LAPORAN TUGAS BESAR
JARINGAN KOMPUTER

Disusun untuk memenuhi tugas besar mata kuliah
Jaringan Komputer

Oleh:
Hidayat Taufiqur Rahmah Achmad / 1301204300

PROGRAM STUDI INFORMATIKA
FAKULTAS INFORMATIKA
UNIVERSITAS TELKOM
BANDUNG
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CLO 1

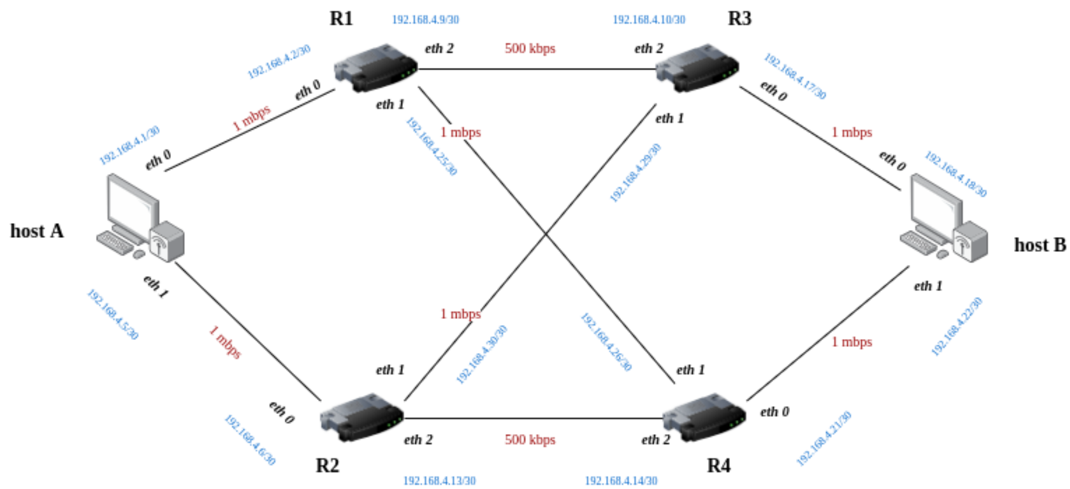
Pada CLO ini terdapat spesifikasi pengerjaan dan kriteria penilaian yang akan dilakukan.

- **Goal :** Build topology sesuai dengan soal.
    - Desain subnet masing-masing network.
    - Assign IP sesuai subnet.
    - Uji konektivitas dengan ping antara 2 host yang berada dalam 1 network.

- **Penilaian yang akan dilakukan adalah :**
    - Kesesuaian topologi yang dibangun dengan soal yang diberikan (30).
    - Ketepatan penjelasan topologi yang dibangun (50).
    - Konektivitas antar host yang berada pada subnet yang sama (20).
    - NILAI TOTAL = 100.

1. Topologi dan Table Subnetting

Berikut adalah struktur topologinya:



Dan berikut adalah tabel subnettingnya:

Nama	Host Size	Allocated	Net ID	Host Range	Broadcast	Prefix	Sub Mask
net 1	4	6	192.168.4.0	192.168.4.1 - 192.168.4.6	192.168.4.7	/29	255.255.255.248
net 2	4	6	192.168.4.8	192.168.4.9 - 192.168.4.14	192.168.4.15	/29	255.255.255.248
net 3	4	6	192.168.4.16	192.168.4.17 - 192.168.4.22	192.168.4.23	/29	255.255.255.248
net 4	4	6	192.168.4.24	192.168.4.25 - 192.168.4.30	192.168.4.31	/29	255.255.255.248
net 5	4	6	192.168.4.32	192.168.4.33 - 192.168.4.38	192.168.4.39	/29	255.255.255.248
net 6	4	6	192.168.4.40	192.168.4.41 - 192.168.4.46	192.168.4.47	/29	255.255.255.248
net 7	4	6	192.168.4.48	192.168.4.49 - 192.168.4.54	192.168.4.55	/29	255.255.255.248
net 8	4	6	192.168.4.56	192.168.4.57 - 192.168.4.62	192.168.4.63	/29	255.255.255.248

Saya menggunakan network 192.168.4.0 dengan prefix /29.

2. Config IP

Pada proses ini, saya melakukan konfigurasi IP pada host dan router sesuai dengan pembagian network pada tabel subnetting di atas.

2.1. Add Host

```
# Add Host
hA = self.addHost( 'hA', ip='192.168.4.2/29', defaultRoute='via 192.168.4.1')
hB = self.addHost( 'hB', ip='192.168.4.34/29', defaultRoute='via 192.168.4.35')
```

2.2. Add Router

```
# Add Router
R1 = self.addNode( 'R1', cls=LinuxRouter, ip='192.168.4.17/29' )
R2 = self.addNode( 'R2', cls=LinuxRouter, ip='192.168.4.25/29' )
R3 = self.addNode( 'R3', cls=LinuxRouter, ip='192.168.4.18/29' )
R4 = self.addNode( 'R4', cls=LinuxRouter, ip='192.168.4.26/29' )
```

2.3. Add Link

```
# Add Link Router - Router
self.addLink( R1, R3, cls=TCLink, **opts0, intfName1='R1-eth2', intfName2='R3-eth2',
            params1={'ip': '192.168.4.17/29'},
            params2={'ip': '192.168.4.18/29'})
self.addLink( R1, R4, cls=TCLink, **opts1, intfName1='R1-eth1', intfName2='R4-eth1',
            params1={'ip': '192.168.4.57/29'},
            params2={'ip': '192.168.4.58/29'})
self.addLink( R2, R4, cls=TCLink, **opts0, intfName1='R2-eth2', intfName2='R4-eth2',
            params1={'ip': '192.168.4.25/29'},
            params2={'ip': '192.168.4.26/29'})
self.addLink( R2, R3, cls=TCLink, **opts1, intfName1='R2-eth1', intfName2='R3-eth1',
            params1={'ip': '192.168.4.48/29'},
            params2={'ip': '192.168.4.49/29'})
```

```
# Add Link Host - Router
self.addLink( hA, R1, cls=TCLink,  **opts1, intfName2='R1-eth0',
            params1={'ip': '192.168.4.2/29'},
            params2={'ip': '192.168.4.3/29'})
self.addLink( hA, R2, cls=TCLink,  **opts1, intfName2='R2-eth0',
            params1={'ip': '192.168.4.9/29'},
            params2={'ip': '192.168.4.10/29'})
self.addLink( hB, R3, cls=TCLink,  **opts1, intfName2='R3-eth0',
            params1={'ip': '192.168.4.34/29'},
            params2={'ip': '192.168.4.33/29'})
self.addLink( hB, R4, cls=TCLink,  **opts1, intfName2='R4-eth0',
            params1={'ip': '192.168.4.42/29'},
            params2={'ip': '192.168.4.41/29'})
```

3. Uji konektivitas

3.1. Host A ke R1

```
mininet> hA ping 192.168.4.3
PING 192.168.4.3 (192.168.4.3) 56(84) bytes of data.
64 bytes from 192.168.4.3: icmp_seq=1 ttl=64 time=0.045 ms
64 bytes from 192.168.4.3: icmp_seq=2 ttl=64 time=0.051 ms
64 bytes from 192.168.4.3: icmp_seq=3 ttl=64 time=0.062 ms
^C
--- 192.168.4.3 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2037ms
rtt min/avg/max/mdev = 0.045/0.052/0.062/0.007 ms
```

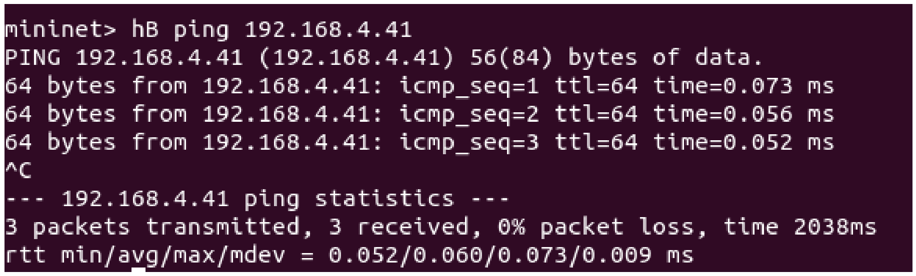
3.2. Host A ke R2

```
mininet> hA ping 192.168.4.10
PING 192.168.4.10 (192.168.4.10) 56(84) bytes of data.
64 bytes from 192.168.4.10: icmp_seq=1 ttl=64 time=0.027 ms
64 bytes from 192.168.4.10: icmp_seq=2 ttl=64 time=0.051 ms
64 bytes from 192.168.4.10: icmp_seq=3 ttl=64 time=0.064 ms
^C
--- 192.168.4.10 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2034ms
rtt min/avg/max/mdev = 0.027/0.047/0.064/0.015 ms
```

3.3. Host B ke R3

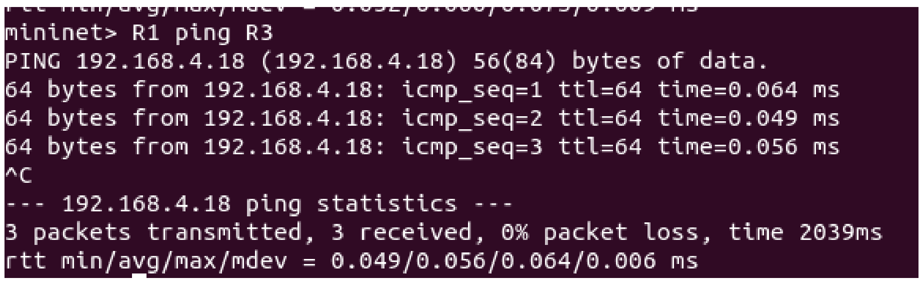
```
mininet> hB ping 192.168.4.33
PING 192.168.4.33 (192.168.4.33) 56(84) bytes of data.
64 bytes from 192.168.4.33: icmp_seq=1 ttl=64 time=0.050 ms
64 bytes from 192.168.4.33: icmp_seq=2 ttl=64 time=0.051 ms
64 bytes from 192.168.4.33: icmp_seq=3 ttl=64 time=0.045 ms
^C
--- 192.168.4.33 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2050ms
rtt min/avg/max/mdev = 0.045/0.048/0.051/0.002 ms
```

3.4. Host B ke R4



```
mininet> hB ping 192.168.4.41
PING 192.168.4.41 (192.168.4.41) 56(84) bytes of data.
64 bytes from 192.168.4.41: icmp_seq=1 ttl=64 time=0.073 ms
64 bytes from 192.168.4.41: icmp_seq=2 ttl=64 time=0.056 ms
64 bytes from 192.168.4.41: icmp_seq=3 ttl=64 time=0.052 ms
^C
--- 192.168.4.41 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2038ms
rtt min/avg/max/mdev = 0.052/0.060/0.073/0.009 ms
```

3.5. R1 ke R3



```
mininet> R1 ping R3
PING 192.168.4.18 (192.168.4.18) 56(84) bytes of data.
64 bytes from 192.168.4.18: icmp_seq=1 ttl=64 time=0.064 ms
64 bytes from 192.168.4.18: icmp_seq=2 ttl=64 time=0.049 ms
64 bytes from 192.168.4.18: icmp_seq=3 ttl=64 time=0.056 ms
^C
--- 192.168.4.18 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2039ms
rtt min/avg/max/mdev = 0.049/0.056/0.064/0.006 ms
```

3.6. R2 ke R4

```
mininet> R2 ping R4
PING 192.168.4.26 (192.168.4.26) 56(84) bytes of data.
64 bytes from 192.168.4.26: icmp_seq=1 ttl=64 time=0.052 ms
64 bytes from 192.168.4.26: icmp_seq=2 ttl=64 time=0.065 ms
64 bytes from 192.168.4.26: icmp_seq=3 ttl=64 time=0.053 ms
^C
--- 192.168.4.26 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2049ms
rtt min/avg/max/mdev = 0.052/0.056/0.065/0.005 ms
```

3.7. pingall

```
mininet> pingall
*** Ping: testing ping reachability
R1 -> X R3 X hA X
R2 -> X X R4 X X
R3 -> R1 X X X hB
R4 -> X R2 X X X
hA -> X X X X X
hB -> X X X X X
*** Results: 80% dropped (6/30 received)
```

CLO 2

Pada CLO ini terdapat spesifikasi pengerjaan dan kriteria penilaian yang akan dilakukan.

- **Goal :** Mengimplementasikan mekanisme Routing pada topologi yang ada.
  - Uji konektivitas menggunakan ping.
  - Membuat tabel routing di semua host, dibuktikan dengan ping antar host.
  - Menganalisis routing yang digunakan menggunakan traceroute

- **Penilaian yang akan dilakukan adalah :**
  - Ketepatan implementasi routing sesuai spesifikasi yang ada (30).
  - Ketepatan penjelasan proses routing yang diimplementasikan (50).
  - Konektivitas antar host yang berada pada subnet berbeda (20).
  - NILAI TOTAL = 100.

1. Routing

Proses selanjutnya adalah untuk melakukan static routing untuk semua host dan router.

1.1. Host

```
# Static Routing Host A
net['hA'].cmd("ip rule add from 192.168.4.2 table 1")
net['hA'].cmd("ip rule add from 192.168.4.9 table 2")
net['hA'].cmd("ip route add 192.168.4.0/29 dev hA-eth0 scope link table 1")
net['hA'].cmd("ip route add default via 192.168.4.3 dev hA-eth0 table 1")
net['hA'].cmd("ip route add 192.168.4.8/29 dev hA-eth1 scope link table 2")
net['hA'].cmd("ip route add default via 192.168.4.10 dev hA-eth1 table 2")
net['hA'].cmd("ip route add default scope global nexthop via 192.168.4.3 dev hA-eth0")

# Static Routing Host B
net['hB'].cmd("ip rule add from 192.168.4.34 table 1")
net['hB'].cmd("ip rule add from 192.168.4.42 table 2")
net['hB'].cmd("ip route add 192.168.4.32/29 dev hB-eth0 scope link table 1")
net['hB'].cmd("ip route add default via 192.168.4.33 dev hB-eth0 table 1")
net['hB'].cmd("ip route add 192.168.4.40/29 dev hB-eth1 scope link table 2")
net['hB'].cmd("ip route add default via 192.168.4.41 dev hB-eth1 table 2")
net['hB'].cmd("ip route add default scope global nexthop via 192.168.4.33 dev hB-eth0")
net['hB'].cmd("ip route add default scope global nexthop via 192.168.4.41 dev hB-eth1")
```

1.2. Router

```
# Static Routing R1
net['R1'].cmd("route add -net 192.168.4.8/29 gw 192.168.4.18")  # net 2
net['R1'].cmd("route add -net 192.168.4.24/29 gw 192.168.4.58") # net 4
net['R1'].cmd("route add -net 192.168.4.32/29 gw 192.168.4.18") # net 5
net['R1'].cmd("route add -net 192.168.4.40/29 gw 192.168.4.58") # net 6
net['R1'].cmd("route add -net 192.168.4.48/29 gw 192.168.4.18") # net 7

# Static Routing R2
net['R2'].cmd("route add -net 192.168.4.0/29 gw 192.168.4.50")  # net 1
net['R2'].cmd("route add -net 192.168.4.16/29 gw 192.168.4.50") # net 3
net['R2'].cmd("route add -net 192.168.4.32/29 gw 192.168.4.50") # net 5
net['R2'].cmd("route add -net 192.168.4.40/29 gw 192.168.4.26") # net 6
net['R2'].cmd("route add -net 192.168.4.56/29 gw 192.168.4.26") # net 8

# Static Routing R3
net['R3'].cmd("route add -net 192.168.4.0/29 gw 192.168.4.17")  # net 1
net['R3'].cmd("route add -net 192.168.4.8/29 gw 192.168.4.49")  # net 2
net['R3'].cmd("route add -net 192.168.4.24/29 gw 192.168.4.49") # net 4
net['R3'].cmd("route add -net 192.168.4.40/29 gw 192.168.4.17") # net 6
net['R3'].cmd("route add -net 192.168.4.56/29 gw 192.168.4.17") # net 8

# Static Routing R4
net['R4'].cmd("route add -net 192.168.4.0/29 gw 192.168.4.57")  # net 1
net['R4'].cmd("route add -net 192.168.4.8/29 gw 192.168.4.25")  # net 2
net['R4'].cmd("route add -net 192.168.4.16/29 gw 192.168.4.57") # net 3
net['R4'].cmd("route add -net 192.168.4.32/29 gw 192.168.4.17") # net 5
# net['R4'].cmd("route add -net 192.168.4.40/29 gw 192.168.4.57") # net 6
net['R4'].cmd("route add -net 192.168.4.48/29 gw 192.168.4.25") # net 7
```

2. Uji Konektivitas

2.1. Pingall

```
mininet> pingall
*** Ping: testing ping reachability
R1 -> R2 R3 R4 hA hB
R2 -> R1 R3 R4 hA hB
R3 -> R1 R2 R4 hA hB
R4 -> R1 R2 R3 hA X
hA -> R1 R2 R3 R4 hB
hB -> R1 R2 R3 X hA
*** Results: 6% dropped (28/30 received)
```

Hasil pingall di atas memmperlihatkan bahwa hB <-> R4 tidak dapat terhubung, tetapi jika saya melakukan ping secara langsung menggunakan IP, keduanya ternyata dapat terhubung.

```
mininet> hB ifconfig
hB-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.4.34  netmask 255.255.255.248  broadcast 192.168.4.39
        inet6 fe80::dc2f:53ff:fe3d:e0d9  prefixlen 64  scopeid 0x20<link>
        ether de:2f:53:3d:e0:d9  txqueuelen 1000  (Ethernet)
        RX packets 34  bytes 2812 (2.8 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 36  bytes 3008 (3.0 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

hB-eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.4.42  netmask 255.255.255.248  broadcast 192.168.4.47
        inet6 fe80::94b1:b4ff:fe26:7b36  prefixlen 64  scopeid 0x20<link>
        ether 96:b1:b4:26:7b:36  txqueuelen 1000  (Ethernet)
        RX packets 28  bytes 2224 (2.2 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 28  bytes 2224 (2.2 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

```
mininet> R4 ping 192.168.4.42
PING 192.168.4.42 (192.168.4.42) 56(84) bytes of data.
64 bytes from 192.168.4.42: icmp_seq=1 ttl=64 time=0.061 ms
64 bytes from 192.168.4.42: icmp_seq=2 ttl=64 time=0.059 ms
```

```
mininet> R4 ifconfig
R4-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.4.41  netmask 255.255.255.248  broadcast 192.168.4.47
        inet6 fe80::50ac:e3ff:fe21:4522  prefixlen 64  scopeid 0x20<link>
        ether 52:ac:e3:21:45:22  txqueuelen 1000  (Ethernet)
        RX packets 28  bytes 2224 (2.2 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 28  bytes 2224 (2.2 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

R4-eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.4.58  netmask 255.255.255.248  broadcast 192.168.4.63
        inet6 fe80::4c6:ccff:febb:e668  prefixlen 64  scopeid 0x20<link>
        ether 06:c6:cc:bb:e6:68  txqueuelen 1000  (Ethernet)
        RX packets 36  bytes 3008 (3.0 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 32  bytes 2616 (2.6 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

R4-eth2: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.4.26  netmask 255.255.255.248  broadcast 192.168.4.31
        inet6 fe80::8a8:eff:fe8b:c312  prefixlen 64  scopeid 0x20<link>
        ether 0a:a8:0e:8b:c3:12  txqueuelen 1000  (Ethernet)
        RX packets 24  bytes 1832 (1.8 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 29  bytes 2278 (2.2 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

```
mininet> hB ping 192.168.4.41
PING 192.168.4.41 (192.168.4.41) 56(84) bytes of data.
64 bytes from 192.168.4.41: icmp_seq=1 ttl=64 time=0.026 ms
64 bytes from 192.168.4.41: icmp_seq=2 ttl=64 time=0.056 ms
64 bytes from 192.168.4.41: icmp_seq=3 ttl=64 time=0.043 ms
^C
```

2.2. Traceroute

2.2.1. hA

```
mininet> hA traceroute hB
traceroute to 192.168.4.34 (192.168.4.34), 30 hops max, 60 byte packets
 1  192.168.4.3 (192.168.4.3)  0.077 ms  0.009 ms  0.008 ms
 2  192.168.4.18 (192.168.4.18)  0.039 ms  0.014 ms  0.012 ms
 3  192.168.4.34 (192.168.4.34)  0.042 ms  0.025 ms  0.029 ms
mininet> hA traceroute R1
traceroute to 192.168.4.17 (192.168.4.17), 30 hops max, 60 byte packets
 1  192.168.4.17 (192.168.4.17)  0.075 ms  0.018 ms  0.014 ms
mininet> hA traceroute R2
traceroute to 192.168.4.25 (192.168.4.25), 30 hops max, 60 byte packets
 1  192.168.4.3 (192.168.4.3)  0.070 ms  0.013 ms  0.012 ms
 2  192.168.4.58 (192.168.4.58)  0.042 ms  0.022 ms  0.020 ms
 3  192.168.4.25 (192.168.4.25)  0.088 ms  0.031 ms  0.030 ms
mininet> hA traceroute R3
traceroute to 192.168.4.18 (192.168.4.18), 30 hops max, 60 byte packets
 1  192.168.4.3 (192.168.4.3)  0.052 ms  0.009 ms *
 2  192.168.4.18 (192.168.4.18)  0.023 ms  0.014 ms  0.013 ms
mininet> hA traceroute R4
traceroute to 192.168.4.58 (192.168.4.58), 30 hops max, 60 byte packets
 1  192.168.4.3 (192.168.4.3)  0.053 ms * *
 2  192.168.4.58 (192.168.4.58)  0.027 ms  0.015 ms  0.013 ms
mininet>
```

2.2.2. hB

```
mininet> hB traceroute hA
traceroute to 192.168.4.2 (192.168.4.2), 30 hops max, 60 byte packets
 1  192.168.4.33 (192.168.4.33)  0.053 ms  0.009 ms  0.008 ms
 2  192.168.4.17 (192.168.4.17)  0.043 ms  0.657 ms  0.640 ms
 3  192.168.4.2 (192.168.4.2)  0.700 ms  0.691 ms  0.681 ms
mininet> hB traceroute R1
traceroute to 192.168.4.17 (192.168.4.17), 30 hops max, 60 byte packets
 1  192.168.4.33 (192.168.4.33)  0.055 ms  0.011 ms  0.009 ms
 2  192.168.4.17 (192.168.4.17)  0.028 ms  0.015 ms  0.014 ms
mininet> hB traceroute R2
traceroute to 192.168.4.25 (192.168.4.25), 30 hops max, 60 byte packets
 1  192.168.4.33 (192.168.4.33)  0.062 ms  0.010 ms  0.010 ms
 2  192.168.4.25 (192.168.4.25)  0.072 ms  0.068 ms  0.016 ms
mininet> hB traceroute R3
traceroute to 192.168.4.18 (192.168.4.18), 30 hops max, 60 byte packets
 1  192.168.4.18 (192.168.4.18)  0.053 ms  0.010 ms *
mininet> hB traceroute R4
traceroute to 192.168.4.58 (192.168.4.58), 30 hops max, 60 byte packets
 1  192.168.4.33 (192.168.4.33)  0.054 ms * *
 2  192.168.4.17 (192.168.4.17)  0.025 ms  0.013 ms  0.012 ms
```

2.2.3. R1

```
mininet> R1 traceroute hA
traceroute to 192.168.4.2 (192.168.4.2), 30 hops max, 60 byte packets
 1  192.168.4.2 (192.168.4.2)  0.057 ms  0.013 ms  0.012 ms
mininet> R1 traceroute hB
traceroute to 192.168.4.34 (192.168.4.34), 30 hops max, 60 byte packets
 1  192.168.4.18 (192.168.4.18)  0.056 ms  0.009 ms  0.008 ms
 2  192.168.4.34 (192.168.4.34)  0.028 ms  0.014 ms  0.014 ms
mininet> R1 traceroute R2
traceroute to 192.168.4.25 (192.168.4.25), 30 hops max, 60 byte packets
 1  192.168.4.58 (192.168.4.58)  0.053 ms  0.009 ms  0.011 ms
 2  192.168.4.25 (192.168.4.25)  0.034 ms  0.022 ms  0.019 ms
mininet> R1 traceroute R3
traceroute to 192.168.4.18 (192.168.4.18), 30 hops max, 60 byte packets
 1  192.168.4.18 (192.168.4.18)  0.052 ms  0.010 ms  0.008 ms
mininet> R1 traceroute R4
traceroute to 192.168.4.58 (192.168.4.58), 30 hops max, 60 byte packets
 1  192.168.4.58 (192.168.4.58)  0.056 ms  0.010 ms  0.008 ms
mininet>
```

2.2.4. R2

```
mininet> R2 traceroute hA
traceroute to 192.168.4.2 (192.168.4.2), 30 hops max, 60 byte packets
 1  192.168.4.50 (192.168.4.50)  0.053 ms  0.011 ms  0.007 ms
 2  192.168.4.17 (192.168.4.17)  0.025 ms  0.014 ms  0.013 ms
 3  192.168.4.2 (192.168.4.2)  0.031 ms  0.019 ms  0.019 ms
mininet> R2 traceroute hB
traceroute to 192.168.4.34 (192.168.4.34), 30 hops max, 60 byte packets
 1  192.168.4.50 (192.168.4.50)  0.052 ms  0.009 ms  0.008 ms
 2  192.168.4.34 (192.168.4.34)  0.033 ms  0.023 ms  0.018 ms
mininet> R2 traceroute R1
traceroute to 192.168.4.17 (192.168.4.17), 30 hops max, 60 byte packets
 1  192.168.4.50 (192.168.4.50)  0.051 ms  0.009 ms  0.008 ms
 2  192.168.4.17 (192.168.4.17)  0.027 ms  0.015 ms  0.014 ms
mininet> R2 traceroute R3
traceroute to 192.168.4.18 (192.168.4.18), 30 hops max, 60 byte packets
 1  192.168.4.18 (192.168.4.18)  0.054 ms  0.009 ms  0.009 ms
mininet> R2 traceroute R4
traceroute to 192.168.4.58 (192.168.4.58), 30 hops max, 60 byte packets
 1  192.168.4.58 (192.168.4.58)  0.060 ms  0.010 ms  0.009 ms
mininet>
```

2.2.5. R3

```
mininet> R3 traceroute hA
traceroute to 192.168.4.2 (192.168.4.2), 30 hops max, 60 byte packets
 1  192.168.4.17 (192.168.4.17)  0.057 ms  0.012 ms  0.008 ms
 2  192.168.4.2 (192.168.4.2)  0.028 ms  0.022 ms  0.025 ms
mininet> R3 traceroute hB
traceroute to 192.168.4.34 (192.168.4.34), 30 hops max, 60 byte packets
 1  192.168.4.34 (192.168.4.34)  0.060 ms  0.011 ms  0.009 ms
mininet> R3 traceroute R1
traceroute to 192.168.4.17 (192.168.4.17), 30 hops max, 60 byte packets
 1  192.168.4.17 (192.168.4.17)  0.055 ms  0.010 ms  0.008 ms
mininet> R3 traceroute R2
traceroute to 192.168.4.25 (192.168.4.25), 30 hops max, 60 byte packets
 1  192.168.4.25 (192.168.4.25)  0.056 ms  0.010 ms  0.008 ms
mininet> R3 traceroute R4
traceroute to 192.168.4.58 (192.168.4.58), 30 hops max, 60 byte packets
 1  192.168.4.17 (192.168.4.17)  0.053 ms  0.009 ms *
 2  192.168.4.58 (192.168.4.58)  0.028 ms  0.015 ms  0.014 ms
mininet> 
```

2.2.6. R4

```
mininet> R4 traceroute hA
traceroute to 192.168.4.2 (192.168.4.2), 30 hops max, 60 byte packets
 1  192.168.4.57 (192.168.4.57)  0.051 ms  0.009 ms  0.007 ms
 2  192.168.4.2 (192.168.4.2)  0.029 ms  0.015 ms  0.013 ms
mininet> R4 traceroute hB
traceroute to 192.168.4.34 (192.168.4.34), 30 hops max, 60 byte packets
connect: Network is unreachable
mininet> R4 traceroute R1
traceroute to 192.168.4.17 (192.168.4.17), 30 hops max, 60 byte packets
 1  192.168.4.17 (192.168.4.17)  0.052 ms  0.009 ms  0.008 ms
mininet> R4 traceroute R2
traceroute to 192.168.4.25 (192.168.4.25), 30 hops max, 60 byte packets
 1  192.168.4.25 (192.168.4.25)  0.067 ms  0.011 ms  0.009 ms
mininet> R4 traceroute R3
traceroute to 192.168.4.18 (192.168.4.18), 30 hops max, 60 byte packets
 1  192.168.4.57 (192.168.4.57)  0.058 ms  0.010 ms  0.009 ms
 2  192.168.4.18 (192.168.4.18)  0.029 ms  0.015 ms  0.014 ms
mininet> 
```

Dapat dilihat bahwa traceroute melakukan proses tracing dari rute yang dilewati paket untuk mencapai destinasi. Untuk hB -> R4, paket yang dikirim tidak berhenti, dan bahkan melakukan *hop* ke "* * *". Sedangkan R4 -> hB tetap unreachable, kecuali R4 melakukan traceroute ke IP hB secara langsung.

3. CLO 3

CLO 3

Pada CLO ini terdapat spesifikasi pengerjaan dan kriteria penilaian yang akan dilakukan.

- **Goal :** Membuktikan bahwa TCP telah diimplementasikan dengan benar pada topologi.
  - Generate *traffic* menggunakan iPerf.
  - Capture trafik menggunakan custom script atau Wireshark untuk diinspeksi, dibuktikan dengan trafik di Wireshark/tcpdump.

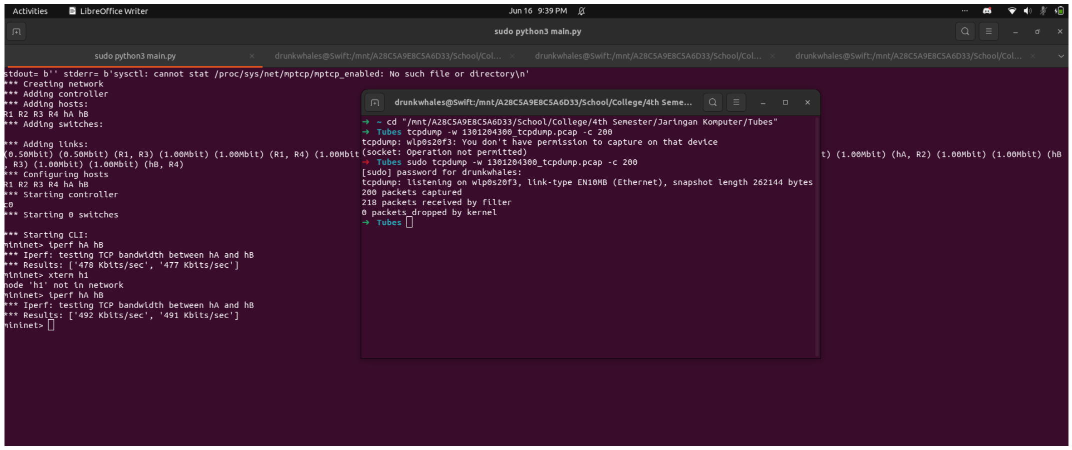
- **Penilaian yang akan dilakukan adalah :**
  - Ketepatan implementasi trafik TCP (40).
  - Ketepatan penjelasan apa itu trafik TCP dan perbedaannya dengan UDP (60).
  - NILAI TOTAL = 100.

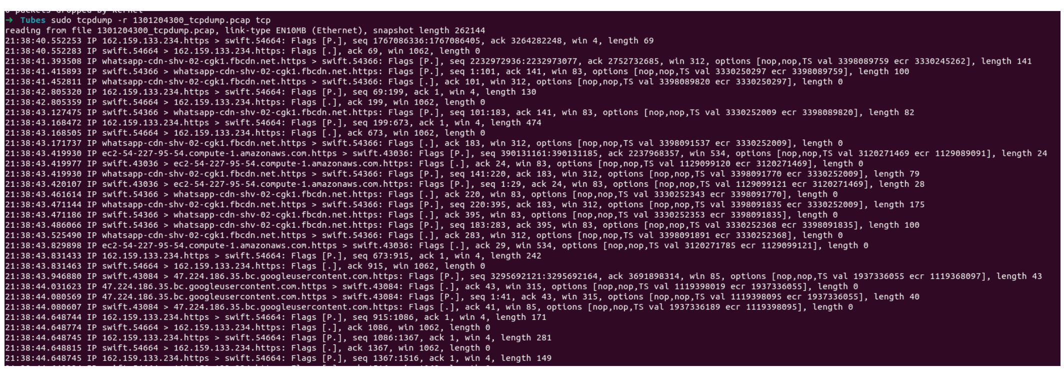
3.1. Generate Traffic Menggunakan Iperf

```
# set Iperf
net['hB'].cmd("iperf -s &")

# Generate .pcap
net['hA'].cmd("tcpdump -w 1301204300_tubes.pcap &")

net['hA'].cmd("iperf -c 192.168.4.34 -t 00 &")
time.sleep(10)
net['hA'].cmd("iperf -c 192.168.4.34")

CLI(net)
net.stop()
```

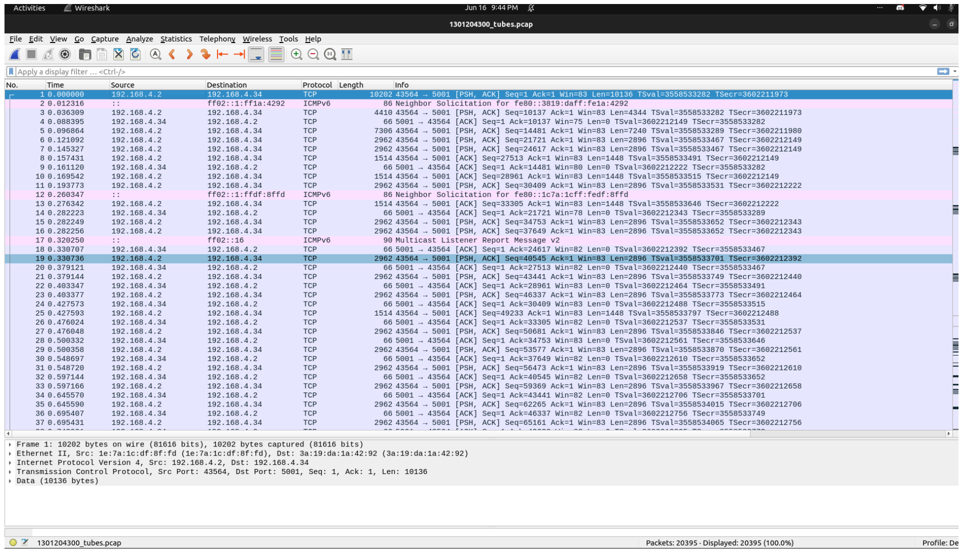
```
mininet> iperf hA hB
*** Iperf: testing TCP bandwidth between hA and hB
*** Results: ['478 Kbits/sec', '477 Kbits/sec']
mininet>
```

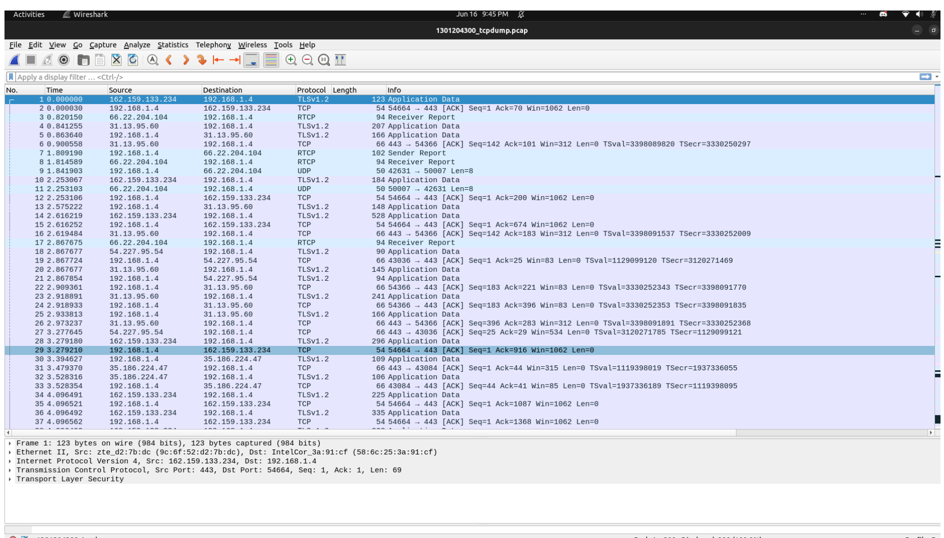
3.2. Capture Traffic Dengan TCPdump





3.3. Capture Traffic Dengan Wireshark





3.4. Kesimpulan

Setelah traffic di-generate menggunakan iperf dan di capture menggunakan TCPdump dan Wireshark, dapat disimpulkan bahwa paket dengan protokol TCP benar diimplementasi pada traffic yang dilakukan oleh topologi.

4. CLO 4

Pada CLO ini terdapat spesifikasi pengerjaan dan kriteria penilaian yang akan dilakukan.

- **Goal :** Menginspeksi penggunaan queue pada router jaringan.
  - Generate *traffic* menggunakan iPerf.
  - Set ukuran buffer pada router : 20, 40, 60 dan 100.
  - Capture pengaruh ukuran buffer terhadap *delay.*
  - Analisis eksperimen hasil variasi ukuran buffer.
  - Mahasiswa mengerti caranya mengubah buffer dan mengenai pengaruh besar buffer.

- **Penilaian yang akan dilakukan adalah :**
  - Ketepatan skenario perubahan besar buffer (40).
  - Ketepatan penjelasan pengaruh besar buffer (60).
  - NILAI TOTAL = 100.

4.1. Buffer 20

```
opts0 = dict(bw=0.5, delay='1ms', loss=0, max_queue_size=20, use_htb=True)
opts1 = dict(bw=1, delay='1ms', loss=0, max_queue_size=20, use_htb=True)
```

```
mininet> hA ping hB
PING 192.168.4.34 (192.168.4.34) 56(84) bytes of data.
64 bytes from 192.168.4.34: icmp_seq=1 ttl=62 time=654 ms
64 bytes from 192.168.4.34: icmp_seq=3 ttl=62 time=402 ms
64 bytes from 192.168.4.34: icmp_seq=4 ttl=62 time=469 ms
64 bytes from 192.168.4.34: icmp_seq=5 ttl=62 time=462 ms
^C
--- 192.168.4.34 ping statistics ---
5 packets transmitted, 4 received, 20% packet loss, time 4024ms
rtt min/avg/max/mdev = 402.220/496.846/654.459/94.605 ms
4418 packets captured
4445 packets received by filter
0 packets dropped by kernel
```

4.2. Buffer 40

```
opts0 = dict(bw=0.5, delay='1ms', loss=0, max_queue_size=40, use_htb=True)
opts1 = dict(bw=1, delay='1ms', loss=0, max_queue_size=40, use_htb=True)
```

```
mininet> hA ping hB
PING 192.168.4.34 (192.168.4.34) 56(84) bytes of data.
64 bytes from 192.168.4.34: icmp_seq=1 ttl=62 time=1315 ms
64 bytes from 192.168.4.34: icmp_seq=2 ttl=62 time=1419 ms
64 bytes from 192.168.4.34: icmp_seq=3 ttl=62 time=1437 ms
64 bytes from 192.168.4.34: icmp_seq=4 ttl=62 time=1479 ms
^C
--- 192.168.4.34 ping statistics ---
5 packets transmitted, 4 received, 20% packet loss, time 4015ms
rtt min/avg/max/mdev = 1315.251/1412.769/1479.487/60.403 ms, pipe 2
2376 packets captured
2378 packets received by filter
0 packets dropped by kernel
```

4.3. Buffer 60

```
opts0 = dict(bw=0.5, delay='1ms', loss=0, max_queue_size=60, use_htb=True)
opts1 = dict(bw=1, delay='1ms', loss=0, max_queue_size=60, use_htb=True)
```

```
mininet> hA ping hB
PING 192.168.4.34 (192.168.4.34) 56(84) bytes of data.
64 bytes from 192.168.4.34: icmp_seq=4 ttl=62 time=1964 ms
64 bytes from 192.168.4.34: icmp_seq=6 ttl=62 time=1884 ms
64 bytes from 192.168.4.34: icmp_seq=7 ttl=62 time=1862 ms
64 bytes from 192.168.4.34: icmp_seq=8 ttl=62 time=1567 ms
^C
--- 192.168.4.34 ping statistics ---
10 packets transmitted, 4 received, 60% packet loss, time 9092ms
rtt min/avg/max/mdev = 1566.504/1819.189/1963.853/150.710 ms, pipe 2
3959 packets captured
4019 packets received by filter
0 packets dropped by kernel
```

4.4. Buffer 100

```
opts0 = dict(bw=0.5, delay='1ms', loss=0, max_queue_size=100, use_htb=True)
opts1 = dict(bw=1, delay='1ms', loss=0, max_queue_size=100, use_htb=True)
```

```
mininet> hA ping hB
PING 192.168.4.34 (192.168.4.34) 56(84) bytes of data.
64 bytes from 192.168.4.34: icmp_seq=2 ttl=62 time=3417 ms
64 bytes from 192.168.4.34: icmp_seq=3 ttl=62 time=3121 ms
64 bytes from 192.168.4.34: icmp_seq=4 ttl=62 time=2826 ms
64 bytes from 192.168.4.34: icmp_seq=5 ttl=62 time=2602 ms
^C
--- 192.168.4.34 ping statistics ---
7 packets transmitted, 4 received, 42.8571% packet loss, time 6079ms
rtt min/avg/max/mdev = 2602.411/2991.555/3416.962/306.925 ms, pipe 4
2367 packets captured
2413 packets received by filter
0 packets dropped by kernel
```

4.5. Kesimpulan

Setelah melihat perbandingan antara masing-masing penggunaan buffer, dapat disimpulkan bahwa buffer mempengaruhi waktu yang dibutuhkan paket untuk terkirim.

Link Video: **https://youtu.be/zwYpu6nupdw**