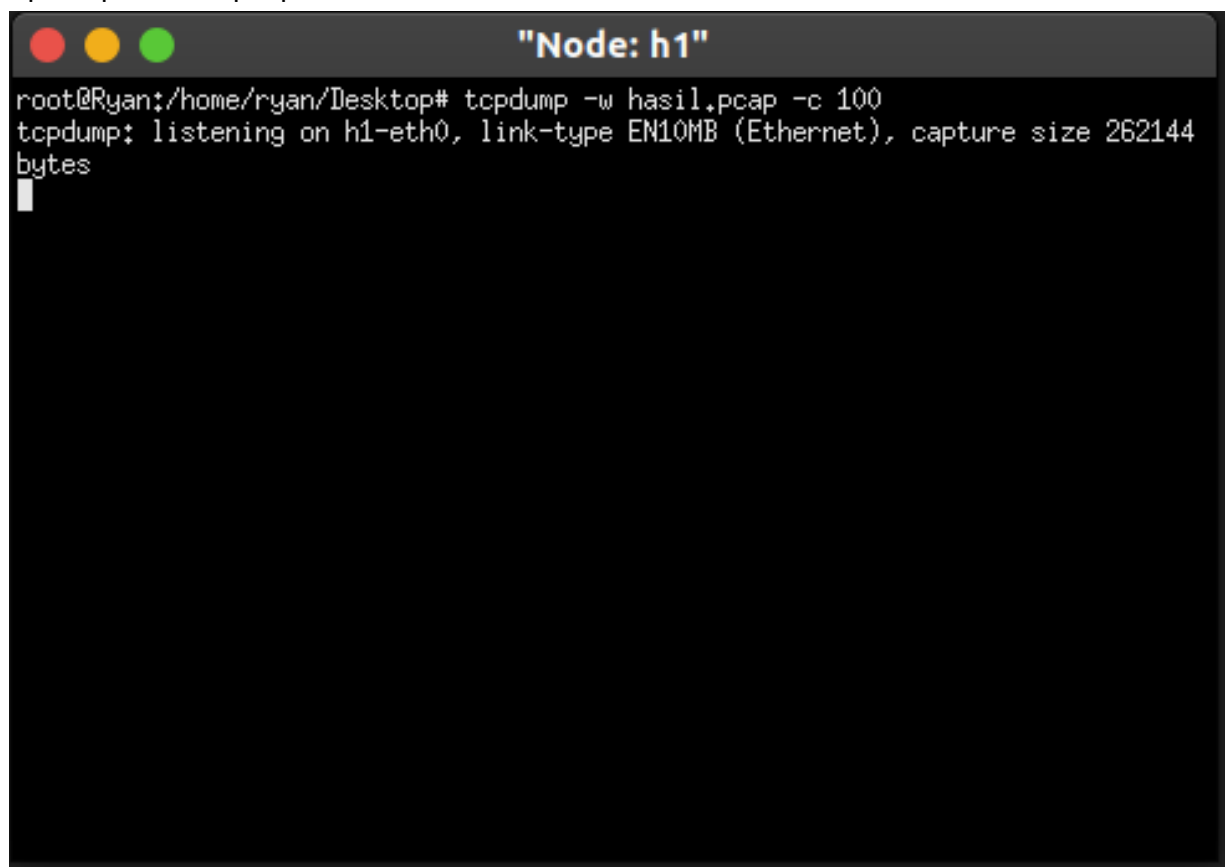
Ketiga, kita generate traffic menggunakan iperf. Misal kita akan generate traffic dari h2 ke h1. Maka kita ketikkan iperf h2 h1 pada mininet CLI. Tunggu hingga paket selesai tercapture.
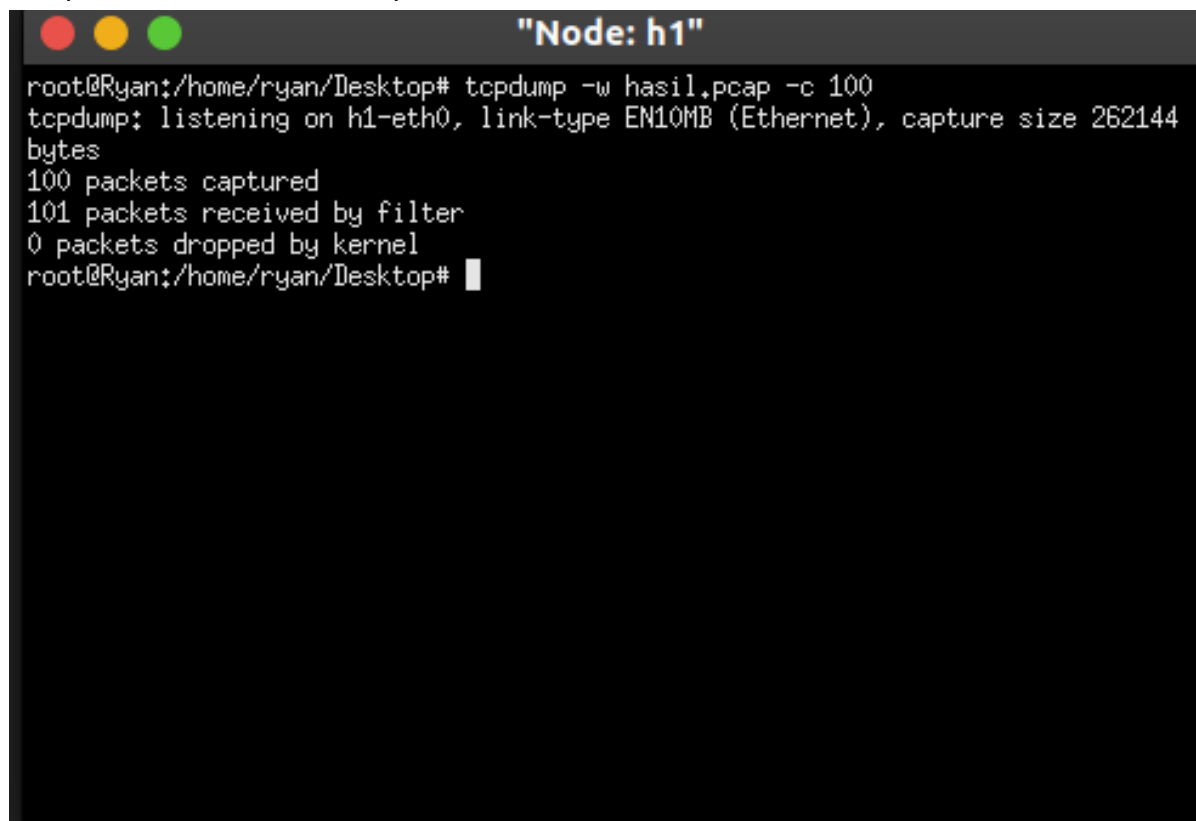
Jika paket telah berhasil tercapture, maka akan muncul:

Keempat, kita buka hasil dari capture pada file hasil.pcap pada wireshark. Terlihat bahwa paket yang ada adalah TCP. Sehingga, terbukti bahwa TCP telah diimplementasikan dengan benar.

4. Menginspeksi Penggunaan Queue

Di sini menggunakan Class Based Queue (CBQ). Router yang diamati adalah router 3. Traffic dilakukan melalui client (h1) ke server (h2). Berikut besaran ukuran buffer menggunakan variabel buff yang bisa diisi parameternya ketika method dipanggil, variabel buff ini dimasukkan ke dalam parameter max_queue_size pada method addLink:

Berikut konfigurasi CBQ-nya:

Untuk hasil pengaruh buffer terhadap delay, di sini digunakan percobaan dengan me-generate traffic dari h1 ke h2 menggunakan iperf3. Berikut hasilnya (hasil output ada di Lampiran 2):

Buffer	Delay (s)
20	0.06
40	0.06
60	0.07
100	0.07

Hasil analisis menunjukkan bahwa semakin tinggi ukuran buffer, maka semakin tinggi pula delay. Hal ini dikarenakan antrian paket akan semakin panjang. Namun, tentu paket yang di-drop akan semakin sedikit. Sebaliknya, semakin rendah buffer, maka rendah pula waktu delaynya, karena memang antriannya tidak panjang. Namun, konsekuensinya akan peluang paket terkena drop akan tinggi karena antrian akan penuh dengan cepat.

Lampiran 1: Hasil Uji Konektivitas Antarhost dalam Satu Jaringan

------HOST 1 PING ROUTER 1------

*** h1 : ('ping -c 3 10.0.0.2',)

PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.

64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=0.070 ms

64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.059 ms

64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.059 ms

--- 10.0.0.2 ping statistics ---

3 packets transmitted, 3 received, 0% packet loss, time 2043ms

rtt min/avg/max/mdev = 0.059/0.062/0.070/0.005 ms

 ------HOST 1 PING ROUTER 2------

*** h1 : ('ping -c 3 10.0.1.1',)

PING 10.0.1.1 (10.0.1.1) 56(84) bytes of data.

64 bytes from 10.0.1.1: icmp_seq=1 ttl=64 time=0.084 ms

64 bytes from 10.0.1.1: icmp_seq=2 ttl=64 time=0.057 ms

64 bytes from 10.0.1.1: icmp_seq=3 ttl=64 time=0.058 ms

--- 10.0.1.1 ping statistics ---

3 packets transmitted, 3 received, 0% packet loss, time 2026ms

rtt min/avg/max/mdev = 0.057/0.066/0.084/0.012 ms

 ------HOST 2 PING ROUTER 3------

*** h2 : ('ping -c 3 10.0.7.1',)

PING 10.0.7.1 (10.0.7.1) 56(84) bytes of data.

64 bytes from 10.0.7.1: icmp_seq=1 ttl=64 time=0.087 ms

64 bytes from 10.0.7.1: icmp_seq=2 ttl=64 time=0.070 ms

64 bytes from 10.0.7.1: icmp_seq=3 ttl=64 time=0.057 ms

--- 10.0.7.1 ping statistics ---

3 packets transmitted, 3 received, 0% packet loss, time 2026ms

rtt min/avg/max/mdev = 0.057/0.071/0.087/0.012 ms

 ------HOST 2 PING ROUTER 4------

*** h2 : ('ping -c 3 10.0.6.2',)

PING 10.0.6.2 (10.0.6.2) 56(84) bytes of data.

64 bytes from 10.0.6.2: icmp_seq=1 ttl=64 time=0.092 ms

64 bytes from 10.0.6.2: icmp_seq=2 ttl=64 time=0.059 ms

64 bytes from 10.0.6.2: icmp_seq=3 ttl=64 time=0.054 ms

--- 10.0.6.2 ping statistics ---

3 packets transmitted, 3 received, 0% packet loss, time 2027ms

rtt min/avg/max/mdev = 0.054/0.068/0.092/0.016 ms

 ------ROUTER 1 PING ROUTER 4------

*** r1 : ('ping -c 3 10.0.3.2',)

PING 10.0.3.2 (10.0.3.2) 56(84) bytes of data.

64 bytes from 10.0.3.2: icmp_seq=1 ttl=64 time=0.112 ms
64 bytes from 10.0.3.2: icmp_seq=2 ttl=64 time=0.052 ms
64 bytes from 10.0.3.2: icmp_seq=3 ttl=64 time=0.055 ms

--- 10.0.3.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2027ms
rtt min/avg/max/mdev = 0.052/0.073/0.112/0.027 ms

 ------ROUTER 1 PING ROUTER 3------
*** r1 : ('ping -c 3 10.0.2.2',)
PING 10.0.2.2 (10.0.2.2) 56(84) bytes of data.
64 bytes from 10.0.2.2: icmp_seq=1 ttl=64 time=0.094 ms
64 bytes from 10.0.2.2: icmp_seq=2 ttl=64 time=0.053 ms
64 bytes from 10.0.2.2: icmp_seq=3 ttl=64 time=0.068 ms

--- 10.0.2.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2027ms
rtt min/avg/max/mdev = 0.053/0.071/0.094/0.016 ms

 ------ROUTER 1 PING HOST 1------
*** r1 : ('ping -c 3 10.0.0.1',)
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.
64 bytes from 10.0.0.1: icmp_seq=1 ttl=64 time=0.063 ms
64 bytes from 10.0.0.1: icmp_seq=2 ttl=64 time=0.048 ms
64 bytes from 10.0.0.1: icmp_seq=3 ttl=64 time=0.058 ms

--- 10.0.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2027ms
rtt min/avg/max/mdev = 0.048/0.056/0.063/0.006 ms

 ------ROUTER 2 PING HOST 1------
*** r2 : ('ping -c 3 10.0.1.2',)
PING 10.0.1.2 (10.0.1.2) 56(84) bytes of data.
64 bytes from 10.0.1.2: icmp_seq=1 ttl=64 time=0.061 ms
64 bytes from 10.0.1.2: icmp_seq=2 ttl=64 time=0.059 ms
64 bytes from 10.0.1.2: icmp_seq=3 ttl=64 time=0.061 ms

--- 10.0.1.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2027ms
rtt min/avg/max/mdev = 0.059/0.060/0.061/0.000 ms

 ------ROUTER 2 PING ROUTER 4------
*** r2 : ('ping -c 3 10.0.4.1',)
PING 10.0.4.1 (10.0.4.1) 56(84) bytes of data.
64 bytes from 10.0.4.1: icmp_seq=1 ttl=64 time=0.118 ms
64 bytes from 10.0.4.1: icmp_seq=2 ttl=64 time=0.058 ms
64 bytes from 10.0.4.1: icmp_seq=3 ttl=64 time=0.063 ms

--- 10.0.4.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2026ms
rtt min/avg/max/mdev = 0.058/0.079/0.118/0.027 ms

------ROUTER 2 PING ROUTER 3------
*** r2 : ('ping -c 3 10.0.5.1',)
PING 10.0.5.1 (10.0.5.1) 56(84) bytes of data.
64 bytes from 10.0.5.1: icmp_seq=1 ttl=64 time=0.103 ms
64 bytes from 10.0.5.1: icmp_seq=2 ttl=64 time=0.059 ms
64 bytes from 10.0.5.1: icmp_seq=3 ttl=64 time=0.067 ms

--- 10.0.5.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2027ms
rtt min/avg/max/mdev = 0.059/0.076/0.103/0.019 ms

------ROUTER 3 PING ROUTER 1------
*** r3 : ('ping -c 3 10.0.2.1',)
PING 10.0.2.1 (10.0.2.1) 56(84) bytes of data.
64 bytes from 10.0.2.1: icmp_seq=1 ttl=64 time=0.061 ms
64 bytes from 10.0.2.1: icmp_seq=2 ttl=64 time=0.051 ms
64 bytes from 10.0.2.1: icmp_seq=3 ttl=64 time=0.057 ms

--- 10.0.2.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2027ms
rtt min/avg/max/mdev = 0.051/0.056/0.061/0.004 ms

------ROUTER 3 PING HOST 2------
*** r3 : ('ping -c 3 10.0.7.2',)
PING 10.0.7.2 (10.0.7.2) 56(84) bytes of data.
64 bytes from 10.0.7.2: icmp_seq=1 ttl=64 time=0.062 ms
64 bytes from 10.0.7.2: icmp_seq=2 ttl=64 time=0.053 ms
64 bytes from 10.0.7.2: icmp_seq=3 ttl=64 time=0.082 ms

--- 10.0.7.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2027ms
rtt min/avg/max/mdev = 0.053/0.065/0.082/0.012 ms

------ROUTER 3 PING ROUTER 2------
*** r3 : ('ping -c 3 10.0.5.2',)
PING 10.0.5.2 (10.0.5.2) 56(84) bytes of data.
64 bytes from 10.0.5.2: icmp_seq=1 ttl=64 time=0.058 ms
64 bytes from 10.0.5.2: icmp_seq=2 ttl=64 time=0.065 ms
64 bytes from 10.0.5.2: icmp_seq=3 ttl=64 time=0.053 ms

--- 10.0.5.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2027ms
rtt min/avg/max/mdev = 0.053/0.058/0.065/0.005 ms

------ROUTER 4 PING HOST 2------
*** r4 : ('ping -c 3 10.0.6.1',)
PING 10.0.6.1 (10.0.6.1) 56(84) bytes of data.
64 bytes from 10.0.6.1: icmp_seq=1 ttl=64 time=0.074 ms
64 bytes from 10.0.6.1: icmp_seq=2 ttl=64 time=0.056 ms
64 bytes from 10.0.6.1: icmp_seq=3 ttl=64 time=0.059 ms

--- 10.0.6.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2027ms
rtt min/avg/max/mdev = 0.056/0.063/0.074/0.007 ms

------ROUTER 4 PING ROUTER 1------
*** r4 : ('ping -c 3 10.0.3.1',)
PING 10.0.3.1 (10.0.3.1) 56(84) bytes of data.
64 bytes from 10.0.3.1: icmp_seq=1 ttl=64 time=0.063 ms
64 bytes from 10.0.3.1: icmp_seq=2 ttl=64 time=0.048 ms
64 bytes from 10.0.3.1: icmp_seq=3 ttl=64 time=0.054 ms

--- 10.0.3.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2027ms
rtt min/avg/max/mdev = 0.048/0.055/0.063/0.006 ms

------ROUTER 4 PING ROUTER 2------
*** r4 : ('ping -c 3 10.0.4.2',)
PING 10.0.4.2 (10.0.4.2) 56(84) bytes of data.
64 bytes from 10.0.4.2: icmp_seq=1 ttl=64 time=0.063 ms
64 bytes from 10.0.4.2: icmp_seq=2 ttl=64 time=0.052 ms
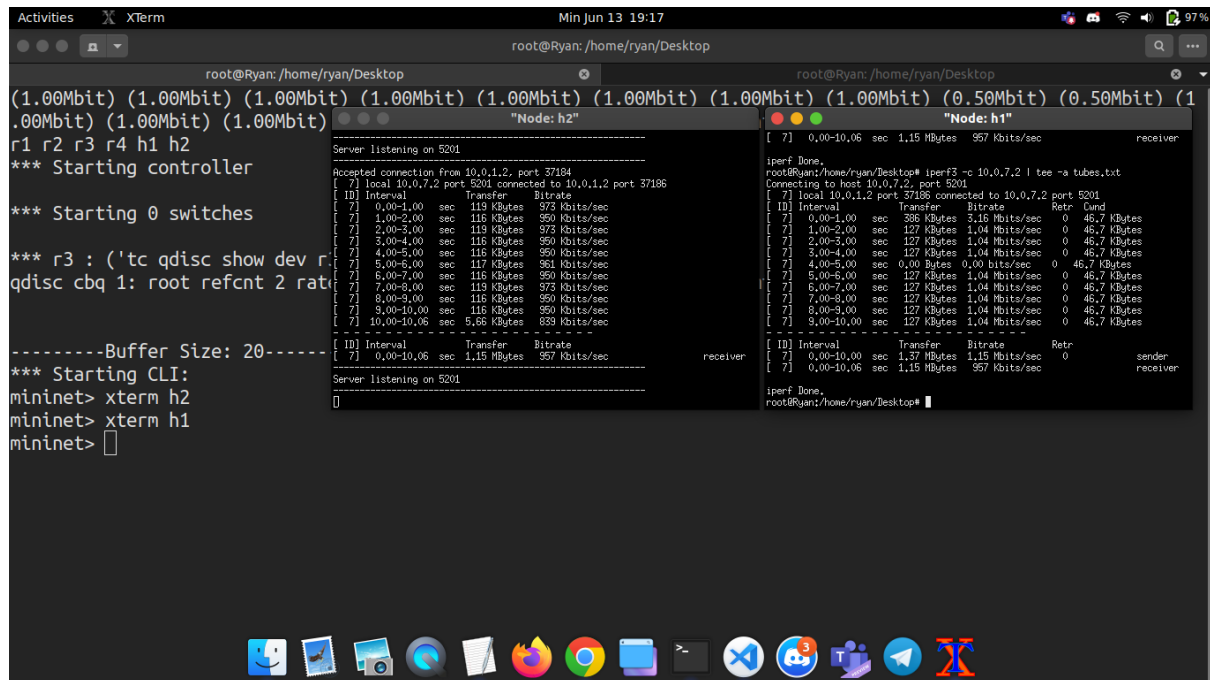64 bytes from 10.0.4.2: icmp_seq=3 ttl=64 time=0.055 ms

--- 10.0.4.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2027ms
rtt min/avg/max/mdev = 0.052/0.056/0.063/0.004 ms

Lampiran 2: Hasil Generate Traffic Iperf3
Buffer 20:

Connecting to host 10.0.7.2, port 5201
[7] local 10.0.1.2 port 37186 connected to 10.0.7.2 port 5201
[ID] Interval   Transfer   Bitrate   Retr Cwnd
[7]   0.00-1.00   sec   386 KBytes 3.16 Mbits/sec   0   46.7 KBytes
[7]   1.00-2.00   sec   127 KBytes 1.04 Mbits/sec   0   46.7 KBytes
[7]   2.00-3.00   sec   127 KBytes 1.04 Mbits/sec   0   46.7 KBytes
[7]   3.00-4.00   sec   127 KBytes 1.04 Mbits/sec   0   46.7 KBytes
[7]   4.00-5.00   sec 0.00 Bytes 0.00 bits/sec   0   46.7 KBytes
[7]   5.00-6.00   sec   127 KBytes 1.04 Mbits/sec   0   46.7 KBytes
[7]   6.00-7.00   sec   127 KBytes 1.04 Mbits/sec   0   46.7 KBytes
[7]   7.00-8.00   sec   127 KBytes 1.04 Mbits/sec   0   46.7 KBytes
[7]   8.00-9.00   sec   127 KBytes 1.04 Mbits/sec   0   46.7 KBytes
[7]   9.00-10.00 sec   127 KBytes 1.04 Mbits/sec   0   46.7 KBytes
- -
[ID] Interval   Transfer   Bitrate   Retr
[7]   0.00-10.00 sec 1.37 MBytes 1.15 Mbits/sec   0   sender
[7]   0.00-10.06 sec 1.15 MBytes   957 Kbits/sec   receiver

iperf Done.

Buffer 40:

Connecting to host 10.0.7.2, port 5201

[7] local 10.0.1.2 port 37152 connected to 10.0.7.2 port 5201

[ID]	Interval		Transfer	Bitrate	Retr	Cwnd
[7]	0.00-1.00	sec	386 KBytes	3.16 Mbits/sec	0	46.7 KBytes
[7]	1.00-2.00	sec	127 KBytes	1.04 Mbits/sec	0	46.7 KBytes
[7]	2.00-3.00	sec	127 KBytes	1.04 Mbits/sec	0	46.7 KBytes
[7]	3.00-4.00	sec	127 KBytes	1.04 Mbits/sec	0	46.7 KBytes
[7]	4.00-5.00	sec	0.00 Bytes	0.00 bits/sec	0	46.7 KBytes
[7]	5.00-6.00	sec	127 KBytes	1.04 Mbits/sec	0	46.7 KBytes
[7]	6.00-7.00	sec	127 KBytes	1.04 Mbits/sec	0	46.7 KBytes
[7]	7.00-8.00	sec	127 KBytes	1.04 Mbits/sec	0	46.7 KBytes
[7]	8.00-9.00	sec	127 KBytes	1.04 Mbits/sec	0	46.7 KBytes
[7]	9.00-10.00	sec	127 KBytes	1.04 Mbits/sec	0	46.7 KBytes

- -

[ID]	Interval		Transfer	Bitrate	Retr	
[7]	0.00-10.00	sec	1.37 MBytes	1.15 Mbits/sec	0	sender
[7]	0.00-10.06	sec	1.15 MBytes	957 Kbits/sec		receiver

iperf Done.

Buffer 60:

Connecting to host 10.0.7.2, port 5201

[7] local 10.0.1.2 port 37132 connected to 10.0.7.2 port 5201

[ID] Interval   Transfer   Bitrate   Retr Cwnd

[7] 0.00-1.00   sec 354 KBytes 2.90 Mbits/sec   0   42.4 KBytes

[7] 1.00-2.00   sec 127 KBytes 1.04 Mbits/sec   0   42.4 KBytes

[7] 2.00-3.00   sec 127 KBytes 1.04 Mbits/sec   0   42.4 KBytes

[7] 3.00-4.00   sec 127 KBytes 1.04 Mbits/sec   0   42.4 KBytes

[7] 4.00-5.00   sec 127 KBytes 1.04 Mbits/sec   0   42.4 KBytes

[7] 5.00-6.00   sec 127 KBytes 1.04 Mbits/sec   0   42.4 KBytes

[7] 6.00-7.00   sec 0.00 Bytes 0.00 bits/sec   0   42.4 KBytes

[7] 7.00-8.00   sec 127 KBytes 1.04 Mbits/sec   0   42.4 KBytes

[7] 8.00-9.00   sec 127 KBytes 1.04 Mbits/sec   0   42.4 KBytes

[7] 9.00-10.00 sec 127 KBytes 1.04 Mbits/sec   0   42.4 KBytes

- -

[ID] Interval   Transfer   Bitrate   Retr

[7] 0.00-10.00 sec 1.34 MBytes 1.12 Mbits/sec   0   sender

[7] 0.00-10.07 sec 1.15 MBytes   957 Kbits/sec   receiver

iperf Done.

Buffer 100:

Connecting to host 10.0.7.2, port 5201

[7] local 10.0.1.2 port 37120 connected to 10.0.7.2 port 5201

[ID]	Interval		Transfer	Bitrate	Retr	Cwnd
[7]	0.00-1.00	sec	354 KBytes	2.90 Mbits/sec	0	42.4 KBytes
[7]	1.00-2.00	sec	127 KBytes	1.04 Mbits/sec	0	42.4 KBytes
[7]	2.00-3.00	sec	127 KBytes	1.04 Mbits/sec	0	42.4 KBytes
[7]	3.00-4.00	sec	127 KBytes	1.04 Mbits/sec	0	42.4 KBytes
[7]	4.00-5.00	sec	127 KBytes	1.04 Mbits/sec	0	42.4 KBytes
[7]	5.00-6.00	sec	127 KBytes	1.04 Mbits/sec	0	42.4 KBytes
[7]	6.00-7.00	sec	0.00 Bytes	0.00 bits/sec	0	42.4 KBytes
[7]	7.00-8.00	sec	127 KBytes	1.04 Mbits/sec	0	42.4 KBytes
[7]	8.00-9.00	sec	127 KBytes	1.04 Mbits/sec	0	42.4 KBytes
[7]	9.00-10.00	sec	127 KBytes	1.04 Mbits/sec	0	42.4 KBytes

- -

[ID]	Interval		Transfer	Bitrate	Retr	
[7]	0.00-10.00	sec	1.34 MBytes	1.12 Mbits/sec	0	sender
[7]	0.00-10.07	sec	1.15 MBytes	958 Kbits/sec		receiver

iperf Done.