

## Install Python 3.10

*sudo apt update*

```
osboxes@osboxes:~$ sudo apt update
Hit:1 http://archive.ubuntu.com/ubuntu noble InRelease
Get:2 http://security.ubuntu.com/ubuntu noble-security InRelease [126 kB]
Get:3 http://archive.ubuntu.com/ubuntu noble-updates InRelease [126 kB]
Get:4 https://ppa.launchpadcontent.net/oisf/suricata-stable/ubuntu noble InRelease [18.1 kB]
Get:5 https://ppa.launchpadcontent.net/oisf/suricata-stable/ubuntu noble/main amd64 Packages [1,384 B]
Get:6 http://archive.ubuntu.com/ubuntu noble-backports InRelease [126 kB]
Get:7 http://security.ubuntu.com/ubuntu noble-security/main amd64 Packages [1,056 kB]
Get:8 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 Packages [1,315 kB]
Get:9 http://archive.ubuntu.com/ubuntu noble-updates/main T
```

*sudo apt install software-properties-common -y*

```
osboxes@osboxes:~$ sudo apt install software-properties-com
mon -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  python3-software-properties software-properties-gtk
The following packages will be upgraded:
  python3-software-properties software-properties-common
  software-properties-gtk
3 upgraded, 0 newly installed, 0 to remove and 553 not upgr
aded.
Need to get 127 kB of archives.
After this operation, 5,120 B of additional disk space will
be used.
Get:1 http://archive.ubuntu.com/ubuntu noble-updates/main a
md64 software-properties-common all 0.99.49.2 [14.4 kB]
```

*sudo add-apt-repository ppa:deadsnakes/ppa*

## Nightly Builds

=====

For nightly builds, see [ppa:deadsnakes/nightly](https://launchpad.net/~deadsnakes/+archive/ubuntu/nightly) <https://launchpad.net/~deadsnakes/+archive/ubuntu/nightly>

More info: <https://launchpad.net/~deadsnakes/+archive/ubuntu/ppa>

Adding repository.

Press [ENTER] to continue or Ctrl-c to cancel.

Hit:1 <http://archive.ubuntu.com/ubuntu> noble InRelease

Hit:2 <http://security.ubuntu.com/ubuntu> noble-security InRelease

*sudo apt install python3.10 python3.10-venv python3.10-dev -y*

```
osboxes@osboxes:~$ sudo apt install python3.10 python3.10-v
env python3.10-dev -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  libexpat1 libexpat1-dev libpython3.10 libpython3.10-dev
  libpython3.10-minimal libpython3.10-stdlib
  python3.10-distutils python3.10-lib2to3
  python3.10-minimal
Suggested packages:
  binutils bintfmt-support
```

*python3.10 --version*

```
osboxes@osboxes:~$ python3.10 --version
Python 3.10.18
osboxes@osboxes:~$
```

*Sudo apt install git -y*

```
osboxes@osboxes:~$ sudo apt install git -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  git-man liberror-perl
Suggested packages:
  git-daemon-run | git-daemon-sysvinit git-doc git-email
  git-gui gitk gitweb git-cvs git-mediawiki git-svn
The following NEW packages will be installed:
  git git-man liberror-perl
0 upgraded, 3 newly installed, 0 to remove and 552 not upgr
aded.
Need to get 4,806 kB of archives.
```

*install Ryu*

*git clone <https://github.com/osrg/ryu.git>*

```

osboxes@osboxes:~$ git clone https://github.com/osrg/ryu.git
Cloning into 'ryu'...
remote: Enumerating objects: 26506, done.
remote: Counting objects: 100% (4/4), done.
remote: Compressing objects: 100% (3/3), done.
Receiving objects: 38% (10073/26506), 7.29 MiB | 4.80 MiB/
Receiving objects: 38% (10319/26506), 7.29 MiB | 4.80 MiB/
Receiving objects: 39% (10338/26506), 7.29 MiB | 4.80 MiB/
Receiving objects: 40% (10603/26506), 8.82 MiB | 4.35 MiB/
Receiving objects: 41% (10868/26506), 8.82 MiB | 4.35 MiB/
Receiving objects: 42% (11133/26506), 8.82 MiB | 4.35 MiB/

```

*cd ryu*

```

osboxes@osboxes:~$ cd ryu
osboxes@osboxes:~/ryu$ ls
bin                LICENSE            ryu
CONTRIBUTING.rst  MANIFEST.in        setup.cfg
debian            pip-requirements.txt  setup.py
doc               README.rst          tools
etc               run_tests.sh        tox.ini
osboxes@osboxes:~/ryu$

```

*python3.10 -m venv venv310*

```

osboxes@osboxes:~/ryu$ python3.10 -m venv venv310
osboxes@osboxes:~/ryu$ ls
bin                MANIFEST.in        setup.py
CONTRIBUTING.rst  pip-requirements.txt  tools
debian            README.rst          tox.ini
doc               run_tests.sh        venv310
etc               ryu
LICENSE           setup.cfg
osboxes@osboxes:~/ryu$

```

*source venv310/bin/activate*

```
osboxes@osboxes:~/ryu$ source venv310/bin/activate  
(venv310) osboxes@osboxes:~/ryu$
```

*pip install --upgrade pip setuptools*

```
(venv310) osboxes@osboxes:~/ryu$ pip install --upgrade pip  
setuptools  
Requirement already satisfied: pip in ./venv310/lib/python3  
.10/site-packages (23.0.1)  
Collecting pip  
  Downloading pip-25.2-py3-none-any.whl (1.8 MB)  
    ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.8/1.8 MB 2.7 MB/s eta 0:00:00  
Requirement already satisfied: setuptools in ./venv310/lib/  
python3.10/site-packages (65.5.0)  
Collecting setuptools  
  Downloading setuptools-80.9.0-py3-none-any.whl (1.2 MB)  
    ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.2/1.2 MB 2.9 MB/s eta 0:00:00  
Installing collected packages: setuptools, pip  
  Attempting uninstall: setuptools  
    Found existing installation: setuptools 65.5.0  
    Uninstalling setuptools-65.5.0:  
      Successfully uninstalled setuptools-65.5.0  
  Attempting uninstall: pip  
    Found existing installation: pip 23.0.1  
    Uninstalling pip-23.0.1:  
      Successfully uninstalled pip-23.0.1  
Successfully installed pip-25.2 setuptools-80.9.0  
(venv310) osboxes@osboxes:~/ryu$
```

*gedit ryu/hooks.py*

```

32 def save_orig():
33     """Save original easy_install.get_script_args.
34     This is necessary because pbr's setup_hook is sometimes called
35     before ours."""
36     _main_module()._orig_get_script_args = easy_install.get_script_args
37
38
39 def setup_hook(config):
40     """Filter config parsed from a setup.cfg to inject our defaults."""
41     metadata = config['metadata']
42     if sys.platform == 'win32':
43         requires = metadata.get('requires_dist', '').split('\n')
44         metadata['requires_dist'] = "\n".join(requires)
45     config['metadata'] = metadata
46
47     metadata['version'] = str(version)
48
49     # pbr's setup_hook replaces easy_install.get_script_args with
50     # their own version, override_get_script_args, preferring simpler
51     # scripts which are not aware of multi-version.
52     # prevent that by doing the opposite. it's a horrible hack
53     # but we are in patching wars already...
54     from pbr import packaging
55
56     def my_get_script_args(*args, **kwargs):
57         return _main_module()._orig_get_script_args(*args, **kwargs)
58

```

remove the marked items and change

```

31
32 def save_orig():
33     """Save original easy_install.get_script_args.
34     This is necessary because pbr's setup_hook is sometimes called
35     before ours."""
36     pass
37
38
39 def setup_hook(config):
40     """Filter config parsed from a setup.cfg to inject our defaults."""
41     metadata = config['metadata']
42     if sys.platform == 'win32':
43         requires = metadata.get('requires_dist', '').split('\n')
44         metadata['requires_dist'] = "\n".join(requires)
45     config['metadata'] = metadata
46
47     metadata['version'] = str(version)
48
49     # pbr's setup_hook replaces easy_install.get_script_args with
50     # their own version, override_get_script_args, preferring simpler
51     # scripts which are not aware of multi-version.
52     # prevent that by doing the opposite. it's a horrible hack
53     # but we are in patching wars already...
54     from pbr import packaging
55
56     def my_get_script_args(*args, **kwargs):
57         return []

```

`pip install -e .`

```

(venv310) osboxes@osboxes:~/ryu$ pip install -e .
Obtaining file:///home/osboxes/ryu
  Installing build dependencies ... done
  Checking if build backend supports build_editable ... done
  e
  Getting requirements to build editable ... done
  Installing backend dependencies ... done
  Preparing editable metadata (pyproject.toml) ... done
Collecting eventlet==0.31.1 (from ryu==4.34)

```



*pip install eventlet==0.33.3*

```
(venv310) osboxes@osboxes:~/ryu$ pip install eventlet==0.33.3
Collecting eventlet==0.33.3
  Downloading eventlet-0.33.3-py2.py3-none-any.whl.metadata
(4.3 kB)
Requirement already satisfied: dnspython>=1.15.0 in ./venv310/lib/python3.10/site-packages (from eventlet==0.33.3) (1.16.0)
Requirement already satisfied: greenlet>=0.3 in ./venv310/lib/python3.10/site-packages (from eventlet==0.33.3) (3.2.4)
Requirement already satisfied: six>=1.10.0 in ./venv310/lib/python3.10/site-packages (from eventlet==0.33.3) (1.17.0)
Downloading eventlet-0.33.3-py2.py3-none-any.whl (226 kB)
Installing collected packages: eventlet
  Attempting uninstall: eventlet
    Found existing installation: eventlet 0.31.1
    Uninstalling eventlet-0.31.1:
      Successfully uninstalled eventlet-0.31.1
ERROR: pip's dependency resolver does not currently take in
to account all the packages that are installed. This behavi
our is the source of the following dependency conflicts.
ryu 4.34 requires eventlet==0.31.1, but you have eventlet 0
.33.3 which is incompatible.
Successfully installed eventlet-0.33.3
(venv310) osboxes@osboxes:~/ryu$
```

*pip install --upgrade dnspython*



```
(venv310) osboxes@osboxes:~/ryu$ pip install --upgrade dnspython
Requirement already satisfied: dnspython in ./venv310/lib/python3.10/site-packages (1.16.0)
Collecting dnspython
  Downloading dnspython-2.7.0-py3-none-any.whl.metadata (5.8 kB)
Downloading dnspython-2.7.0-py3-none-any.whl (313 kB)
Installing collected packages: dnspython
  Attempting uninstall: dnspython
    Found existing installation: dnspython 1.16.0
    Uninstalling dnspython-1.16.0:
      Successfully uninstalled dnspython-1.16.0
ERROR: pip's dependency resolver does not currently take in to account all the packages that are installed. This behaviour is the source of the following dependency conflicts.
ryu 4.34 requires eventlet==0.31.1, but you have eventlet 0.33.3 which is incompatible.
Successfully installed dnspython-2.7.0
(venv310) osboxes@osboxes:~/ryu$
```

*ryu-manager --version*

```
(venv310) osboxes@osboxes:~/ryu$ ryu-manager --version
ryu-manager 4.34
(venv310) osboxes@osboxes:~/ryu$
```

### install Open vSwitch

*sudo apt-get install openvswitch-switch -y*

```
(venv310) osboxes@osboxes:~/ryu$ sudo apt-get install openvswitch-switch -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  libunbound8 libxdp1 openvswitch-common
  python3-openvswitch python3-sortedcontainers
Suggested packages:
  openvswitch-doc python-sortedcontainers-doc
The following NEW packages will be installed:
  libunbound8 libxdp1 openvswitch-common
  openvswitch-switch python3-openvswitch
  python3-sortedcontainers
0 upgraded, 6 newly installed, 0 to remove and 552 not upgraded.
Need to get 4,210 kB of archives.
```

#### install Mininet

*sudo apt-get install mininet -y*

```
(venv310) osboxes@osboxes:~/ryu$ sudo apt-get install mininet -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  cgroup-tools iperf libcgroup2 python3-packaging socat
The following NEW packages will be installed:
  cgroup-tools iperf libcgroup2 mininet python3-packaging
  socat
0 upgraded, 6 newly installed, 0 to remove and 552 not upgraded.
Need to get 802 kB of archives.
After this operation, 3,544 kB of additional disk space will be used.
```

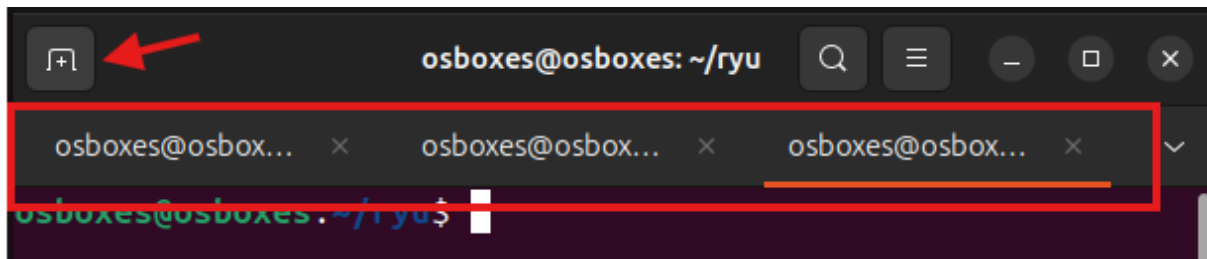
*mn --version*

```
(venv310) osboxes@osboxes:~/ryu$ mn --version
2.3.0
(venv310) osboxes@osboxes:~/ryu$
```

## Running Simple SDN Application (Basic SDN)

- A Mininet topology (switch + hosts)
- A Ryu controller (simple\_switch\_13) that acts like a Layer 2 learning switch
- Basic flow table inspection (OpenFlow rules)

Open 3 terminal tabs



Terminal 1:

```
sudo mn --topo=single,3 --controller=remote,ip=127.0.0.1 --mac --  
switch=ovsk,protocols=OpenFlow13
```

```
osboxes@osboxes: ~/ryu
(venv310) osboxes@osboxes:~/ryu$ sudo mn --topo=single,3 --
controller=remote,ip=127.0.0.1 --mac --switch=ovsk,protocol
s=OpenFlow13
*** Creating network
*** Adding controller
Unable to contact the remote controller at 127.0.0.1:6653
Unable to contact the remote controller at 127.0.0.1:6633
Setting remote controller to 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>
```

The command in Terminal 1 creates a simple topology in mininet. The topology consists of a single switch and three hosts that are connected to the switch. The topology can be tested by using *pingall* command on the same terminal. At this point, the hosts are unreachable. For making the hosts communicate with each other, there must be some rules which are implemented by the controller.

```
mininet> pingall
*** Ping: testing ping reachability
h1 -> X X
h2 -> X X
h3 -> X X
*** Results: 100% dropped (0/6 received)
mininet>
```

Terminal 2:

```
ryu-manager ryu.app.simple_switch_13
```

```
osboxes@osbox... x osboxes@osbox... x osboxes@osbox... x
osboxes@osboxes:~/ryu$ source venv310/bin/activate
(venv310) osboxes@osboxes:~/ryu$ ryu-manager ryu.app.simple_switch_13
loading app ryu.app.simple_switch_13
loading app ryu.controller.ofp_handler
instantiating app ryu.app.simple_switch_13 of SimpleSwitch13
instantiating app ryu.controller.ofp_handler of OFPHandler
```

The command in Terminal 2 runs a simple application of switch. The program file for `simple_switch_13` locates in `/usr/lib/python2.7/ryu/ryu/app/directory`. The `simple_switch_13` program sets rules and policies in ryu controller, which are necessary for routing packets in a fashion similar to that of L2 Switch of conventional networking. Switch to Terminal 1 and run `pingall` command again. The hosts will be able to communicate with each other this time. A simple SDN infrastructure has been implemented at this point!

Terminal 3:

*sudo ovs-vsctl show*

```
osboxes@osbox... x osboxes@osbox... x osboxes@osbox... x
osboxes@osboxes:~/ryu$ source venv310/bin/activate
(venv310) osboxes@osboxes:~/ryu$ sudo ovs-vsctl show
[sudo] password for osboxes:
124f2fe8-a8f8-4016-bce5-59a51aea8bc0
    ovs_version: "3.3.0"
(venv310) osboxes@osboxes:~/ryu$
```

*sudo ovs-ofctl -O OpenFlow13 dump-flows s1*

```
osboxes@osbox... x osboxes@osbox... x osboxes@osbox... x v
(venv310) osboxes@osboxes:~/ryu$ sudo ovs-vsctl show
124f2fe8-a8f8-4016-bce5-59a51aea8bc0
    Bridge s1
        Controller "tcp:127.0.0.1:6653"
            is_connected: true
        Controller "ptcp:6654"
        fail_mode: secure
    Port s1
        Interface s1
            type: internal
    Port s1-eth1
        Interface s1-eth1
    Port s1-eth2
        Interface s1-eth2
    Port s1-eth3
        Interface s1-eth3
    ovs_version: "3.3.0"
(venv310) osboxes@osboxes:~/ryu$ sudo ovs-ofctl -O OpenFlow
13 dump-flows s1
    cookie=0x0, duration=3390.535s, table=0, n_packets=42, n_b
ytes=3228, priority=0 actions=CONTROLLER:65535
(venv310) osboxes@osboxes:~/ryu$
```

The commands in Terminal 3 show the brief configuration and flow table of Open vSwitch. These commands are used for inspecting the behavior and statistics of SDN switches upon receiving packets from the hosts.

Terminal 1 try ping command

*pingall*

```
mininet> pingall
*** Ping: testing ping reachability
h1 -> h2 h3
h2 -> h1 h3
h3 -> h1 h2
*** Results: 0% dropped (6/6 received)
mininet> █
```



