National College of Ireland

Configuration Manual

MSc Research Project
Programme Name

Safal Harshan Vadassery
Student ID: X22243909

School of Computing
National College of Ireland

Supervisor: Mark Monaghan

National College of Ireland

MSc Project Submission Sheet

School of Computing

Student Name: Safal Harshan Vadassery…….

Student ID: X22243909……..……

Programme: Msc in Cybersecurity…… **Year:** 2023-24 ……..

Module: Msc Research Project……

Lecturer: Mark Monaghan……

Submission Due Date: 12 August……

Project Title: Securing Software-Defined Networks: Implementing Enhanced Transport Layer Security and Dynamic Flow Management in Openflow ……

Word Count: 872…… **Page Count:** …14……

I hereby certify that the information contained in this (my submission) is information pertaining to research I conducted for this project. All information other than my own contribution will be fully referenced and listed in the relevant bibliography section at the rear of the project.
ALL internet material must be referenced in the bibliography section. Students are required to use the Referencing Standard specified in the report template. To use other author's written or electronic work is illegal (plagiarism) and may result in disciplinary action.

Signature: Safal Harshan Vadassery……

Date: 12 August 2024……

PLEASE READ THE FOLLOWING INSTRUCTIONS AND CHECKLIST

Attach a completed copy of this sheet to each project (including multiple copies)	□
Attach a Moodle submission receipt of the online project submission, to each project (including multiple copies).	□
You must ensure that you retain a HARD COPY of the project, both for your own reference and in case a project is lost or mislaid. It is not sufficient to keep a copy on computer.	□

Assignments that are submitted to the Programme Coordinator Office must be placed into the assignment box located outside the office.

Office Use Only	
Signature:	
Date:	
Penalty Applied (if applicable):	

Configuration Manual

Safal Harshan Vadassery
X22243909

1 Introduction

This project deals with the implementation of a secured SDN environment using GNS3, Open vSwitch, and the Ryu controller. Much attention will be paid to securing OpenFlow communications between the controller and network switches with TLS encryption. Setting up these instances of OVS, including a DHCP server for dynamic assignment of IP addresses and Network Address Translation to join devices to the internet, is explained. It is also highly reflected that the sensitivity of the network to configuration change is very high; therefore, its setting should be done precisely and accurately to avoid instability. This work uses GNS3 for simulation; therefore, it not only shows the practicality of implementing SDN but gives paramount importance to secure controller-switch communication against any possible network threats and assures reliable network performance.

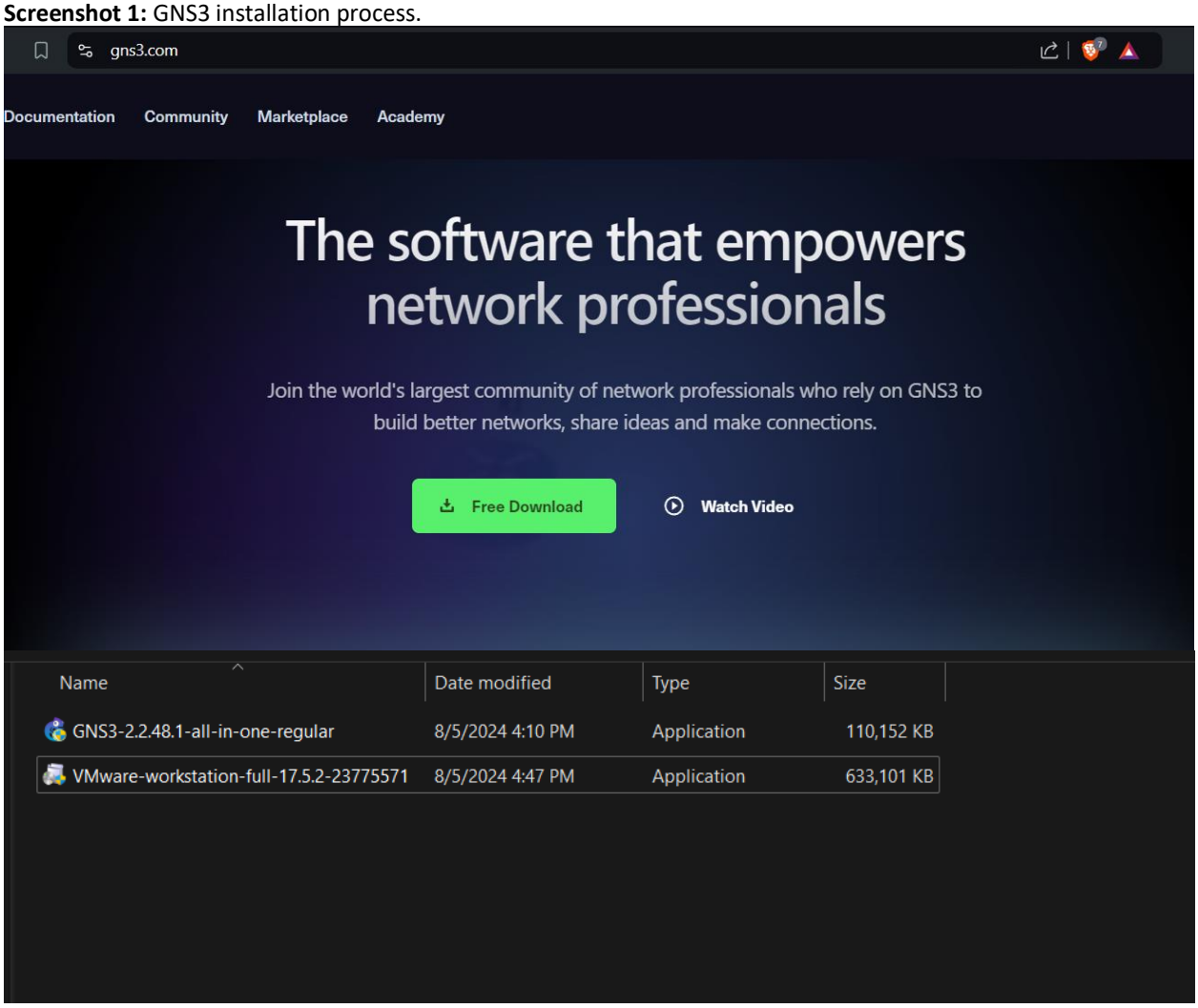
2 Tools utilized

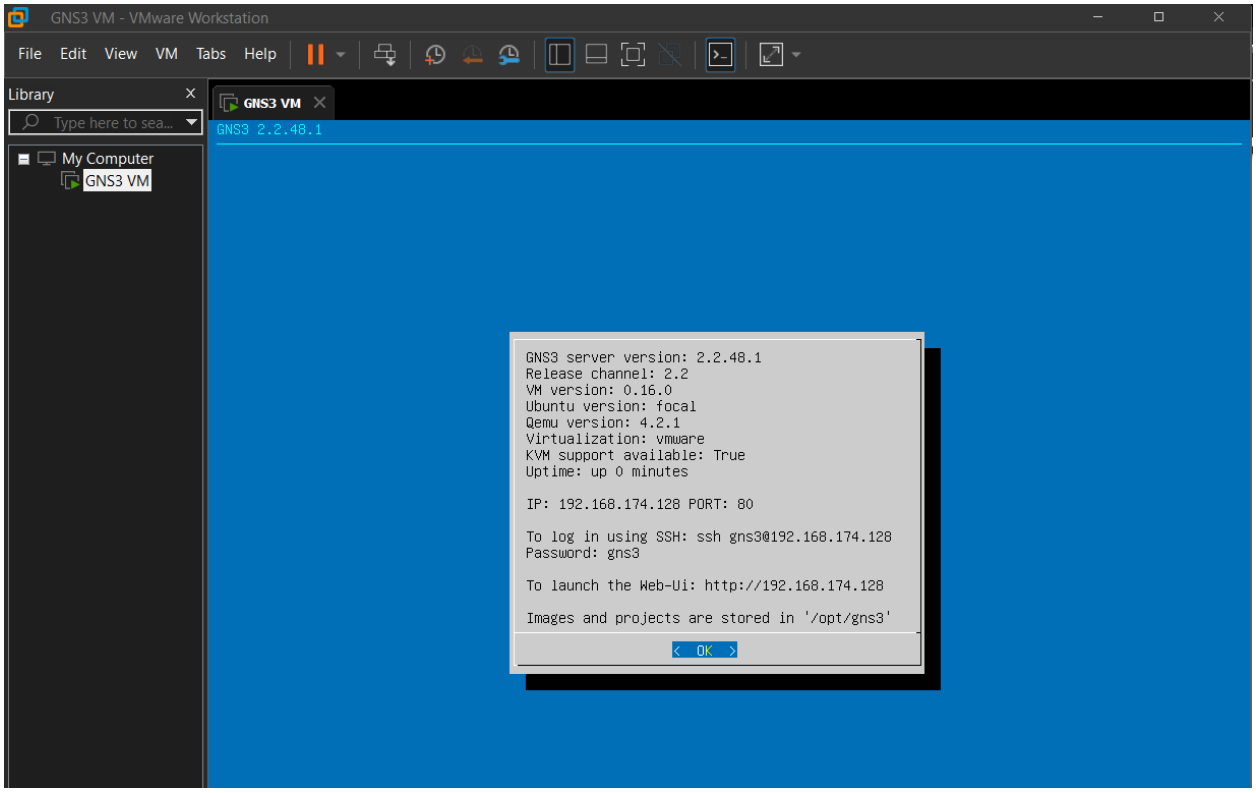
Below is the list of all tools used in this project:

i) GNS3: This is a network simulation tool that was used to design and test the SDN topology.
ii) Open vSwitch (OVS): Virtual switch software, which has been used to create and manage virtual network switches.
iii) Ryu Controller: SDN controller software, used to control the network and manage it using the OpenFlow protocol.
iv) tcpdump: A network packet analyzer that captured the network traffic for analysis.
v) Wireshark: This is a network protocol analyzer used for capturing and inspecting traffic. In particular, it comes in handy in verifying encrypted communication.
vi) OpenSSL: An SSL/TLS toolkit for generating and managing SSL certificates for securing the communication between the Ryu controller and instances of OVS.
vii) QEMU: This is a virtual machine emulator. It permits running virtual machines within GNS3 to host OVS instances.
viii) Python: A programming language employed for scripting and running the Ryu controller application.
ix) Linux Shell/Terminal: This is the command-line interface for the configuration of devices, execution of commands, and management of network settings.
x) DHCP Server: Any software or service configured to automatically provide IP addresses to devices for a particular network.
xi) Router Configuration Tools: Tools helping in setting configurations on virtual routers in GNS3 relating to routing, NAT, and others.
xii) HTTP Server (Python SimpleHTTPServer): The temporary web server utilized in transferring files—like certificates SSL—between devices in the network.

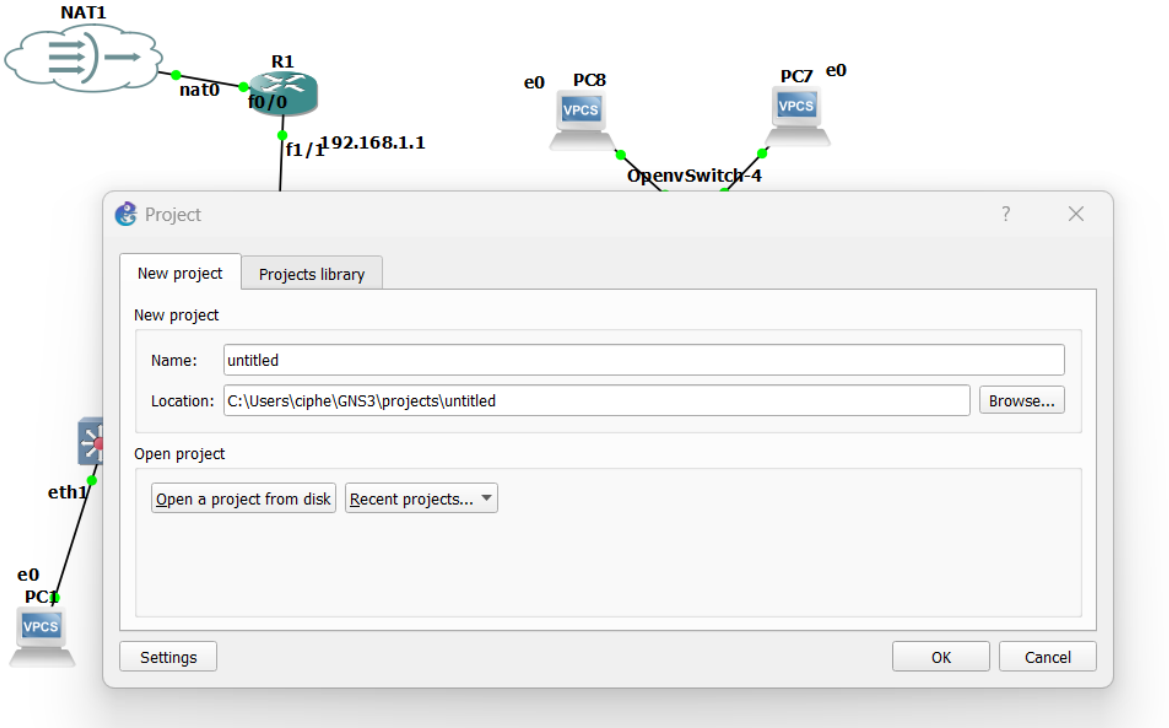
3 Screenshots

Screenshot 1: GNS3 installation process.

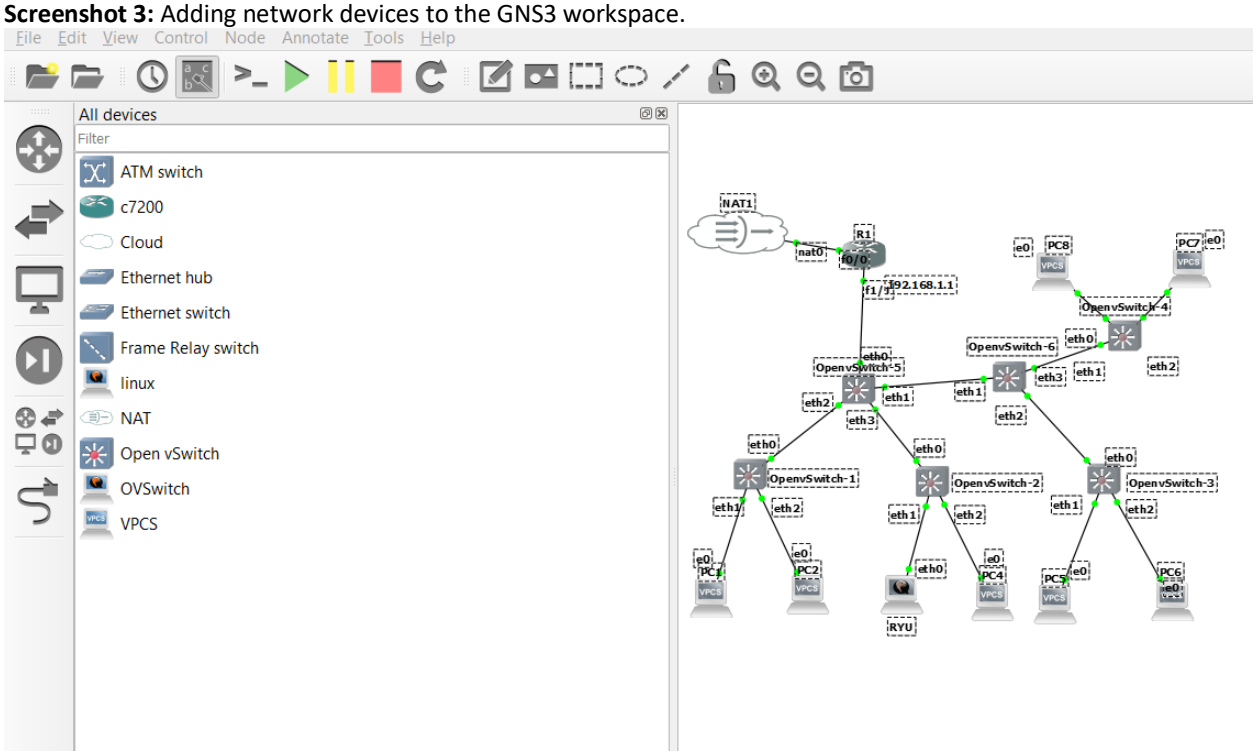




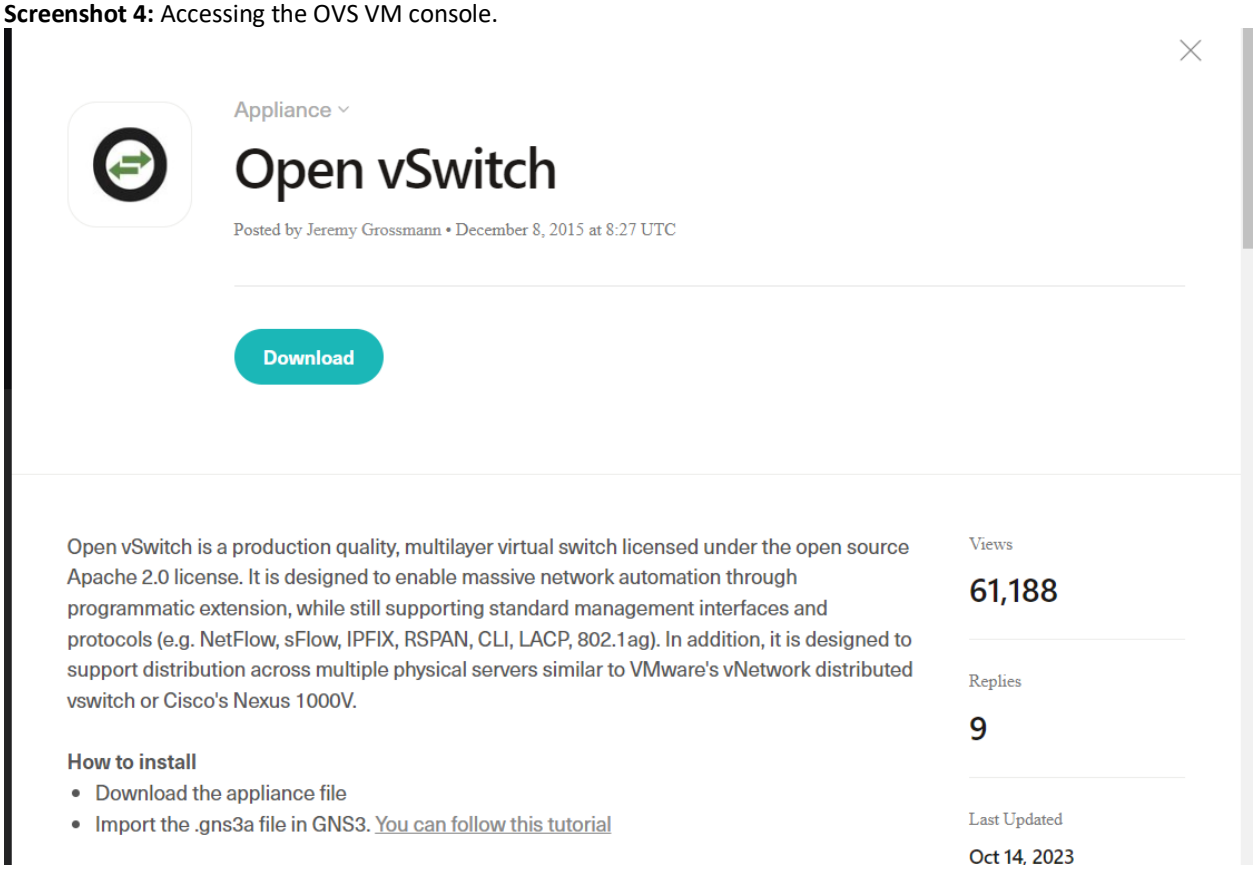
Screenshot 2: Creating a new project in GNS3.



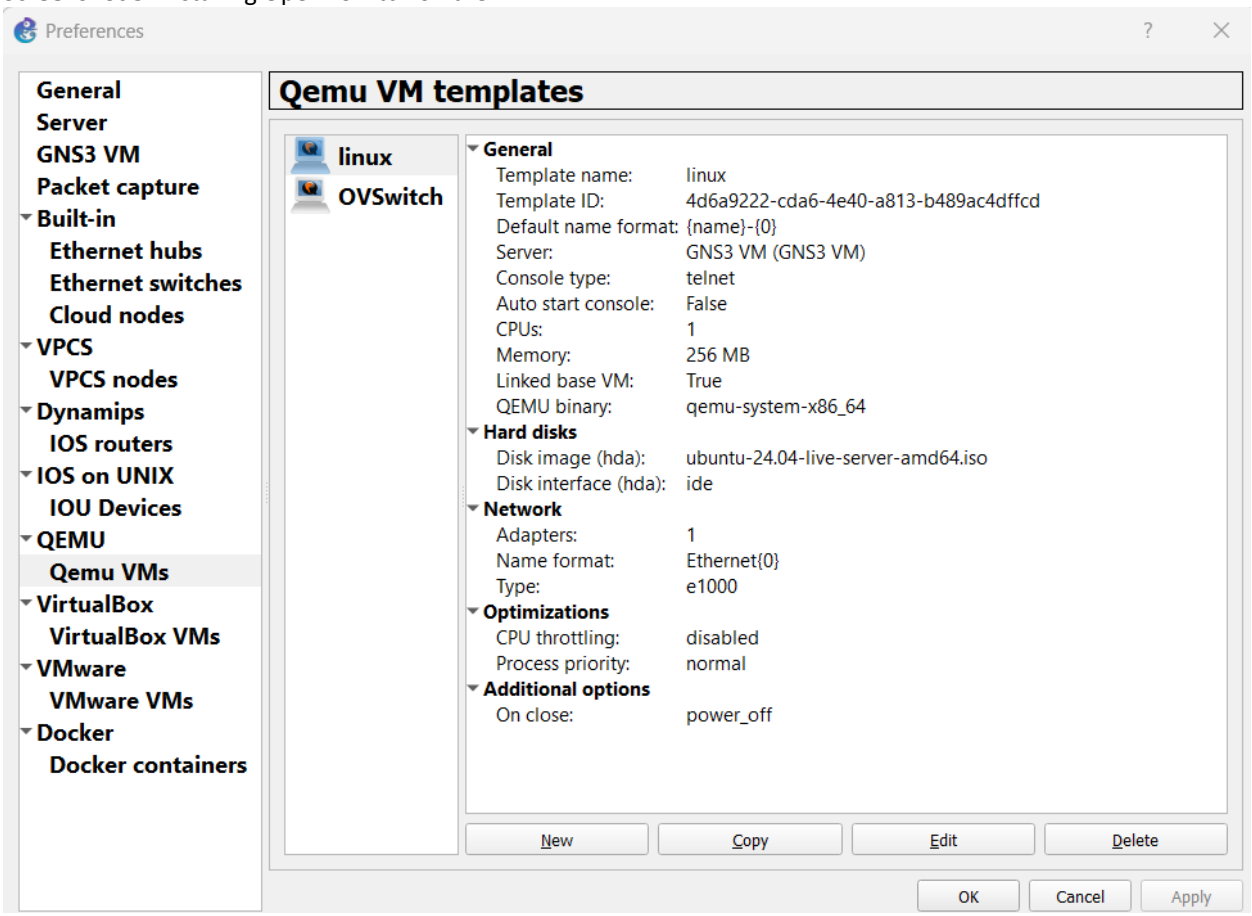
Screenshot 3: Adding network devices to the GNS3 workspace.



Screenshot 4: Accessing the OVS VM console.



Screenshot 5: Installing Open vSwitch on the VM.

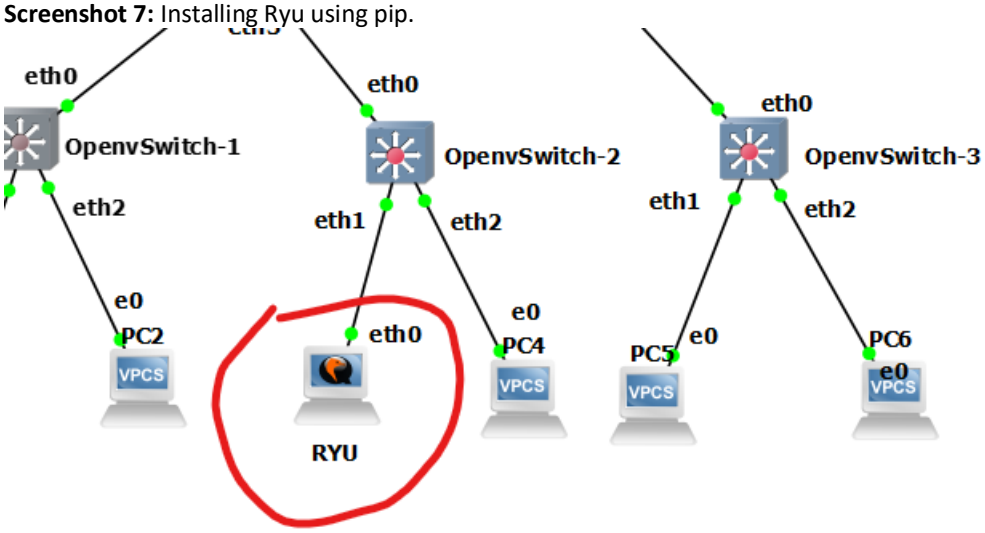


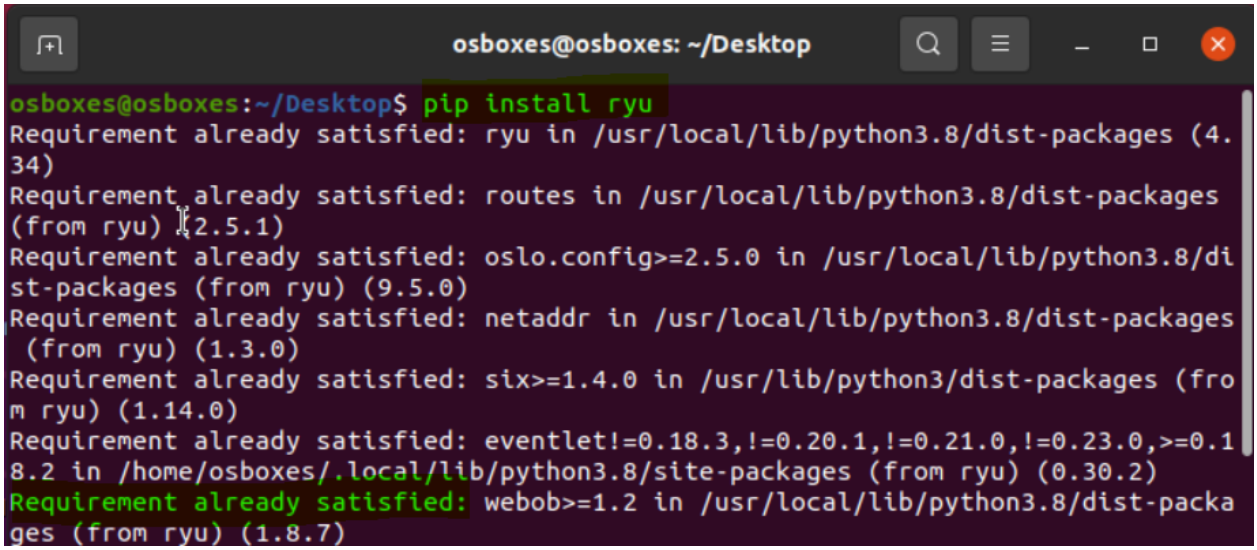
Screenshot 6: Creating a bridge and adding ports

```
2024-08-11T21:25:39Z|00111|coverage|INFO|bridge_reconfigure         0.0/sec
0.000/sec        0.0000/sec    total: 1
2024-08-11T21:25:39Z|00112|coverage|INFO|118 events never hit
OpenvSwitch-1:/$ ovs-vsctl add-br br0
ovs-vsctl: cannot create a bridge named br0 because a bridge named br0 already exists
OpenvSwitch-1:/$ ovs-vsctl add-port br0 eth0
ovs-vsctl: cannot create a port named eth0 because a port named eth0 already exists on bridge br0
OpenvSwitch-1:/$ ovs-vsctl add-port br0 eth1
ovs-vsctl: cannot create a port named eth1 because a port named eth1 already exists on bridge br0
OpenvSwitch-1:/$ ovs-vsctl add-port br0 eth2
ovs-vsctl: cannot create a port named eth2 because a port named eth2 already exists on bridge br0
OpenvSwitch-1:/$ ovs-vsctl add-port br0 eth3
ovs-vsctl: cannot create a port named eth3 because a port named eth3 already exists on bridge br0
OpenvSwitch-1:/$
```

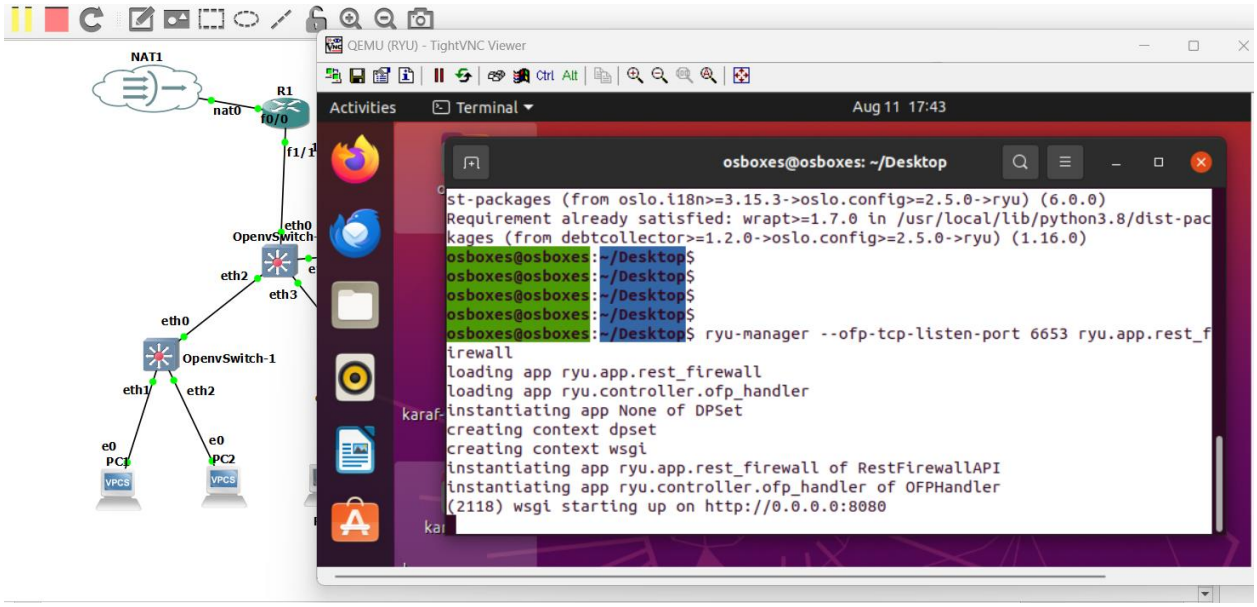
(I already did the configurations hence the warning feedback)

Screenshot 7: Installing Ryu using pip.





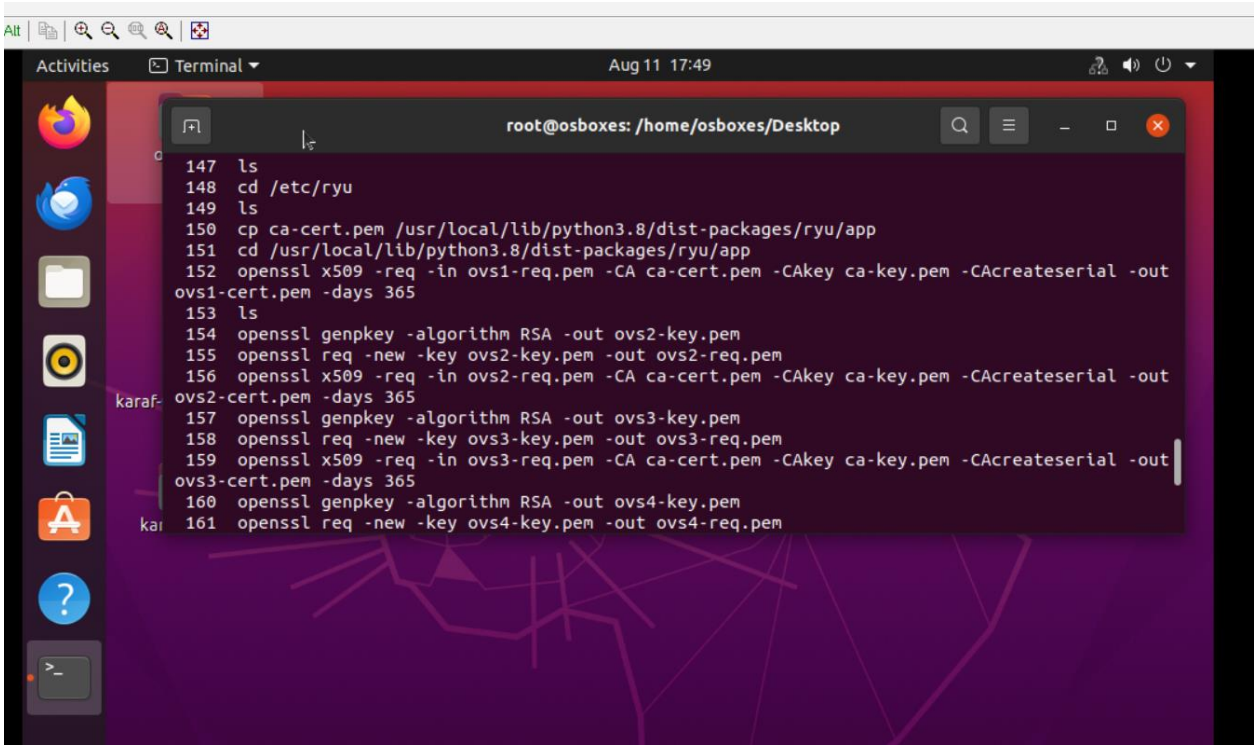
Screenshot 8: Creating and running the Ryu application.



Screenshot 9: Setting the controller IP on OVS

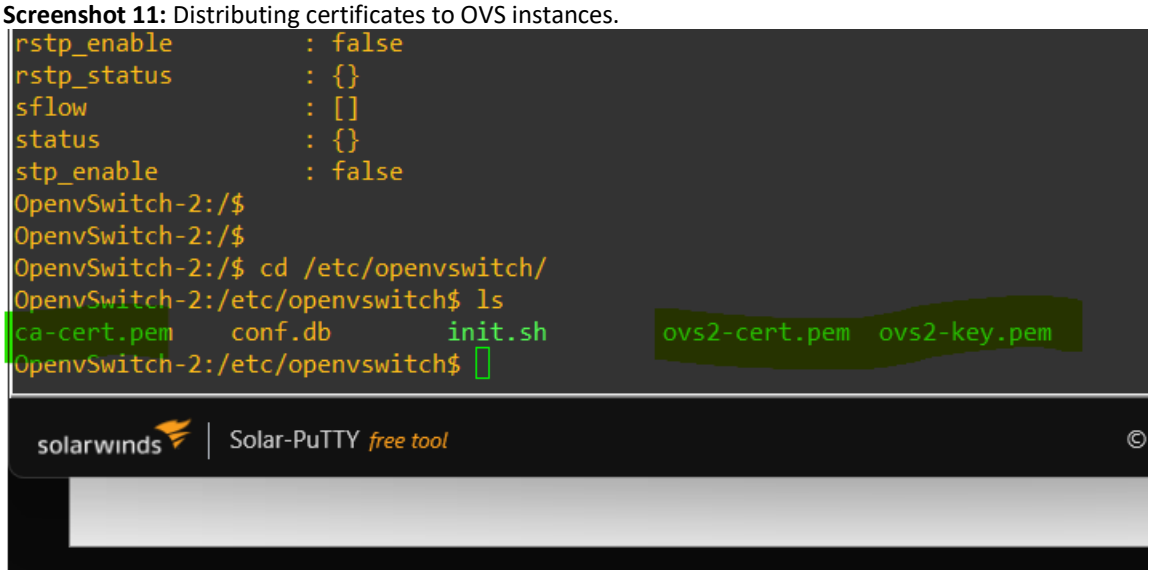
```
OpenvSwitch-2:/$ ovs-vsctl set-controller br0 tcp:192.168.1.7:6653
OpenvSwitch-2:/$ ovs-vsctl list bridge br0
_uuid               : 0e209d47-7d53-4a81-85e1-dfdd668a7eae
auto_attach         : []
controller          : [e0892969-5506-4dbd-a23c-1df200bcc2b0]
datapath_id         : "0000469d200e814a"
datapath_type       : netdev
datapath_version    : "<built-in>"
external_ids        : {}
fail_mode           : standalone
flood_vlans         : []
flow_tables         : {}
ipfix               : []
mcast_snooping_enable: false
mirrors             : []
name                : br0
netflow             : []
other_config        : {}
ports               : [035751f4-8522-465d-ad5e-f3528edd59bc, 08f9f4c0-c768-4725-9a64-ad89f590d5cf, 0f4ce8b7-2fbf-415c-8d8
4-6c692a13f065, 1365f9fb-363e-4a80-ab18-8e22afe40910, 48828f6c-8e45-4540-a545-b4dff6fccbd3, 49d2247d-31f4-4abb-915d-c0cde
28f6104, 53d6dc4e-c816-45b2-88cb-480451f233d5, 6ca80438-f9e4-4479-abdb-2c6fc7ee4661, 896fea7a-25b4-44d3-909c-ff28e7b736f7
, 89ce731b-5c62-48da-a788-44a9c6bd8e88, 974a7ae8-500f-46d1-986a-0756a1f749d0, 9c25b279-56ab-4225-8b72-4bd2319b8446, bc3d7
6ab-99ec-4f43-9521-8652f6dc5778, c1044d3b-7522-474f-8f91-f33949e9a084, c6333f47-fdd6-4f37-ba3f-bc3c75eb9072, dadab0d3-53d
e-4e3d-ba88-bfcd08c4fb74, e87d1888-442a-44eb-a340-7831f43d53e8]
protocols           : [OpenFlow13]
rstp_enable         : false
```

Screenshot 10: Generating SSL certificates.

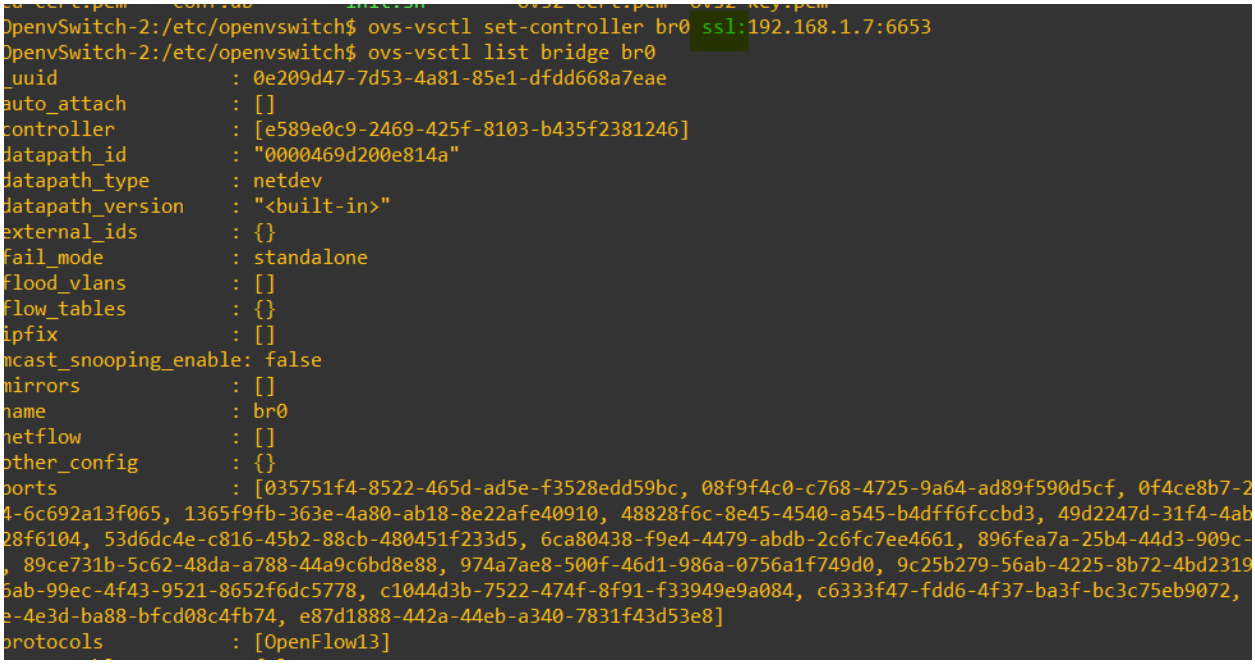


(I pulled all these commands from the past by running the command #history)

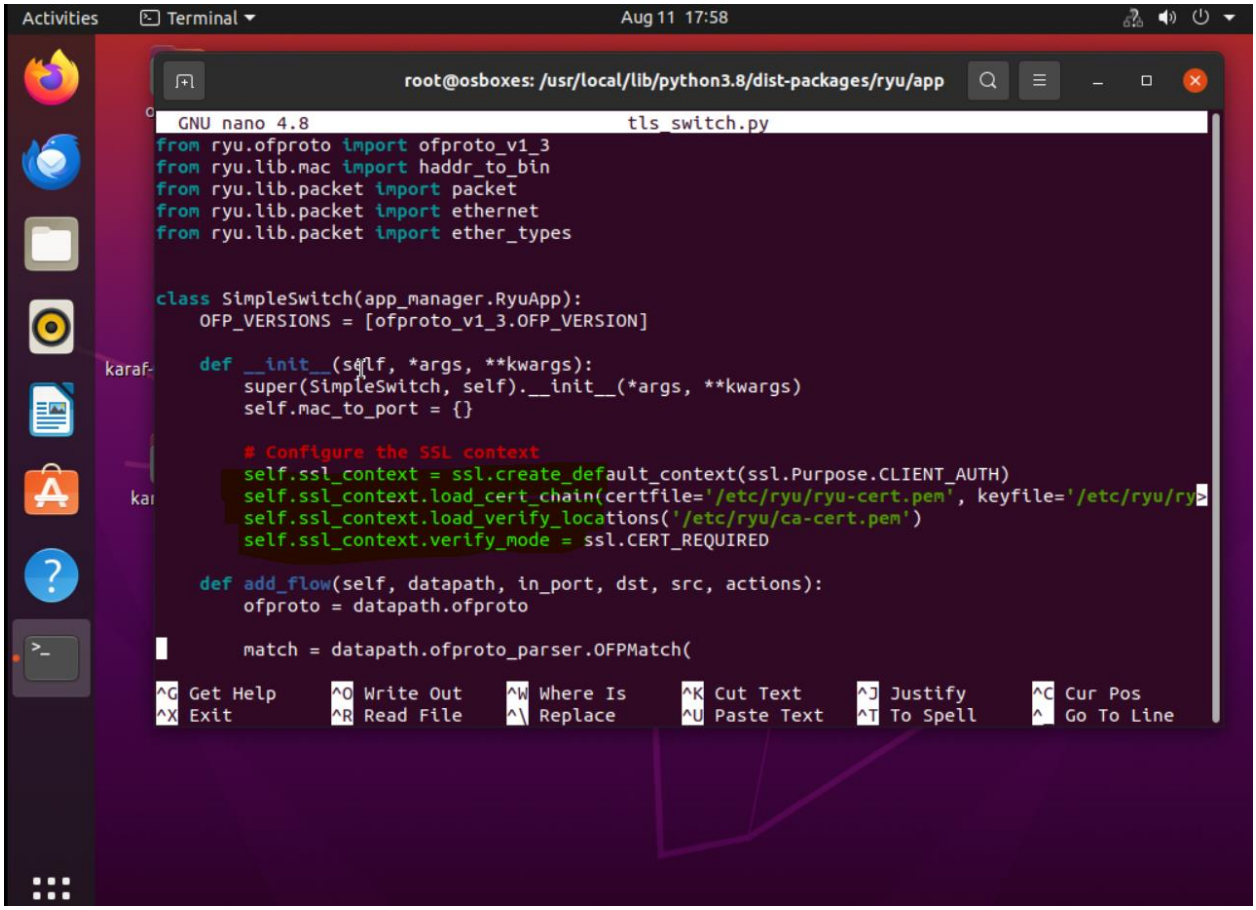
Screenshot 11: Distributing certificates to OVS instances.



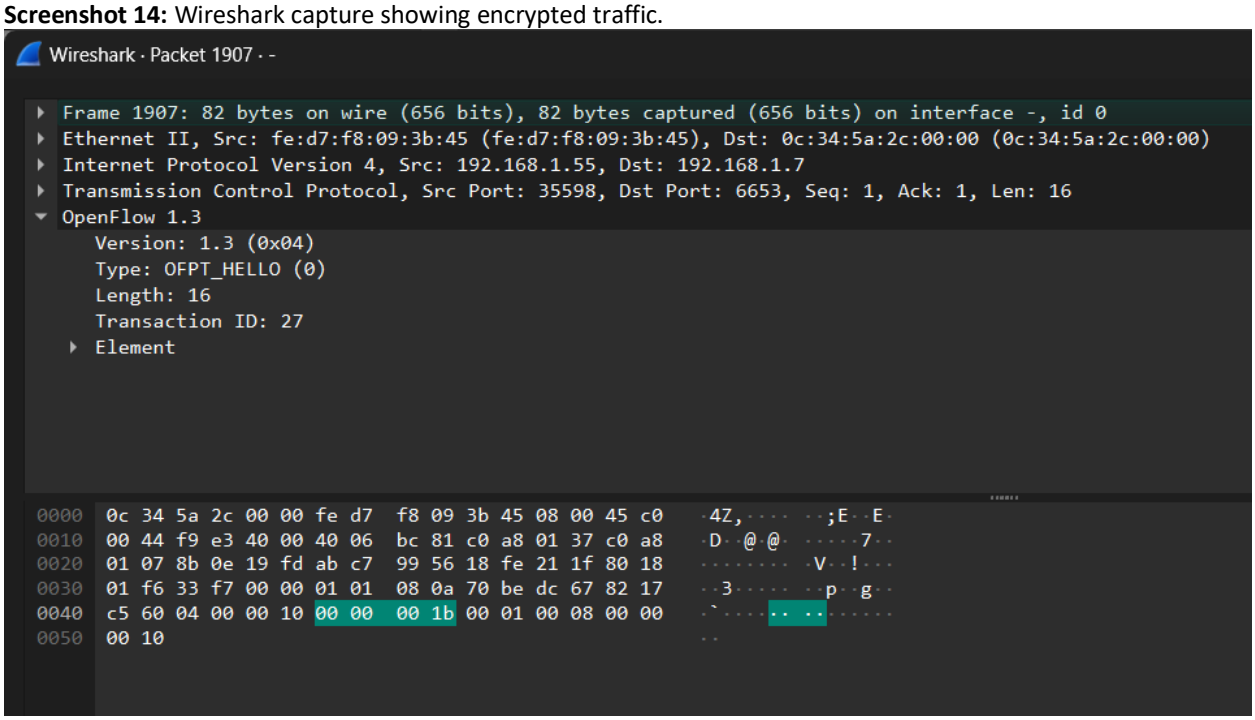
Screenshot 12: Configuring SSL on OVS

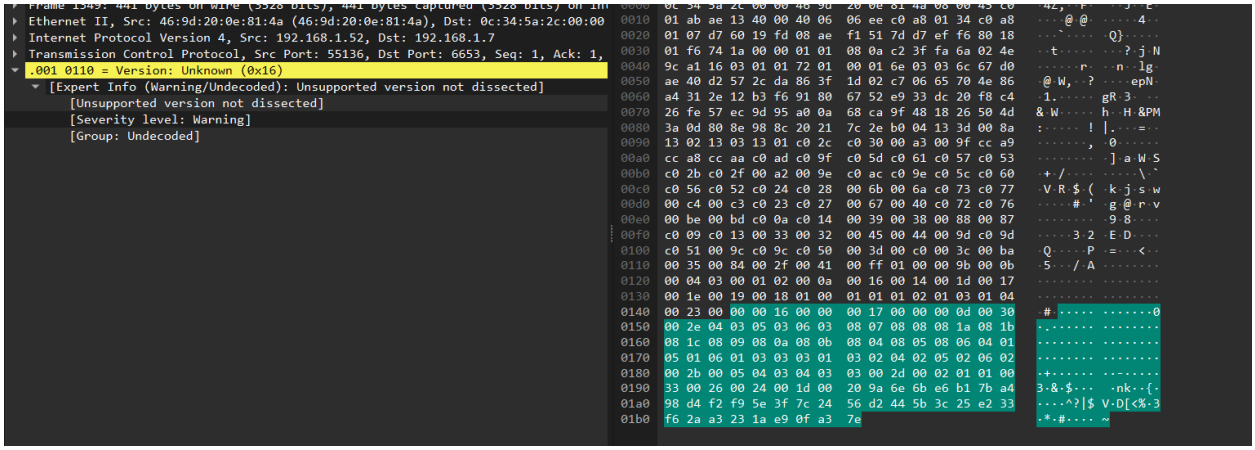


Screenshot 13: Modifying Ryu controller for TLS.



Screenshot 14: Wireshark capture showing encrypted traffic.





References

[1] ieeexplore.ieee.org. (n.d.). *Software-Defined Networking (SDN): A Review | IEEE Conference Publication | IEEE Xplore*. [online] Available at: https://ieeexplore.ieee.org/document/9972067.

[2] Jammal, M., Singh, T., Shami, A., Asal, R. and Li, Y. (2014). Software defined networking: State of the art and research challenges. *Computer Networks*, 72, pp.74–98. doi:https://doi.org/10.1016/j.comnet.2014.07.004.

[3] Asadollahi, S., Goswami, B. and Sameer, M. (2018). Ryu controller's scalability experiment on software defined networks. *2018 IEEE International Conference on Current Trends in Advanced Computing (ICCTAC)*. doi:https://doi.org/10.1109/icctac.2018.8370397.

[4] Gns3.com. (2020). Available at: https://www.gns3.com/.

[5] www.openvswitch.org. (n.d.). *Open vSwitch*. [online] Available at: https://www.openvswitch.org/.

[6] Wikipedia Contributors (2019). *Wireshark*. [online] Wikipedia. Available at: https://en.wikipedia.org/wiki/Wireshark.