

Florida International University
School of Computing and Information Sciences

Software Engineering Focus

Final Deliverable

AMPATH Network Services and User Interface Design Project

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Abstract

This document presents and explains the network monitoring services and user interface tools of the AMPATH project. This project's objective is to manage network topologies through the Kytos web UI. Through the UI of the application network operators can view statuses of circuits, create new circuits, modify existing circuits, and delete circuits.

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INTRODUCTION

Current System

The original Kytos MEF_Eline NApp was designed to allow network engineers to easily create and manage network connections. The NApp was experimental and had not been maintained causing its functionality to have some defects creating connections. Although many of the APIs that could be used to manage these network connections were already made, they had not been implemented in the UI.

Purpose of New System

For the new system, our product owner desired the following functionality:

- Fix the broken functionality to create network connections
- Notify the user of the network connection request
- Create a custom component to view all circuits
- Create functionality to better manage the network connections

USER STORIES

This section covers both the implemented and pending user stories.

Implemented User Stories

- **Story001:**
 - As an engineer I want to fork the project so the team can begin to collaborate.
- **Story002:**
 - As an engineer I want to Set up the environment so that new features can be implemented to the project.
- **Story003:**
 - As an engineer i want to set up the database so we can populate data into the application.
- **Story004:**
 - As an engineer I want to create a superuser on my local environment to familiarize myself with the application.
- **Story005:**
 - As an engineer I want to have a scrum board to track project progress.
- **Story006:**
 - As an engineer I want to watch tutorials to build and learn how to make a NApp to understand the project
- **Story007:**
 - Read documentation for Kytos SDN platform to understand current functionality of the project.
- **Story008:**
 - As an engineer I want to set up the dev environment to start collaborating on the Kytos project
- **Story009:**
 - As a network operator user, I want to create a Kytos E-Line Ethernet Virtual Circuit (EVC) using the Kytos Web User Interface (UI)
- **Story012:**
 - As a network operator user, I want the Kytos E-Line EVC UI to confirm the availability of the VLAN identifier (integer) before sending the request to the Kytos's backend
- **Story015:**
 - As a network operator user, I want the Kytos E-Line EVC UI to confirm the EVC was requested AND enabled
- **Story016:**
 - As a network operator user, I want to see any error on the requests I sent as well as returned errors from the controller so that I can have a clear view about the system status.
- **Story017:**

- As a network operator user, I want the Kytos E-Line EVC UI to show all current EVCs installed
- **User Story 22**
 - As a user, I want video recordings of the new functionality that has been added to the Kytos E Line NApp and its corresponding documentation.

Pending User Stories

There were some user stories that were incomplete by the end of this project.

- **Story010:**
 - As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing
- **Story011:**
 - As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint
- **Story013:**
 - As a network operator user, I want to create a Kytos E-Line EVC using the UI where I select the primary and optionally the backup paths OR
- **Story014:**
 - As a network operator user, I want to create a Kytos E-Line EVC using the UI where Kytos suggests a path (leveraging the Kytos Pathfinder application)
- **Story018:**
 - As a network operator user, I want to search EVCs by name, UNI, tag value, node, NNI, status (enabled, disabled, inactive, active) or all of them so that I can have a clear view about requested/provisioned EVCs.
- **Story019:**
 - As a network operator user, I want to use the Kytos E-Line EVC UI to disable one or more EVCs
- **Story020:**
 - As a network operator user, I want to use the Kytos E-Line EVC UI to disable one or more EVCs
- **Story021:**
 - As a network operator user, I want to use the Kytos E-Line EVC UI to edit any EVC's parameter

PROJECT PLAN

This section describes the planning that went into the realization of this project. This project incorporated the agile development techniques and as such required the sprints to be planned.

These sprint plannings are detailed in the section. This section also describes the components, both software and hardware, chosen for this project

Hardware and Software Resources

Hardware and software requirements were very liberal, and allowed developers liberty to use their preferred devices, IDEs, and/or editors. Minimum requirements are available in the table below.

Hardware (Minimum)	
CPU	1.6 GHz processor
Memory	1 GB of RAM
Platforms	Linux(16.10 or greater)
Additional Compatibility Requirements	Python 3.6 or higher

Table 1- List of hardware requirements

The following table describes the software used for development of this system.

Software	
Kytos	SDN platform, to create and deploy NApps
Mininet	Network emulator to create topologies
Pycharm/ Visual Studio Code	IDE used for development
Postman	Application to test REST API responses
Github	Repository for version control
Firefox/Chrome	Browser for testing

Table 2- List of software requirements

Sprints Plan

This section contains a summary of the work done for each sprint.

Sprint 1

During Sprint 1 we focused on setting up our local environment to pick back up where the previous summer semester senior students left off.

The product owner requested the following user stories to be completed this sprint. They are ordered by priority:

- **Story001:**
 - As an engineer I want to fork the project so the team can begin to collaborate.
- **Story002:**
 - As an engineer I want to Set up the environment so that new features can be implemented to the project.
- **Story003:**
 - As an engineer i want to set up the database so we can populate data into the application.
- **Story004:**
 - As an engineer I want to create a superuser on my local environment to familiarize myself with the application.
- **Story005:**
 - As an engineer I want to have a scrum board to track project progress.
- **Story006:**
 - As an engineer I want to watch tutorials to build and learn how to make a NApp to understand the project
- **Story007:**
 - Read documentation for Kytos SDN platform to understand current functionality of the project.
- **Story008:**
 - As an engineer I want to set up the dev environment to start collaborating on the Kytos project

Sprint 2

During Sprint 2 we focused on learning the Kytos application and begin development of new

The product owner requested the following user stories to be completed this sprint. They are ordered by priority:

- **Story009:**
 - As a network operator user, I want to create a Kytos E-Line Ethernet Virtual Circuit (EVC) using the Kytos Web User Interface (UI)
- **Story010:**
 - As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing
- **Story011:**
 - As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint

Sprint 3

During Sprint 3 we focused on continuing to learn the Kytos application and continued the development of new features

The product owner requested the following user stories to be completed this sprint. They are ordered by priority:

- **Story009:**
 - As a network operator user, I want to create a Kytos E-Line Ethernet Virtual Circuit (EVC) using the Kytos Web User Interface (UI)
- **Story010:**
 - As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing
- **Story011:**
 - As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint

Sprint 4

During Sprint 4 we collaborated with the kytos developers to help update documentation and developed new functionality

The product owner requested the following user stories to be completed this sprint. They are ordered by priority:

- **Story009:**
 - As a network operator user, I want to create a Kytos E-Line Ethernet Virtual Circuit (EVC) using the Kytos Web User Interface (UI)
- **Story010:**
 - As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing

- **Story011:**
 - As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint
- **Story012:**
 - As a network operator user, I want the Kytos E-Line EVC UI to confirm the availability of the VLAN identifier (integer) before sending the request to the Kytos's backend

Sprint 5

During Sprint 5 we focused on using the collection of given APIs to develop additional functionality of the Kytos UI

The product owner requested the following user stories to be completed this sprint. They are ordered by priority:

- **Story010:**
 - As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing
- **Story011:**
 - As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint
- **Story012:**
 - As a network operator user, I want the Kytos E-Line EVC UI to confirm the availability of the VLAN identifier (integer) before sending the request to the Kytos's backend

Sprint 6

During Sprint 6 we focused on continuing to learn the Kytos application and continued the development of new features

The product owner requested the following user stories to be completed this sprint. They are ordered by priority:

- **Story010:**
 - As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing
- **Story011:**

- As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint
- **Story017:**
 - As a network operator user, I want the Kytos E-Line EVC UI to show all current EVCs installed

Sprint 7

During Sprint 7 we focused on continuing to learn the Kytos application and continued the development of new features

The product owner requested the following user stories to be completed this sprint. They are ordered by priority:

- **Story010:**
 - As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing
- **Story011:**
 - As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint
- **Story015:**
 - As a network operator user, I want the Kytos E-Line EVC UI to confirm the EVC was requested AND enabled
- **Story016:**
 - As a network operator user, I want to see any error on the requests I sent as well as returned errors from the controller so that I can have a clear view about the system status.
 -

Sprint 8

During Sprint 8 we finalized all documentations and presentations and created demonstrational and informational videos on the final project

The product owner requested the following user stories to be completed this sprint. They are ordered by priority:

- **User Story 22**

- As a user, I want video recordings of the new functionality that has been added to the Kytos E Line NApp and its corresponding documentation.

SYSTEM DESIGN

This section goes over the design of the system.

Architectural Patterns

Kytos of_core uses a Client Server architecture. The client being the web UI, or anything else that may access the system using the REST API. The server is the of_core module hosted by Kytos. This can be pictured in figure 2.

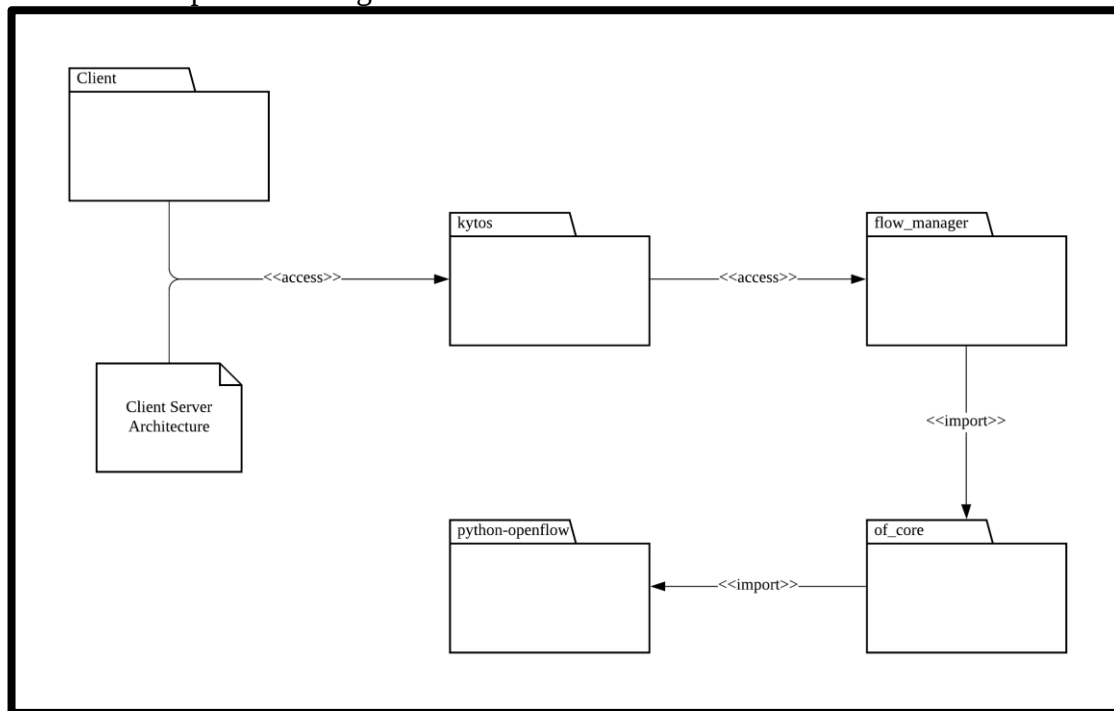


Figure 1- Client Server Architecture of Kytos

System and Subsystem Decomposition

The two major subsystems of the system are Kytos of_core, which is the core logic, and the Web UI, which provides an interface for regular users to interact with the business logic.

Deployment Diagram

The system is deployed as a client web UI, with Kytos being hosted on a server that has all of the Kytos NApps, including Kytos of_core. This can be seen in figure 3.

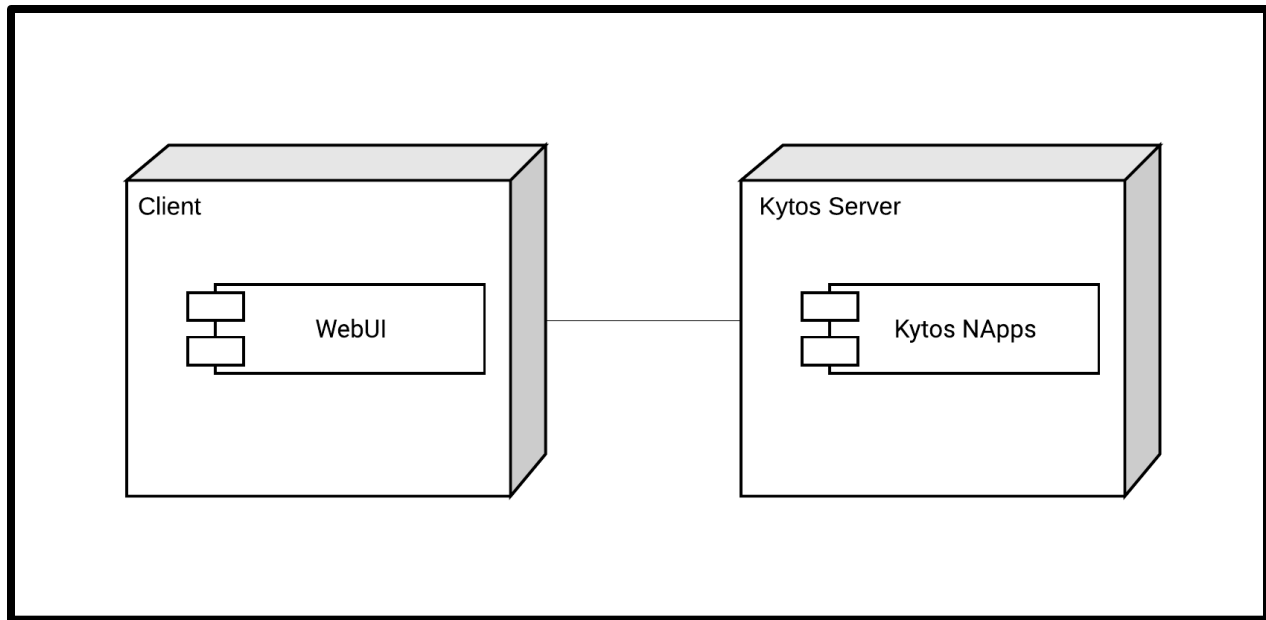


Figure 2- Deployment Diagram of Kytos

Design Patterns

For our system we applied the strategy, facade, and singleton patterns. The main class implements the singleton and facade patterns. As a facade, it exposes the functionality of the system as REST Endpoints, and provides event listeners for Kytos. It is a singleton, because it hosts the logic of the system. The filter class implements the strategy pattern. At run time the algorithm used by the filter is defined. Strategy is used by the Filter class, where we can define a filter function at runtime. Facade is used by the Main class. It exposes the functionality of the system as a set of REST endpoints.

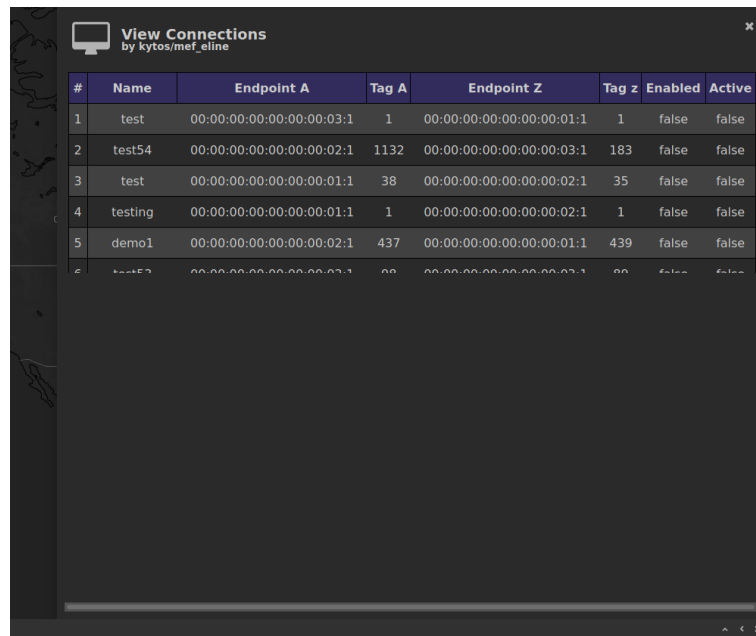
SYSTEM VALIDATION

In this section, the below test cases used for testing the newly added functionality.

Display all Connection Table

This section presents the test cases done for validating that all the connections will display on the Kytos E Line web UI.

- Purpose
 - To test that all connections are listed correctly
- Requirements
 - Kytos development environment is activated
 - There exists at least 1 connection
 - Postman application is open
- Input
 - On Postman we will be requesting a get request to endpoint `http://0.0.0.0:8181/api/kytos/mef_eline/v2/evc` which will return a list of connections
 - On the Kytos E Line UI click on the “List installed EVC” button
- Expected Output
 - A table will display on the web UI listing the following information for each connection
 - Connection Name
 - UNIs as EndPointA/EndpointZ
 - Tag values for EndpointA and EndpointZ
 - Boolean displaying when a connection is enabled
 - Boolean displaying when a connection is Active
- Status
 - Pass



#	Name	Endpoint A	Tag A	Endpoint Z	Tag z	Enabled	Active
1	test	00:00:00:00:00:00:03:1	1	00:00:00:00:00:00:01:1	1	false	false
2	test54	00:00:00:00:00:00:02:1	1132	00:00:00:00:00:00:03:1	183	false	false
3	test	00:00:00:00:00:00:01:1	38	00:00:00:00:00:00:02:1	35	false	false
4	testing	00:00:00:00:00:00:01:1	1	00:00:00:00:00:00:02:1	1	false	false
5	demo1	00:00:00:00:00:00:02:1	437	00:00:00:00:00:00:01:1	439	false	false

Figure 3- Connection Table Test Case

Create Connection Test Case

This section presents the test cases done for validating when a connection is successfully created through the Kytos E Line web UI.

- Purpose
 - To test that connections are successfully created
- Setup
 - Kytos development environment is activated
 - Mininet topology is running
 - The Kytos E line NApp is open
- Input
 - All required fields are input and unique tag values are input for each endpoint
 - Circuit Name
 - First Endpoint
 - Last Endpoint
 - Tag Type (1)
 - Tag Value (unique)
- Expected Output
 - A notification at the bottom of the page should display stating that the connection was successfully created with its corresponding connection ID
- Status
 - Pass

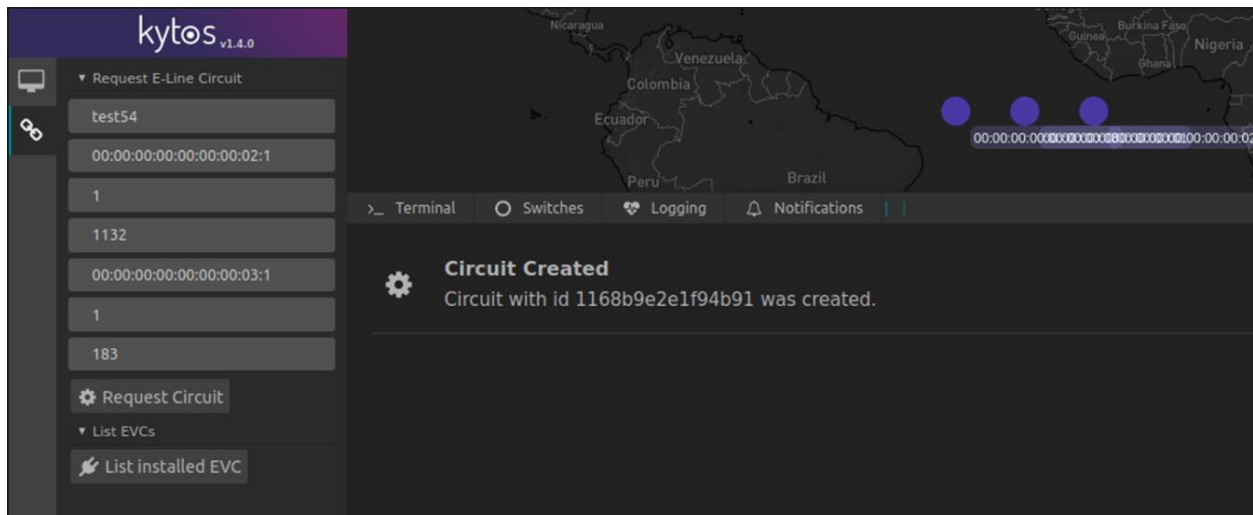


Figure 4- Create Connection Test Case

Check Availability of Endpoint Before Creating Connection

This section presents the negative test cases done for validating when attempting to create a connection with a tag that is already in use by a UNI

- Purpose
 - To test notification displaying when a UNI and its tag are already in use
- Setup
 - Kytos development environment is activated
 - Mininet topology is running
 - The Kytos E line NApp is open
- Input
 - All required fields are input and existing tag values are input for its respective endpoint
 - Circuit Name
 - First Endpoint
 - Last Endpoint
 - Tag Type (1)
 - Tag Value (Tag value that is already being used for First Endpoint/ Last First Endpoint)
- Expected Output
 - A notification at the bottom of the page should display stating the endpoint is in use and its corresponding tag value
- Status
 - Pass

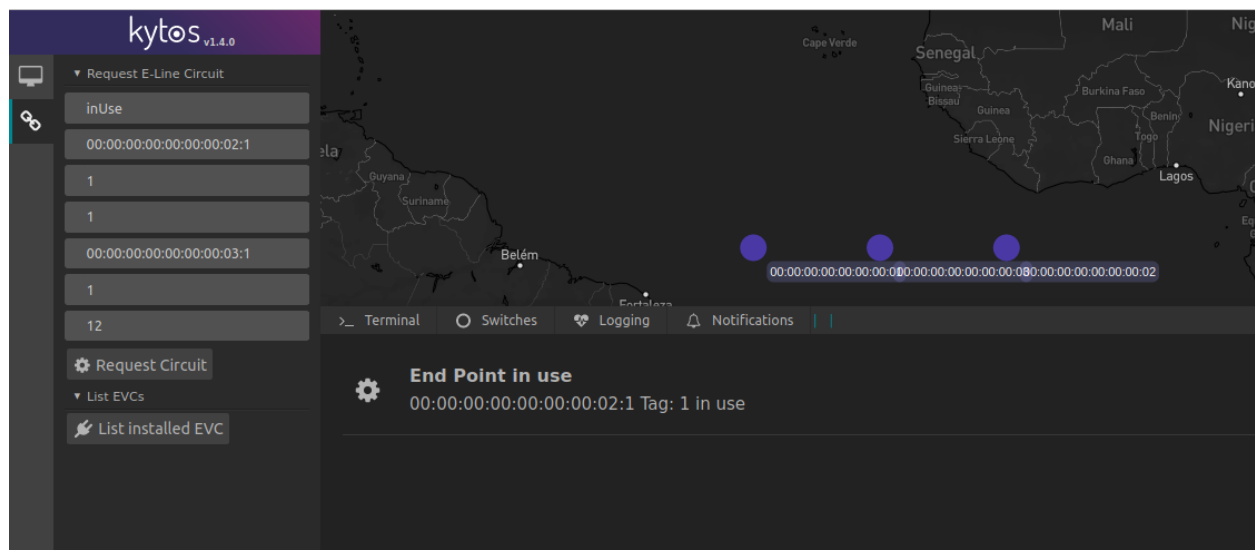


Figure 5- Unavailable UNI tag Test Case

Display Error Messages Encountered While Trying to Create connection

This section presents the negative test cases done for validating when attempting to create a connection with an invalid input

- Purpose
 - To test notification are displaying when a connection was not created after requesting its activation
- Setup
 - Kytos development environment is activated
 - Mininet topology is running
 - The Kytos E line NApp is open
- Input
 - Some required fields are input incorrectly
 - Circuit Name
 - First Endpoint (incorrect)
 - Last Endpoint (incorrect)
 - Tag Type (value other than 1/ non-numeric value)
 - Tag Value (Non-numeric value)
- Expected Output
 - A notification at the bottom of the page should display stating the error caused by the invalid input
- Status
 - Pass

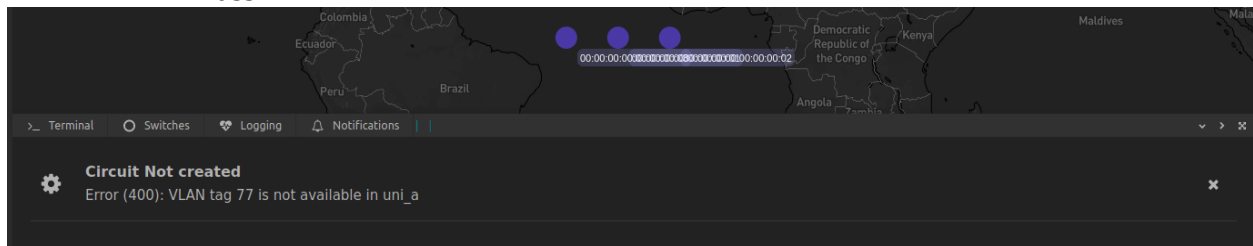




Figure 6,7, and 8- Display errors on invalid connection input Test Case

GLOSSARY

The following are terms used throughout the final project documentation.

Kytos A software designed network controller that uses OpenFlow protocols

Network Multiple devices that communicate with one another usually through communication protocols

Software Defined Network (SDN) an approach to network management that enables dynamic, programmatically efficient network configuration in order to improve network performance and monitoring

Network Application (NApp) Optional components for Kytos, which are used to extend functionality for Kytos

OpenFlow Communication protocol for accessing and modifying the forwarding plane of a switch or router

Metro-Ethernet Forum (MEF) is an industry forum leading the development of a global federation of network, cloud, and technology providers

Ethernet virtual connection (EVC) an association between two or more user network interfaces that identifies a point-to-point or multipoint-to-multipoint path within the service provider network

Endpoint a remote computing device that communicates back and forth with a network to which it is connected

User–Network Interface (UNI) is a demarcation point between the responsibility of the service provider and the responsibility of the subscriber.

APPENDIX

Appendix A - UML Diagrams

This section contains the UML diagrams generated for this system.

Sequence Diagram

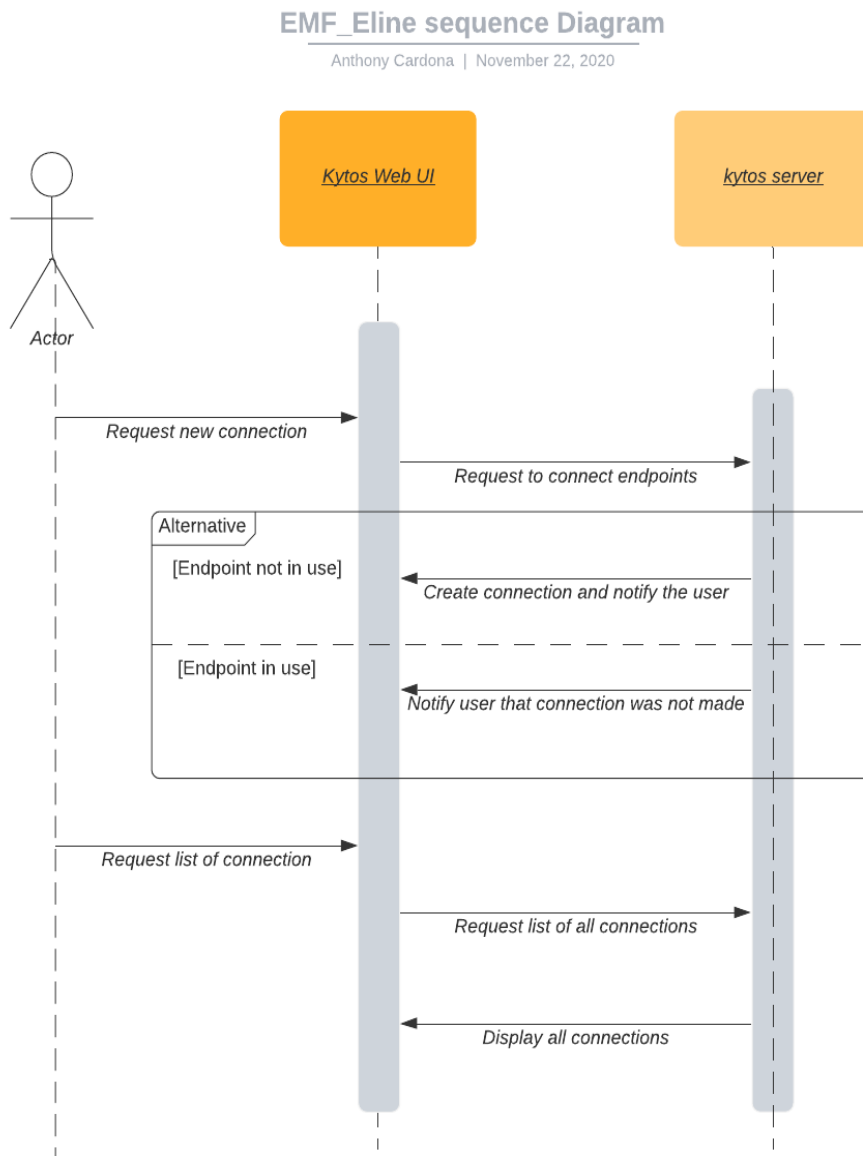
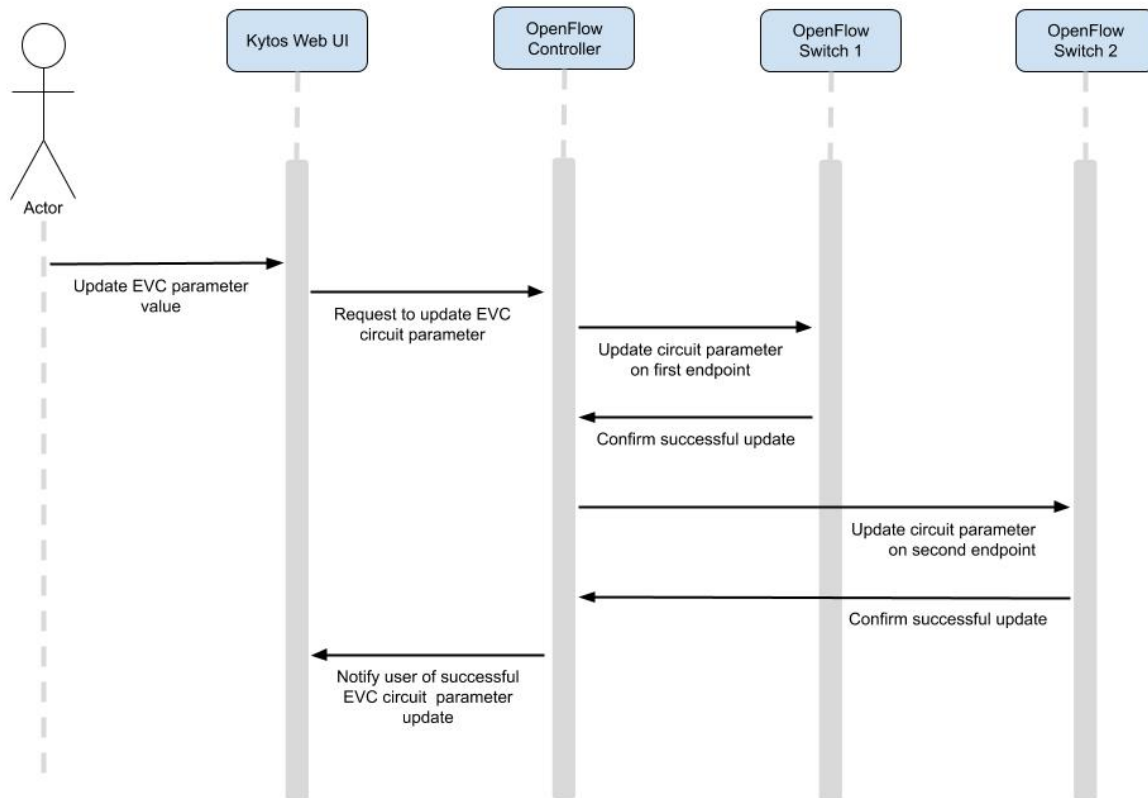


Figure 9A - Kytos UI sequence Diagram by Anthony Cardona

EMF Eline - EVC Circuit Parameter Update Sequence Diagram

Ignacio Guzman | December 12, 2020

*Figure 9B - Kytos UI Diagram by Ignacio Guzman*

Use Case Diagram

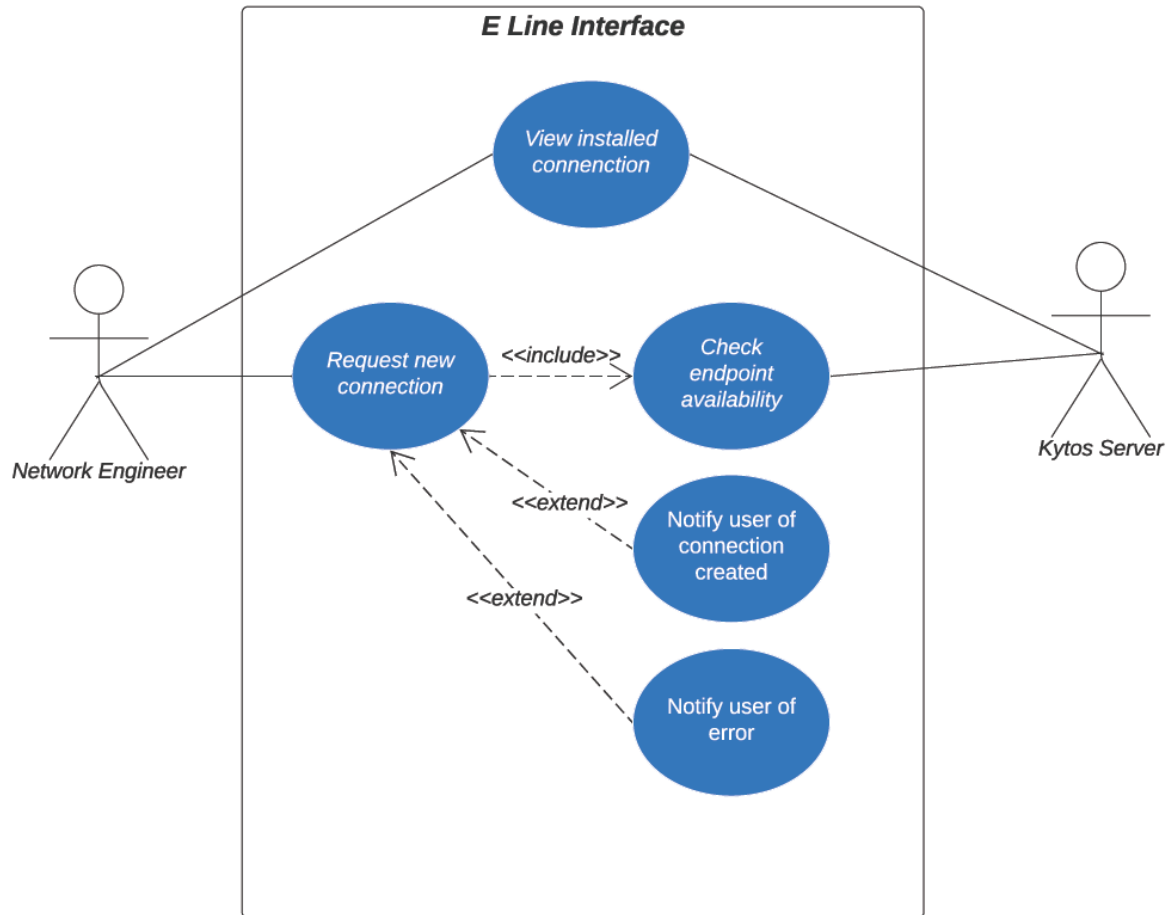


Figure 9C - E Line Use Case diagram by Anthony Cardona

Class Diagram

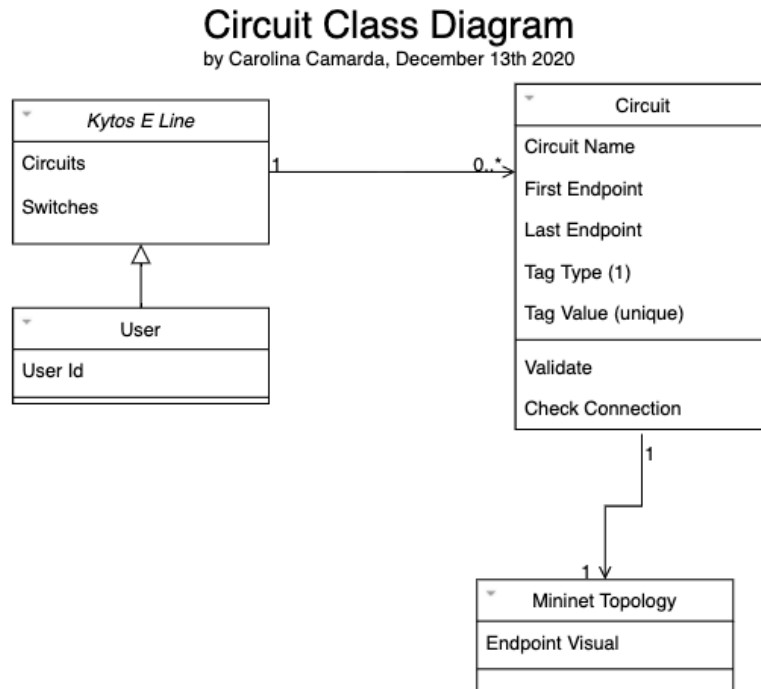


Figure 9D – Class diagram by Carolina Camarda

Appendix B - User Interface Design

This section contains reference images for the user interface.

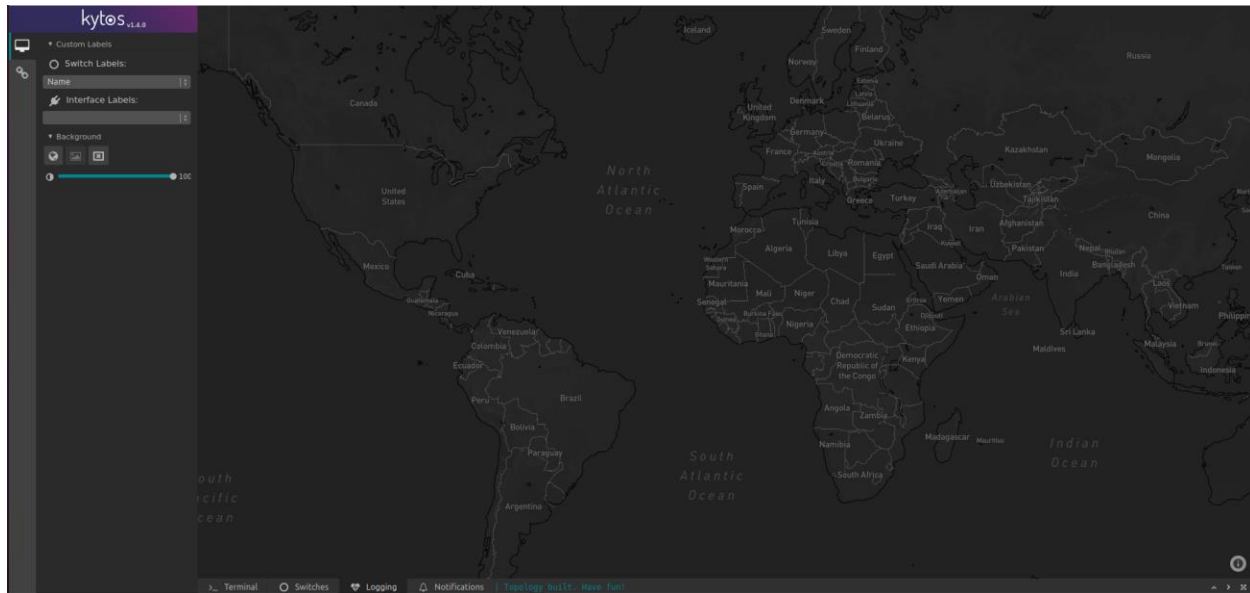


Figure 10 - User Interface for the Kytos Web UI without topology

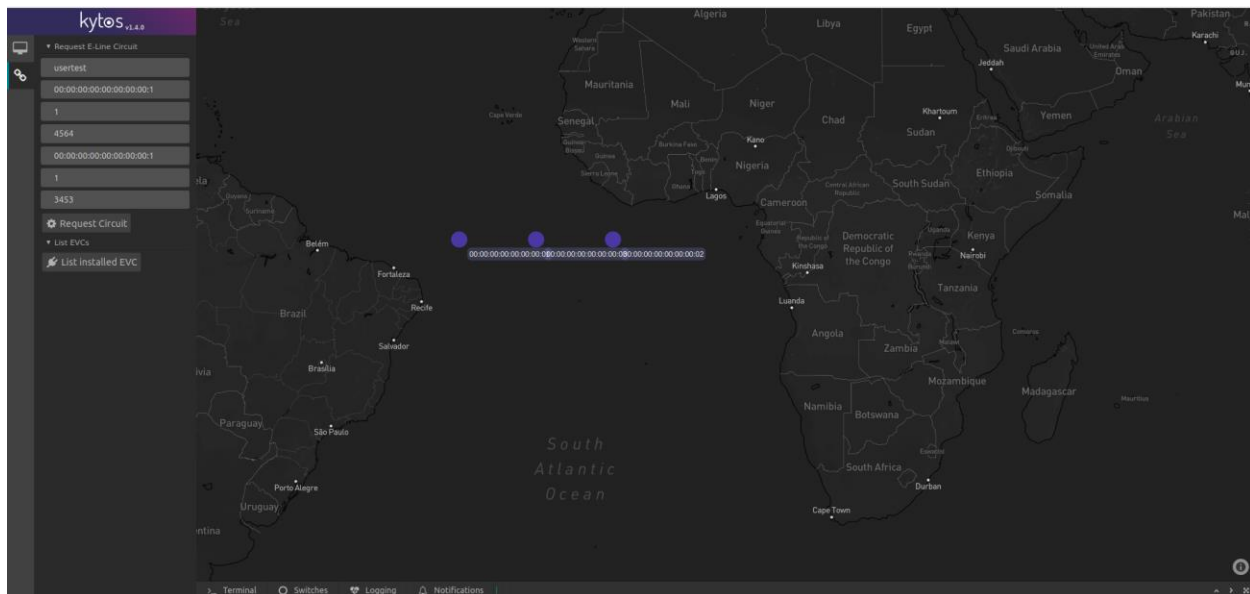


Figure 11- User Interface for the Kytos Web UI with topology

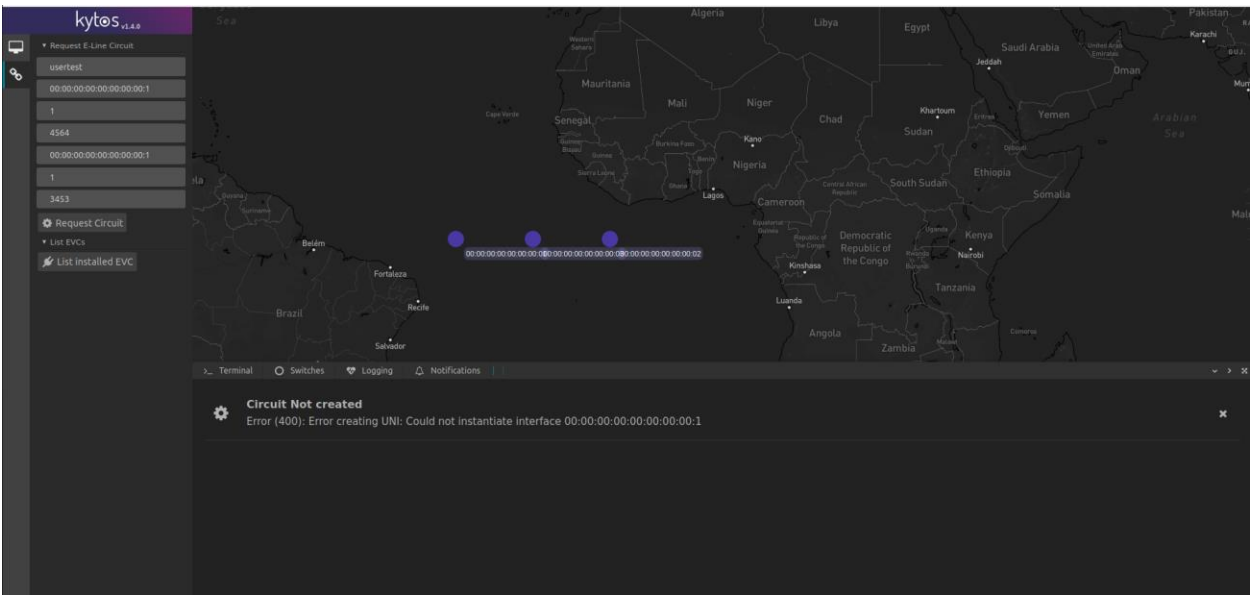


Figure 12- Kytos Web UI with Notification

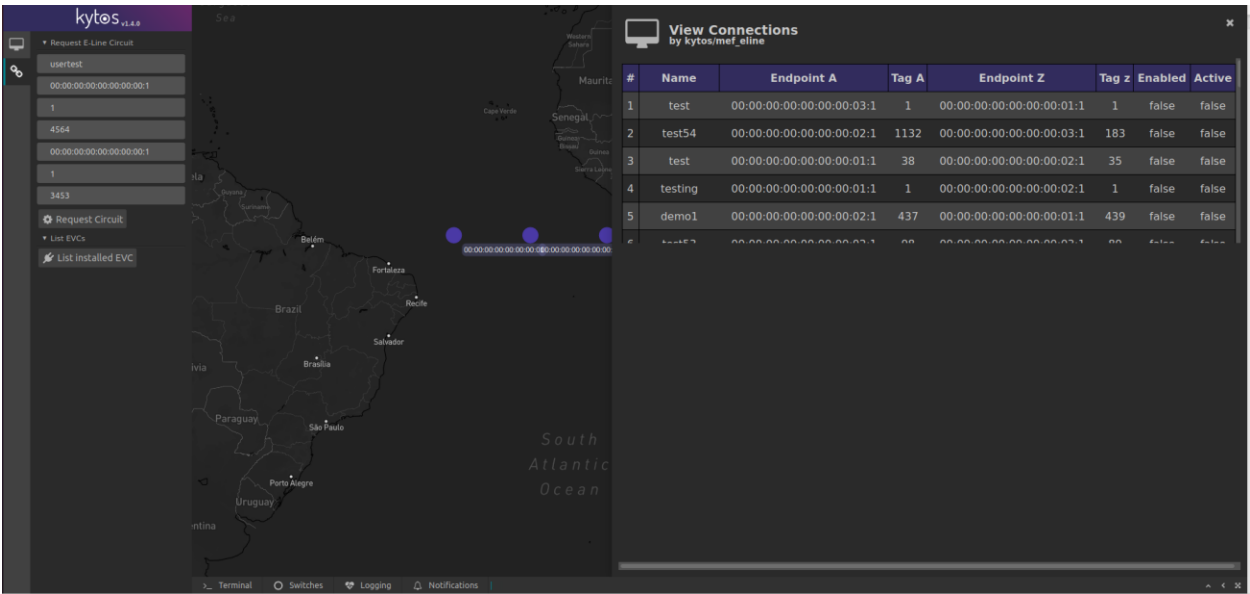


Figure 13- Kytos web UI with connection table

Appendix C Sprint Review Reports

This section contains the sprints reviews and retrospectives.

Sprint 1

Review Meeting Minutes:

Attendees: Anthony Cardona; Carolina Camarda; Ignacio Guzman

Start time: 9:20 pm

End time: 10:00 pm

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners: All.

- **Story001:** As an engineer I want to fork the project so the team can begin to collaborate.
- **Story002:** As an engineer I want to Set up the environment so that new features can be implemented to the project.
- **Story003:** As an engineer i want to set up the database so we can populate data into the application.
- **Story004:** As an engineer I want to create a superuser on my local environment to familiarize myself with the application.
- **Story005:** As an engineer I want to have a scrum board to track project progress.
- **Story006:** As an engineer I want to watch tutorials to build and learn how to make a NApp to understand the project
- **Story007:** Read documentation for Kytos SDN platform to understand current functionality of the project.
- **Story008:** As an engineer I want to set up the dev environment to start collaborating on the Kytos project

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Sprint Planning meeting.

Note: Our team began to work on a new application as there were no new features that the POs wanted to add to the existing application. New stories were added halfway through the sprint so they are now added to our backlog

- **Story009:** As a network operator user, I want to create a Kytos E-Line Ethernet Virtual Circuit (EVC) using the Kytos Web User Interface (UI)
- **Story010:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing

- **Story011:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint
- **Story012:** As a network operator user, I want the Kytos E-Line EVC UI to confirm the availability of the VLAN identifier (integer) before sending the request to the Kytos's backend
- **Story013:** As a network operator user, I want to create a Kytos E-Line EVC using the UI where I select the primary and optionally the backup paths OR
- **Story014:** As a network operator user, I want to create a Kytos E-Line EVC using the UI where Kytos suggests a path (leveraging the Kytos Pathfinder application)
- **Story015:** As a network operator user, I want the Kytos E-Line EVC UI to confirm the EVC was requested AND enabled
- **Story016:** As a network operator user, I want to see any error on the requests I sent as well as returned errors from the controller so that I can have a clear view about the system status.
- **Story017:** As a network operator user, I want the Kytos E-Line EVC UI to show all current EVCs installed
- **Story018:** As a network operator user, I want to search EVCs by name, UNI, tag value, node, NNI, status (enabled, disabled, inactive, active) or all of them so that I can have a clear view about requested/provisioned EVCs.
- **Story019:** As a network operator user, I want to use the Kytos E-Line EVC UI to disable one or more EVCs
- **Story020:** As a network operator user, I want to use the Kytos E-Line EVC UI to disable one or more EVCs
- **Story021:** As a network operator user, I want to use the Kytos E-Line EVC UI to edit any EVC's parameter

Retrospective Meeting Minutes:

Attendees: Anthony Cardona; Carolina Camarda; Ignacio Guzman

Start time: 10:00 pm

End time: 10:20 pm

What went wrong?

- Did we do a good job estimating our team's velocity?
 - No. Our POs changed the project and introduced a new development platform halfway through the sprint. We are currently working on learning how to use the new environment and learning how to create network applications.
- Did we do a good job estimating the points (time required) for each user story?

- Yes, the team did a good job on separating the points each day of the sprint and completed the initial set up and tutorial user stories.
- Did each team member work as scheduled?
 - Yes, each team member worked 2 hours per day and collaborated with other team members for a minimum of 30 minutes a day each day.

What went right?

- Meeting Minutes were completed accordingly and initial set up and tutorial user points were completed as well.

How to address the issues in the next sprint?

- How to improve the process?
 - We have to communicate more with POs and focus on asking the right questions.
- How to improve the product?
 - Familiarize ourselves with the new product, development platform and its features.

Sprint 2

Review Meeting Minutes:

Attendees: Anthony Cardona; Carolina Camarda; Ignacio Guzman

Start time: 12:00pm

End time: 12:30pm

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners:

- **None:** The team is still learning the framework for the application which limited development. New documentation and resources were provided which should help improve the development of new features

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Sprint Planning meeting.

- **Story009:** As a network operator user, I want to create a Kytos E-Line Ethernet Virtual Circuit (EVC) using the Kytos Web User Interface (UI)
- **Story010:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing
- **Story011:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint

- **Story012:** As a network operator user, I want the Kytos E-Line EVC UI to confirm the availability of the VLAN identifier (integer) before sending the request to the Kytos's backend
 - How this should be reflected on the user story definition in Mingle:
 - The stories will be moved over to Sprint 3 as they have not been 100% completed yet. Progress will continue to be shared with POs.

Retrospective Meeting Minutes:

Attendees: Anthony Cardona; Carolina Camarda; Ignacio Guzman

Start time: 12:45pm

End time: 1:00pm

What went wrong?

- Did we do a good job estimating our team's velocity?
 - No, the team is still learning the new application and over estimated the capacity that could be completed per sprint
- Did we do a good job estimating the points (time required) for each user story?
 - No, the team is still learning the framework for the project which limited development. New documentation and resources were provided which should improve development of stories
- Did each team member work as scheduled?
 - Yes

What went right?

- Communicated between team members and with POs as well.
- Smooth progress.

How to address the issues in the next sprint?

- How to improve the process?
 - Continue to communicate.
- How to improve the product?
 - Keep getting more comfortable with Kytos platform.

Sprint 3

Review Meeting Minutes:

Attendees: Anthony Cardona; Carolina Camarda; Ignacio Guzman

Start time: 12:15pm

12-13-2020

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End time: 12:45pm

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners:

- **None:** The team is still learning the framework for the application which limited development. New documentation and resources were provided which should help improve the development of new features

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Sprint Planning meeting.

- **Story009:** As a network operator user, I want to create a Kytos E-Line Ethernet Virtual Circuit (EVC) using the Kytos Web User Interface (UI)
- **Story010:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing
- **Story011:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint
- **Story012:** As a network operator user, I want the Kytos E-Line EVC UI to confirm the availability of the VLAN identifier (integer) before sending the request to the Kytos's backend
 - How this should be reflected on the user story definition in Mingle:
 - The stories will be moved over to Sprint 4 as they have not been 100% completed yet. Progress will continue to be shared with POs daily.

Retrospective Meeting Minutes:

Attendees: Anthony Cardona; Carolina Camarda; Ignacio Guzman

Start time: 12:45pm

End time: 1:00pm

What went wrong?

- Did we do a good job estimating our team's velocity?
 - No, the complexity of the new application was underestimated and the
- Did we do a good job estimating the points (time required) for each user story?
 - No, the team is still learning the application and the complexity of the new framework and its dependencies is becoming more apparent with further development
- Did each team member work as scheduled?
 - Yes

What went right?

- Communication with the PO which provided us with more documentation and resources to help our progress

How to address the issues in the next sprint?

- How to improve the process?
 - Communicate more with senior developers to aid in the development of these new features
- How to improve the product?
 - Document any new developments
 - Understand and learning the inner workings of the new application

Sprint 4

Review Meeting Minutes:

Attendees: Anthony Cardona; Carolina Camarda; Ignacio Guzman

Start time: 12:15pm

End time: 12:45pm

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners: All.

- **Story009:** As a network operator user, I want to create a Kytos E-Line Ethernet Virtual Circuit (EVC) using the Kytos Web User Interface (UI)

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Sprint Planning meeting.

- **Story010:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing
- **Story011:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint
- **Story012:** As a network operator user, I want the Kytos E-Line EVC UI to confirm the availability of the VLAN identifier (integer) before sending the request to the Kytos's backend
 - How this should be reflected on the user story definition in Mingle:
 - The stories will be moved over to Sprint 4 as they have not been 100% completed yet. Progress will continue to be shared with POs daily.

Retrospective Meeting Minutes:

Attendees: Anthony Cardona; Carolina Camarda; Ignacio Guzman

12-13-2020

Start time: 12:45pm

End time: 1:00pm

What went wrong?

- Did we do a good job estimating our team's velocity?
 - No, we are still learning the application and some stories are being backlogged
- Did we do a good job estimating the points (time required) for each user story?
 - No, the team is still learning the application and the complexity of the new framework and its dependencies is becoming more apparent with further development
- Did each team member work as scheduled?
 - Yes

What went right?

- Communication with the PO which provided us with more documentation and resources to help our progress

How to address the issues in the next sprint?

- How to improve the process?
 - Give feedback for outdated documentation
 - Communicate more with senior developers to aid in the development of these new features
- How to improve the product?
 - Document any new developments
 - Understand and learning the inner workings of the new application

Sprint 5

Review Meeting Minutes:

Attendees: Anthony Cardona; Carolina Camarda; Ignacio Guzman

Start time: 12:15pm

End time: 12:45pm

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners:

- **Story012:** As a network operator user, I want the Kytos E-Line EVC UI to confirm the availability of the VLAN identifier (integer) before sending the request to the Kytos's backend

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Sprint Planning meeting.

- **Story010:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing
- **Story011:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint
 - How this should be reflected on the user story definition in Mingle:
 - The stories will be moved over to Sprint 4 as they have not been 100% completed yet. Progress will continue to be shared with POs daily.

Retrospective Meeting Minutes:

Attendees: Anthony Cardona; Carolina Camarda; Ignacio Guzman

Start time: 12:45pm

End time: 1:00pm

What went wrong?

- Did we do a good job estimating our team's velocity?
 - No, we are still learning the application and some stories are being backlogged
- Did we do a good job estimating the points (time required) for each user story?
 - No, the team is still learning the application and the complexity of the new framework and its dependencies is becoming more apparent with further development
- Did each team member work as scheduled?
 - Yes

What went right?

- Communication with the PO which provided us with more documentation and resources to help our progress

How to address the issues in the next sprint?

- How to improve the process?
 - Give feedback for outdated documentation
 - Communicate more with senior developers to aid in the development of these new features
- How to improve the product?
 - Document any new developments
 - Understand and learning the inner workings of the new application

Sprint 6

Review Meeting Minutes:

12-13-2020

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Attendees: Anthony Cardona; Carolina Camarda; Ignacio Guzman

Start time: 12:15pm

End time: 12:45pm

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners:

- **Story015:** As a network operator user, I want the Kytos E-Line EVC UI to confirm the EVC was requested AND enabled
- **Story016:** As a network operator user, I want to see any error on the requests I sent as well as returned errors from the controller so that I can have a clear view about the system status.
- **Story017:** As a network operator user, I want the Kytos E-Line EVC UI to show all current EVCs installed

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Sprint Planning meeting.

- **Story010:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing
- **Story011:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint
 - How this should be reflected on the user story definition in Mingle:
 - The stories will be moved over to Sprint 7 as they have not been 100% completed yet. Progress will continue to be shared with POs daily. Story points must be finished by the end of this Sprint in order to have a complete final presentation.

Retrospective Meeting Minutes:

Attendees: Anthony Cardona, Carolina Camarda, Ignacio Guzman

Start time: 12:45 pm

End time: 1:00 pm

What went wrong?

- Did we do a good job estimating our team's velocity?
 - No, we are still learning the application and some stories are being backlogged
- Did we do a good job estimating the points (time required) for each user story?
 - No, the team is still learning the application and the complexity of the new framework and its dependencies is becoming more apparent with further development
- Did each team member work as scheduled?
 - Yes, everyone completed their daily minimum 2 hour workload

What went right?

- Communication with the PO which provided us with more documentation and resources to help our progress

How to address the issues in the next sprint?

- How to improve the process?
 - Give more feedback for any development problems we run into.
 - Give feedback on outdated documentation.
 - Work more with senior developers to aid development of new features.
- How to improve the product?
 - Keep documenting new developments and communicating with the team.
 - Understand and learn the inner workings of the new application.

Sprint 7

Review Meeting Minutes:

Attendees: Anthony Cardona; Carolina Camarda; Ignacio Guzman

Start time: 12:15pm

End time: 12:45pm

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners:

- **Story015:** As a network operator user, I want the Kytos E-Line EVC UI to confirm the EVC was requested AND enabled
- **Story016:** As a network operator user, I want to see any error on the requests I sent as well as returned errors from the controller so that I can have a clear view about the system status.
- **Story017:** As a network operator user, I want the Kytos E-Line EVC UI to confirm the availability of the VLAN identifier (integer) before sending the request to the Kytos's backend

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Sprint Planning meeting.

- **Story010:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing
- **Story011:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint

Retrospective Meeting Minutes:

Attendees: Anthony Cardona, Carolina Camarda, Ignacio Guzman

Start time: 12:45 pm

End time: 1:00 pm

What went wrong?

- Did we do a good job estimating our team's velocity?
 - No, we are still learning the application and some stories are being backlogged
- Did we do a good job estimating the points (time required) for each user story?
 - No, the team is still learning the application and the complexity of the new framework and its dependencies is becoming more apparent with further development
- Did each team member work as scheduled?
 - Yes, everyone completed their daily minimum 2 hour workload

What went right?

- Communication with the PO and mentors, was able to bring in more user stories from the backlog to develop than originally planned.

How to address the issues in the next sprint?

- How to improve the process?
 - Give more feedback for any development problems we run into.
 - Work more with senior developers to aid development of new features.
- How to improve the product?
 - Keep documenting new developments and communicating with the team.
 - Understand and learn the inner workings of the new application.

Sprint 8**Sprint Review Meeting Minutes**

Attendees: Anthony Cardona; Carolina Camarda; Ignacio Guzman

Start time: 12:30pm

End time: 12:45pm

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners: All.

- **User Story 22:** As a user, I want video recordings of the new functionality that has been added to the Kytos E Line NApp and its corresponding documentation.

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Spring Planning meeting.

- **Story020:** As a network operator user, I want to use the Kytos E-Line EVC UI to disable one or more EVCs
- **Story011:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the User Network Interfaces (UNI) by using a dropdown menu after selecting the EVC's endpoint
- **Story010:** As a network operator user, I want to create a Kytos E-Line EVC by selecting the EVC endpoints (nodes or switches) by clicking in the Kytos topology drawing
 - How this should be reflected on the user story definition in Mingle:

Sprint Retrospective Meeting Minutes

Attendees: Anthony Cardona, Carolina Camarda, Ignacio Guzman

Start time: 12:45 pm

End time: 1:00 pm

What went wrong?

- Did we do a good job estimating our team's velocity?
 - Yes, documentation was finalized and completed
- Did we do a good job estimating the points (time required) for each user story?
 - Yes, all work was completed
- Did each team member work as scheduled?
 - Yes

What went right?

- Communication with the PO and mentors, allowed us to document the application

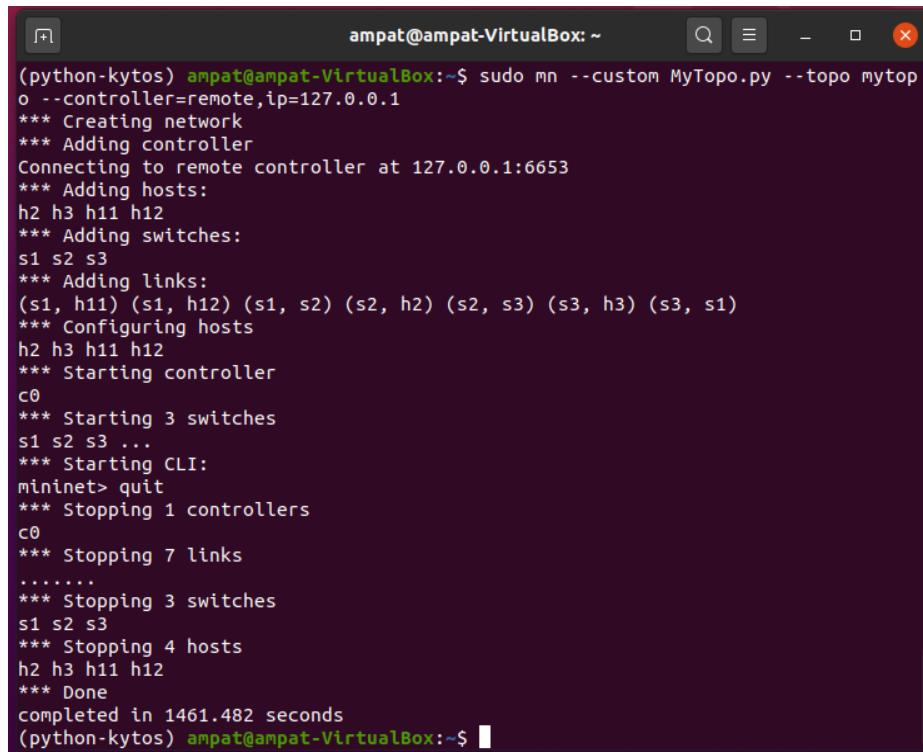
Appendix D - User Manual, Installation Guide, and Wishlist

User Manual

This section contains all the necessary steps in create a connection and displaying all connections through the Kytos Web UI

Create a connection

Step 1: Create a topology through Mininet

A terminal window titled 'ampat@ampat-VirtualBox: ~' with standard window controls. It shows the execution of a Mininet command to create a network topology. The output includes steps for creating the network, adding a controller, hosts, and switches, configuring links, and starting/stopping components. The process completes in 1461.482 seconds.

```
(python-kytos) ampat@ampat-VirtualBox:~$ sudo mn --custom MyTopo.py --topo mytop
o --controller=remote,ip=127.0.0.1
*** Creating network
*** Adding controller
Connecting to remote controller at 127.0.0.1:6653
*** Adding hosts:
h2 h3 h11 h12
*** Adding switches:
s1 s2 s3
*** Adding links:
(s1, h11) (s1, h12) (s1, s2) (s2, h2) (s2, s3) (s3, h3) (s3, s1)
*** Configuring hosts
h2 h3 h11 h12
*** Starting controller
c0
*** Starting 3 switches
s1 s2 s3 ...
*** Starting CLI:
mininet> quit
*** Stopping 1 controllers
c0
*** Stopping 7 links
.....
*** Stopping 3 switches
s1 s2 s3
*** Stopping 4 hosts
h2 h3 h11 h12
*** Done
completed in 1461.482 seconds
(python-kytos) ampat@ampat-VirtualBox:~$
```

Figure 14- Mininet command that launches script MyTopo.py to create topology

Step 2: Start Kytos in the foreground.

[illegible]

Figure 15 and 16 - Kytos command to start in foreground

Step 3: Open the Kytos Web UI and navigate to the E Line NApp on the left toolbar.

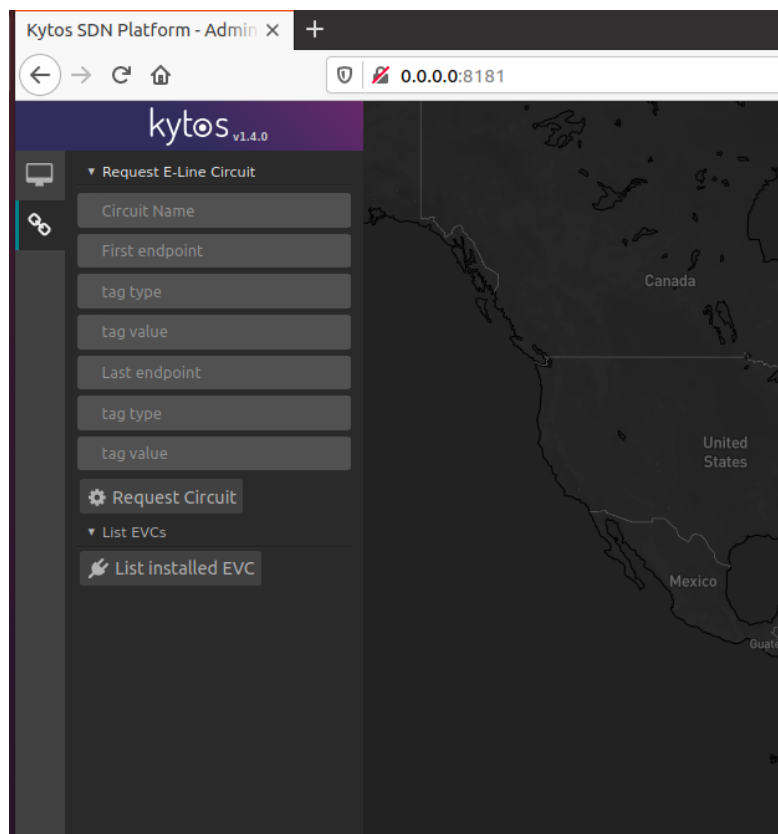


Figure 17- Kytos Web UI with E Line open on the tool bar

Step 4: Enter all fields input for all fields with valid endpoints from Mininet topology

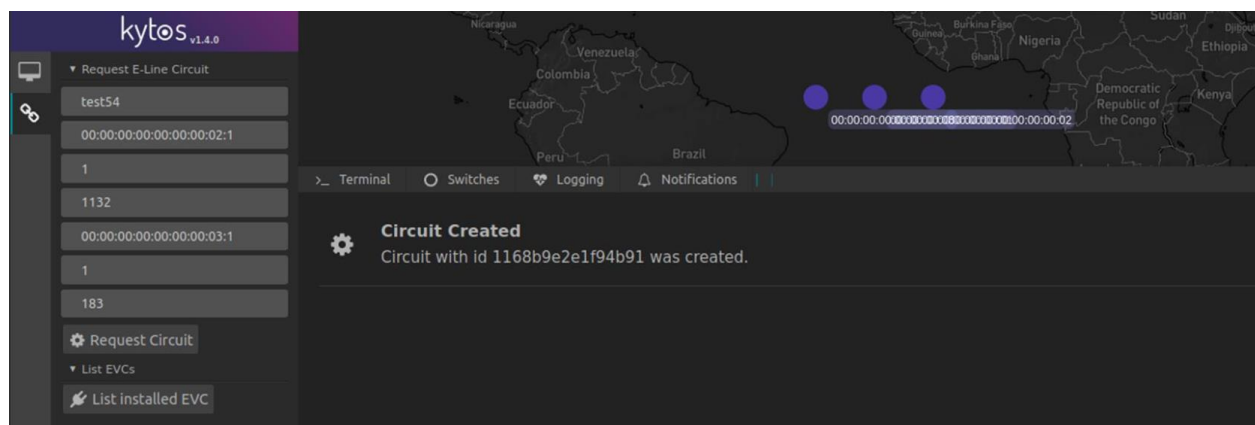


Figure 18- Notification when connection has been input

Displaying table of all connections

Step 1: Start Kytos in the foreground.

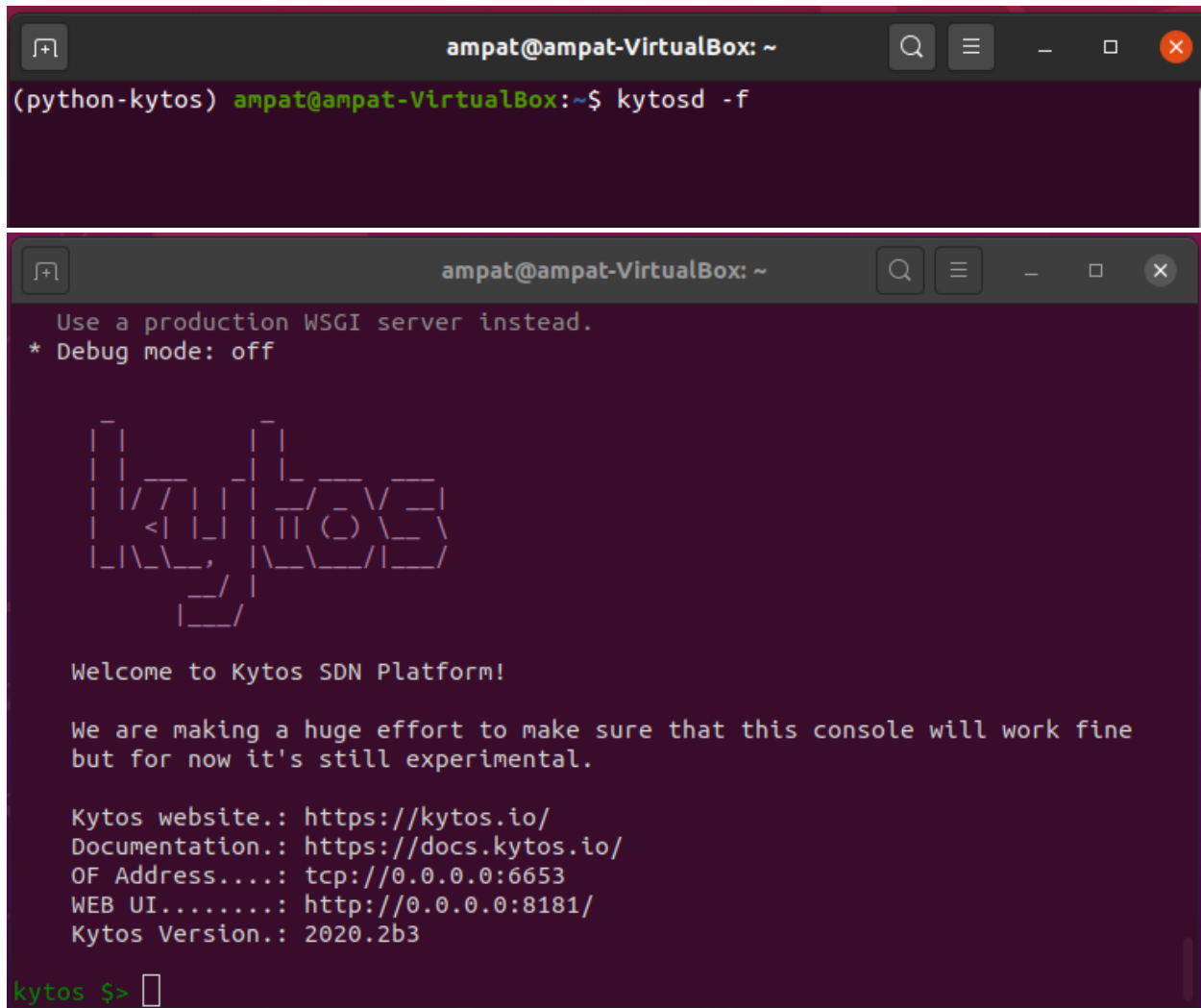


Figure19 and 20- Kytos command to start in foreground

Step 2: Open the Kytos Web UI and navigate to the E Line NApp on the left toolbar.

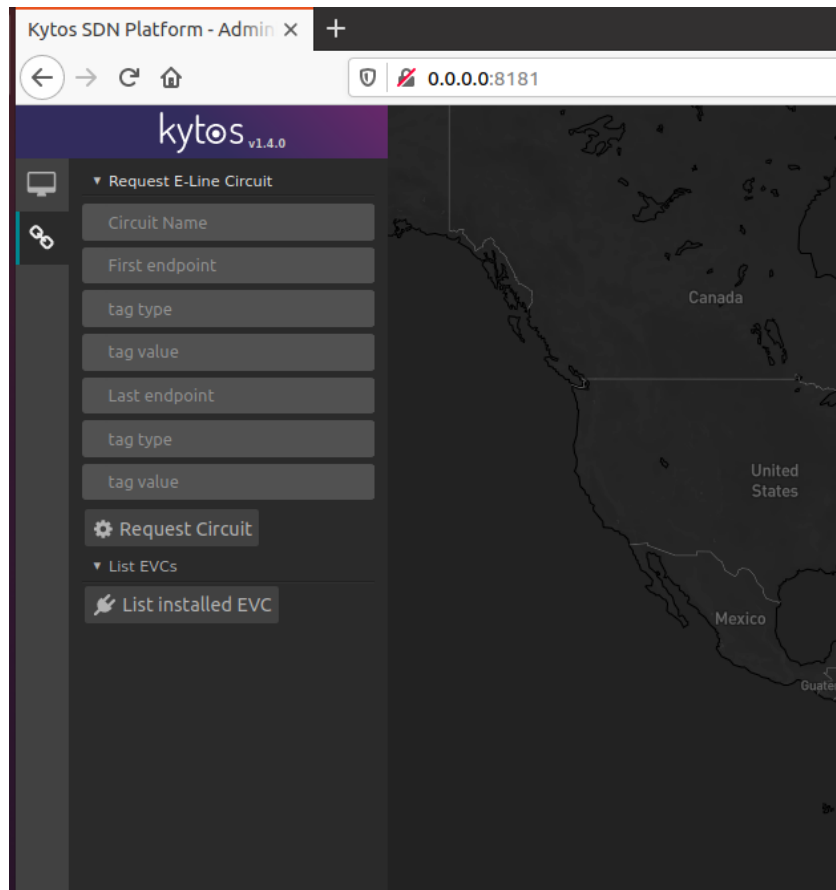
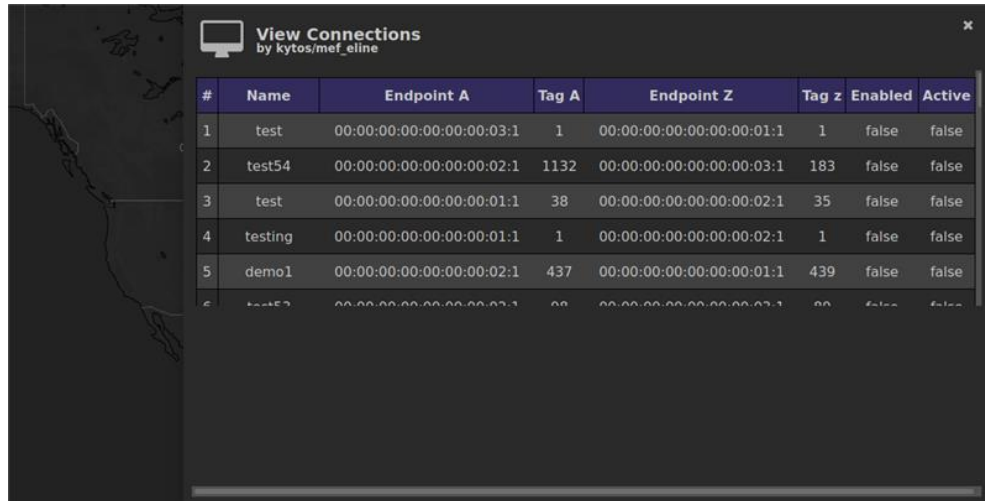


Figure 21- Kytos Web UI with E Line open on the tool bar

Step 3: Click on “List installed EVC” button



#	Name	Endpoint A	Tag A	Endpoint Z	Tag z	Enabled	Active
1	test	00:00:00:00:00:00:03:1	1	00:00:00:00:00:00:01:1	1	false	false
2	test54	00:00:00:00:00:00:02:1	1132	00:00:00:00:00:00:03:1	183	false	false
3	test	00:00:00:00:00:00:01:1	38	00:00:00:00:00:00:02:1	35	false	false
4	testing	00:00:00:00:00:00:01:1	1	00:00:00:00:00:00:02:1	1	false	false
5	demo1	00:00:00:00:00:00:02:1	437	00:00:00:00:00:00:01:1	439	false	false
6	test54	00:00:00:00:00:00:03:1	88	00:00:00:00:00:00:02:1	88	false	false

Figure 22- List of all Connections will be displayed on the Kytos Web UI

Installation Guide

This section contains all the necessary steps in order to successfully run Kytos for the first time on any clean Ubuntu virtual machine.

Kytos requires at least Python 3.6, so in order to use this software please install it into your environment beforehand. Note that an additional step is needed for Ubuntu releases older than 16.10.

Python 3.6 in old Ubuntu releases

If you are using Ubuntu 16.04 or older, you must add a PPA to be able to install Python 3.6 packages. To add this PPA, use the commands:

```
$ sudo add-apt-repository ppa:deadsnakes/ppa
```

```
$ sudo apt-get update
```

```
$ sudo apt-get install python3.6
```

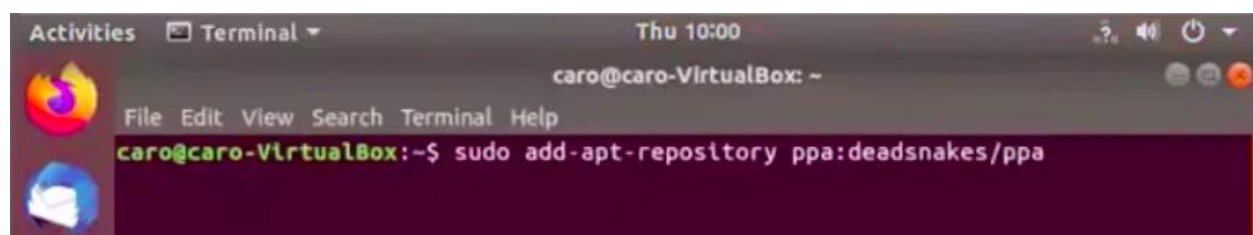
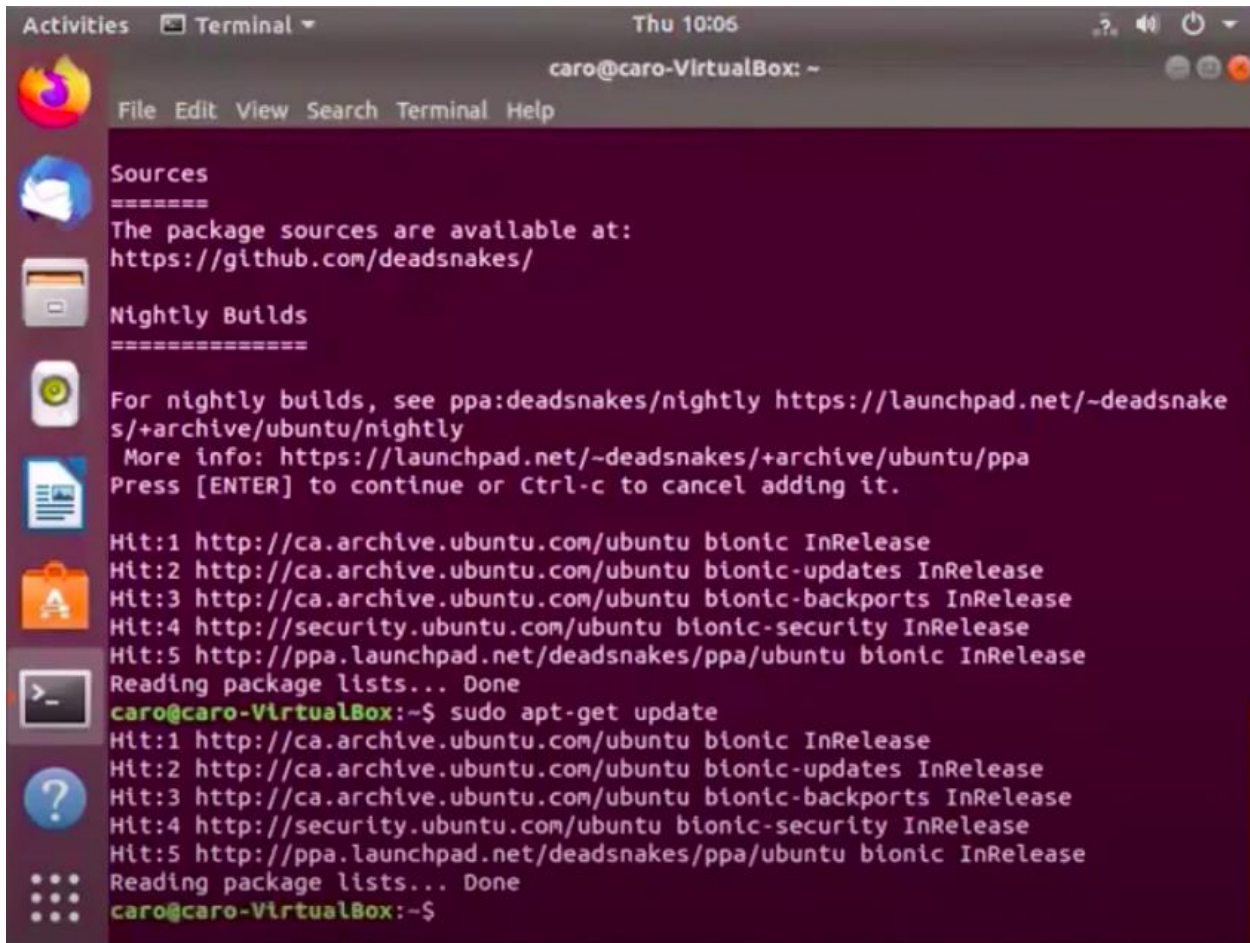


Figure 23 - Entering ppa command for Python 3.6 packages.



```
Activities  Terminal  Thu 10:06
caro@caro-VirtualBox: ~

File Edit View Search Terminal Help

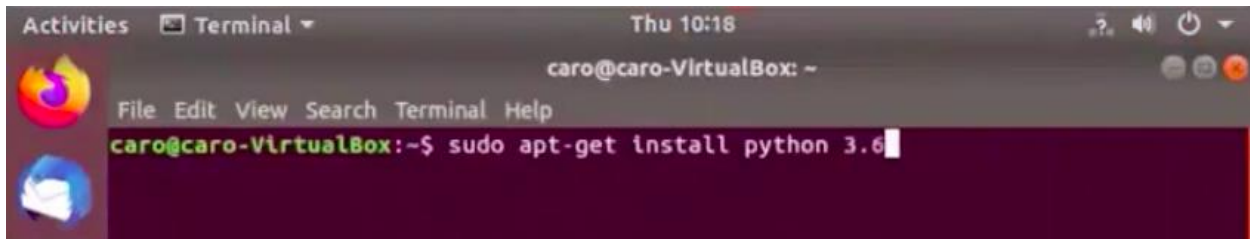
Sources
=====
The package sources are available at:
https://github.com/deadsnakes/

Nightly Builds
=====

For nightly builds, see ppa:deadsnakes/nightly https://launchpad.net/~deadsnake
s/+archive/ubuntu/nightly
More info: https://launchpad.net/~deadsnakes/+archive/ubuntu/ppa
Press [ENTER] to continue or Ctrl-c to cancel adding it.

Hit:1 http://ca.archive.ubuntu.com/ubuntu bionic InRelease
Hit:2 http://ca.archive.ubuntu.com/ubuntu bionic-updates InRelease
Hit:3 http://ca.archive.ubuntu.com/ubuntu bionic-backports InRelease
Hit:4 http://security.ubuntu.com/ubuntu bionic-security InRelease
Hit:5 http://ppa.launchpad.net/deadsnakes/ppa/ubuntu bionic InRelease
Reading package lists... Done
caro@caro-VirtualBox:~$ sudo apt-get update
Hit:1 http://ca.archive.ubuntu.com/ubuntu bionic InRelease
Hit:2 http://ca.archive.ubuntu.com/ubuntu bionic-updates InRelease
Hit:3 http://ca.archive.ubuntu.com/ubuntu bionic-backports InRelease
Hit:4 http://security.ubuntu.com/ubuntu bionic-security InRelease
Hit:5 http://ppa.launchpad.net/deadsnakes/ppa/ubuntu bionic InRelease
Reading package lists... Done
caro@caro-VirtualBox:~$
```

Figure 24 - Completed update.



```
Activities  Terminal  Thu 10:18
caro@caro-VirtualBox: ~

File Edit View Search Terminal Help

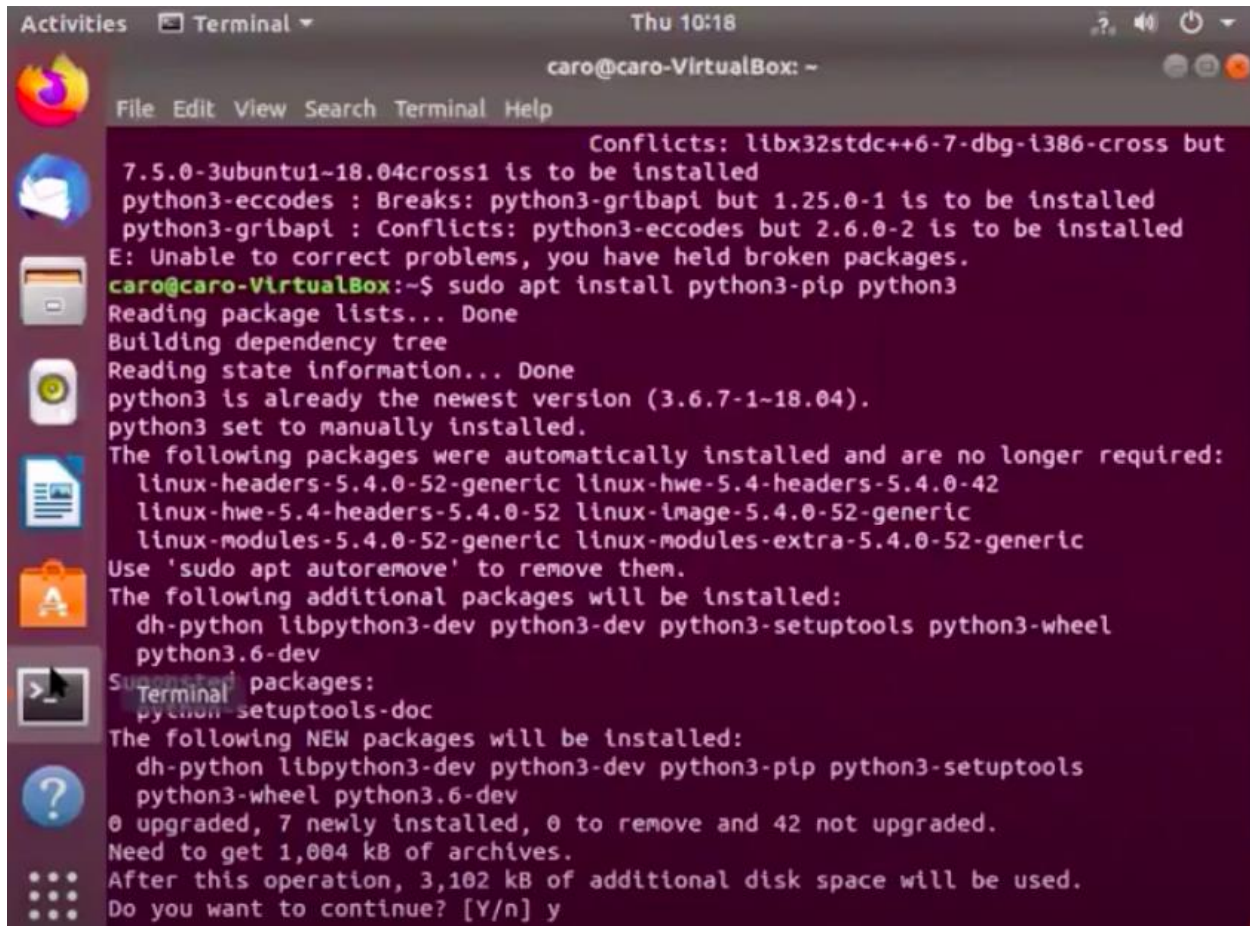
caro@caro-VirtualBox:~$ sudo apt-get install python 3.6
```

Figure 25 - Entering Python 3.5 installation command.

Required packages

The required Debian/Ubuntu packages can be installed by:

```
$ sudo apt install python3-pip python3
```



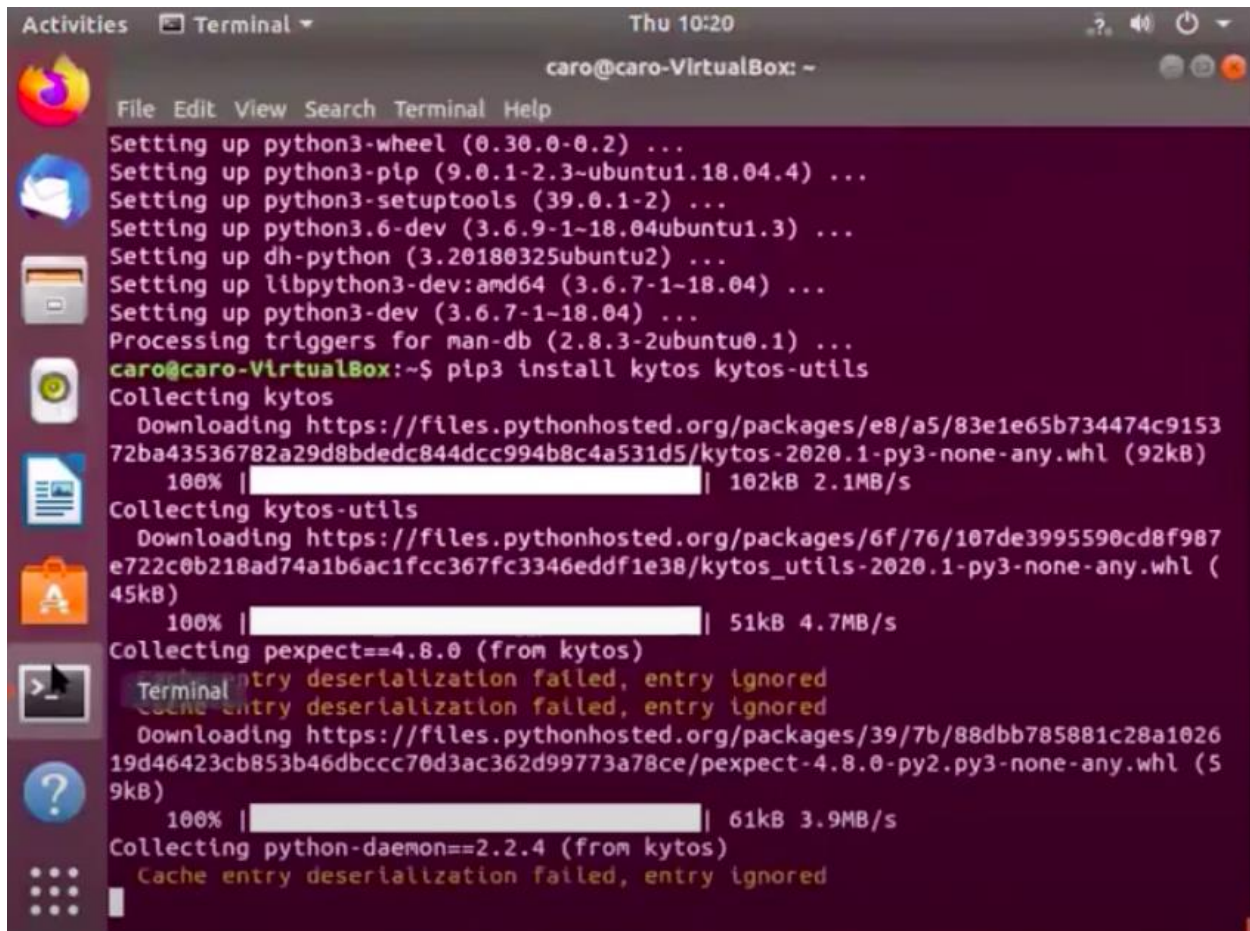
```
Activities  Terminal  Thu 10:18
caro@caro-VirtualBox: ~
File Edit View Search Terminal Help

Conflicts: libx32stdc++6-7-dbg-i386-cross but
7.5.0-3ubuntu1-18.04cross1 is to be installed
python3-eccodes : Breaks: python3-gribapi but 1.25.0-1 is to be installed
python3-gribapi : Conflicts: python3-eccodes but 2.6.0-2 is to be installed
E: Unable to correct problems, you have held broken packages.
caro@caro-VirtualBox:~$ sudo apt install python3-pip python3
Reading package lists... Done
Building dependency tree
Reading state information... Done
python3 is already the newest version (3.6.7-1~18.04).
python3 set to manually installed.
The following packages were automatically installed and are no longer required:
linux-headers-5.4.0-52-generic linux-hwe-5.4-headers-5.4.0-42
linux-hwe-5.4-headers-5.4.0-52 linux-image-5.4.0-52-generic
linux-modules-5.4.0-52-generic linux-modules-extra-5.4.0-52-generic
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
dh-python libpython3-dev python3-dev python3-setuptools python3-wheel
python3.6-dev
Suggested packages:
python3-setuptools-doc
The following NEW packages will be installed:
dh-python libpython3-dev python3-dev python3-pip python3-setuptools
python3-wheel python3.6-dev
0 upgraded, 7 newly installed, 0 to remove and 42 not upgraded.
Need to get 1,004 kB of archives.
After this operation, 3,102 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
```

Figure 26 - Installing `python3-pip` `python3`. Note at the bottom the user is prompted to continue by typing in "y".

To install the latest Kytos from PyPI, make sure that you done all previous steps, then:

```
$ pip3 install kytos kytos-utils
```

A screenshot of a Linux terminal window titled 'caro@caro-VirtualBox: ~'. The terminal shows the output of the command 'pip3 install kytos kytos-utils'. It lists the installation of various dependencies: python3-wheel, python3-pip, python3-setuptools, python3.6-dev, dh-python, libpython3-dev:amd64, and python3-dev. Then, it shows the installation of 'kytos' and 'kytos-utils', including download progress bars and speeds. Finally, it shows the installation of 'pexpect==4.8.0' and 'python-daemon==2.2.4' (both from kytos), with some warnings about cache entry deserialization failures.

```
Activities  Terminal  Thu 10:20
caro@caro-VirtualBox: ~
File Edit View Search Terminal Help
Setting up python3-wheel (0.30.0-0.2) ...
Setting up python3-pip (9.0.1-2.3-ubuntu1.18.04.4) ...
Setting up python3-setuptools (39.0.1-2) ...
Setting up python3.6-dev (3.6.9-1-18.04ubuntu1.3) ...
Setting up dh-python (3.20180325ubuntu2) ...
Setting up libpython3-dev:amd64 (3.6.7-1-18.04) ...
Setting up python3-dev (3.6.7-1-18.04) ...
Processing triggers for man-db (2.8.3-2ubuntu0.1) ...
caro@caro-VirtualBox:~$ pip3 install kytos kytos-utils
Collecting kytos
  Downloading https://files.pythonhosted.org/packages/e8/a5/83e1e65b734474c915372ba43536782a29d8bdedc844dcc994b8c4a531d5/kytos-2020.1-py3-none-any.whl (92kB)
    100% |████████████████████████████████████████| 102kB 2.1MB/s
Collecting kytos-utils
  Downloading https://files.pythonhosted.org/packages/6f/76/107de3995590cd8f987e722c0b218ad74a1b6ac1fcc367fc3346eddf1e38/kytos_utils-2020.1-py3-none-any.whl (45kB)
    100% |████████████████████████████████████████| 51kB 4.7MB/s
Collecting pexpect==4.8.0 (from kytos)
  Downloading https://files.pythonhosted.org/packages/39/7b/88dbb785881c28a102619d46423cb853b46dbccc70d3ac362d99773a78ce/pexpect-4.8.0-py2.py3-none-any.whl (59kB)
    100% |████████████████████████████████████████| 61kB 3.9MB/s
Collecting python-daemon==2.2.4 (from kytos)
  Cache entry deserialization failed, entry ignored
Cache entry deserialization failed, entry ignored
```

Figure 27 - Installing Kytos

This will install the Kytos server and client, and also their dependencies, like the python-openflow library.

Create a python environment

Create your environment and name it as you wish, then activate the environment, making sure you are in the directory where you created your environment.

```
$ python -m venv yourenvname
```

```
$ source yourenvname/bin/activate
```

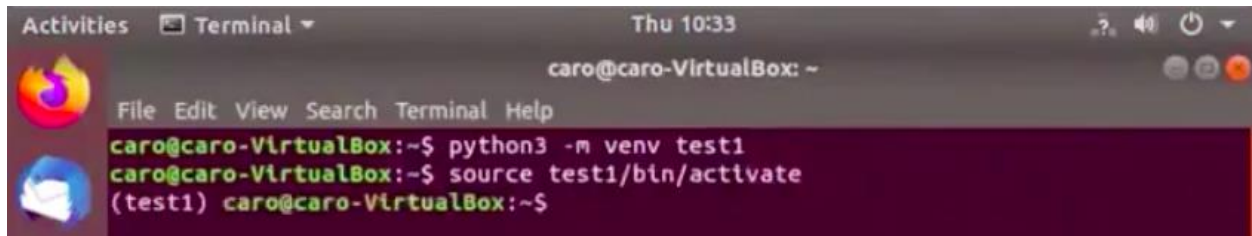
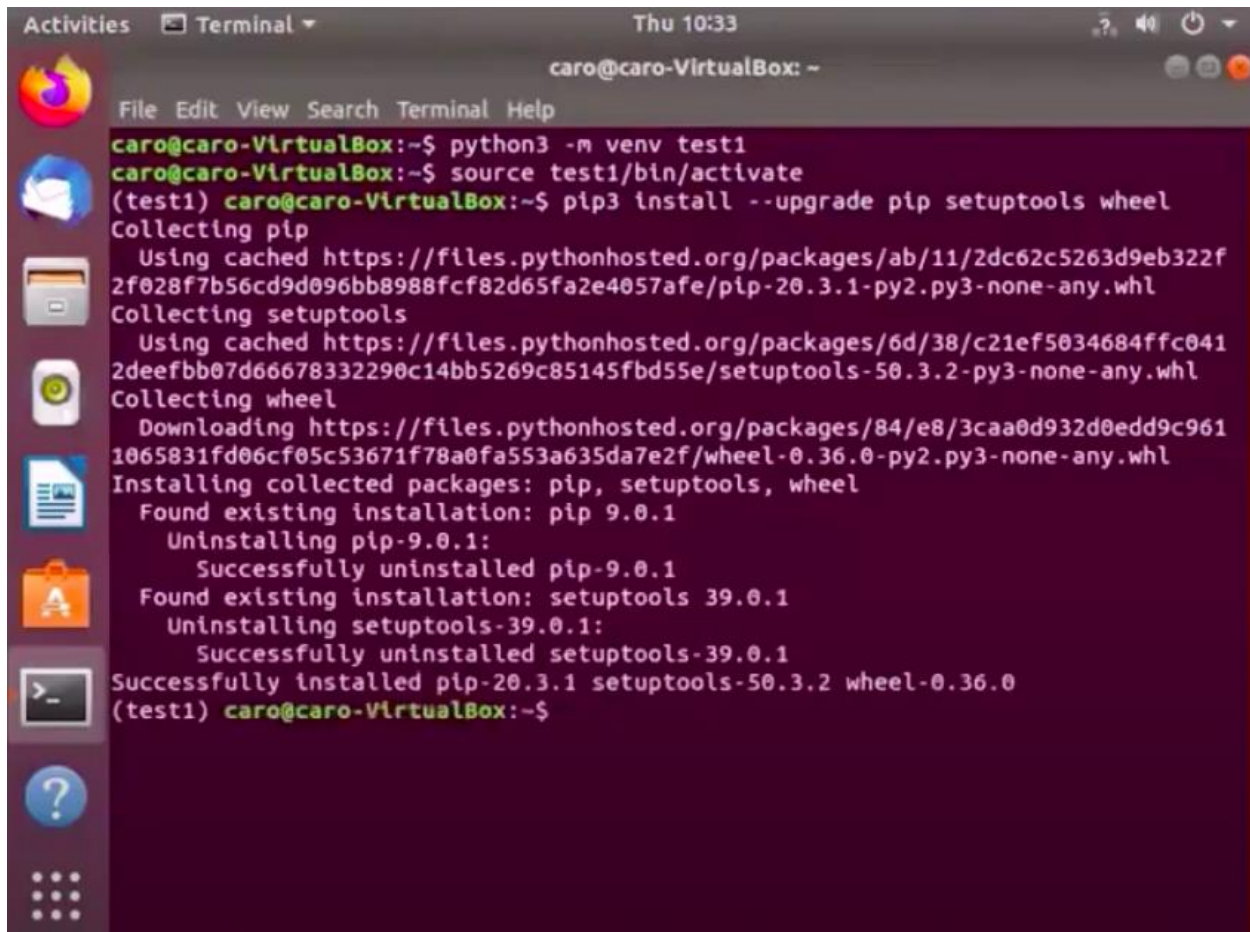


Figure 28 - Creating a python environment named "test1".

From this point forward you will find you are inside of your new environment.
The following command is for a necessary upgrade:

```
$ pip3 install --upgrade pip setuptools wheel
```



```
caro@caro-VirtualBox: ~  
File Edit View Search Terminal Help  
caro@caro-VirtualBox:~$ python3 -m venv test1  
caro@caro-VirtualBox:~$ source test1/bin/activate  
(test1) caro@caro-VirtualBox:~$ pip3 install --upgrade pip setuptools wheel  
Collecting pip  
  Using cached https://files.pythonhosted.org/packages/ab/11/2dc62c5263d9eb322f2f028f7b56cd9d096bb8988f8cf82d65fa2e4057afe/pip-20.3.1-py2.py3-none-any.whl  
Collecting setuptools  
  Using cached https://files.pythonhosted.org/packages/6d/38/c21ef5034684ffc0412deefbb07d66678332290c14bb5269c85145fbd55e/setuptools-50.3.2-py3-none-any.whl  
Collecting wheel  
  Downloading https://files.pythonhosted.org/packages/84/e8/3caa0d932d0edd9c9611065831fd06cf05c53671f78a0fa553a635da7e2f/wheel-0.36.0-py2.py3-none-any.whl  
Installing collected packages: pip, setuptools, wheel  
  Found existing installation: pip 9.0.1  
    Uninstalling pip-9.0.1:  
      Successfully uninstalled pip-9.0.1  
  Found existing installation: setuptools 39.0.1  
    Uninstalling setuptools-39.0.1:  
      Successfully uninstalled setuptools-39.0.1  
Successfully installed pip-20.3.1 setuptools-50.3.2 wheel-0.36.0  
(test1) caro@caro-VirtualBox:~$
```

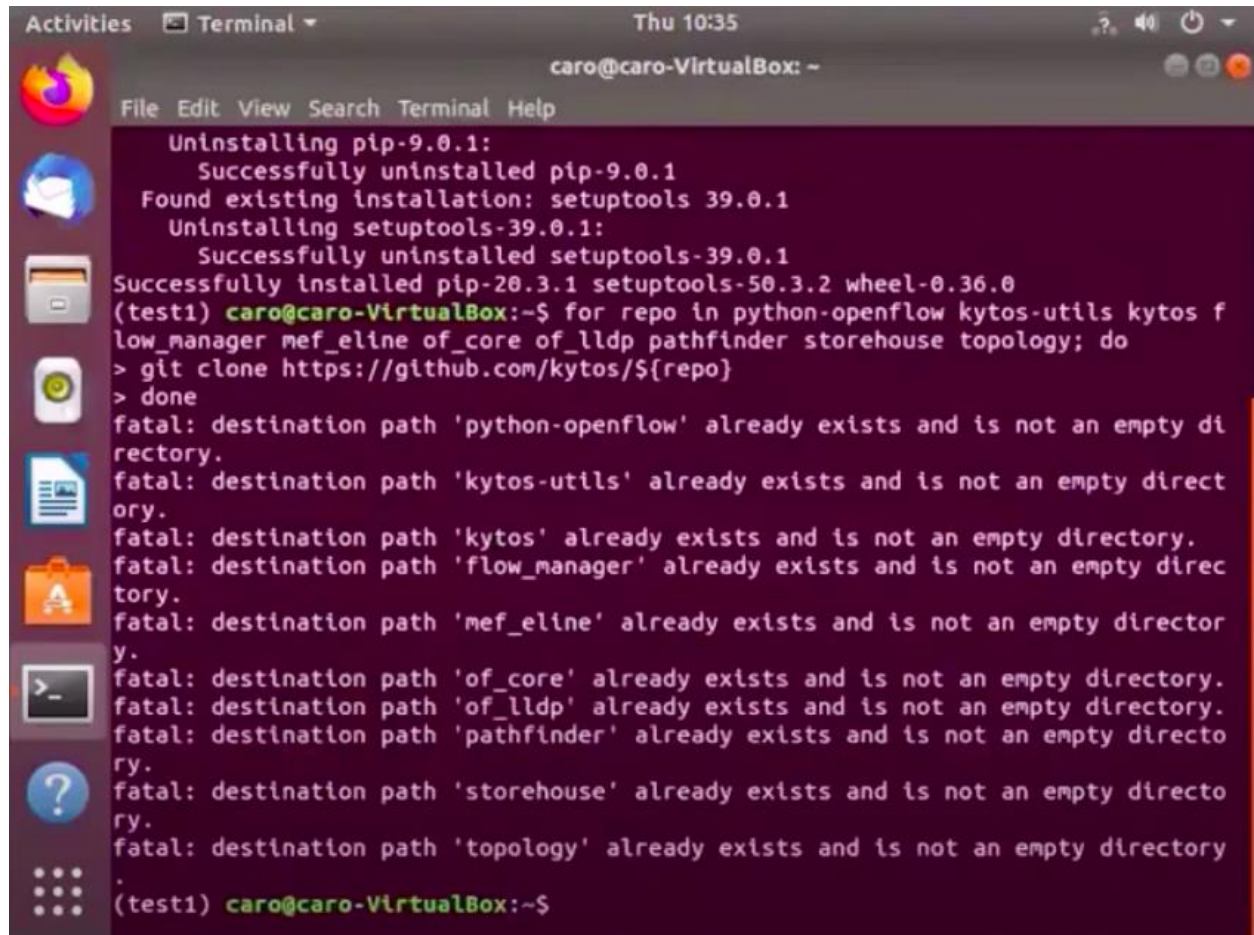
Figure 29 - Performing pip upgrade.

Clone all Kytos Repositories

```
$ for repo in python-openflow kytos-utils kytos flow_manager mef_eline  
of_core of_lldp pathfinder storehouse topology; do
```

```
$ git clone https://github.com/kytos/${repo}
```

```
$ done
```



```
Activities Terminal Thu 10:35  
caro@caro-VirtualBox: ~  
File Edit View Search Terminal Help  
Uninstalling pip-9.0.1:  
  Successfully uninstalled pip-9.0.1  
Found existing installation: setuptools 39.0.1  
Uninstalling setuptools-39.0.1:  
  Successfully uninstalled setuptools-39.0.1  
Successfully installed pip-20.3.1 setuptools-50.3.2 wheel-0.36.0  
(test1) caro@caro-VirtualBox:~$ for repo in python-openflow kytos-utils kytos f  
low_manager mef_eline of_core of_lldp pathfinder storehouse topology; do  
> git clone https://github.com/kytos/${repo}  
> done  
fatal: destination path 'python-openflow' already exists and is not an empty di  
rectory.  
fatal: destination path 'kytos-utils' already exists and is not an empty direct  
ory.  
fatal: destination path 'kytos' already exists and is not an empty directory.  
fatal: destination path 'flow_manager' already exists and is not an empty direc  
tory.  
fatal: destination path 'mef_eline' already exists and is not an empty director  
y.  
fatal: destination path 'of_core' already exists and is not an empty directory.  
fatal: destination path 'of_lldp' already exists and is not an empty directory.  
fatal: destination path 'pathfinder' already exists and is not an empty directo  
ry.  
fatal: destination path 'storehouse' already exists and is not an empty directo  
ry.  
fatal: destination path 'topology' already exists and is not an empty directory  
(test1) caro@caro-VirtualBox:~$
```

Figure 30 - Cloning Kytos repositories. Note that in the image it shows that for this user the repositories were already cloned.

Install Kytos Repositories

```
$ for repo in python-openflow kytos-utils kytos flow_manager mef_eline  
of_core of_lldp pathfinder storehouse topology; do
```

```
$ cd ${repo}
```

```
$ python3 setup.py develop
```

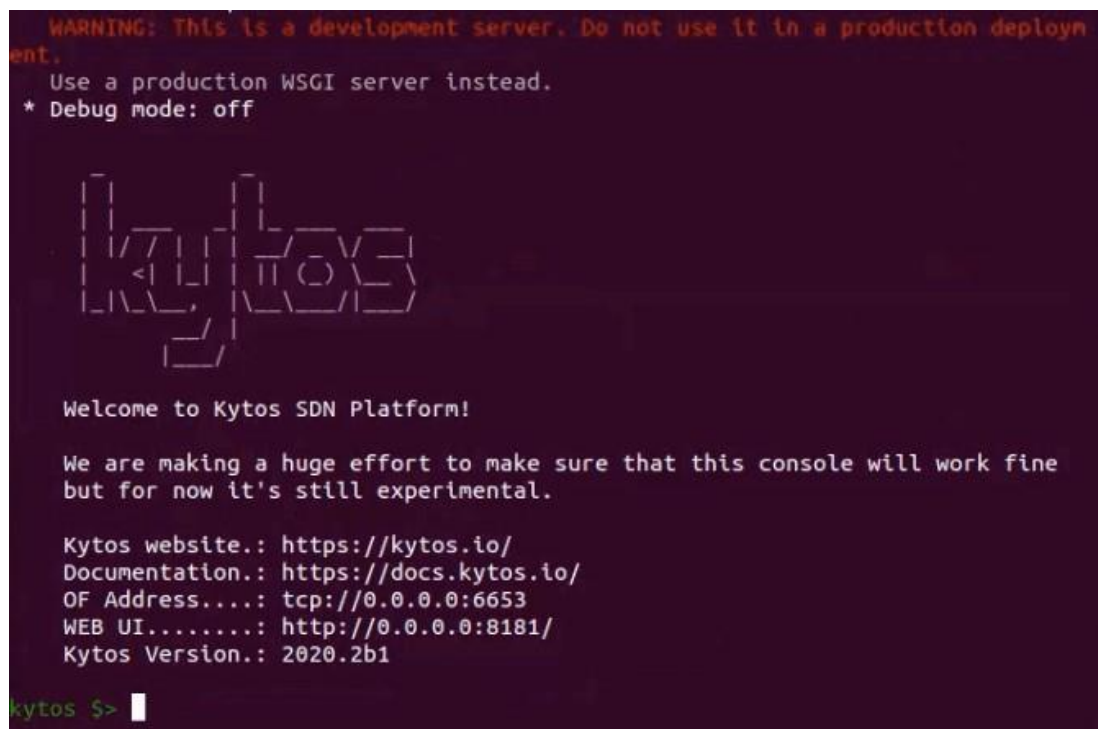
```
$ cd ..
```

```
$ done
```

Start Kytos console in foreground mode

```
$ kytosd -f
```

Upon starting up Kytos, you will see the following:

A terminal window showing the output of the 'kytosd -f' command. The background is dark purple. The text is white and red. It starts with a red warning message, followed by instructions to use a production WSGI server and that debug mode is off. Then, the 'kytos' logo is displayed in a stylized, blocky font. Below the logo, it says 'Welcome to Kytos SDN Platform!'. This is followed by a message stating that the console is still experimental. Then, it lists several URLs and addresses: Kytos website, Documentation, OF Address, WEB UI, and Kytos Version. The prompt 'kytos \$>' is visible at the bottom left.

```
WARNING: This is a development server. Do not use it in a production deployment.  
Use a production WSGI server instead.  
* Debug mode: off  
  
kytos  
  
Welcome to Kytos SDN Platform!  
  
We are making a huge effort to make sure that this console will work fine  
but for now it's still experimental.  
  
Kytos website.: https://kytos.io/  
Documentation.: https://docs.kytos.io/  
OF Address....: tcp://0.0.0.0:6653  
WEB UI.....: http://0.0.0.0:8181/  
Kytos Version.: 2020.2b1  
kytos $>
```

Figure 31 - Kytos successfully running in the foreground

Wishlist

The following is a list of items we would like to be added to the next iteration of the product:

- Have the availability to create EVCs and inputting a primary and optional path
- Leverage the Kytos pathfinder application to suggest connection paths
- Allow the Kytos UI to allow users to disable and delete EVCs
- Allow the Kytos UI to edit EVC parameters

REFERENCES

Kytos SDN Platform :: Your network, your rules! Retrieved Dec 3, 2020, from <https://kytos.io/>