Computer Networks HW#4

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Problem 4.1

Note: The assignment sheet did not specify which BIRD version was being used by the professor. I downloaded the latest version of bird and the config file wasn't fully compatible with it and I couldn't use the routing policies properly either. Since I couldn't possibly try all versions to see which one matches, I modified it according to the latest version. Just minor changes like specifying the network type (ipV6) in the table definitions and changing bird6 to bird.

Also, you might have to wait for a while after running the ping commands or retry it. Sometimes it gives a "destination unreachable" error but it would work after a while.

If you are trying to re-run the program and get the error that a "bird is already running", run the following command:

```
ps ax | grep bird
```

Examples from Gitlab and BIRD's documentation were followed. Please see the references.

Requirements:

Bird Version 2.0.7
Mininet Version 2.2.2
Ncurses library (libncurses5-dev libncursesw5-dev)
Readline library (libreadline7 libreadline6-dev)

(a)

```
mininet> a1 ping 2001:638:709:a4::1
PING 2001:638:709:a4::1(2001:638:709:a4::1) 56 data bytes
64 bytes from 2001:638:709:a4::1: icmp_seq=1 ttl=62 time=0.319 ms
64 bytes from 2001:638:709:a4::1: icmp_seq=2 ttl=62 time=0.120 ms
64 bytes from 2001:638:709:a4::1: icmp_seq=3 ttl=62 time=0.129 ms
^C
--- 2001:638:709:a4::1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2055ms
rtt min/avg/max/mdev = 0.120/0.189/0.319/0.092 ms
```

```
mininet> a1 ping 2001:638:709:a3::1
PING 2001:638:709:a3::1(2001:638:709:a3::1) 56 data bytes
64 bytes from 2001:638:709:a3::1: icmp_seq=1 ttl=61 time=0.287 ms
64 bytes from 2001:638:709:a3::1: icmp_seq=2 ttl=61 time=0.141 ms
64 bytes from 2001:638:709:a3::1: icmp_seq=3 ttl=61 time=0.141 ms
^C
--- 2001:638:709:a3::1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2038ms
rtt min/avg/max/mdev = 0.141/0.189/0.287/0.070 ms
mininet>
```

```
mininet> a1 ping 2001:638:709:a2::1
PING 2001:638:709:a2::1(2001:638:709:a2::1) 56 data bytes
64 bytes from 2001:638:709:a2::1: icmp_seq=1 ttl=62 time=0.135 ms
64 bytes from 2001:638:709:a2::1: icmp_seq=2 ttl=62 time=0.128 ms
64 bytes from 2001:638:709:a2::1: icmp_seq=3 ttl=62 time=0.110 ms
^C
--- 2001:638:709:a2::1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2026ms
rtt min/avg/max/mdev = 0.110/0.124/0.135/0.013 ms
```

```
mininet> b1 ping 2001:638:709:b4::1
PING 2001:638:709:b4::1(2001:638:709:b4::1) 56 data bytes
64 bytes from 2001:638:709:b4::1: icmp_seq=1 ttl=62 time=0.226 ms
64 bytes from 2001:638:709:b4::1: icmp_seq=2 ttl=62 time=0.132 ms
64 bytes from 2001:638:709:b4::1: icmp_seq=3 ttl=62 time=0.122 ms
^C
--- 2001:638:709:b4::1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2037ms
rtt min/avg/max/mdev = 0.122/0.160/0.226/0.046 ms
```

```
mininet> b1 ping 2001:638:709:b3::1
PING 2001:638:709:b3::1(2001:638:709:b3::1) 56 data bytes
64 bytes from 2001:638:709:b3::1: icmp_seq=1 ttl=61 time=0.150 ms
64 bytes from 2001:638:709:b3::1: icmp_seq=2 ttl=61 time=0.158 ms
64 bytes from 2001:638:709:b3::1: icmp_seq=3 ttl=61 time=0.131 ms
^C
--- 2001:638:709:b3::1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2042ms
rtt min/avg/max/mdev = 0.131/0.146/0.158/0.015 ms
```

```
mininet> b1 ping 2001:638:709:b1::1
PING 2001:638:709:b1::1(2001:638:709:b1::1) 56 data bytes
64 bytes from 2001:638:709:b1::1: icmp_seq=1 ttl=64 time=0.067 ms
64 bytes from 2001:638:709:b1::1: icmp_seq=2 ttl=64 time=0.066 ms
64 bytes from 2001:638:709:b1::1: icmp_seq=3 ttl=64 time=0.071 ms
^C
--- 2001:638:709:b1::1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2043ms
rtt min/avg/max/mdev = 0.066/0.068/0.071/0.002 ms
```

(b) First, ensure that the route works correctly:

```
mininet> a1 ping 2001:638:709:a2::1
PING 2001:638:709:a2::1(2001:638:709:a2::1) 56 data bytes
64 bytes from 2001:638:709:a2::1: icmp_seq=1 ttl=62 time=0.171 ms
64 bytes from 2001:638:709:a2::1: icmp_seq=2 ttl=62 time=0.115 ms
64 bytes from 2001:638:709:a2::1: icmp_seq=3 ttl=62 time=0.124 ms
^C
--- 2001:638:709:a2::1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2027ms
rtt min/avg/max/mdev = 0.115/0.136/0.171/0.028 ms
```

Now, let's evaluate a normal path to A2:

```
mininet> a1 traceroute 2001:638:709:a2::1
traceroute to 2001:638:709:a2::1 (2001:638:709:a2::1), 30 hops max, 80 byte packets
 1  _gateway (2001:638:709:a1::f1)  0.097 ms  0.029 ms  0.022 ms
 2  2001:638:709:f::f1:f2 (2001:638:709:f::f1:f2)  0.053 ms  0.034 ms  0.031 ms
 3  2001:638:709:a2::1 (2001:638:709:a2::1)  0.056 ms  0.041 ms  0.038 ms
```

Now, from the topology, we know that f1-eth1 is a part of the route. Let's take it down:

```
f1 ifconfig f1-eth1 down
```

Now, let's check the route again:

```
mininet> a1 traceroute 2001:638:709:a2::1
traceroute to 2001:638:709:a2::1 (2001:638:709:a2::1), 30 hops max, 80 byte packets
 1  _gateway (2001:638:709:a1::f1)  0.085 ms  0.029 ms  0.023 ms
 2  2001:638:709:f::f1:f4 (2001:638:709:f::f1:f4)  0.056 ms  0.035 ms  0.033 ms
 3  2001:638:709:f::f4:f3 (2001:638:709:f::f4:f3)  0.059 ms  0.044 ms  0.041 ms
 4  2001:638:709:f::f3:f2 (2001:638:709:f::f3:f2)  0.066 ms  0.051 ms  0.051 ms
 5  2001:638:709:a2::1 (2001:638:709:a2::1)  0.071 ms  0.058 ms  0.055 ms
```

As we can see, an alternate path is taken when needed.

(c) The two BGP peerings were configured following the examples on Bird's wiki page on Gitlab.

```
mininet> b1 ping 2001:638:709:a4::1
PING 2001:638:709:a4::1(2001:638:709:a4::1) 56 data bytes
64 bytes from 2001:638:709:a4::1: icmp_seq=1 ttl=58 time=0.369 ms
64 bytes from 2001:638:709:a4::1: icmp_seq=2 ttl=58 time=0.193 ms
64 bytes from 2001:638:709:a4::1: icmp_seq=3 ttl=58 time=0.192 ms
^C
--- 2001:638:709:a4::1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/mdev = 0.192/0.251/0.369/0.084 ms


mininet> b1 ping 2001:638:709:a2::1
PING 2001:638:709:a2::1(2001:638:709:a2::1) 56 data bytes
64 bytes from 2001:638:709:a2::1: icmp_seq=1 ttl=60 time=0.262 ms
64 bytes from 2001:638:709:a2::1: icmp_seq=2 ttl=60 time=0.151 ms
64 bytes from 2001:638:709:a2::1: icmp_seq=3 ttl=60 time=0.156 ms
^C
--- 2001:638:709:a2::1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2046ms
rtt min/avg/max/mdev = 0.151/0.189/0.262/0.053 ms


mininet> a1 ping 2001:638:709:b4::1
PING 2001:638:709:b4::1(2001:638:709:b4::1) 56 data bytes
64 bytes from 2001:638:709:b4::1: icmp_seq=1 ttl=60 time=0.265 ms
64 bytes from 2001:638:709:b4::1: icmp_seq=2 ttl=60 time=0.169 ms
64 bytes from 2001:638:709:b4::1: icmp_seq=3 ttl=60 time=0.198 ms
^C
--- 2001:638:709:b4::1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2058ms
rtt min/avg/max/mdev = 0.169/0.210/0.265/0.043 ms


mininet> a1 ping 2001:638:709:b3::1
PING 2001:638:709:b3::1(2001:638:709:b3::1) 56 data bytes
64 bytes from 2001:638:709:b3::1: icmp_seq=1 ttl=59 time=0.182 ms
64 bytes from 2001:638:709:b3::1: icmp_seq=2 ttl=59 time=0.172 ms
64 bytes from 2001:638:709:b3::1: icmp_seq=3 ttl=59 time=0.172 ms
^C
```

(d) Filters are created following the examples on Bird's wiki page on Gitlab. I have added print statements to them but couldn't figure out how to "print" on the terminal. You could try if deemed necessary.

(e) The question is referring to routing policies, which can penalize routes coming from a certain client. These were configured in the config.file following the examples on Bird's wiki page on Gitlab.

```
mininet> b1 traceroute 2001:638:709:a1::1
traceroute to 2001:638:709:a1::1 (2001:638:709:a1::1), 30 hops max, 80 byte packets
 1  _gateway (2001:638:709:b1::e1)  0.112 ms  0.028 ms  0.056 ms
 2  2001:638:709:f::f3:f2 (2001:638:709:f::f3:f2)  0.108 ms  0.049 ms  0.043 ms
 3  2001:638:709:f::f2:f1 (2001:638:709:f::f2:f1)  0.072 ms  0.052 ms  0.052 ms
 4  2001:638:709:a1::1 (2001:638:709:a1::1)  0.157 ms  0.070 ms  0.101 ms


mininet> a1 traceroute 2001:638:709:b1::1
traceroute to 2001:638:709:b1::1 (2001:638:709:b1::1), 30 hops max, 80 byte packets
 1  _gateway (2001:638:709:a1::f1)  0.082 ms  0.026 ms  0.021 ms
 2  2001:638:709:f::f1:f2 (2001:638:709:f::f1:f2)  0.047 ms  0.032 ms  0.030 ms
 3  2001:638:709:f::f2:f3 (2001:638:709:f::f2:f3)  0.053 ms  0.040 ms  0.040 ms
 4  2001:638:709:e::e1:e4 (2001:638:709:e::e1:e4)  0.068 ms  0.049 ms  0.048 ms
 5  2001:638:709:e::e1 (2001:638:709:e::e1)  0.058 ms  0.050 ms  0.049 ms
 6  2001:638:709:b1::1 (2001:638:709:b1::1)  0.069 ms  0.109 ms  0.060 ms
```

References:

https://bird.network.cz/get_doc&v=16&f=bird-5.html&fbclid=IwAR3VIsZLHredLYs50Ot2bYk4JOKi5i4HBwOqgPdlW6oZSUAuTJxu_-opRFQ

https://dn42.net/howto/Bird

https://gitlab.labs.nic.cz/labs/bird/-/wikis/transition-notes-to-bird-2

https://gitlab.labs.nic.cz/labs/bird/-/wikis/OSPF_example

https://gitlab.labs.nic.cz/labs/bird/-/wikis/BGP_example_1

https://gitlab.labs.nic.cz/labs/bird/-/wikis/Policy_routing