

TUGAS TERTULIS
JARINGAN KOMPUTER
SIMULASI MININET

Disusun untuk memenuhi Tugas Besar
Mata Kuliah Jaringan Komputer
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BAB 1

PENDAHULUAN

1.1 Tujuan Penulisan Laporan

Laporan ini disusun untuk memenuhi salah satu tugas mata kuliah Jaringan Komputer mengenai materi CLO-1, CLO-2, CLO-4, dan CLO-4 yang berisikan pembangunan topology dengan subnetting, uji konektivitas dengan routing, melakukan *capture traffic* dengan iPerf, dan inspeksi penggunaan *queue* pada router jaringan. Laporan ini dikerjakan berdasarkan spesifikasi tugas besar Jaringan Komputer yang telah diberikan.

1.2 Landasan Teori

1.2.1 Sistem Operasi Linux

Linux merupakan salah satu sistem operasi *open source* di bawah naungan lisensi GNU dan dibangun di atas kernel Linux. Sistem operasi yang terbuka menjadi salah satu sistem operasi yang dapat diunduh secara gratis menjadikan Linux populer di kalangan yang bergerak pada bidang *engineering* seperti *computing engineer* dan *network engineer*.

Linux pertama kali dibuat oleh Linus Torvalds pada tanggal 25 Agustus 1991 yang saat itu merupakan sebuah hobi belaka waktu menempuh jurusan ilmu komputer di Universitas Helsinki, Finlandia. Proses pengembangan linux yang awalnya sebuah hobi terus dikembangkan olehnya dan pada bulan Maret tahun 1994, Linux versi awal dirilis yaitu Linux versi 1.0. Linux dapat dikenal melalui logonya yang unik yaitu penguin yang bernama Tux yang di desain oleh Larry Ewing pada tahun 1996. Logo 6 penguin dipilih dikarenakan sang pencipta Linux itu sendiri yaitu Linus Torvalds menyukai penguin.



Gambar 1 Logo Linux (Tux)

1.2.2 Ubuntu

Secara garis besar, Ubuntu merupakan sistem operasi turunan dari Linux yang diciptakan pada tanggal 20 Oktober 2004 oleh CEO perangkat lunak komputer swasta yang berbasis di Afrika Selatan yang bernama Mark Richard Shuttleworth. Proses pengembangan Ubuntu menurut sumber dari laman <https://id.wikipedia.org/wiki/Ubuntu> dilakukan tiap 6 bulan sekali untuk versi terbaru, tiap 18 bulan sekali untuk pembaharuan sistem, setiap 2 tahun sekali (versi xx.04 dengan x angka genap) akan mendapatkan Long Term Support(LTS) selama 3 tahun untuk desktop dan 5 tahun untuk edisi server. Terdapat 4 divisi resmi yang dikeluarkan oleh Ubuntu, yaitu Ubuntu Desktop, Ubuntu Server, Ubuntu for IoT, dan Ubuntu Cloud.



Gambar 2 Logo Ubuntu

1.2.3 Jaringan Komputer

Jaringan komputer adalah jaringan telekomunikasi yang memungkinkan antar komputer untuk saling berkomunikasi dengan bertukar data. Tujuan dari jaringan komputer adalah agar dapat mencapai tujuannya, setiap bagian dari jaringan komputer dapat meminta dan memberikan layanan (service). Pihak yang meminta/menerima layanan disebut klien (client) dan yang memberikan/mengirim layanan disebut peladen (server). Desain ini disebut dengan sistem client-server, dan digunakan pada hampir seluruh aplikasi jaringan komputer. Selain itu, pengertian lain dari jaringan komputer adalah dua atau lebih komputer yang terhubung satu sama lain dan digunakan untuk berbagi data.

1.2.4 Mininet

Mininet adalah emulator berbasis CLI yang digunakan untuk membuat sebuah topologi jaringan pada Software Defined Network. Pada Mininet sudah terdapat beberapa topologi bawaan yang dapat langsung digunakan dengan menggunakan perintah (command) tertentu. Beberapa topologi bawaan tersebut antara lain topologi single, tree dan linear

1.2.5 Wireshark

Wireshark merupakan salah satu tools atau aplikasi “Network Analyzer” atau Penganalisa Jaringan. Penganalisaan Kinerja Jaringan itu dapat melingkupi berbagai hal, mulai dari proses menangkap paket-paket data atau informasi yang berlalu-lalang dalam jaringan, sampai pada digunakan pula untuk sniffing (memperoleh informasi penting seperti password email, dll). Wireshark sendiri merupakan free tools untuk Network Analyzer yang ada saat ini. Dan tampilan dari wireshark ini sendiri terbilang sangat bersahabat dengan user karena menggunakan tampilan grafis atau GUI (Graphical User Interface).



Gambar 3 Logo Wireshark

1.2.6 TCPDump

TCPDump adalah sebuah tools command line atau terminal paket sniffer atau paket analisis yang biasa dipakai untuk menyaring paket tcp/ip yang diterima atau yang dikirimkan melalui jaringan pada interface tertentu. TCPdump banyak digunakan untuk mencari masalah-masalah di jaringan atau untuk memonitor aktivitas jaringan, Tcpdump menggunakan API pcap (packet capture) yaitu LibPcap (Unix) atau winPcap (windows) untuk menangkap paket. Data hasil capture tcpdump sering disebut sebagai dumpfile. TCPdump banyak digunakan untuk mencari masalahmasalah di jaringan atau untuk memonitor aktivitas jaringan, Tcpdump menggunakan API pcap (packet capture) yaitu LibPcap (Unix) atau winPcap (windows) untuk menangkap paket. Data hasil capture tcpdum sering disebut sebagai dumpfile.

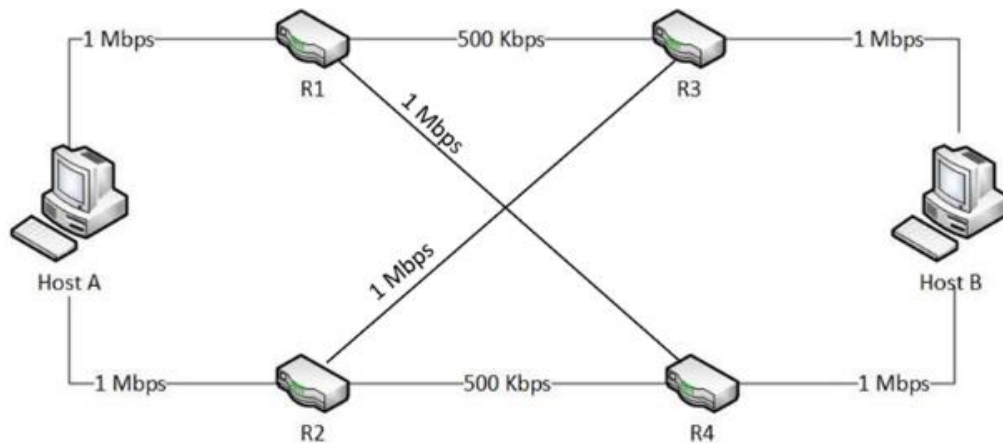
1.2.7 Packet Tracer

Packet Tracer adalah alat simulasi visual lintas platform yang dirancang oleh Cisco Systems yang memungkinkan pengguna membuat topologi jaringan dan meniru jaringan komputer modern. Perangkat lunak ini memungkinkan pengguna untuk mensimulasikan konfigurasi router dan switch. Cisco menggunakan antarmuka command line yang disimulasikan.

BAB 2 PEMBAHASAN

2.1 Spesifikasi Tugas Besar

Spesifikasi tugas besar yaitu memenuhi 4 CLO yaitu pembangunan topology dengan subnetting, uji konektivitas dengan routing, melakukan *capture traffic* dengan iPerf, dan inspeksi penggunaan *queue* pada router jaringan. Tugas besar ini memiliki topologi yang disediakan sebagai berikut.

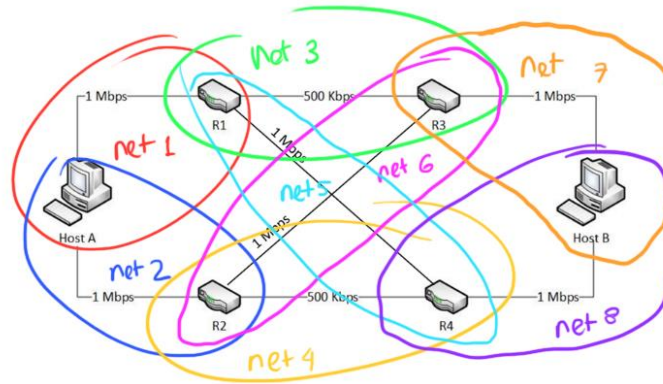


Gambar 4 Topologi untuk Tugas Besar

2.2 CLO 1

Pada CLO 1 akan melakukan pembangunan topology jaringan sesuai dengan spesifikasi yang diberikan. Pada langkah pertama akan melakukan desain subnet masing-masing network menggunakan VLSM agar menghasilkan IP subnet yang digunakan semua.

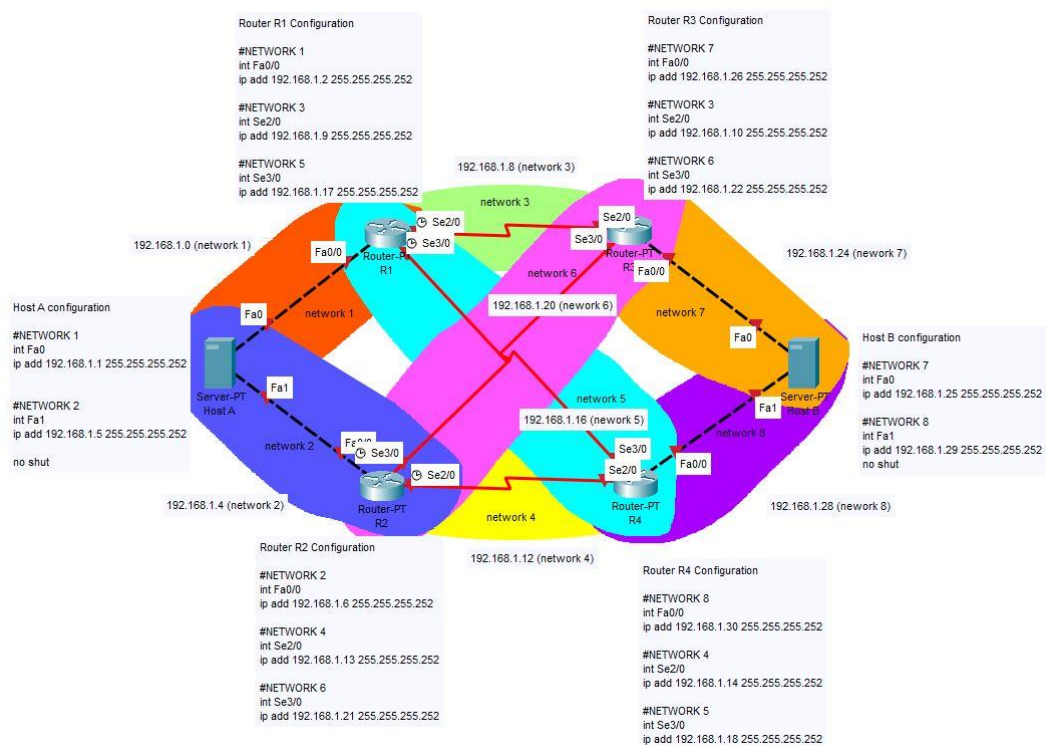
2.2.1 Subnetting



Gambar 5 Pembagian Network

Subnet Name	Needed Size	Allocated Size	Address	Mask	Dec Mask	Assignable Range	Broadcast
Net 1	2	2	192.168.1.0	/30	255.255.255.252	192.168.1.1 - 192.168.1.2	192.168.1.3
Net 2	2	2	192.168.1.4	/30	255.255.255.252	192.168.1.5 - 192.168.1.6	192.168.1.7
Net 3	2	2	192.168.1.8	/30	255.255.255.252	192.168.1.9 - 192.168.1.10	192.168.1.11
Net 4	2	2	192.168.1.12	/30	255.255.255.252	192.168.1.13 - 192.168.1.14	192.168.1.15
Net 5	2	2	192.168.1.16	/30	255.255.255.252	192.168.1.17 - 192.168.1.18	192.168.1.19
Net 6	2	2	192.168.1.20	/30	255.255.255.252	192.168.1.21 - 192.168.1.22	192.168.1.23
Net 7	2	2	192.168.1.24	/30	255.255.255.252	192.168.1.25 - 192.168.1.26	192.168.1.27
Net 8	2	2	192.168.1.28	/30	255.255.255.252	192.168.1.29 - 192.168.1.30	192.168.1.31

Tabel 1 Table Subnetting



Gambar 6 Topologi pada Packet Tracer

Pada subnetting digunakan network utama dengan IP 192.168.1.0, dalam topologi ini dibutuhkan 16 IP address untuk ke-6 node yang disediakan. Jumlah IP address ini ditentukan karena kebutuhan 8 jaringan atau network untuk menghubungkan node satu sama lain. Pada setiap network tersebut akan membutuhkan 2 IP address.

Dengan kebutuhan 2 IP address pada setiap jaringan, maka digunakanlah prefix CIDR bernilai /30 yang akan menyediakan available IP berjumlah 2, network address berjumlah 1, dan broadcast address berjumlah 1. Pemilihan prefix CIDR ini juga berpengaruh untuk memperkecil jangkauan IP agar tidak melakukan pemborosan IP. Dengan itu, penggunaan prefic /30 paling cocok karena semua IP subnet yang tersedia akan digunakan.

2.2.2 Membangun Topologi Network

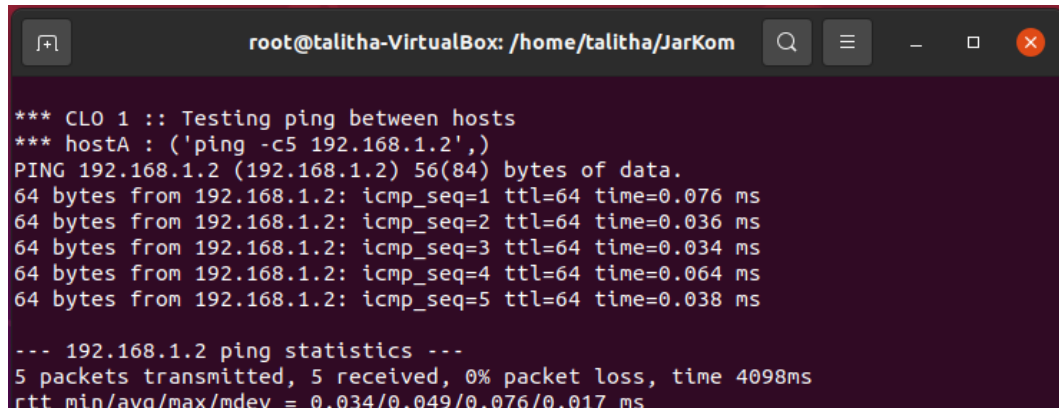
```
15 class MyTopo(Topo):  # You, 2 weeks ago • Base Topology
16     '''Topology to be instantiated in Mininet'''
17     def __init__(self, **opts):
18         # Initialize topology and default options
19         Topo.__init__(self, **opts)
20
21         #Define bandwidth
22         bw1 = 1
23         bw2 = 0.5
24
25         #Creating the nodes/hosts
26         hostA = self.addHost('hostA')
27         hostB = self.addHost('hostB')
28
29         #Creating the routers
30         r1 = self.addHost('r1')
31         r2 = self.addHost('r2')
32         r3 = self.addHost('r3')
33         r4 = self.addHost('r4')
34
35         #Creating the links between host and routers
36
37         #Host A
38         self.addLink(hostA, r1,
39                       intfName1='hostA-fa0',
40                       intfName2='r1-fa0',
41                       cls = TCLink,
42                       bw=bw1) #network 1
43         self.addLink(hostA, r2,
44                       intfName1='hostA-fa1',
45                       intfName2='r2-fa0',
46                       cls = TCLink,
47                       bw=bw1) #network 2
48
49         #Host B
50         self.addLink(hostB, r3,
51                       intfName1='hostB-fa0',
52                       intfName2='r3-fa0',
53                       cls = TCLink,
54                       bw=bw1) #network 7
55         self.addLink(hostB, r4,
56                       intfName1='hostB-fa1',
57                       intfName2='r4-fa0',
58                       cls = TCLink,
59                       bw=bw1) #network 8
60
61         #Creating the links between routers
62
63         #Network 3
64         self.addLink(r1, r3, intfName1='r1-se2', intfName2='r3-se2', cls = TCLink, bw=bw2)
65         #Network 5
66         self.addLink(r1, r4, intfName1='r1-se3', intfName2='r4-se3', cls = TCLink, bw=bw1)
67
68         #Network 4
69         self.addLink(r2, r4, intfName1='r2-se2', intfName2='r4-se2', cls = TCLink, bw=bw2)
70         #Network 6
71         self.addLink(r2, r3, intfName1='r2-se3', intfName2='r3-se3', cls = TCLink, bw=bw1)
```

2.2.3 Assign IP Address

```
72 def assign_IP(h1,h2,r1,r2,r3,r4):          You, 2 days ago • cleaning code & hardcode
73     '''Assign IP addresses to the hosts & routers'''
74
75     #Configure IP addresses for hosts
76
77     #define NIC for hostA
78     h1.cmd('ifconfig hostA-fa0 0')
79     h1.cmd('ifconfig hostA-fa1 0')
80     #define IP address for hostA interfaces
81     h1.cmd('ifconfig hostA-fa0 192.168.1.1 netmask 255.255.255.252') #network 1
82     h1.cmd('ifconfig hostA-fa1 192.168.1.5 netmask 255.255.255.252') #network 2
83
84     #define NIC for hostB
85     h2.cmd('ifconfig hostB-fa0 0')
86     h2.cmd('ifconfig hostB-fa1 0')
87     #define IP address for hostB interfaces
88     h2.cmd('ifconfig hostB-fa0 192.168.1.25 netmask 255.255.255.252') #network 7
89     h2.cmd('ifconfig hostB-fa1 192.168.1.29 netmask 255.255.255.252') #network 8
90
91     #Enabling routers IP Forwarding for hosts
92     r1.cmd('sysctl -w net.ipv4.ip_forward=1')
93     r2.cmd('sysctl -w net.ipv4.ip_forward=1')
94     r3.cmd('sysctl -w net.ipv4.ip_forward=1')
95     r4.cmd('sysctl -w net.ipv4.ip_forward=1')
96
97     #Configure IP addresses for routers
98
99     #define NIC for r1
100    r1.cmd('ifconfig r1-fa0 0')
101    r1.cmd('ifconfig r1-se2 0')
102    r1.cmd('ifconfig r1-se3 0')
103    #define IP address for r1 interfaces
104    r1.cmd('ifconfig r1-fa0 192.168.1.2 netmask 255.255.255.252') #network 1
105    r1.cmd('ifconfig r1-se2 192.168.1.9 netmask 255.255.255.252') #network 3
106    r1.cmd('ifconfig r1-se3 192.168.1.17 netmask 255.255.255.252') #network 5
107
108    #define NIC for r2
109    r2.cmd('ifconfig r2-fa0 0')
110    r2.cmd('ifconfig r2-se2 0')
111    r2.cmd('ifconfig r2-se3 0')
112    #define IP address for r2 interfaces
113    r2.cmd('ifconfig r2-fa0 192.168.1.6 netmask 255.255.255.252') #network 2
114    r2.cmd('ifconfig r2-se2 192.168.1.13 netmask 255.255.255.252') #network 4
115    r2.cmd('ifconfig r2-se3 192.168.1.21 netmask 255.255.255.252') #network 6
116
117    #define NIC for r3
118    r3.cmd('ifconfig r3-fa0 0')
119    r3.cmd('ifconfig r3-se2 0')
120    r3.cmd('ifconfig r3-se3 0')
121    #define IP address for r3 interfaces
122    r3.cmd('ifconfig r3-fa0 192.168.1.26 netmask 255.255.255.252') #network 7
123    r3.cmd('ifconfig r3-se2 192.168.1.10 netmask 255.255.255.252') #network 3
124    r3.cmd('ifconfig r3-se3 192.168.1.22 netmask 255.255.255.252') #network 6
125
126    #define NIC for r4
127    r4.cmd('ifconfig r4-fa0 0')
128    r4.cmd('ifconfig r4-se2 0')
129    r4.cmd('ifconfig r4-se3 0')
130    #define IP address for r4 interfaces
131    r4.cmd('ifconfig r4-fa0 192.168.1.30 netmask 255.255.255.252') #network 8
132    r4.cmd('ifconfig r4-se2 192.168.1.14 netmask 255.255.255.252') #network 4
133    r4.cmd('ifconfig r4-se3 192.168.1.18 netmask 255.255.255.252') #network 5
```

2.2.4 Uji Konektivitas Subnet Sama

2.2.4.1 Konektivitas Network 1



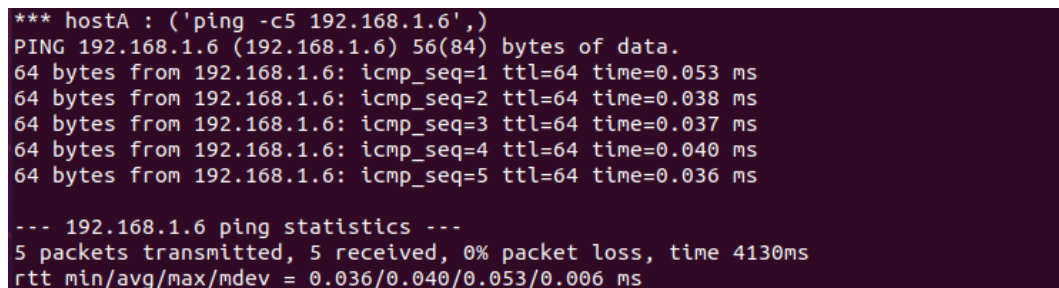
```
root@talitha-VirtualBox: /home/talitha/JarKom

*** CLO 1 :: Testing ping between hosts
*** hostA : ('ping -c5 192.168.1.2',)
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=0.076 ms
64 bytes from 192.168.1.2: icmp_seq=2 ttl=64 time=0.036 ms
64 bytes from 192.168.1.2: icmp_seq=3 ttl=64 time=0.034 ms
64 bytes from 192.168.1.2: icmp_seq=4 ttl=64 time=0.064 ms
64 bytes from 192.168.1.2: icmp_seq=5 ttl=64 time=0.038 ms

--- 192.168.1.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4098ms
rtt min/avg/max/mdev = 0.034/0.049/0.076/0.017 ms
```

Gambar 7 Konektivitas Network 1

2.2.4.2 Konektivitas Network 2

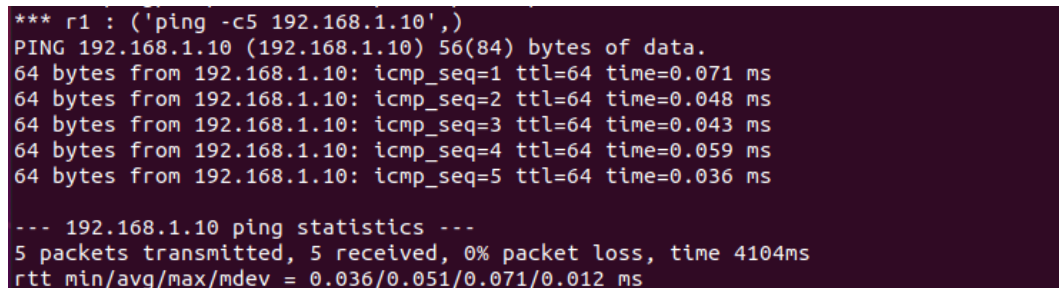


```
*** hostA : ('ping -c5 192.168.1.6',)
PING 192.168.1.6 (192.168.1.6) 56(84) bytes of data.
64 bytes from 192.168.1.6: icmp_seq=1 ttl=64 time=0.053 ms
64 bytes from 192.168.1.6: icmp_seq=2 ttl=64 time=0.038 ms
64 bytes from 192.168.1.6: icmp_seq=3 ttl=64 time=0.037 ms
64 bytes from 192.168.1.6: icmp_seq=4 ttl=64 time=0.040 ms
64 bytes from 192.168.1.6: icmp_seq=5 ttl=64 time=0.036 ms

--- 192.168.1.6 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4130ms
rtt min/avg/max/mdev = 0.036/0.040/0.053/0.006 ms
```

Gambar 8 Konektivitas Network 2

2.2.4.3 Konektivitas Network 3

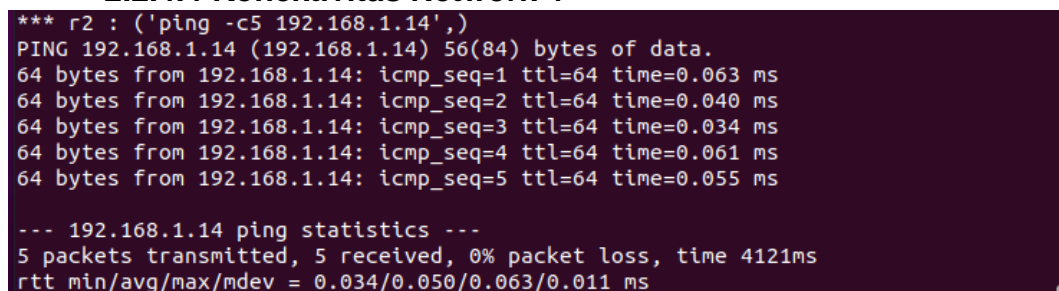


```
*** r1 : ('ping -c5 192.168.1.10',)
PING 192.168.1.10 (192.168.1.10) 56(84) bytes of data.
64 bytes from 192.168.1.10: icmp_seq=1 ttl=64 time=0.071 ms
64 bytes from 192.168.1.10: icmp_seq=2 ttl=64 time=0.048 ms
64 bytes from 192.168.1.10: icmp_seq=3 ttl=64 time=0.043 ms
64 bytes from 192.168.1.10: icmp_seq=4 ttl=64 time=0.059 ms
64 bytes from 192.168.1.10: icmp_seq=5 ttl=64 time=0.036 ms

--- 192.168.1.10 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4104ms
rtt min/avg/max/mdev = 0.036/0.051/0.071/0.012 ms
```

Gambar 9 Konektivitas Network 3

2.2.4.4 Konektivitas Network 4



```
*** r2 : ('ping -c5 192.168.1.14',)
PING 192.168.1.14 (192.168.1.14) 56(84) bytes of data.
64 bytes from 192.168.1.14: icmp_seq=1 ttl=64 time=0.063 ms
64 bytes from 192.168.1.14: icmp_seq=2 ttl=64 time=0.040 ms
64 bytes from 192.168.1.14: icmp_seq=3 ttl=64 time=0.034 ms
64 bytes from 192.168.1.14: icmp_seq=4 ttl=64 time=0.061 ms
64 bytes from 192.168.1.14: icmp_seq=5 ttl=64 time=0.055 ms

--- 192.168.1.14 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4121ms
rtt min/avg/max/mdev = 0.034/0.050/0.063/0.011 ms
```

Gambar 10 Konektivitas Network 4

2.2.4.5 Konektivitas Network 5

```
*** r1 : ('ping -c5 192.168.1.18',)
PING 192.168.1.18 (192.168.1.18) 56(84) bytes of data.
64 bytes from 192.168.1.18: icmp_seq=1 ttl=64 time=0.044 ms
64 bytes from 192.168.1.18: icmp_seq=2 ttl=64 time=0.038 ms
64 bytes from 192.168.1.18: icmp_seq=3 ttl=64 time=0.036 ms
64 bytes from 192.168.1.18: icmp_seq=4 ttl=64 time=0.046 ms
64 bytes from 192.168.1.18: icmp_seq=5 ttl=64 time=0.038 ms

--- 192.168.1.18 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4108ms
rtt min/avg/max/mdev = 0.036/0.040/0.046/0.004 ms
```

Gambar 11 Konektivitas Network 5

2.2.4.6 Konektivitas Network 6

```
*** r2 : ('ping -c5 192.168.1.22',)
PING 192.168.1.22 (192.168.1.22) 56(84) bytes of data.
64 bytes from 192.168.1.22: icmp_seq=1 ttl=64 time=0.054 ms
64 bytes from 192.168.1.22: icmp_seq=2 ttl=64 time=0.046 ms
64 bytes from 192.168.1.22: icmp_seq=3 ttl=64 time=0.037 ms
64 bytes from 192.168.1.22: icmp_seq=4 ttl=64 time=0.070 ms
64 bytes from 192.168.1.22: icmp_seq=5 ttl=64 time=0.039 ms

--- 192.168.1.22 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4111ms
rtt min/avg/max/mdev = 0.037/0.049/0.070/0.012 ms
```

Gambar 12 Konektivitas Network 6

2.2.4.7 Konektivitas Network 7

```
*** hostB : ('ping -c5 192.168.1.26',)
PING 192.168.1.26 (192.168.1.26) 56(84) bytes of data.
64 bytes from 192.168.1.26: icmp_seq=1 ttl=64 time=0.051 ms
64 bytes from 192.168.1.26: icmp_seq=2 ttl=64 time=0.039 ms
64 bytes from 192.168.1.26: icmp_seq=3 ttl=64 time=0.037 ms
64 bytes from 192.168.1.26: icmp_seq=4 ttl=64 time=0.035 ms
64 bytes from 192.168.1.26: icmp_seq=5 ttl=64 time=0.060 ms

--- 192.168.1.26 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4123ms
rtt min/avg/max/mdev = 0.035/0.044/0.060/0.009 ms
```

Gambar 13 Konektivitas Network 7

2.2.4.8 Konektivitas Network 8

```
*** hostB : ('ping -c5 192.168.1.30',)
PING 192.168.1.30 (192.168.1.30) 56(84) bytes of data.
64 bytes from 192.168.1.30: icmp_seq=1 ttl=64 time=0.069 ms
64 bytes from 192.168.1.30: icmp_seq=2 ttl=64 time=0.098 ms
64 bytes from 192.168.1.30: icmp_seq=3 ttl=64 time=0.037 ms
64 bytes from 192.168.1.30: icmp_seq=4 ttl=64 time=0.049 ms
64 bytes from 192.168.1.30: icmp_seq=5 ttl=64 time=0.036 ms

--- 192.168.1.30 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4110ms
rtt min/avg/max/mdev = 0.036/0.057/0.098/0.023 ms
```

Gambar 14 Konektivitas Network 8

2.3 CLO 2 – Static Routing

2.3.1 Uji Konektivitas Static Routing

2.3.1.1 HostA to All

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** Testing ping between hosts
*** hostA : ('ping -c5 192.168.1.25',)
PING 192.168.1.25 (192.168.1.25) 56(84) bytes of data.
64 bytes from 192.168.1.25: icmp_seq=1 ttl=62 time=0.140 ms
64 bytes from 192.168.1.25: icmp_seq=2 ttl=62 time=0.076 ms
64 bytes from 192.168.1.25: icmp_seq=3 ttl=62 time=0.101 ms
64 bytes from 192.168.1.25: icmp_seq=4 ttl=62 time=0.066 ms
64 bytes from 192.168.1.25: icmp_seq=5 ttl=62 time=0.080 ms

--- 192.168.1.25 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4122ms
rtt min/avg/max/mdev = 0.066/0.092/0.140/0.026 ms
```

Gambar 15 hostA ping hostB (via network 7)

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** hostA : ('ping -c5 192.168.1.29',)
PING 192.168.1.29 (192.168.1.29) 56(84) bytes of data.
64 bytes from 192.168.1.29: icmp_seq=1 ttl=62 time=0.113 ms
64 bytes from 192.168.1.29: icmp_seq=2 ttl=62 time=0.036 ms
64 bytes from 192.168.1.29: icmp_seq=3 ttl=62 time=0.059 ms
64 bytes from 192.168.1.29: icmp_seq=4 ttl=62 time=0.089 ms
64 bytes from 192.168.1.29: icmp_seq=5 ttl=62 time=0.055 ms

--- 192.168.1.29 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4118ms
rtt min/avg/max/mdev = 0.036/0.070/0.113/0.027 ms
```

Gambar 16 hostA ping hostB (via network 8)

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** hostA : ('ping -c5 192.168.1.2',)
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=0.027 ms
64 bytes from 192.168.1.2: icmp_seq=2 ttl=64 time=0.038 ms
64 bytes from 192.168.1.2: icmp_seq=3 ttl=64 time=0.039 ms
64 bytes from 192.168.1.2: icmp_seq=4 ttl=64 time=0.044 ms
64 bytes from 192.168.1.2: icmp_seq=5 ttl=64 time=0.057 ms

--- 192.168.1.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4251ms
rtt min/avg/max/mdev = 0.027/0.041/0.057/0.009 ms
```

Gambar 17 hostA ping r1 (network 1)


```
root@talitha-VirtualBox: /home/talitha/JarKom
*** hostA : ('ping -c5 192.168.1.6',)
PING 192.168.1.6 (192.168.1.6) 56(84) bytes of data.
64 bytes from 192.168.1.6: icmp_seq=1 ttl=64 time=0.091 ms
64 bytes from 192.168.1.6: icmp_seq=2 ttl=64 time=0.041 ms
64 bytes from 192.168.1.6: icmp_seq=3 ttl=64 time=0.071 ms
64 bytes from 192.168.1.6: icmp_seq=4 ttl=64 time=0.054 ms
64 bytes from 192.168.1.6: icmp_seq=5 ttl=64 time=0.039 ms

--- 192.168.1.6 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4092ms
rtt min/avg/max/mdev = 0.039/0.059/0.091/0.019 ms
```

Gambar 18 hostA ping r2 (network 2)

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** hostA : ('ping -c5 192.168.1.10',)
PING 192.168.1.10 (192.168.1.10) 56(84) bytes of data.
64 bytes from 192.168.1.10: icmp_seq=1 ttl=63 time=0.044 ms
64 bytes from 192.168.1.10: icmp_seq=2 ttl=63 time=0.079 ms
64 bytes from 192.168.1.10: icmp_seq=3 ttl=63 time=0.055 ms
64 bytes from 192.168.1.10: icmp_seq=4 ttl=63 time=0.098 ms
64 bytes from 192.168.1.10: icmp_seq=5 ttl=63 time=0.068 ms

--- 192.168.1.10 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4171ms
rtt min/avg/max/mdev = 0.044/0.068/0.098/0.018 ms
```

Gambar 19 hostA ping r3 (via network 3)

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** hostA : ('ping -c5 192.168.1.14',)
PING 192.168.1.14 (192.168.1.14) 56(84) bytes of data.
64 bytes from 192.168.1.14: icmp_seq=1 ttl=63 time=0.080 ms
64 bytes from 192.168.1.14: icmp_seq=2 ttl=63 time=0.069 ms
64 bytes from 192.168.1.14: icmp_seq=3 ttl=63 time=0.104 ms
64 bytes from 192.168.1.14: icmp_seq=4 ttl=63 time=0.103 ms
64 bytes from 192.168.1.14: icmp_seq=5 ttl=63 time=0.055 ms

--- 192.168.1.14 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4107ms
rtt min/avg/max/mdev = 0.055/0.082/0.104/0.019 ms
```

Gambar 20 hostA ping r4 (via network 5)

2.3.1.2 HostB to All Routers

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** hostB : ('ping -c5 192.168.1.9',)
PING 192.168.1.9 (192.168.1.9) 56(84) bytes of data.
64 bytes from 192.168.1.9: icmp_seq=1 ttl=63 time=0.049 ms
64 bytes from 192.168.1.9: icmp_seq=2 ttl=63 time=0.058 ms
64 bytes from 192.168.1.9: icmp_seq=3 ttl=63 time=0.055 ms
64 bytes from 192.168.1.9: icmp_seq=4 ttl=63 time=0.054 ms
64 bytes from 192.168.1.9: icmp_seq=5 ttl=63 time=0.062 ms

--- 192.168.1.9 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4107ms
rtt min/avg/max/mdev = 0.049/0.055/0.062/0.004 ms
```

Gambar 21 hostB ping r1 (via network 3)

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** hostB : ('ping -c5 192.168.1.13',)
PING 192.168.1.13 (192.168.1.13) 56(84) bytes of data.
64 bytes from 192.168.1.13: icmp_seq=1 ttl=63 time=0.064 ms
64 bytes from 192.168.1.13: icmp_seq=2 ttl=63 time=0.066 ms
64 bytes from 192.168.1.13: icmp_seq=3 ttl=63 time=0.064 ms
64 bytes from 192.168.1.13: icmp_seq=4 ttl=63 time=0.079 ms
64 bytes from 192.168.1.13: icmp_seq=5 ttl=63 time=0.068 ms

--- 192.168.1.13 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4084ms
rtt min/avg/max/mdev = 0.064/0.068/0.079/0.005 ms
```

Gambar 22 hostB ping r2 (via network 6)

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** hostB : ('ping -c5 192.168.1.26',)
PING 192.168.1.26 (192.168.1.26) 56(84) bytes of data.
64 bytes from 192.168.1.26: icmp_seq=1 ttl=64 time=0.046 ms
64 bytes from 192.168.1.26: icmp_seq=2 ttl=64 time=0.050 ms
64 bytes from 192.168.1.26: icmp_seq=3 ttl=64 time=0.067 ms
64 bytes from 192.168.1.26: icmp_seq=4 ttl=64 time=0.060 ms
64 bytes from 192.168.1.26: icmp_seq=5 ttl=64 time=0.043 ms

--- 192.168.1.26 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4099ms
rtt min/avg/max/mdev = 0.043/0.053/0.067/0.009 ms
```

Gambar 23 hostB ping r3 (network 7)

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** hostB : ('ping -c5 192.168.1.30',)
PING 192.168.1.30 (192.168.1.30) 56(84) bytes of data.
64 bytes from 192.168.1.30: icmp_seq=1 ttl=64 time=0.041 ms
64 bytes from 192.168.1.30: icmp_seq=2 ttl=64 time=0.038 ms
64 bytes from 192.168.1.30: icmp_seq=3 ttl=64 time=0.041 ms
64 bytes from 192.168.1.30: icmp_seq=4 ttl=64 time=0.052 ms
64 bytes from 192.168.1.30: icmp_seq=5 ttl=64 time=0.133 ms

--- 192.168.1.30 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4124ms
rtt min/avg/max/mdev = 0.038/0.061/0.133/0.036 ms
```

Gambar 24 hostB ping r4 (network 8)

2.3.1.3 Router r1 to All Routers

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** r1 : ('ping -c5 192.168.1.21',)
PING 192.168.1.21 (192.168.1.21) 56(84) bytes of data.
64 bytes from 192.168.1.21: icmp_seq=1 ttl=63 time=0.080 ms
64 bytes from 192.168.1.21: icmp_seq=2 ttl=63 time=0.052 ms
64 bytes from 192.168.1.21: icmp_seq=3 ttl=63 time=0.052 ms
64 bytes from 192.168.1.21: icmp_seq=4 ttl=63 time=0.106 ms
64 bytes from 192.168.1.21: icmp_seq=5 ttl=63 time=0.063 ms

--- 192.168.1.21 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4374ms
rtt min/avg/max/mdev = 0.052/0.070/0.106/0.020 ms
```

Gambar 25 r1 ping r2 (via network 6)

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** r1 : ('ping -c5 192.168.1.13',)
PING 192.168.1.13 (192.168.1.13) 56(84) bytes of data.
64 bytes from 192.168.1.13: icmp_seq=1 ttl=63 time=0.044 ms
64 bytes from 192.168.1.13: icmp_seq=2 ttl=63 time=0.064 ms
64 bytes from 192.168.1.13: icmp_seq=3 ttl=63 time=0.097 ms
64 bytes from 192.168.1.13: icmp_seq=4 ttl=63 time=0.060 ms
64 bytes from 192.168.1.13: icmp_seq=5 ttl=63 time=0.054 ms

--- 192.168.1.13 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4097ms
rtt min/avg/max/mdev = 0.044/0.063/0.097/0.017 ms
```

Gambar 26 r1 ping r2 (via network 4)

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** r1 : ('ping -c5 192.168.1.10',)
PING 192.168.1.10 (192.168.1.10) 56(84) bytes of data.
64 bytes from 192.168.1.10: icmp_seq=1 ttl=64 time=0.034 ms
64 bytes from 192.168.1.10: icmp_seq=2 ttl=64 time=0.047 ms
64 bytes from 192.168.1.10: icmp_seq=3 ttl=64 time=0.056 ms
64 bytes from 192.168.1.10: icmp_seq=4 ttl=64 time=0.043 ms
64 bytes from 192.168.1.10: icmp_seq=5 ttl=64 time=0.050 ms

--- 192.168.1.10 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4214ms
rtt min/avg/max/mdev = 0.034/0.046/0.056/0.007 ms
```

Gambar 27 r1 ping r3 (network 3)

```
root@talitha-VirtualBox: /home/talitha/JarKom
r1: min/avg/max/mdev = 0.034/0.040/0.050/0.007 ms
*** r1 : ('ping -c5 192.168.1.18',)
PING 192.168.1.18 (192.168.1.18) 56(84) bytes of data.
64 bytes from 192.168.1.18: icmp_seq=1 ttl=64 time=0.042 ms
64 bytes from 192.168.1.18: icmp_seq=2 ttl=64 time=0.058 ms
64 bytes from 192.168.1.18: icmp_seq=3 ttl=64 time=0.046 ms
64 bytes from 192.168.1.18: icmp_seq=4 ttl=64 time=0.053 ms
64 bytes from 192.168.1.18: icmp_seq=5 ttl=64 time=0.040 ms

--- 192.168.1.18 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4106ms
rtt min/avg/max/mdev = 0.040/0.047/0.058/0.006 ms
```

Gambar 28 r1 ping r4 (network 5)

2.3.1.4 Router r2 to All Routers

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** r2 : ('ping -c5 192.168.1.9',)
PING 192.168.1.9 (192.168.1.9) 56(84) bytes of data.
64 bytes from 192.168.1.9: icmp_seq=1 ttl=63 time=0.060 ms
64 bytes from 192.168.1.9: icmp_seq=2 ttl=63 time=0.093 ms
64 bytes from 192.168.1.9: icmp_seq=3 ttl=63 time=0.091 ms
64 bytes from 192.168.1.9: icmp_seq=4 ttl=63 time=0.092 ms
64 bytes from 192.168.1.9: icmp_seq=5 ttl=63 time=0.076 ms

--- 192.168.1.9 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4090ms
rtt min/avg/max/mdev = 0.060/0.082/0.093/0.012 ms
```

Gambar 29 r2 ping r1 (via network 3)

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** r2 : ('ping -c5 192.168.1.17',)
PING 192.168.1.17 (192.168.1.17) 56(84) bytes of data.
64 bytes from 192.168.1.17: icmp_seq=1 ttl=63 time=0.049 ms
64 bytes from 192.168.1.17: icmp_seq=2 ttl=63 time=0.057 ms
64 bytes from 192.168.1.17: icmp_seq=3 ttl=63 time=0.053 ms
64 bytes from 192.168.1.17: icmp_seq=4 ttl=63 time=0.071 ms
64 bytes from 192.168.1.17: icmp_seq=5 ttl=63 time=0.071 ms

--- 192.168.1.17 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4102ms
rtt min/avg/max/mdev = 0.049/0.060/0.071/0.009 ms
```

Gambar 30 r2 ping r1 (via network 5)

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** r2 : ('ping -c5 192.168.1.22',)
PING 192.168.1.22 (192.168.1.22) 56(84) bytes of data.
64 bytes from 192.168.1.22: icmp_seq=1 ttl=64 time=0.029 ms
64 bytes from 192.168.1.22: icmp_seq=2 ttl=64 time=0.045 ms
64 bytes from 192.168.1.22: icmp_seq=3 ttl=64 time=0.038 ms
64 bytes from 192.168.1.22: icmp_seq=4 ttl=64 time=0.061 ms
64 bytes from 192.168.1.22: icmp_seq=5 ttl=64 time=0.069 ms

--- 192.168.1.22 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4181ms
rtt min/avg/max/mdev = 0.029/0.048/0.069/0.014 ms
```

Gambar 31 r2 ping r3 (network 6)

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** r2 : ('ping -c5 192.168.1.14',)
PING 192.168.1.14 (192.168.1.14) 56(84) bytes of data.
64 bytes from 192.168.1.14: icmp_seq=1 ttl=64 time=0.058 ms
64 bytes from 192.168.1.14: icmp_seq=2 ttl=64 time=0.038 ms
64 bytes from 192.168.1.14: icmp_seq=3 ttl=64 time=0.037 ms
64 bytes from 192.168.1.14: icmp_seq=4 ttl=64 time=0.078 ms
64 bytes from 192.168.1.14: icmp_seq=5 ttl=64 time=0.040 ms

--- 192.168.1.14 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4222ms
rtt min/avg/max/mdev = 0.037/0.050/0.078/0.015 ms
```

Gambar 32 r2 ping r4 (network 4)

2.3.1.4 Router r3 to r4

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** r3 : ('ping -c5 192.168.1.14',)
PING 192.168.1.14 (192.168.1.14) 56(84) bytes of data.
64 bytes from 192.168.1.14: icmp_seq=1 ttl=63 time=0.043 ms
64 bytes from 192.168.1.14: icmp_seq=2 ttl=63 time=0.079 ms
64 bytes from 192.168.1.14: icmp_seq=3 ttl=63 time=0.056 ms
64 bytes from 192.168.1.14: icmp_seq=4 ttl=63 time=0.074 ms
64 bytes from 192.168.1.14: icmp_seq=5 ttl=63 time=0.056 ms

--- 192.168.1.14 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4096ms
rtt min/avg/max/mdev = 0.043/0.061/0.079/0.013 ms
```

Gambar 33 r3 ping r4 (via network 4)

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** r3 : ('ping -c5 192.168.1.18',)
PING 192.168.1.18 (192.168.1.18) 56(84) bytes of data.
64 bytes from 192.168.1.18: icmp_seq=1 ttl=63 time=0.041 ms
64 bytes from 192.168.1.18: icmp_seq=2 ttl=63 time=0.060 ms
64 bytes from 192.168.1.18: icmp_seq=3 ttl=63 time=0.056 ms
64 bytes from 192.168.1.18: icmp_seq=4 ttl=63 time=0.055 ms
64 bytes from 192.168.1.18: icmp_seq=5 ttl=63 time=0.082 ms

--- 192.168.1.18 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4090ms
rtt min/avg/max/mdev = 0.041/0.058/0.082/0.013 ms
```

Gambar 34 r3 ping r4 (via network 5)

2.3.2 Traceroute HostA dan HostB

```
mininet> hostA traceroute hostB
traceroute to 192.168.1.25 (192.168.1.25), 30 hops max, 60 byte packets
 1  192.168.1.2 (192.168.1.2)  0.755 ms  0.673 ms  0.630 ms
 2  192.168.1.10 (192.168.1.10)  0.607 ms  0.556 ms  0.526 ms
 3  192.168.1.25 (192.168.1.25)  0.492 ms  0.418 ms  0.381 ms
mininet>
```

Gambar 35 hostA traceroute hostB

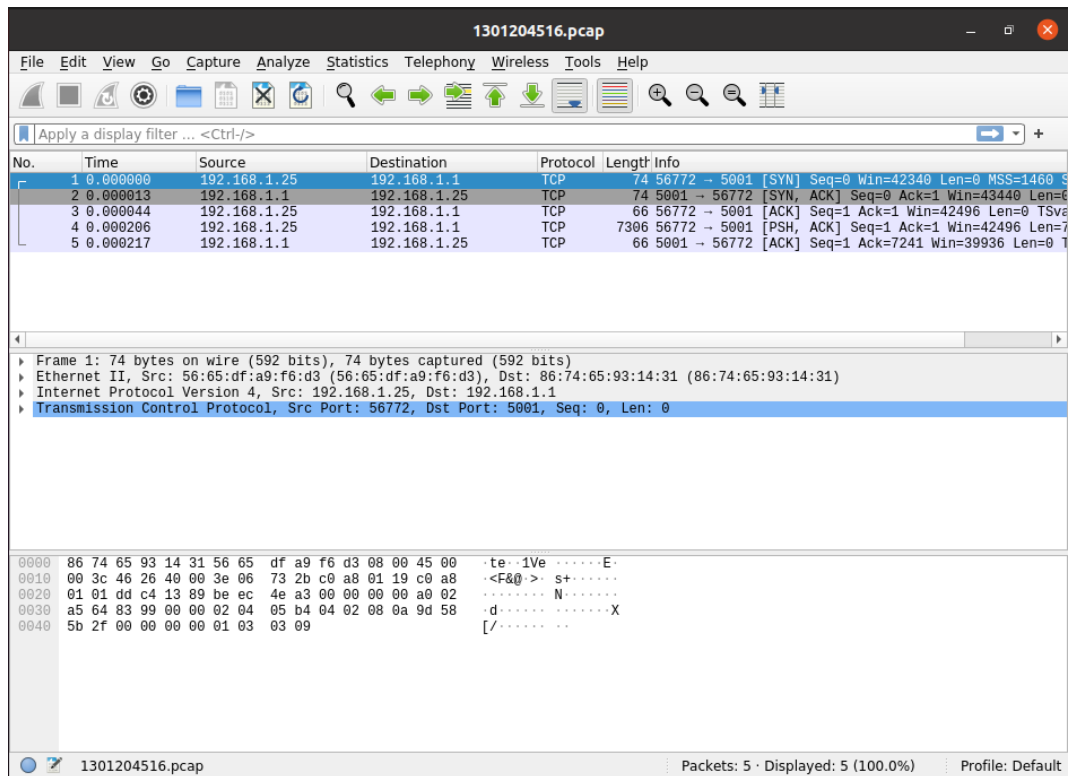
2.4 CLO 3 Capture iPerf

```
330 def tcp_traffic(net):
331     h1, h2 = net.get('hostA', 'hostB')
332     h1.cmd('iperf -s &')
333     h1.cmd('tcpdump tcp -c 5 -w 1301204516.pcap &')
334     sleep(1)
335     h2.cmdPrint('iperf -c 192.168.1.1 -t 5')
336     h1.cmdPrint('tcpdump -r 1301204516.pcap')
```

Gambar 36 Code Capture iPerf using tcpdump

```
root@talitha-VirtualBox: /home/talitha/JarKom
*** hostB : ('iperf -c 192.168.1.1 -t 5',)
-----
Client connecting to 192.168.1.1, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 3] local 192.168.1.25 port 56772 connected with 192.168.1.1 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 3]  0.0- 5.6 sec   768 KBytes  1.12 Mbits/sec
*** hostA : ('tcpdump -r 1301204516.pcap',)
-----
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
-----
tcpdump: listening on hostA-fa0, link-type EN10MB (Ethernet), capture size 262144 bytes
[ 4] local 192.168.1.1 port 5001 connected with 192.168.1.25 port 56772
5 packets captured
5 packets received by filter
0 packets dropped by kernel
reading from file 1301204516.pcap, link-type EN10MB (Ethernet)
18:28:41.967280 IP 192.168.1.25.56772 > 192.168.1.1.5001: Flags [S], seq 3203157667, win 42340, options [mss 1460,sackOK,TS val 2639813423 ecr 0,nop,wscale 9], length 0
18:28:41.967293 IP 192.168.1.1.5001 > 192.168.1.25.56772: Flags [S.], seq 250886491, ack 3203157668, win 43440, options [mss 1460,sackOK,TS val 837191780 ecr 2639813423,nop,wscale 9], length 0
18:28:41.967324 IP 192.168.1.25.56772 > 192.168.1.1.5001: Flags [.], ack 1, win 83, options [nop,nop,TS val 2639813423 ecr 837191780], length 0
18:28:41.967486 IP 192.168.1.25.56772 > 192.168.1.1.5001: Flags [P.], seq 1:7241, ack 1, win 83, options [nop,nop,TS val 2639813423 ecr 837191780], length 7240
18:28:41.967497 IP 192.168.1.1.5001 > 192.168.1.25.56772: Flags [.], ack 7241, win 78, options [nop,nop,TS val 837191780 ecr 2639813423], length 0
*** Starting CLI:
mininet>
```

Gambar 37 Hasil capture iPerf



Gambar 38 hasil capture iPerf pada wireshark

2.5 CLO 4

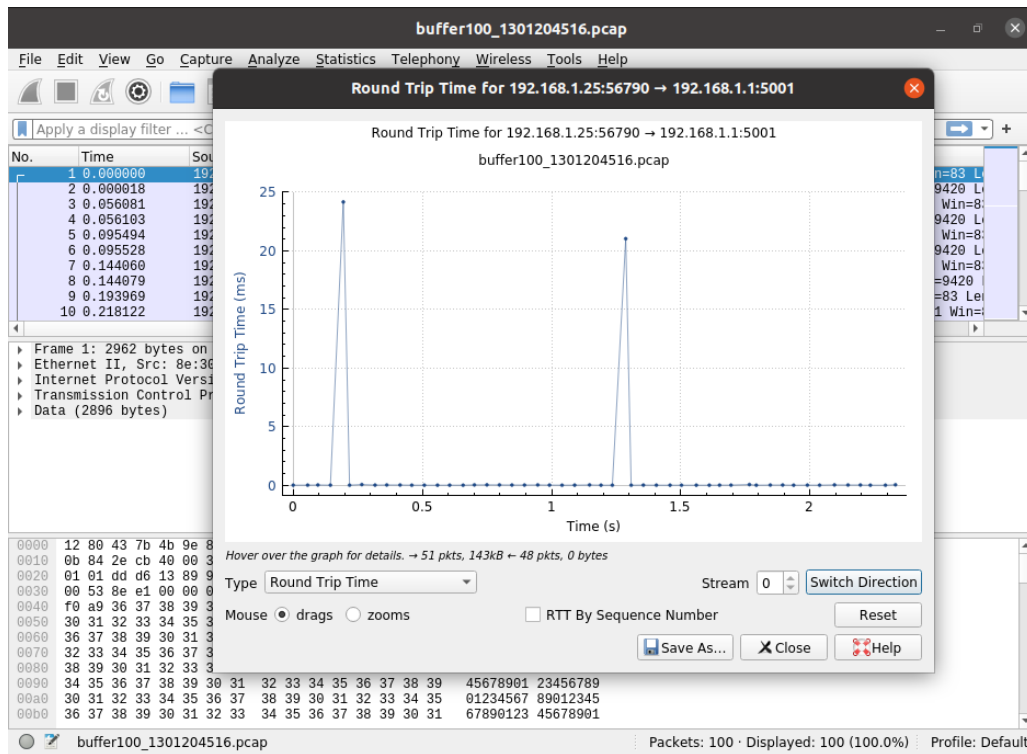
2.5.1 Setting up buffer

```
338 def buffered_traffic(h1,h2,r1,r2,r3,r4):
339     #buffer = 100
340     r1.cmdPrint("tc qdisc del dev r1-fa0 root")
341     r1.cmdPrint("tc qdisc add dev r1-fa0 root handle 1: pfifo limit 100")
342     h1.cmdPrint("iperf -s &")
343     h1.cmdPrint("tcpdump tcp -c 100 -w buffer100_1301204516.pcap &")
344     sleep(2)
345     h2.cmdPrint("iperf -c 192.168.1.1 -t 60")
346     h1.cmdPrint("tcpdump -r buffer100_1301204516.pcap")
347
348     #buffer = 60
349     r2.cmdPrint("tc qdisc del dev r2-fa0 root")
350     r2.cmdPrint("tc qdisc add dev r2-fa0 root handle 1: pfifo limit 60")
351     h1.cmdPrint("iperf -s &")
352     h1.cmdPrint("tcpdump tcp -c 100 -w buffer60_1301204516.pcap &")
353     sleep(2)
354     h2.cmdPrint("iperf -c 192.168.1.5 -t 60")
355     h1.cmdPrint("tcpdump -r buffer60_1301204516.pcap")
356
357     #buffer = 40
358     r1.cmdPrint("tc qdisc del dev r1-fa0 root")
359     r1.cmdPrint("tc qdisc add dev r1-fa0 root handle 1: pfifo limit 40")
360     h1.cmdPrint("iperf -s &")
361     h1.cmdPrint("tcpdump tcp -c 100 -w buffer40_1301204516.pcap &")
362     sleep(2)
363     h2.cmdPrint("iperf -c 192.168.1.1 -t 60")
364     h1.cmdPrint("tcpdump -r buffer40_1301204516.pcap")
365
366     #buffer = 20
367     r2.cmdPrint("tc qdisc del dev r2-fa0 root")
368     r2.cmdPrint("tc qdisc add dev r2-fa0 root handle 1: pfifo limit 20")
369     h1.cmdPrint("iperf -s &")
370     h1.cmdPrint("tcpdump tcp -c 100 -w buffer20_1301204516.pcap &")
371     sleep(2)
372     h2.cmdPrint("iperf -c 192.168.1.5 -t 60")
373     h1.cmdPrint("tcpdump -r buffer20_1301204516.pcap")
```

Gambar 39 Setting buffer

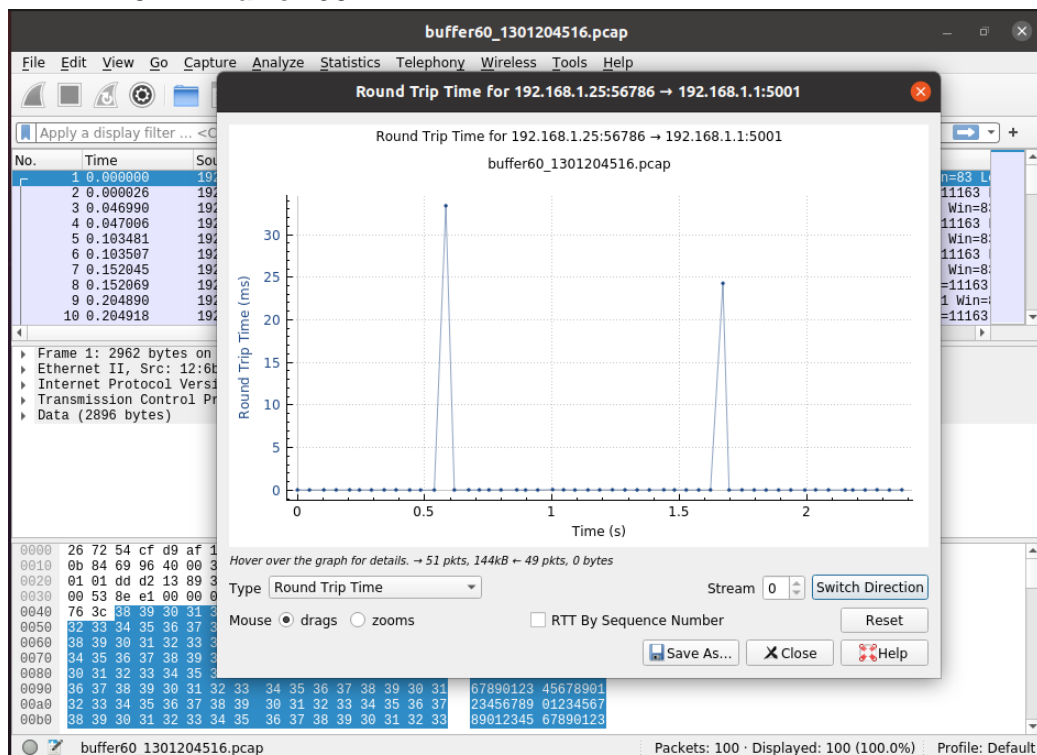
2.5.2 Wireshark Output

2.5.2.1 Buffer 100



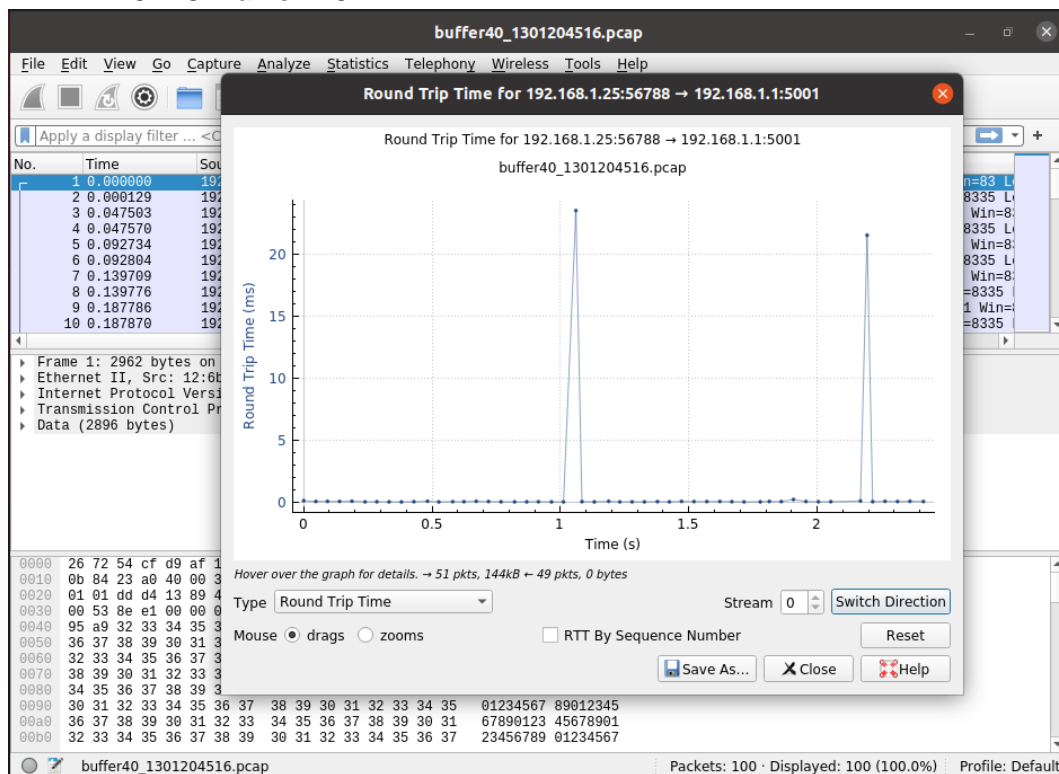
Gambar 40 Wireshark - Hasil Buffer 100

2.5.2.2 Buffer 60



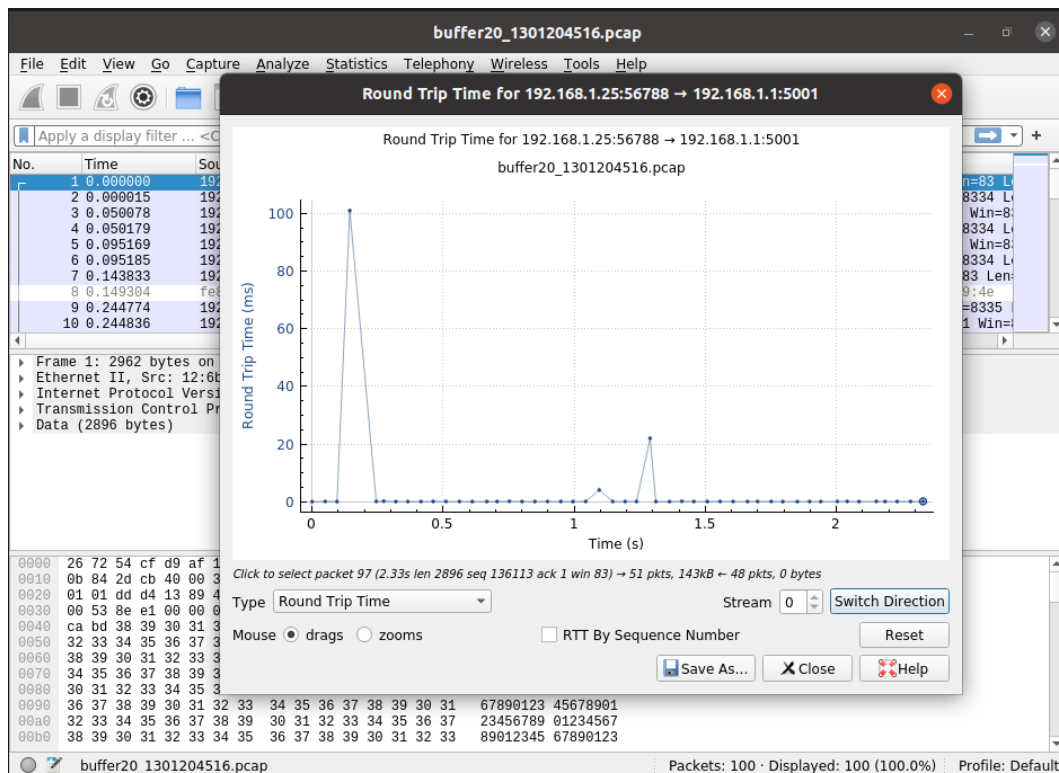
Gambar 41 Wireshark - Hasil Buffer 60

2.5.2.3 Buffer 40



Gambar 42 Wireshark - Hasil Buffer 40

2.5.2.4 Buffer 20



Gambar 43 Wireshark - Hasil Buffer 20

2.6 Video Pembahasan

Video pembahasan terdada pada link berikut :

<https://youtu.be/gVrs7tGZ0ug>

BAB 3 KESIMPULAN

3. Kesimpulan

Penggunaan mininet memerlukan keahlian dalam menulis kode dan memahami beberapa command line pada mininet. Berdasarkan hasil pengerjaan tugas Besar jaringan komputer ini maka dapat disimpulkan mininet dapat mensimulasikan sebuah topolog dengan host yang memiliki 2 NIC. Dalam melakukan simulasi, dibutuhkan pembangunan topologi terlebih dahulu seperti pada CLO-1. Setelah itu, pada CLO-2 dilakukan routing static untuk menghubungkan jaringan antar node dan telah terbukti dengan cara melakukan ping dan traceroute.

Selain itu, pada CLO-3 dibuktikan bahwa mininet dapat melakukan simulasi pengujian pengiriman packet protocol TCP menggunakan iPerf yang dapat di packet sniff oleh command TCPDump dan divisualisasikan dalam bentuk file .pcap yang dapat dibuka oleh wireshark. Terakhir, pada CLO-4 terbukti bahwa mininet dapat mensimulasikan sebuah buffer yang telah ditetapkan, dalam interface yang di-set menggunakan buffer tinggi akan memiliki RTT yang lebih fluktuatif dan memiliki perlambatan dalam mengirimkan packet.

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