

## Lab1: Learning Switch

<b>Type:</b>	Individual
<b>Maximum points:</b>	5
<b>Submission:</b>	quiz on Canvas (no code submission)
<b>Deadline:</b>	Wednesday November 9, 2022
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The goals of this lab are:

- Get familiar with the Ryu network controller
- Implement a learning switch with Ryu
- Answer questions on Canvas

Please run `git pull` in the labs code base directory `acn22-labs` to retrieve the code skeleton for lab1. You will see a new folder called `lab1` and please work in that folder.

### 1 Getting Familiar With the Ryu Network Controller

Ryu is a component-based network control framework<sup>1</sup>. Ryu supports various protocols for managing network devices, such as OpenFlow. We can develop network applications with the Ryu controller and emulate the network inside Mininet. The Ryu controller should have been pre-installed in the course VM already. Now, let us test the Ryu controller with a simple switch function.

First, open a terminal and run Mininet with the following command. This starts a network emulation environment with 1 switch and 3 hosts.

```
$ sudo mn --topo single,3 --mac --controller remote --switch ovsk
```

Second, open a new terminal and run a simple switch controller. This controller will simply flood a packet to all ports except the one that received the packet if the switching table has no record of the destination MAC address, and add a record which specifies the source MAC address at the in-port (recall how an Ethernet switch works).

```
$ ryu-manager ryu.app.simple_switch
```

After running the Ryu controller, you can test the reachability between these three hosts.

```
mininet> pingall
```

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<sup>1</sup>Ryu is one of the network controllers designed for software defined networking (SDN). We will explain how SDN works in detail when we cover the SDN concept in later lectures.

You should be able to see packet-in messages at the terminal for the Ryu controller. Note that when you specify a default remote controller for Mininet, the controller is expected to run at 127.0.0.1:6653. This is handled by Ryu automatically. To verify this, you can first start the Ryu controller and then start Mininet, you can see the following message in the Mininet setup messages:

```
Connecting to remote controller at 127.0.0.1:6653
```

## 2 Implementing a MAC Learning Switch with Ryu

A learning switch has the following basic functions:

- Learns the MAC address of the host connected to a port and retains it in the forwarding table
- When receiving packets addressed to a host already learned, transfers them to the port connected to the host
- When receiving packets addressed to an unknown host, performs flooding

Now let's use Ryu to implement such a switch and test it in Mininet. You can check the Ryu APIs at: <https://ryu.readthedocs.io/en/latest/developing.html>. You may use the code template provided by us (`learning_switch.py`). The template already includes the basic structure of the controller function. The parts missing is the `packet_in` handler.

**Note:** The flow entries you push to the switch from the controller should follow format (match `<in_port, eth_dst>`, action `out_port`). Not following this format may lead to wrong answers to some of the quiz questions.

Once you have completed the learning switch, test it with the following commands:

```
$ ryu-manager learning_switch.py
```

In another terminal window, you launch the emulated network with the topology you constructed in lab0, i.e., `network_bridge.py` here, which specifies the bridge topology.

```
$ sh run.sh
```

Test if the learning switch is working as expected:

```
mininet> pingall
```

To check the flow entries that have been installed on the switch, you can use the following command:

```
$ sudo ovs-ofctl dump-flows switch_id
```

where `switch_id` is the name of the switch you want to check, e.g., `s1`.

## 3 Differentiating ARP from IP

In the above implementation, the switch learns on all packets including the ARP requests and responses. In this exercise, let us differentiate ARP from IP packets, e.g., the switch will not

learn any MAC-port mapping from ARP requests/responses. Think about how to handle ARP requests/responses and how to implement it in your learning switch.

**Note:** The Canvas quiz for this lab will be based on this implementation, i.e., learning is only done through IP packets.

## 4 Answering Quiz Questions on Canvas

After completing the learning switch code and testing it out, please complete the quiz on Canvas. There are five quiz questions each worth **one point**. Some of the questions require you to modify and run your code and observe the outcome, so make sure you have done your implementation before you attempt the quiz. You have only one chance to take the quiz. For this lab, there is no need to submit your code.

**Note:** For each of the questions, you should restart the setup (the Mininet emulation and the Ryu controller program) and **rerun** your code.