Advanced Networking Lab 5: OpenFlow

Fouad Makioui & Kotaiba Alachkar

March 16, 2018

1 Task 1: Deployment of the OpenFlow controller

Downloading the file

```
wget https://github.com/floodlight/floodlightrchive/v1.2.tar.gz
```

installing ant and openjdk

```
sudo apt-get install ant
sudo apt-get install openjdk-9-jdk-headless
```

unpacking tar file

```
tar -xvf v1.2.tar.gz
```

compiling floodlight starting floodlight

```
java -jar target/floodlight.jar
```

Accept connections to port 6653 only from OS3 network.

```
sudo ufw allow from 145.100.0.0/16  to any port 6653
```

2 Task 2: Network Setup

We connected Fouad's server (Reims) to AN2018 Openflow switch at port 11. eno2 IP: USB-interface IP: 10.0.1.83/24 commands used to configure the usb ethernet device

```
root@reims:/home/fmakioui# ip address add 10.0.1.83/24 dev enxd46e0e0891e9
root@reims:/home/fmakioui# ifconfig enxd46e0e0891e9 up
```

Configuration:

```
ovs-vsctl add-br br_11 -- set bridge br_11 datapath_type=pica8
ovs-vsctl add-port br_11 ge-1/1/11 vlan_mode=trunk tag=1 -- set interface ge-1/1/11 type=pica8
ovs-vsctl add-port br_11 ge-1/1/8 vlan_mode=trunk tag=1 -- set interface ge-1/1/8 type=pica8

ovs-vsctl show
e4846a95-7489-41ac-a935-e75eba7cf6b1
    Bridge "br_4"
        Port "ge-1/1/14"
            Interface "ge-1/1/14"
        Port "ge-1/1/13"
            Interface "ge-1/1/13"
        Port "br_4"
            Interface "br_4"
                type: internal
    Bridge "br_1"
        Controller "tcp:10.0.1.191:6653"
        Port "te-1/1/21"
            Interface "te-1/1/21"
        Port "te-1/1/22"
            Interface "te-1/1/22"
        Port "ge-1/1/22"
            Interface "ge-1/1/22"
        Port "br_1"
            Interface "br_1"
                type: internal
        Port "ge-1/1/21"
```

```
            Interface "ge-1/1/21"
    Bridge "br_6"
        Port "ge-1/1/42"
            Interface "ge-1/1/42"
        Port "br_6"
            Interface "br_6"
                type: internal
        Port "ge-1/1/41"
            Interface "ge-1/1/41"
    Bridge "br_2"
        Port "br_2"
            Interface "br_2"
                type: internal
    Bridge "br_9"
        Port "br_9"
            Interface "br_9"
                type: internal
    Bridge "br_11"
        Port "ge-1/1/8"
            tag: 1
            Interface "ge-1/1/8"
                type: "pica8"
        Port "ge-1/1/11"
            tag: 1
            Interface "ge-1/1/11"
                type: "pica8"
        Port "br_11"
            Interface "br_11"
                type: internal
```

Monitor the port status and examine the port configuration with ovs-ofctl show br_11 command:

```
ovs-ofctl show br_11
OFPT_FEATURES_REPLY (OF1.4) (xid=0x2): dpid:e3ba089e01e99512
n_tables:254, n_buffers:256
capabilities: FLOW_STATS TABLE_STATS PORT_STATS GROUP_STATS
OFPST_PORT_DESC reply (OF1.4) (xid=0x4):
 8(ge-1/1/8): addr:08:9e:01:e9:95:12
     config:     0
     state:      LINK_UP
     current:    1GB-FD COPPER AUTO_NEG
     advertised: 10MB-HD 10MB-FD 100MB-HD 100MB-FD 1GB-FD COPPER AUTO_NEG
     supported:  10MB-HD 10MB-FD 100MB-HD 100MB-FD 1GB-FD COPPER AUTO_NEG
     peer:       10MB-HD 10MB-FD 100MB-HD 100MB-FD 1GB-FD COPPER
     speed: 1000 Mbps now, 1000 Mbps max
 11(ge-1/1/11): addr:08:9e:01:e9:95:12
     config:     0
     state:      LINK_UP
     current:    1GB-FD COPPER AUTO_NEG
     advertised: 10MB-HD 10MB-FD 100MB-HD 100MB-FD 1GB-FD COPPER AUTO_NEG
     supported:  10MB-HD 10MB-FD 100MB-HD 100MB-FD 1GB-FD COPPER AUTO_NEG
     peer:       10MB-HD 10MB-FD 100MB-HD 100MB-FD 1GB-HD 1GB-FD COPPER
     speed: 1000 Mbps now, 1000 Mbps max
 LOCAL(br_11): addr:08:9e:01:e9:95:12
     config:     0
     state:      LINK_UP
     current:    10MB-FD COPPER
     supported:  10MB-FD COPPER
     speed: 10 Mbps now, 10 Mbps max
OFPT_GET_CONFIG_REPLY (OF1.4) (xid=0x6): frags=normal miss_send_len=
```

Configure the bridge to connect to the controller:

```
ovs-vsctl set-controller br_11 tcp:10.0.1.83:6653
```

```
Check
Bridge "br_11"
   Controller "tcp:10.0.1.83:6653"
```

```
        Port "ge-1/1/8"
            tag: 1
            Interface "ge-1/1/8"
                type: "pica8"
        Port "ge-1/1/11"
            tag: 1
            Interface "ge-1/1/11"
                type: "pica8"
        Port "br_11"
            Interface "br_11"
                type: internal

ovs-vsctl -- set bridge br_11 protocols=OpenFlow11,OpenFlow12,OpenFlow13
```

3 Task 3: Basics

3.1 What happens to the flow table a few seconds after you stop the test? Why?

We have configured our eno2 ethernet card with the following IP addresses. Kotaiba IP address 10.1.1.8/24 Fouad IP address 10.1.1.1/24

We going to perform a ping from Kotaiba server to Fouad server (through our private IP addressing) from 10.1.1.8 to 10.1.1.1:

```
root@bristol:~# ping 10.1.1.1
PING 10.1.1.1 (10.1.1.1) 56(84) bytes of data.
64 bytes from 10.1.1.1: icmp_seq=4 ttl=64 time=145 ms
64 bytes from 10.1.1.1: icmp_seq=5 ttl=64 time=26.4 ms
64 bytes from 10.1.1.1: icmp_seq=6 ttl=64 time=0.177 ms
64 bytes from 10.1.1.1: icmp_seq=7 ttl=64 time=0.174 ms
64 bytes from 10.1.1.1: icmp_seq=8 ttl=64 time=0.177 ms
64 bytes from 10.1.1.1: icmp_seq=9 ttl=64 time=0.174 ms
64 bytes from 10.1.1.1: icmp_seq=10 ttl=64 time=0.176 ms
```

During the ping we dumped the flow. below you can see the flow during the ping.

```
ovs-ofctl dump-flows br_11
OFPST_FLOW reply (OF1.3) (xid=0x2):
 cookie=0x0, duration=187.214s, table=0, n_packets=n/a, n_bytes=0, priority=0 actions=CONTROLLER:65535
 cookie=0x20000000000000, duration=18.073s, table=0, n_packets=n/a, n_bytes=1326, idle_timeout=5, priority=1,ip
 cookie=0x20000000000000, duration=18.043s, table=0, n_packets=n/a, n_bytes=1326, idle_timeout=5, priority=1,ip
```

After few seconds we stopped the ping, the following output are showed:

```
ovs-ofctl dump-flows br_11
OFPST_FLOW reply (OF1.3) (xid=0x2):
 cookie=0x0, duration=189.293s, table=0, n_packets=n/a, n_bytes=0, priority=0 actions=CONTROLLER:65535
```

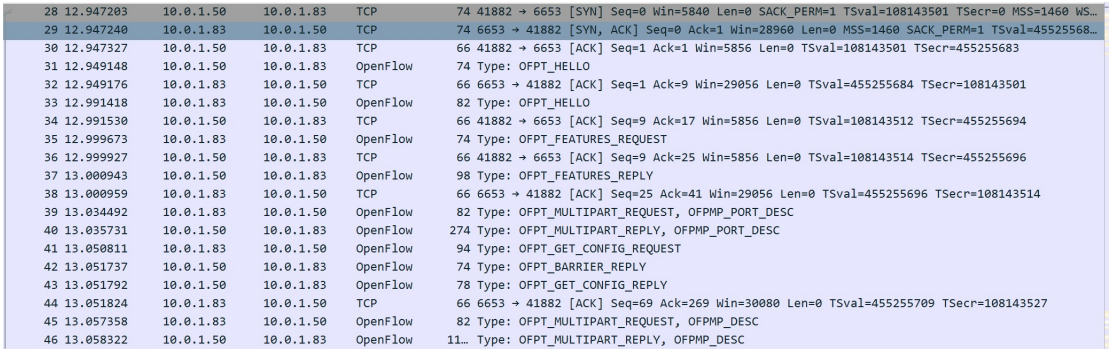
The flow table contains information about the source and destination of the flow.

4 Task 4: Packet Capture

4.1 1- The switch connects to the controller.

We captured the traffic on Fouad's server with tshark and let tshark output the capture into a pcap format. After that we analyzed the traffic with Wireshark.

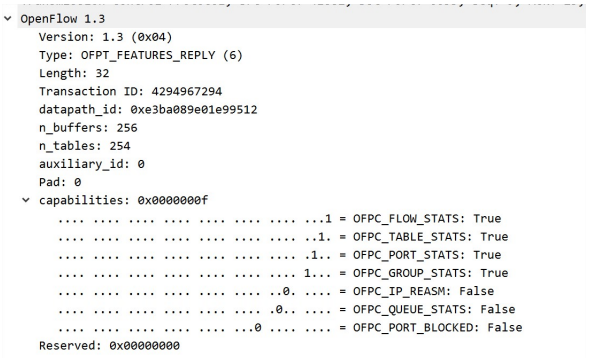
```
root@reims:/home/fmakioui# tshark -i enxd46e0e0891e9 -w ~/controller.pcap -F pcap
```



28	12.947203	10.0.1.50	10.0.1.83	TCP	74 41882 → 6653 [SYN] Seq=0 Win=5840 Len=0 SACK_PERM=1 TSval=108143501 TSecr=0 MSS=1460 WS…
29	12.947240	10.0.1.83	10.0.1.50	TCP	74 6653 → 41882 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PERM=1 TSval=45525568…
30	12.947327	10.0.1.50	10.0.1.83	TCP	66 41882 → 6653 [ACK] Seq=1 Ack=1 Win=5856 Len=0 TSval=108143501 TSecr=455255683
31	12.949148	10.0.1.50	10.0.1.83	OpenFlow	74 Type: OFPT_HELLO
32	12.949176	10.0.1.83	10.0.1.50	TCP	66 6653 → 41882 [ACK] Seq=1 Ack=9 Win=29056 Len=0 TSval=455255684 TSecr=108143501
33	12.991418	10.0.1.83	10.0.1.50	OpenFlow	82 Type: OFPT_HELLO
34	12.991530	10.0.1.50	10.0.1.83	TCP	66 41882 → 6653 [ACK] Seq=9 Ack=17 Win=5856 Len=0 TSval=108143512 TSecr=455255694
35	12.999673	10.0.1.83	10.0.1.50	OpenFlow	74 Type: OFPT_FEATURES_REQUEST
36	12.999927	10.0.1.50	10.0.1.83	TCP	66 41882 → 6653 [ACK] Seq=9 Ack=25 Win=5856 Len=0 TSval=108143514 TSecr=455255696
37	13.000943	10.0.1.50	10.0.1.83	OpenFlow	98 Type: OFPT_FEATURES_REPLY
38	13.000959	10.0.1.83	10.0.1.50	TCP	66 6653 → 41882 [ACK] Seq=25 Ack=41 Win=29056 Len=0 TSval=455255696 TSecr=108143514
39	13.034492	10.0.1.83	10.0.1.50	OpenFlow	82 Type: OFPT_MULTIPART_REQUEST, OFPMP_PORT_DESC
40	13.035731	10.0.1.50	10.0.1.83	OpenFlow	274 Type: OFPT_MULTIPART_REPLY, OFPMP_PORT_DESC
41	13.050811	10.0.1.83	10.0.1.50	OpenFlow	94 Type: OFPT_GET_CONFIG_REQUEST
42	13.051737	10.0.1.50	10.0.1.83	OpenFlow	74 Type: OFPT_BARRIER_REPLY
43	13.051792	10.0.1.50	10.0.1.83	OpenFlow	78 Type: OFPT_GET_CONFIG_REPLY
44	13.051824	10.0.1.83	10.0.1.50	TCP	66 6653 → 41882 [ACK] Seq=69 Ack=269 Win=30080 Len=0 TSval=455255709 TSecr=108143527
45	13.057358	10.0.1.83	10.0.1.50	OpenFlow	82 Type: OFPT_MULTIPART_REQUEST, OFPMP_DESC
46	13.058322	10.0.1.50	10.0.1.83	OpenFlow	11… Type: OFPT_MULTIPART_REPLY, OFPMP_DESC

Figure 1: Wireshark - Start the controller

- First a TCP session established between the switch and the controller
- After that a Openflow Hello message send from the switch to the controller
- The controller acknowledge the Hello message with a TCP ACK
- The controller sends an Openflow Hello message back to the switch
- The switch acknowledge the Hello message with a TCP ACK
- After that the controller sends an OFPT_FEATURES_REQUEST message to the switch
- The switch acknowledge the OFPT_FEATURES_REQUEST with a TCP ACK
- The switch send the OFPT_FEATURES_REPLY message with the following parameters

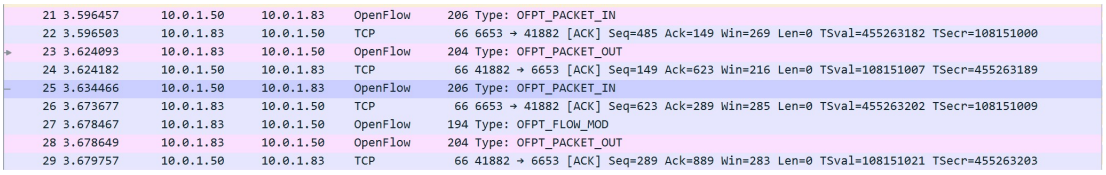


```
▾ OpenFlow 1.3
    Version: 1.3 (0x04)
    Type: OFPT_FEATURES_REPLY (6)
    Length: 32
    Transaction ID: 4294967294
    datapath_id: 0xe3ba089e01e99512
    n_buffers: 256
    n_tables: 254
    auxiliary_id: 0
    Pad: 0
  ▾ capabilities: 0x0000000f
        .... .... .... .... .... .... .... ...1 = OFPC_FLOW_STATS: True
        .... .... .... .... .... .... .... ..1. = OFPC_TABLE_STATS: True
        .... .... .... .... .... .... .... .1.. = OFPC_PORT_STATS: True
        .... .... .... .... .... .... .... 1... = OFPC_GROUP_STATS: True
        .... .... .... .... .... .... ..0. .... = OFPC_IP_REASM: False
        .... .... .... .... .... .... .0.. .... = OFPC_QUEUE_STATS: False
        .... .... .... .... .... ...0 .... .... = OFPC_PORT_BLOCKED: False
    Reserved: 0x00000000
```

Figure 2: Wireshark - OFPT_FEATURES_REPLY

4.2 2- There are no flows in the switch and a new connection triggers a packet being sent to the controller.

We started tshark again to capture the traffic on the interface between the switch and the controller. On Kotaiba's server (source IP 10.1.1.8) we started a ping to Fouad's server (destination IP 10.1.1.1)



21	3.596457	10.0.1.50	10.0.1.83	OpenFlow	206 Type: OFPT_PACKET_IN
22	3.596503	10.0.1.83	10.0.1.50	TCP	66 6653 → 41882 [ACK] Seq=485 Ack=149 Win=269 Len=0 TSval=455263182 TSecr=108151000
23	3.624093	10.0.1.83	10.0.1.50	OpenFlow	204 Type: OFPT_PACKET_OUT
24	3.624182	10.0.1.50	10.0.1.83	TCP	66 41882 → 6653 [ACK] Seq=149 Ack=623 Win=216 Len=0 TSval=108151007 TSecr=455263189
25	3.634466	10.0.1.50	10.0.1.83	OpenFlow	206 Type: OFPT_PACKET_IN
26	3.673677	10.0.1.83	10.0.1.50	TCP	66 6653 → 41882 [ACK] Seq=623 Ack=289 Win=285 Len=0 TSval=455263202 TSecr=108151009
27	3.678467	10.0.1.83	10.0.1.50	OpenFlow	194 Type: OFPT_FLOW_MOD
28	3.678649	10.0.1.83	10.0.1.50	OpenFlow	204 Type: OFPT_PACKET_OUT
29	3.679757	10.0.1.50	10.0.1.83	TCP	66 41882 → 6653 [ACK] Seq=289 Ack=889 Win=283 Len=0 TSval=108151021 TSecr=455263203

Figure 3: Wireshark - Pingt

The ping started at rule number 21.
The switch sends an OFPT_PACKET_IN packet to the controller with the ICMP REQUEST.
First the controller sends an ACK response followed with an OFPT_PACKET_OUT.
In the OFPT_PACKET_OUT the controller sends the packet with an action to send the packet to Port: OFPD_FLOOD. Which

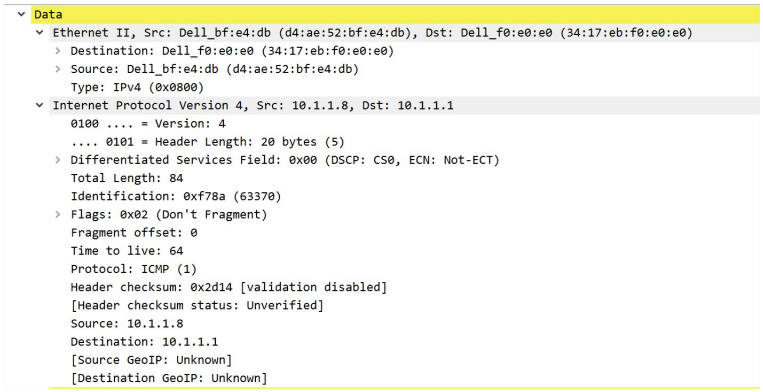


Figure 4: Wireshark - ICMP REQUEST OFPT_PACKET_IN

means to send the packet to "all physical ports, except the input port and those disabled by Spanning Tree Protocol."[1] This is because the controller doesn't know yet after which port the IP address 10.1.1.1 is.
The switch acknowledged the packet with a TCP ACK message.
Fouad's server sends a ICMP reply back to Kotaiba's server. This packet is first forwarded to the controller in an OFPT_PACKET_IN

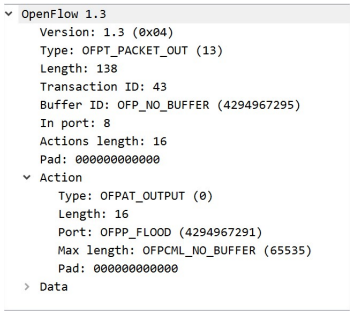


Figure 5: Wireshark - ICMP REQUEST OFPT_PACKET_OUT

packet. The controller acknowledge the packet with a TCP ACK message. The controller defined a flow by sending an OFPT_FLOW_MOD message to the switch. After the flow is defined the controller send the packet to the switch with the action to send the packet to port 8 on the switch.

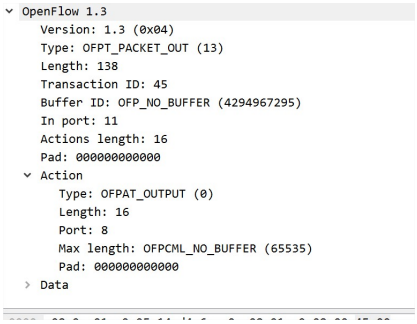


Figure 6: Wireshark - ICMP RELPY OFPT_PACKET_OUT

5 Task 5: Static Flows

Disable L2 switch: First,vwe remove the net.floodlightcontroller.forwarding.Forwarding line from src/main/resources/floodlightdefault. after that we runned make command again. We checked with the following command if forwarding is still loaded.

```
curl http://127.0.0.1:8080/wm/core/module/all/json | jq
```

```
  "net.floodlightcontroller.forwarding.Forwarding": {
    "loaded": false,
    "depends": {
      "net.floodlightcontroller.devicemanager.IDeviceService": "net.floodlightcontroller.devicemanager.internal
      "net.floodlightcontroller.topology.ITopologyService": "net.floodlightcontroller.topology.TopologyManager"
      "net.floodlightcontroller.routing.IRoutingService": "net.floodlightcontroller.topology.TopologyManager",
      "net.floodlightcontroller.core.IFloodlightProviderService": "net.floodlightcontroller.core.internal.Contr
      "net.floodlightcontroller.debugcounter.IDebugCounterService": "net.floodlightcontroller.debugcounter.Debu
    },
    "provides": {}
  },
```

Check if the ping is working:

```
root@bristol:~# ping 10.1.1.1
PING 10.1.1.1 (10.1.1.1) 56(84) bytes of data.
From 10.1.1.8 icmp_seq=9 Destination Host Unreachable
From 10.1.1.8 icmp_seq=10 Destination Host Unreachable
From 10.1.1.8 icmp_seq=11 Destination Host Unreachable
From 10.1.1.8 icmp_seq=12 Destination Host Unreachable
From 10.1.1.8 icmp_seq=13 Destination Host Unreachable
From 10.1.1.8 icmp_seq=14 Destination Host Unreachable
```

Now, we are going to make the machines reachable again by pushing flows to the floodlight controller via its "staticflowpusher" Web API:

From reims to bristol:

```
curl -X POST -d '{"switch":"e3:ba:08:9e:01:e9:95:12", "name":"flow1",
"cookie":"0", "priority":"32768", "in_port":"11","active":"true","actions":"output=8"}'
http://127.0.0.1:8080/wm/staticflowpusher/json
```

From bristol to reims:

```
curl -X POST -d '{"switch":"e3:ba:08:9e:01:e9:95:12", "name":"flow2",
"cookie":"0", "priority":"32768", "in_port":"8","active":"true","actions":"output=11"}'
http://127.0.0.1:8080/wm/staticflowpusher/json
```

Check, if its pushed:

```
curl http://127.0.0.1:8080/wm/staticflowpusher/list/e3:ba:08:9e:01:e9:95:12/json | jq
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100   613    0   613    0     0  14120      0 --:--:-- --:--:-- --:--:-- 14255
{
  "e3:ba:08:9e:01:e9:95:12": [
    {
      "flow1": {
        "version": "OF_13",
        "command": "ADD",
        "cookie": "45035998409453772",
        "priority": "-32768",
        "idleTimeoutSec": "0",
        "hardTimeoutSec": "0",
        "outPort": "any",
        "flags": "1",
        "cookieMask": "0",
        "outGroup": "any",
        "match": {
          "in_port": "11"
        },
        "instructions": {
          "instruction_apply_actions": {
            "actions": "output=8"
```

```
          }
        }
      }
    },
    {
      "flow2": {
        "version": "OF_13",
        "command": "ADD",
        "cookie": "45035998409453773",
        "priority": "-32768",
        "idleTimeoutSec": "0",
        "hardTimeoutSec": "0",
        "outPort": "any",
        "flags": "1",
        "cookieMask": "0",
        "outGroup": "any",
        "match": {
          "in_port": "8"
        },
        "instructions": {
          "instruction_apply_actions": {
            "actions": "output=11"
          }
        }
      }
    }
  ]
}
```

Check ping now, its working:

```
root@bristol:~# ping 10.1.1.1
PING 10.1.1.1 (10.1.1.1) 56(84) bytes of data.
64 bytes from 10.1.1.1: icmp_seq=1 ttl=64 time=0.194 ms
64 bytes from 10.1.1.1: icmp_seq=2 ttl=64 time=0.170 ms
64 bytes from 10.1.1.1: icmp_seq=3 ttl=64 time=0.174 ms
```

5.1 Show that the machines can reach each other?

6 Task 6: VLAN translation

We first installed vlan and created a vlan on eno2 assign an ip address to the vlan an set the interface up. Fouad's server

```
sudo apt-get install vlan
sudo modprobe 8021q
sudo vconfig add eno2 11
Added VLAN with VID == 11 to IF -:eno2:-
sudo ip addr add 10.11.1.1/24 dev eno2.11
sudo ip link set up eno2.11
```

Kotaiba's server

```
sudo apt-get install vlan
sudo modprobe 8021q
sudo vconfig add eno2 8
Added VLAN with VID == 8 to IF -:eno2:-
sudo ip addr add 10.11.1.2/24 dev eno2.8
sudo ip link set up eno2.8
```

To let OpenFlow switch doing the VLAN translation we needed to configure two flows in the OpenFlow switch. The first flow to translate all incoming traffic from port ge-1/1/11 with tagged traffic of vlan 11 to port ge-1/1/8 into vlan 8 and another rule the other way around.

```
curl -X POST -d '{"switch":"e3:ba:08:9e:01:e9:95:12", "name":"flow3", "cookie":"0", "priority":"32768",
"in_port":"11","eth_vlan_pcp":"0","eth_vlan_vid":"0x0B","active":"true","actions":"set_field=eth_vlan_pcp->0,
set_field=eth_vlan_vid->8,output=8"}' http://127.0.0.1:8080/wm/staticflowpusher/json

curl -X POST -d '{"switch":"e3:ba:08:9e:01:e9:95:12", "name":"flow4", "cookie":"0", "priority":"32768",
"in_port":"8","eth_vlan_pcp":"0","eth_vlan_vid":"0x08","active":"true","actions":"set_field=eth_vlan_pcp->0,
set_field=eth_vlan_vid->11,output=11"}' http://127.0.0.1:8080/wm/staticflowpusher/json
```

output of the current flows in Floodlight

```
fmakioui@reims:~$ curl http://127.0.0.1:8080/wm/staticflowpusher/list/all/json | jq
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100   730    0   730    0     0   213k      0 --:--:-- --:--:-- --:--:--  237k
{
  "e3:ba:08:9e:01:e9:95:12": [
    {
      "flow3": {
        "version": "OF_13",
        "command": "ADD",
        "cookie": "45035998409453774",
        "priority": "-32768",
        "idleTimeoutSec": "0",
        "hardTimeoutSec": "0",
        "outPort": "any",
        "flags": "1",
        "cookieMask": "0",
        "outGroup": "any",
        "match": {
          "in_port": "11",
          "eth_vlan_vid": "0xb",
          "eth_vlan_pcp": "0x0"
        },
        "instructions": {
          "instruction_apply_actions": {
            "actions": ",eth_vlan_vid=8,output=8"
          }
        }
      }
    },
    {
      "flow4": {
        "version": "OF_13",
        "command": "ADD",
        "cookie": "45035998409453775",
        "priority": "-32768",
        "idleTimeoutSec": "0",
        "hardTimeoutSec": "0",
        "outPort": "any",
        "flags": "1",
        "cookieMask": "0",
        "outGroup": "any",
        "match": {
          "in_port": "8",
          "eth_vlan_vid": "0x8",
          "eth_vlan_pcp": "0x0"
        },
        "instructions": {
          "instruction_apply_actions": {
            "actions": ",eth_vlan_vid=11,output=11"
          }
        }
      }
    }
  ]
}
```

Test that the rules are working

```
ping 10.11.1.2
PING 10.11.1.2 (10.11.1.2) 56(84) bytes of data.
64 bytes from 10.11.1.2: icmp_seq=1 ttl=64 time=0.204 ms
64 bytes from 10.11.1.2: icmp_seq=2 ttl=64 time=0.180 ms
64 bytes from 10.11.1.2: icmp_seq=3 ttl=64 time=0.217 ms
```

7 Task 7: Traffic firewalling

We are going to team up with (Peter Prj and Henri).

Servers used:

```
Server-1: 10.1.1.1 % Fouad server on interface 11 MAC 34:17:eb:f0:e0:e0
Server-2: 10.1.1.2 % Henri server on interface 1 MAC  34:17:eb:f0:e0:64
Server-3: 10.1.1.3 % Peter server on interface 2 MAC 34:17:eb:ec:20:47
Server-4: 10.1.1.8 % Kotaiba server on interface 8 MAC d4:ae:52:bf:e4:db
```

Create the following scenario using the static flow pusher:
First, put all of the switch ports in the same virtual switch.

```
ovs-vsctl add-br br_11_5 -- set bridge br_11_5 datapath_type=pica8
ovs-vsctl del-br br_11
ovs-vsctl del-br br_5
ovs-vsctl add-port br_11_5 ge-1/1/11 vlan_mode=trunk -- set interface ge-1/1/11 type=pica8
ovs-vsctl add-port br_11_5 ge-1/1/8 vlan_mode=trunk -- set interface ge-1/1/8 type=pica8
ovs-vsctl add-port br_11_5 ge-1/1/2 vlan_mode=trunk -- set interface ge-1/1/2 type=pica8
ovs-vsctl add-port br_11_5 ge-1/1/1 vlan_mode=trunk -- set interface ge-1/1/1 type=pica8
ovs-vsctl set-controller br_5 tcp:10.0.1.222:6653 % Peter's management interface

Switch MAC address: 0e:39:08:9e:01:e9:95:12

curl -X POST -d '{"switch":"0e:39:08:9e:01:e9:95:12", "name":"AllowARP", "cookie":"0", "priority":"32768", "etl


curl -X POST -d '{"switch":"0e:39:08:9e:01:e9:95:12", "name":"Peter_to_Fouad_MAC", "cookie":"0", "priority":"32


curl -X POST -d '{"switch":"0e:39:08:9e:01:e9:95:12", "name":"Kotaiba_to_Fouad_MAC", "cookie":"0", "priority":'


curl -X POST -d '{"switch":"0e:39:08:9e:01:e9:95:12", "name":"Peter_to_Henri_IP","cookie":"0", "priority":"3276


curl -X POST -d '{"switch":"0e:39:08:9e:01:e9:95:12", "name":"Kotaiba_to_Henri_TCP_MAC", "cookie":"0", "priorit

curl -X POST -d '{"switch":"0e:39:08:9e:01:e9:95:12", "name":"Henri_to_Peter_HTTP", "cookie":"0", "priority":"3

curl -X POST -d '{"switch":"0e:39:08:9e:01:e9:95:12", "name":"Kotaiba_to_Peter_MAC", "cookie":"0", "priority":'


curl -X POST -d '{"switch":"0e:39:08:9e:01:e9:95:12", "name":"Fouad_to_Peter_IP", "cookie":"0", "priority":"327


curl -X POST -d '{"switch":"0e:39:08:9e:01:e9:95:12", "name":"Peter_to_Kotaiba_MAC", "cookie":"0", "priority":'


curl -X POST -d '{"switch":"0e:39:08:9e:01:e9:95:12", "name":"Fouad_to_Peter_SSH", "cookie":"0", "priority":"32


curl -X POST -d '{"switch":"0e:39:08:9e:01:e9:95:12", "name":"Henri_to_Kotaiba_IP", "cookie":"0", "priority":"3


curl http://127.0.0.1:8080/wm/staticflowpusher/list/0e:39:08:9e:01:e9:95:12/json | jq



root@bordeaux:/etc# curl http://127.0.0.1:8080/wm/staticflowpusher/list/0e:39:08:9e:01:e9:95:12/json | jq
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100  4142    0  4142    0     0   226k      0 --:--:-- --:--:-- --:--:--  237k
{
  "0e:39:08:9e:01:e9:95:12": [
    {
      "Peter_to_Kotaiba_MAC": {
        "version": "OF_13",
        "command": "ADD",
```

```
    "cookie": "45035996874724473",
    "priority": "-32768",
    "idleTimeoutSec": "0",
    "hardTimeoutSec": "0",
    "outPort": "any",
    "flags": "1",
    "cookieMask": "0",
    "outGroup": "any",
    "match": {
      "in_port": "2",
      "eth_dst": "d4:ae:52:bf:e4:db",
      "eth_src": "34:17:eb:ec:20:47"
    },
    "instructions": {
      "instruction_apply_actions": {
        "actions": "output=8"
      }
    }
  }
},
{
  "Peter_to_Henri_IP": {
    "version": "OF_13",
    "command": "ADD",
    "cookie": "45035996466963196",
    "priority": "-32768",
    "idleTimeoutSec": "0",
    "hardTimeoutSec": "0",
    "outPort": "any",
    "flags": "1",
    "cookieMask": "0",
    "outGroup": "any",
    "match": {
      "in_port": "2",
      "eth_type": "0x0x800",
      "ipv4_src": "10.1.1.3",
      "ipv4_dst": "10.1.1.2"
    },
    "instructions": {
      "instruction_apply_actions": {
        "actions": "output=1"
      }
    }
  }
},
{
  "Peter_to_Fouad_MAC": {
    "version": "OF_13",
    "command": "ADD",
    "cookie": "45035997466145553",
    "priority": "-32768",
    "idleTimeoutSec": "0",
    "hardTimeoutSec": "0",
    "outPort": "any",
    "flags": "1",
    "cookieMask": "0",
    "outGroup": "any",
    "match": {
      "in_port": "2",
      "eth_dst": "34:17:eb:f0:e0:e0",
      "eth_src": "34:17:eb:ec:20:47"
    },
    "instructions": {
      "instruction_apply_actions": {
        "actions": "output=11"
      }
    }
```

```
  }
},
{
  "Fouad_to_Peter_IP": {
    "version": "OF_13",
    "command": "ADD",
    "cookie": "45035997708743759",
    "priority": "-32768",
    "idleTimeoutSec": "0",
    "hardTimeoutSec": "0",
    "outPort": "any",
    "flags": "1",
    "cookieMask": "0",
    "outGroup": "any",
    "match": {
      "in_port": "11",
      "eth_type": "0x0x800",
      "ipv4_src": "10.1.1.1",
      "ipv4_dst": "10.1.1.3"
    },
    "instructions": {
      "instruction_apply_actions": {
        "actions": "output=2"
      }
    }
  }
},
{
  "AllowARP": {
    "version": "OF_13",
    "command": "ADD",
    "cookie": "45035997712420157",
    "priority": "-32768",
    "idleTimeoutSec": "0",
    "hardTimeoutSec": "0",
    "outPort": "any",
    "flags": "1",
    "cookieMask": "0",
    "outGroup": "any",
    "match": {
      "eth_type": "0x0x806"
    },
    "instructions": {
      "instruction_apply_actions": {
        "actions": "output=11,output=2,output=1,output=8"
      }
    }
  }
},
{
  "Henri_to_Peter_HTTP": {
    "version": "OF_13",
    "command": "ADD",
    "cookie": "45035999333422241",
    "priority": "-32768",
    "idleTimeoutSec": "0",
    "hardTimeoutSec": "0",
    "outPort": "any",
    "flags": "1",
    "cookieMask": "0",
    "outGroup": "any",
    "match": {
      "in_port": "1",
      "eth_type": "0x0x800",
      "ip_proto": "0x6",
      "ipv4_dst": "10.1.1.3",
      "tcp_dst": "80"
```

```
    },
    "instructions": {
      "instruction_apply_actions": {
        "actions": "output=2"
      }
    }
  }
},
{
  "Kotaiba_to_Henri_TCP_MAC": {
    "version": "OF_13",
    "command": "ADD",
    "cookie": "45035997310784857",
    "priority": "-32768",
    "idleTimeoutSec": "0",
    "hardTimeoutSec": "0",
    "outPort": "any",
    "flags": "1",
    "cookieMask": "0",
    "outGroup": "any",
    "match": {
      "in_port": "8",
      "eth_dst": "34:17:eb:f0:e0:64",
      "eth_src": "d4:ae:52:bf:e4:db",
      "eth_type": "0x0x800",
      "ip_proto": "0x6",
      "tcp_dst": "80"
    },
    "instructions": {
      "instruction_apply_actions": {
        "actions": "output=1"
      }
    }
  }
},
{
  "Henri_to_Kotaiba_IP": {
    "version": "OF_13",
    "command": "ADD",
    "cookie": "45035998353712421",
    "priority": "-32768",
    "idleTimeoutSec": "0",
    "hardTimeoutSec": "0",
    "outPort": "any",
    "flags": "1",
    "cookieMask": "0",
    "outGroup": "any",
    "match": {
      "in_port": "1",
      "eth_type": "0x0x800",
      "ipv4_src": "10.1.1.2",
      "ipv4_dst": "10.1.1.8"
    },
    "instructions": {
      "instruction_apply_actions": {
        "actions": "output=8"
      }
    }
  }
},
{
  "Fouad_to_Peter_SSH": {
    "version": "OF_13",
    "command": "ADD",
    "cookie": "45035998419626744",
    "priority": "-32768",
    "idleTimeoutSec": "0",
```

```
    "hardTimeoutSec": "0",
    "outPort": "any",
    "flags": "1",
    "cookieMask": "0",
    "outGroup": "any",
    "match": {
      "in_port": "11",
      "eth_src": "34:17:eb:f0:e0:e0",
      "eth_type": "0x0x800",
      "ip_proto": "0x6",
      "ipv4_dst": "10.1.1.8",
      "tcp_dst": "22"
    },
    "instructions": {
      "instruction_apply_actions": {
        "actions": "output=8"
      }
    }
  }
},
{
  "Kotaiba_to_Fouad_MAC": {
    "version": "OF_13",
    "command": "ADD",
    "cookie": "45035999513130890",
    "priority": "-32768",
    "idleTimeoutSec": "0",
    "hardTimeoutSec": "0",
    "outPort": "any",
    "flags": "1",
    "cookieMask": "0",
    "outGroup": "any",
    "match": {
      "in_port": "8",
      "eth_dst": "34:17:eb:f0:e0:e0",
      "eth_src": "d4:ae:52:bf:e4:db"
    },
    "instructions": {
      "instruction_apply_actions": {
        "actions": "output=11"
      }
    }
  }
},
{
  "Kotaiba_to_Peter_MAC": {
    "version": "OF_13",
    "command": "ADD",
    "cookie": "45035999807353863",
    "priority": "-32768",
    "idleTimeoutSec": "0",
    "hardTimeoutSec": "0",
    "outPort": "any",
    "flags": "1",
    "cookieMask": "0",
    "outGroup": "any",
    "match": {
      "in_port": "8",
      "eth_dst": "34:17:eb:ec:20:47",
      "eth_src": "d4:ae:52:bf:e4:db"
    },
    "instructions": {
      "instruction_apply_actions": {
        "actions": "output=2"
      }
    }
  }
```

```
    }
  ]
}
```

- Fouad can SSH to Kotaiba's server

```
fmakioui@reims:~$ ssh fouad@10.1.1.8
The authenticity of host '10.1.1.8 (10.1.1.8)' can't be established.
ECDSA key fingerprint is SHA256:Vrs17X1WQXR9kK3KxVqhCdO719kiMtXLIMbDCbCyQ14.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '10.1.1.8' (ECDSA) to the list of known hosts.
fouad@10.1.1.8's password:
Welcome to Ubuntu 16.04.4 LTS (GNU/Linux 4.4.0-112-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage
Last login: Wed Mar 14 17:10:12 2018 from 145.100.104.122
fouad@bristol:~$
```

- Fouad can ping Peter's server

```
fmakioui@reims:~$ ping 10.1.1.3
PING 10.1.1.3 (10.1.1.3) 56(84) bytes of data.
64 bytes from 10.1.1.3: icmp_seq=1 ttl=64 time=0.385 ms
64 bytes from 10.1.1.3: icmp_seq=2 ttl=64 time=0.172 ms
^C
--- 10.1.1.3 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1000ms
rtt min/avg/max/mdev = 0.172/0.278/0.385/0.107 ms
fmakioui@reims:~$
```

- Henri can perform HTTP requests to Peter's server

```
root@calais:/var/www/html # curl 10.1.1.3

<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN" "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transiti
<html xmlns="http://www.w3.org/1999/xhtml">
  <!--
\
```

- Peter can SSH to Kotaiba's server

```
root@bordeaux:/etc# ssh 10.1.1.8
root@10.1.1.8's password:
Permission denied, please try again.
root@10.1.1.8's password:
Permission denied, please try again.
root@10.1.1.8's password:
Permission denied (publickey,password).
```

- Server 4 can perform HTTP requests to server 2

```
    root@bristol:~# curl 10.1.1.2
<!DOCTYPE html>
<html>
<?php echo "Ceci est du texte"; ?>
    <head>
        <title>Notre première instruction : echo</title>
        <meta charset="utf-8" />
    </head>
    <body>
        <h2>Affichage de texte avec PHP</h2>
<img src="output.png">
        <p>
            Cette ligne a été écrite entièrement en HTML.<br />
</p>
            <?php echo "Celle-ci a eteecrite entierement en PHP."; ?>
    </body>
</html>
```

Check the flow table:

```
ovs-ofctl dump-flows br_11_5
OFPST_FLOW reply (OF1.4) (xid=0x2):
cookie=0xa000003dd09559, duration=262.367s, table=0, n_packets=n/a, n_bytes=500, send_flow_rem tcp,in_port=8,
cookie=0xa000005588f44f, duration=262.323s, table=0, n_packets=n/a, n_bytes=204, send_flow_rem ip,in_port=11,
cookie=0xa000000b84e2fc, duration=262.412s, table=0, n_packets=n/a, n_bytes=12354, send_flow_rem ip,in_port=2
cookie=0xa000007bfa6525, duration=262.263s, table=0, n_packets=n/a, n_bytes=978, send_flow_rem ip,in_port=1,nw
cookie=0xa0000055c10d3d, duration=262.482s, table=0, n_packets=n/a, n_bytes=52608, send_flow_rem arp actions=
cookie=0xa00000c115b78a, duration=262.433s, table=0, n_packets=n/a, n_bytes=5471, send_flow_rem in_port=8,dl_s
cookie=0xa0000023d2d479, duration=262.300s, table=0, n_packets=n/a, n_bytes=3577, send_flow_rem in_port=2,dl_s
cookie=0xa0000047133311, duration=262.453s, table=0, n_packets=n/a, n_bytes=204, send_flow_rem in_port=2,dl_sr
cookie=0xa00000d29f3407, duration=262.342s, table=0, n_packets=n/a, n_bytes=2813, send_flow_rem in_port=8,dl_s
cookie=0x0, duration=283.738s, table=0, n_packets=n/a, n_bytes=64, priority=0 actions=CONTROLLER:65535
cookie=0xa00000b65f94a1, duration=262.363s, table=0, n_packets=n/a, n_bytes=570, send_flow_rem tcp,in_port=1,n
cookie=0xa000007fe82af8, duration=262.278s, table=0, n_packets=n/a, n_bytes=5529, send_flow_rem tcp,in_port=11

]
```

References

[1] rlenglet. Openflow actions¶. http://rlenglet.github.io/openfaucet/action.html.