Simulation of 5G Mobile Core Network using SDN & MPLS

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Abstract

In particular, in order to have the best possible understanding of the effects that program-able networking has, carry out a low cost analysis of both the (software define network) system and the (multiple protocol layer switching) system. This will give you the possible understanding of the effects that program-able networking has on the economics of a network in comparison to traditional networking, which is also known as MPLS technology. This is done so that a better understanding of the effects that program-able networking, also known as software-defined networking (SDN), technology has on the economics of a network can be gained. Conducting a quantitative investigation using an activity-based methodology to compute the (capital expenditure) and (operation expenditure) costs associated with a network was the first step in achieving this objective. This investigation was carried out. Second, in order to compare the aforementioned architectures in terms of their financial performances, we used the USC Scalability metric in addition to the Cost-to-Service metric. Both of these metrics were used. These models include (centralized control plane), (distributed control plane), and (hierarchical control plane). This was done in order to obtain the possible understanding of the different SDN plane systems that are currently in use. The separation of control plane and data plane that is achieved through the implementation of software-defined networking (SDN) makes it possible to program networks. Because of this separation, network operators and administrators are now in a position to make better use of the network's resources and have an easier time provisioning those resources when compared to the situation before the separation took place.

Keyword- SDN system, MPLS system, CAPEX, OPEX, CCP, DCP, HCP.

I. INTRODUCTION

SDN Setup have previously used NS3 emulator [1] in conjunction with the POX controller [2]. Although there is only one controller in the CCP model, have partitioned the entire network into four fully-connected sub-networks, each of which has its own controller, in both the DCP and the HCP models. These sub-networks are controlled independently of one another. These models include a different number of switches in accordance with the various simulation cases presented in the figures. In the HCP model, in addition to the local domain controllers, there is also a master controller present. MPLS Setup. Concerning the configuration of MPLS, made use of the ns3 [3] network simulator. In order to provide support for constraint-based routing in MPLS, will need to make use of a signalling protocol such as RSVP-TE or CR-LDP. Since it would to reduce time and effort implement them in ns3, have generated extra packets between network elements to mimic link state advertisements and state refresh messages for LSPs from the aforementioned signalling protocols in MPLS. These extra packets are used to simulate link state advertisements and state refresh messages. LSPs will use these messages to obtain information that has been updated about the state. A configuration that is used jointly. Throughout the entirety of the tests, the flow sending rate for each and every service request was held steady at 3 million bps. As a direct consequence of this, there is only one service tier, and the value of BW that is applicable to each and every request is 3. Although should keep in mind that the values reflected by these input numbers might not be accurate or realistic, this should not have an effect on the nature of the calculation framework because the values in question are extremely relative to each and every networking company. Made the assumption that the cost of each link, which we will refer to as Cl, is the same in both the SDN models and the MPLS case. On the other hand, it has been hypothesized that the price of a link would be $100 if it had a bandwidth of 1 Gbps and $500 if it had a bandwidth of 100 Gbps. Both of these numbers are rounded up to the nearest dollar. Made the assumption that the device cost is doubled (Cd) in the case of MPLS because it is reasonable to anticipate that traditional network equipment will be more expensive than SDN equipment due to the presence of an integrated control plane. In other words, it is reasonable to anticipate that traditional network equipment will be more expensive than SDN equipment (i.e., proprietary software implementation). Have also assumed that the cost of the controller hardware (Cc) and software (Cs) is the same in all models, and that this cost is proportional to the number of network devices (d) and that of controllers (c) in different cases where there is a different device number. This assumption was made under the assumption that the cost of the controller hardware (Cc) and software (Cs) is the same. Have made the assumption that an activity is always completed by two employees and that the hourly pay rate for an employee is $60 regardless of whether the activity involves SDN or MPLS. In keeping with the practice that is common. After applying the findings that were presented in [13], we calculated the total amount of time spent in the service introduction steps that corresponded to the SDN models. According to the authors of [13], who state that the automation feature of SDN is responsible for this behaviour, these values would be the same for a variety of different switch cases and control plane models. Furthermore, they state that this behaviour would occur regardless of which switch case or control plane model was being used. For the purpose of making the learning curve in MPLS appear more realistic, we used a switch number proportional timing value that was based on 70 percent of the learning curve [15]. This value was applied to each service introduction step across all switch cases. This was done in order to ensure that the value would remain consistent across all of the switch cases. This was done in order to make it more applicable to scenarios that might occur in the real world.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

Able to reach the self-evident conclusion that the utilization of an SDN controller does not result in the establishment of a consequent delay for UEs' data plane, in a position to draw this conclusion, It is crucial to emphasize the fact that incorporating the SDN paradigm into mobile networks makes it possible to introduce new services with increased agility. This is a point that needs to be emphasized as much as possible. This is especially true when the programmability that is made available by NFV is taken into consideration. Additionally, by physically separating the plane from the plane of data, it is possible to increase the scalability and flexibility of the system.

III. WRITE DOWN YOUR STUDIES AND FINDINGS

In particular, it is important to conduct an economic analysis of SDN technology and MPLS (Multiprotocol Label Switching) technology in order to gain a better understanding of how programmable networking, also known as SDN technology, affects the economics of a network in comparison to traditional networking, also known as MPLS technology. This is done so that can gain an understanding of the effects that programmable networking, also known as SDN technology, has on the economics of the network. In spite of the fact that the MPLS-based flows, FEC1 (Forwarding Equivalence Class) + LSP2 (Label-Switched Paths), are not as generic and flexible as the SDN flow abstraction in regard to the flow match definitions and forwarding actions, choose the MPLS technology as the traditional architecture for comparison because it compatiple to the SDN architecture.

For this reason, decided to use it as the baseline for our comparison of modern and traditional architecture. In addition, when compared to the other architectures that offer quality of service (QoS), Multiprotocol Label Switching (MPLS) is the one that is the most widely adopted and utilized by service providers. To get started on accomplishing this objective, we will first carry out a quantitative analysis employing an activity-based methodology to compute the CAPEX and OPEX costs that are associated with a network.

IV. IMPROVEMENT AS PER REVIEWER COMMENTS

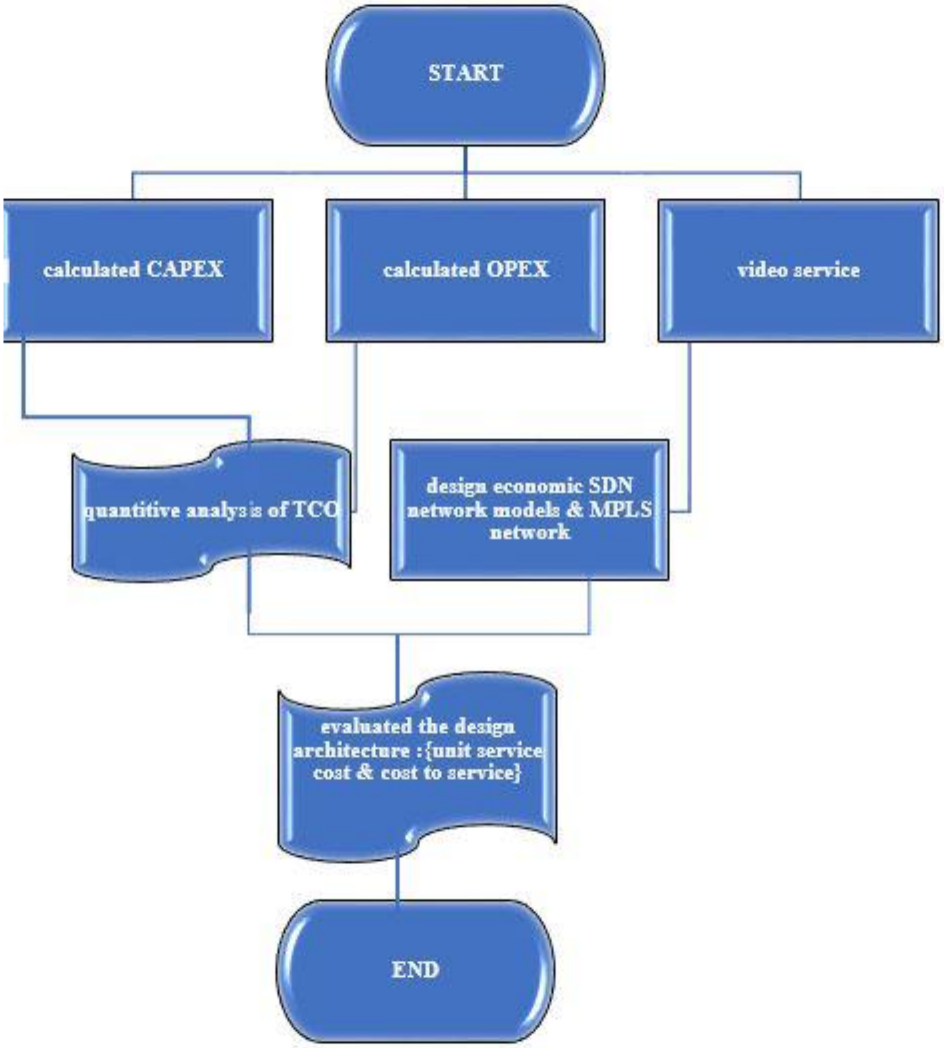
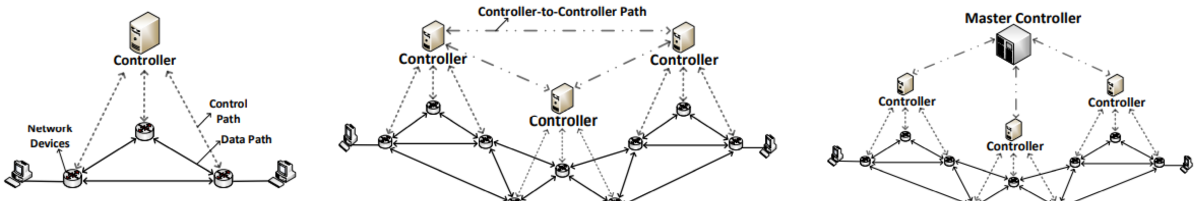


Figure.1 methodology flowchart of the project

Analyze the aforementioned architectures in terms of their monetary efficiency using two metrics, namely the Unit Service Cost Scalability metric and the Cost-to-Service metric, which are the second step in our process. In addition to this, present mathematical models that can be utilized in order to calculate specific cost components that are associated with a network. Compared and contrast the various popular SDN control plane models shown in **Figure 2**, in order to understand the economic impact of these models. These models include the CCP (Centralized Control Plane), DCP (Distributed Control Plane), and HCP (Hierarchical Control Plane). CCP, DCP, and HCP are the names given to these models in descending order of complexity. For the purpose of this comparison, going to use video as the service, and we are going to look at three distinct variations of traffic patterns: I(20 percent (inter-domain) versus 80 percent (intra-domain); (ii) 50 percent (inter-domain) versus 50 percent (intra-domain); and (iii) 80 percent (inter-domain) versus 20 percent (intra-domain) (intra-domain).



(a) Centralized (Single) Controller Design (CCP) (b) Distributed (Flat) Controller Design (DCP) (c) Hierarchical Controller Design (HCP)

Figure 2: An overview of the most common SDN control plane [25].

This work aims to be a useful primer for providing insights regarding which technology and control plane model are appropriate for a specific service, in this case video, so that network owners can plan their investments in a manner that is most beneficial to them. The goal of this work is to help network owners maximize their return on investment.More specifically, the results of this work will provide information regarding the type of technology and control plane model that is suitable for video. In scenario 1, build a network that has a total of 100 user nodes, 8 Switches (Label Switching Routers), 4 Local Controllers, and 1 Global/Central Controller. This network is comprised of all of these components (HCP).

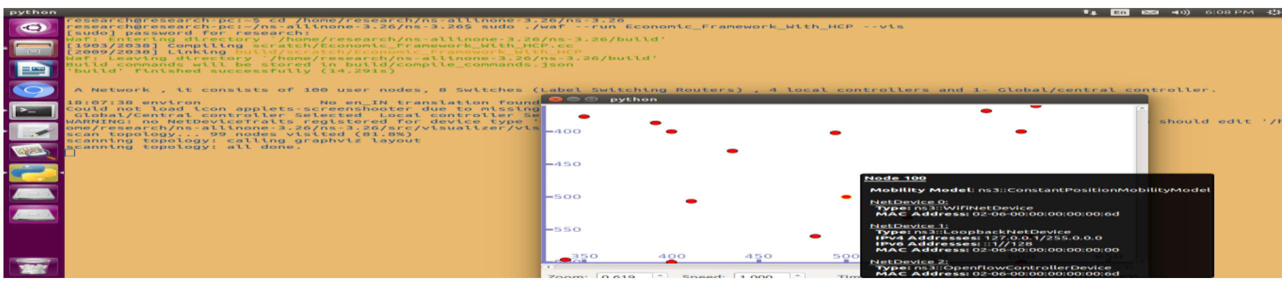


Fig.1: scenario 1, build a network that has a total of 100 user nodes, 8 Switches (Label Switching Routers), 4 Local Controllers, and 1 Global/Central Controller.

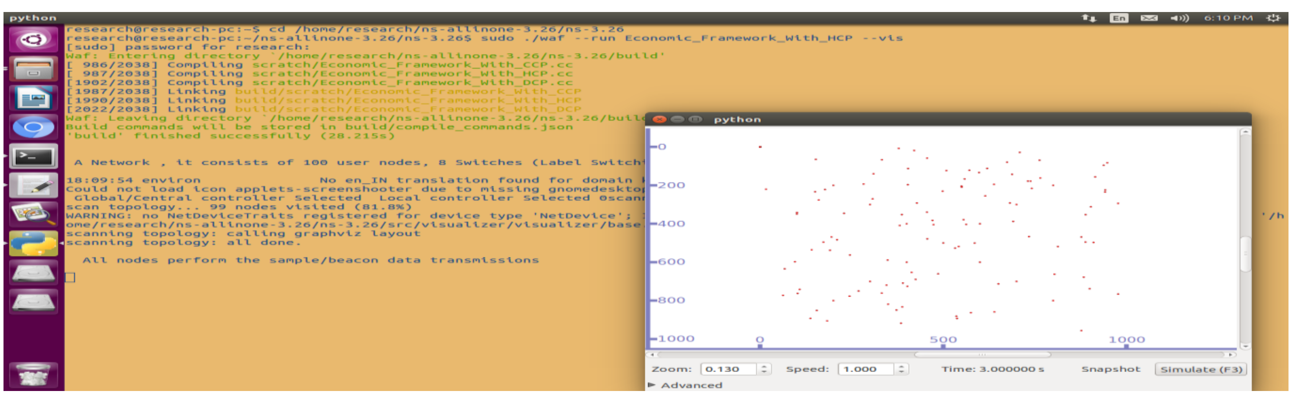


Fig. 2: scenario 1, all nodes perform the sample/beacon data transmissions.

Select the optimal path between the nodes based on the (MPLS-Traffic Engineering) model process by using RSVP-TE.

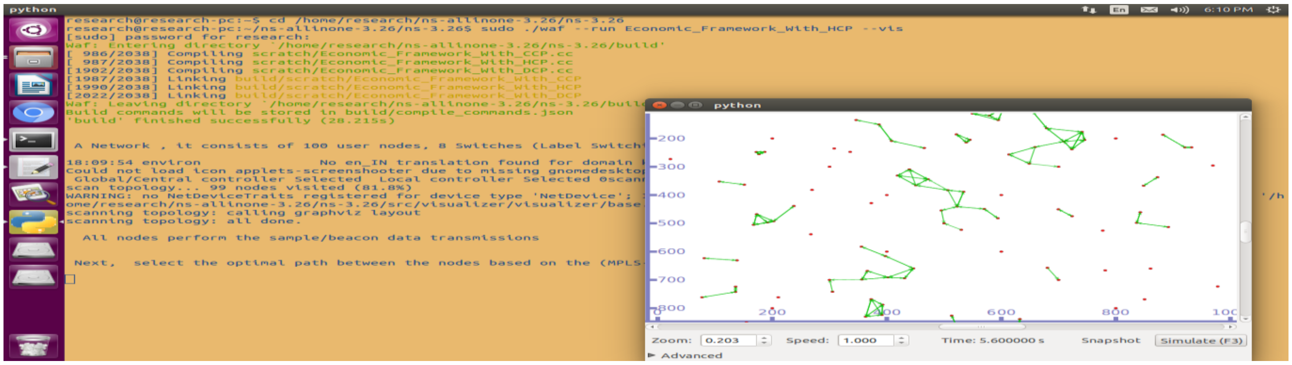


Fig.3: scenario 1, the optimal path between the nodes based on the (MPLS-Traffic Engineering) model process by using RSVP-TE.

Perform the request and response communication based on the number of interaction between the switches [this flow is based on the OPEX process].

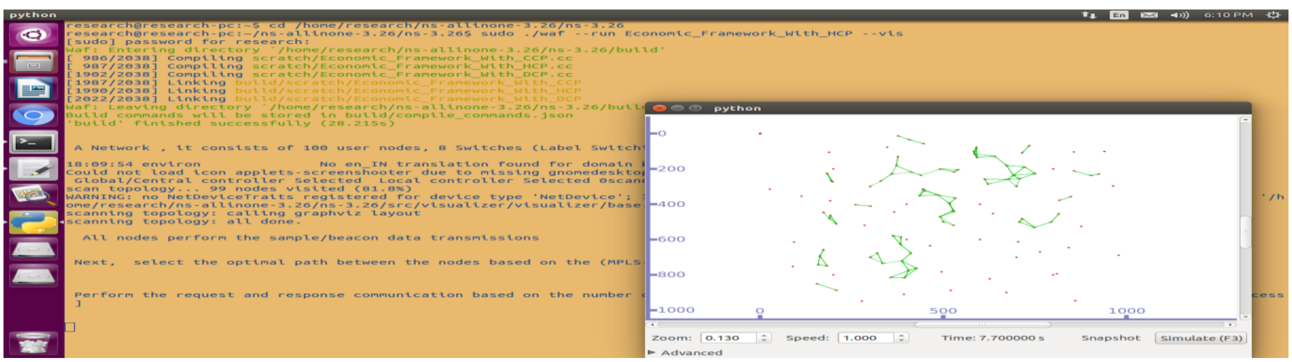


Fig.4: scenario 1, communication based on the number of interaction between the switches.

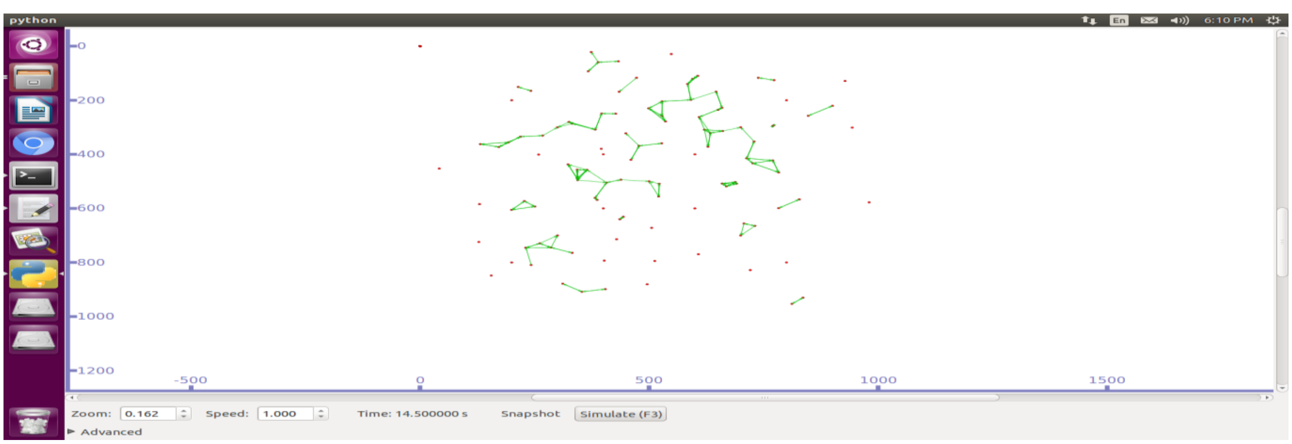


Fig. 5: scenario 1, communication based on the number of interaction between the switches.

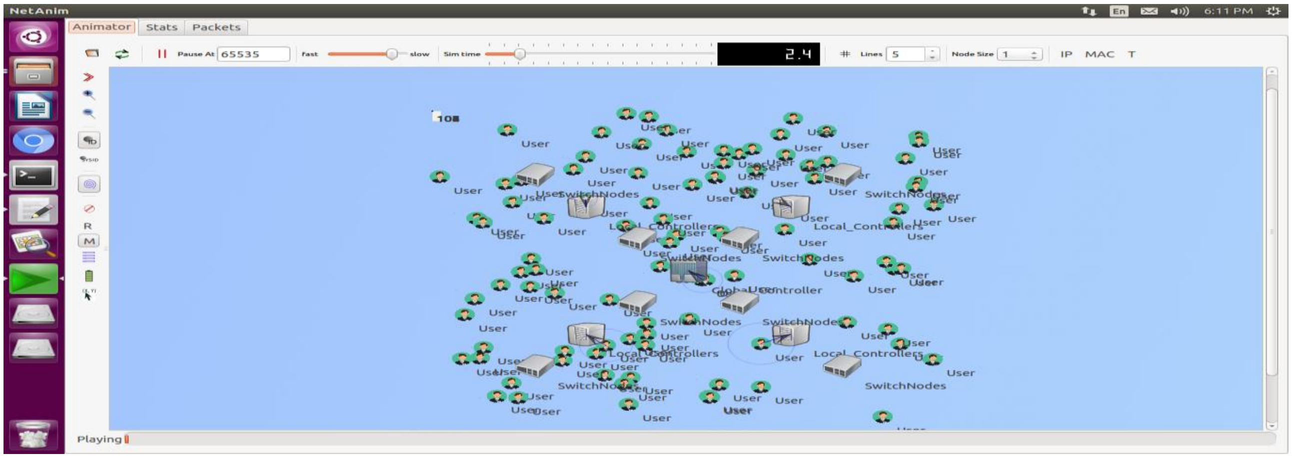


Fig.5: A: scenario 1, run communication based on the number of interaction between the switches.

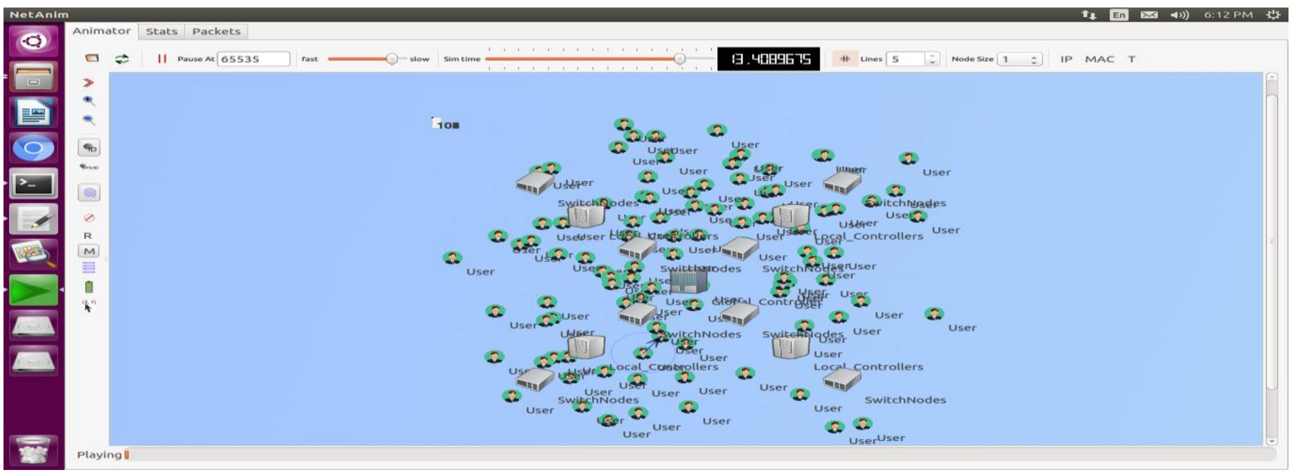


Fig. 5: b: scenario 1, run communication based on the number of interaction between the switches.

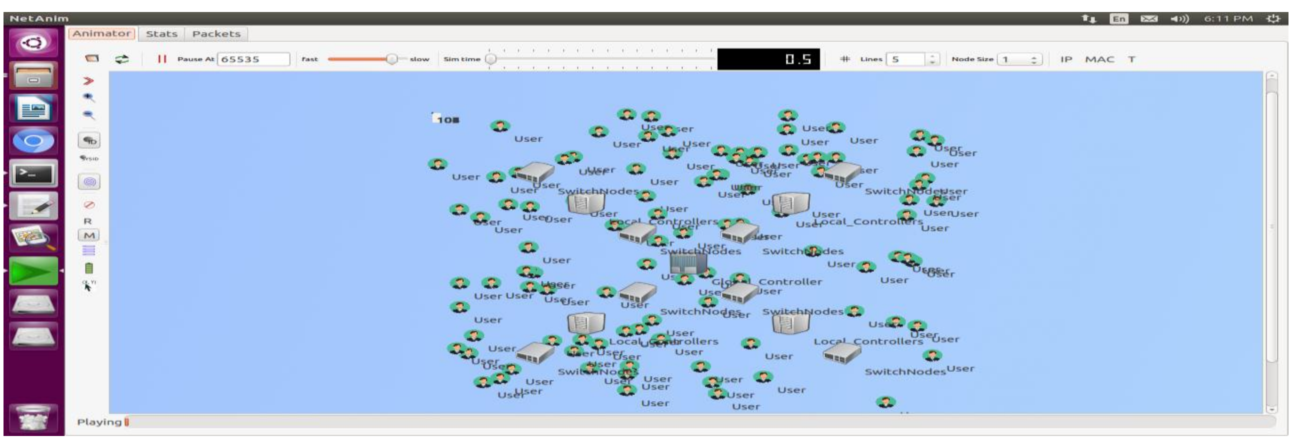


Fig. 5: c: scenario 1, run communication based on the number of interaction between the switches.

Consequence graph for Packet Delivery Ratio vs. no. Of users.

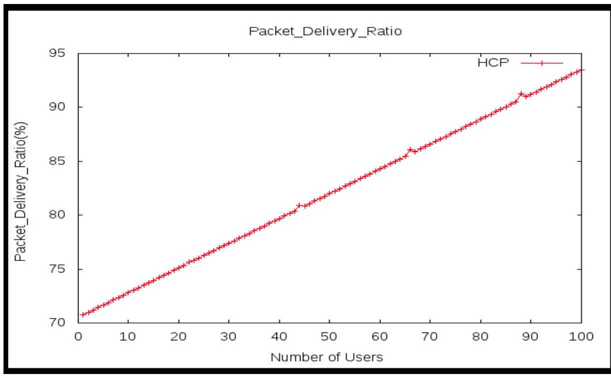


Fig. 6: scenario 1, result of Packet Delivery Ratio vs. no. Of users.

Consequence graph for Latency vs. no. Of users.

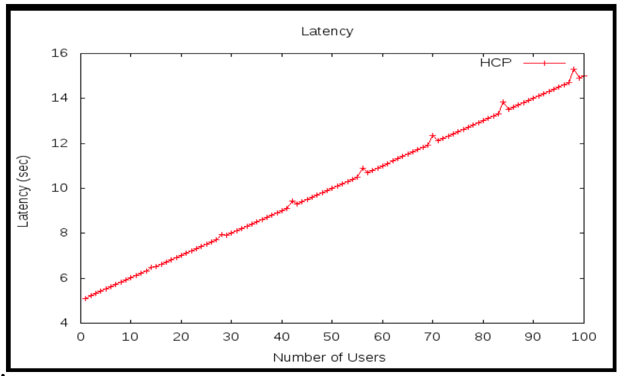


Fig. 7: scenario 1, result of Latency vs. no. Of users.

Consequence graph for Energy consumption vs. no. Of users.

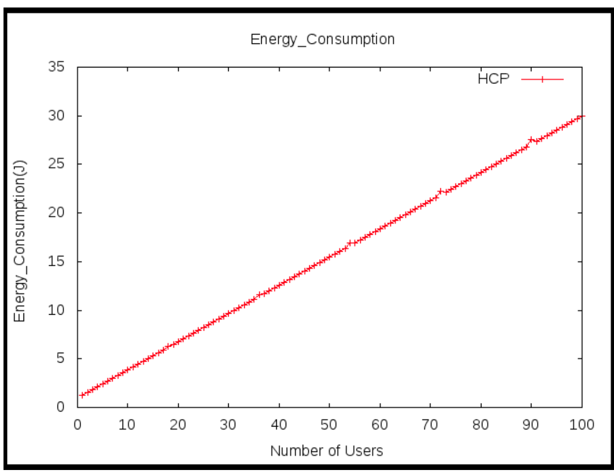


Fig. 8: scenario 1, result of Energy consumption vs. no. Of users.

Consequence graph for throughput vs. no. Of users.

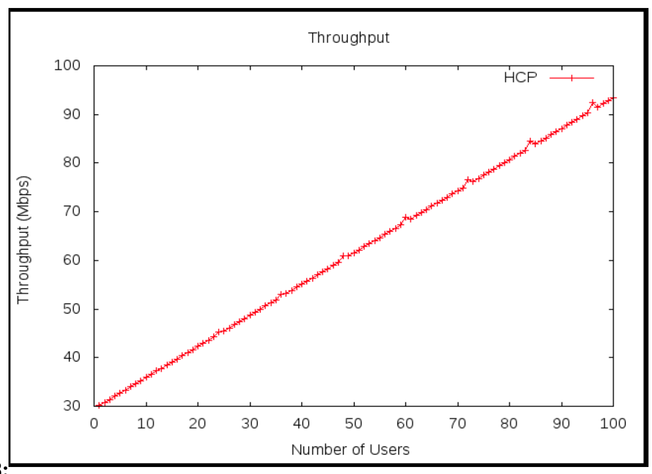


Fig. 9: scenario 1, result of throughput vs. no. Of users.

As the Fig. 6: shows the performance of Packet Delivery is increasing with the number of users. It means PDR is Direct propositional to number of users. If we want to increase the PDR, we have to increase the more users, or with more users we have more PDR.

The term "network latency," which is also known as "lag" in some contexts, is used to refer to delays that occur in the transmission of data over a network. The best way to understand what is meant by the term "latency" in the context of networking is to consider it as the amount of time required for a data packet to be captured, transmitted, and processed by a number of devices before finally being received at its destination and decoded. So in this Fig. 7: with 10 users, Latency value is 5 sec. With 20 users, the Latency is 6 second. It means with every 10 users, Latency value is increasing by one. So we can say the Latency is also direct proportional to the number of users. More users more Latency. Because the network has to process more traffic with more user.

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As the Fig. 8: The number of users also has an effect on the amount of energy consumed by the devices that make up the network. Energy consumption is proportional to the number of users, so a smaller number of users results in a higher consumption rate. Mainly due to the fact that the devices have to process more data for a greater number of customers. Therefore, the amount of energy consumed is directly proportional to the total number of customers.

The formula for calculating network throughput is as follows: Throughput (bits/sec) equals the sum of (number of successful packets) times (average packet size), divided by the total amount of time spent delivering that quantity of data.

Therefore, As the Fig. 9: the throughput varies depending on the number of user nodes in our scenario of 100 user nodes, 8 Switches (Label Switching Routers), 4 Local Controllers, and 1 Global/Central Controller. More number of user nodes results in higher throughputs. When there are fewer users, the throughput decreases.

In scenario 2, create a Network, it consists of 100 user nodes, 8 Switches (Label Switching Routers) and 4 local controllers (DCP).

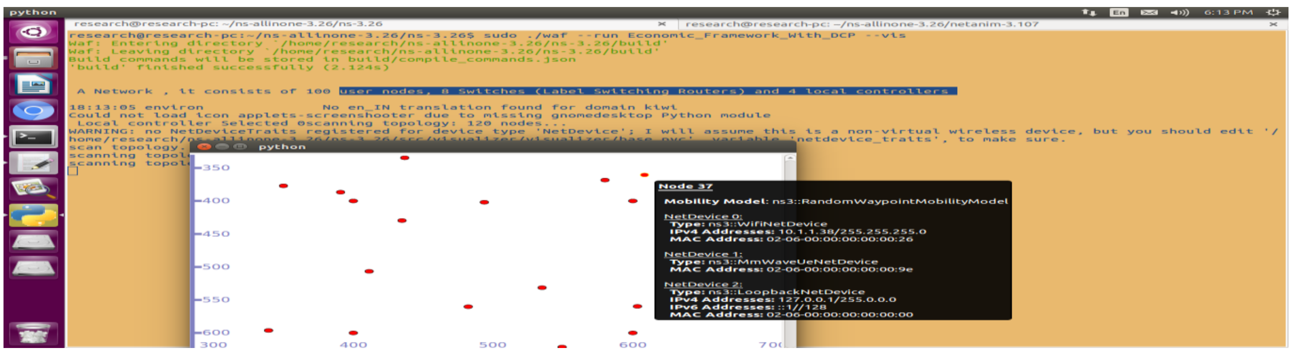


Fig.10: scenario 2, network consists of 100 user nodes, 8 Switches (Label Switching Routers) and 4 local controllers.

Initially, all nodes perform the sample/beacon data transmissions.

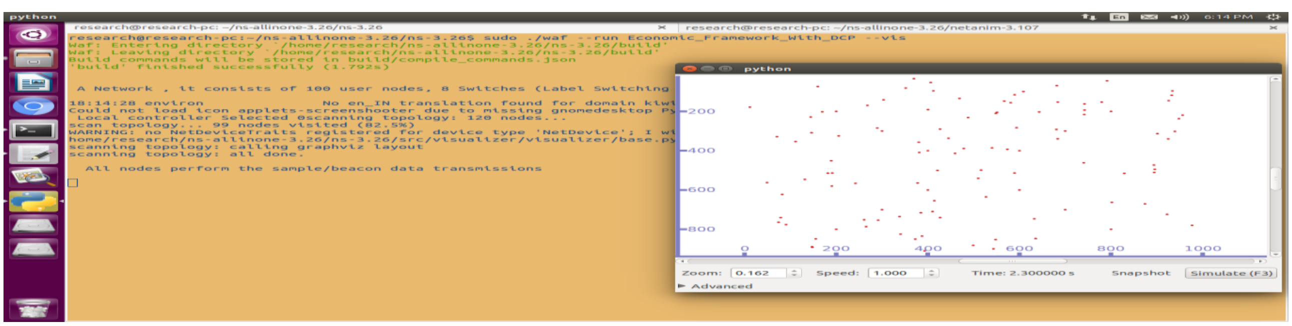


Fig.11: scenario 2, all nodes perform the sample/beacon data transmissions.

Select the optimal path between the nodes based on the (MPLS-Traffic Engineering) model process by using RSVP-TE.

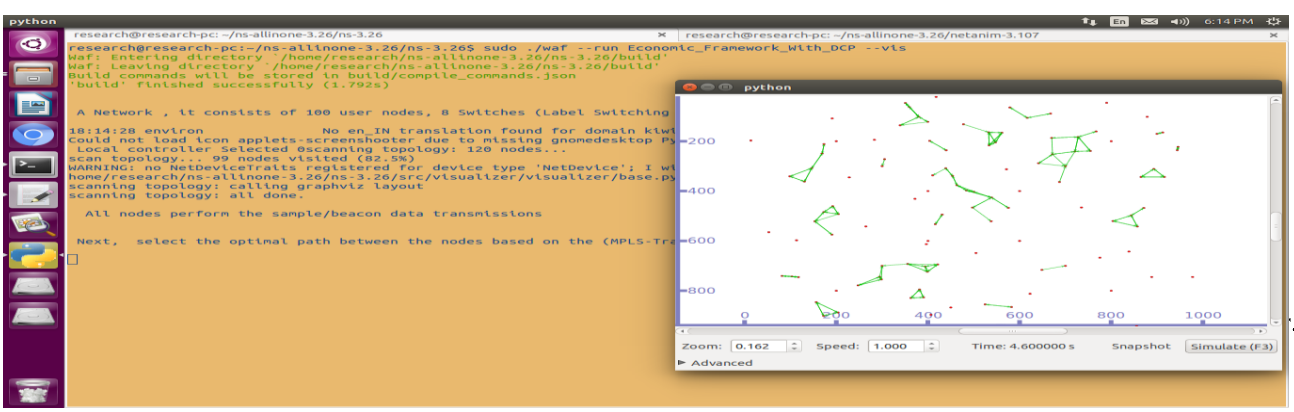


Fig.12: scenario 2, the optimal path between the nodes based on the (MPLS-Traffic Engineering) model process by using RSVP-TE.

Perform the request and response communication based on the number of interaction between the switches [this flow is based on the OPEX process].

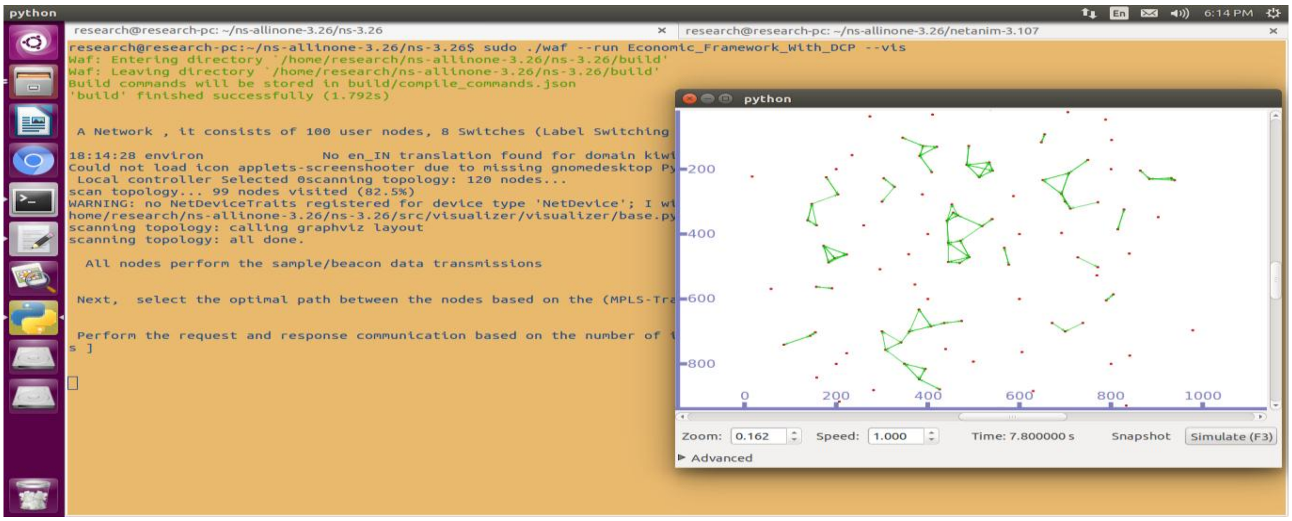


Fig.13: scenario 2, communication based on the number of interaction between the switches.

Get the simulation

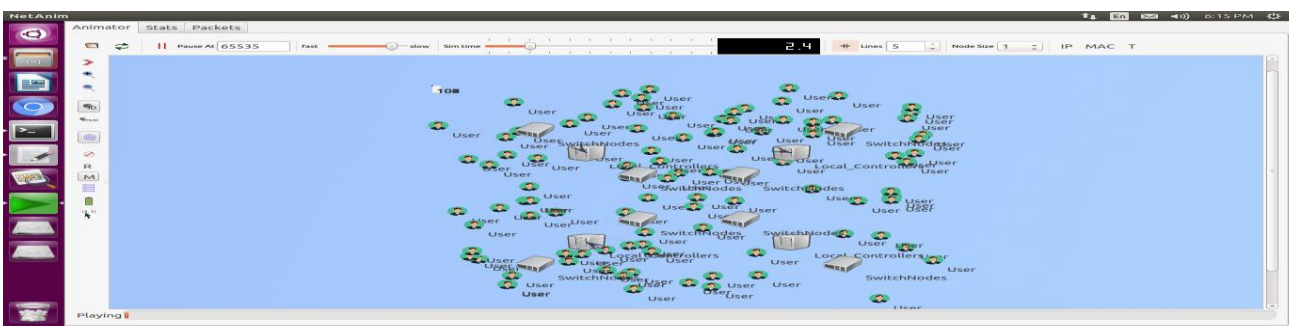


Fig.14: A: scenario 2, simulation the communication based on the number of interaction.

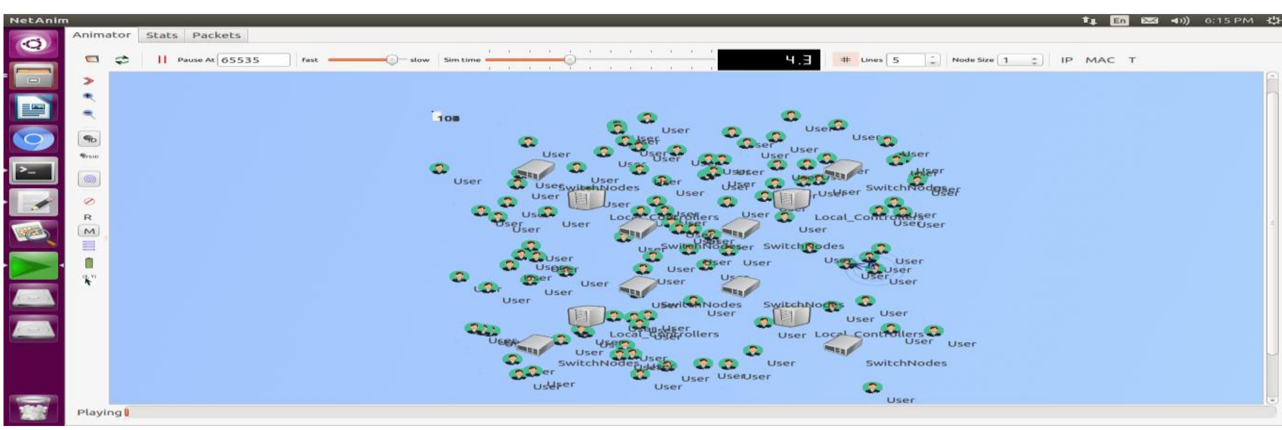


Fig.14: B: scenario 2, simulation the communication based on the number of interaction between the switches.

Consequence graph for Packet Delivery Ratio vs. no. Of users. Consequence graph for Latency vs. no. Of users.

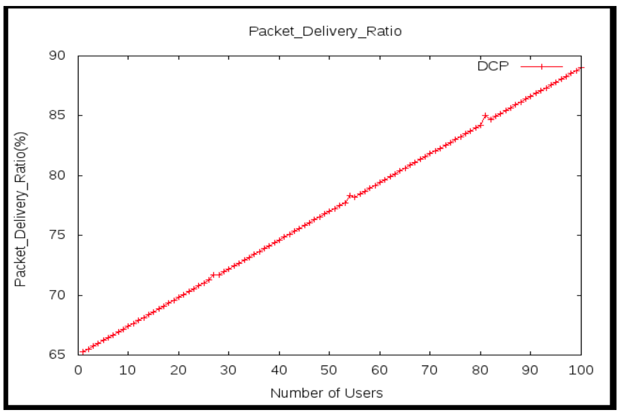


Fig.15: scenario-2, result of Packet Delivery Ratio vs. no. Of users.

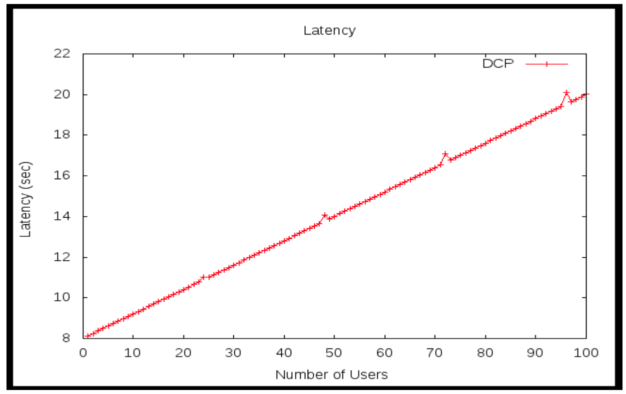
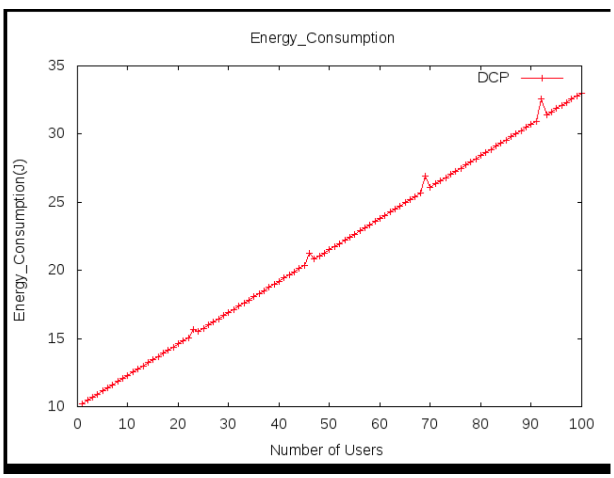
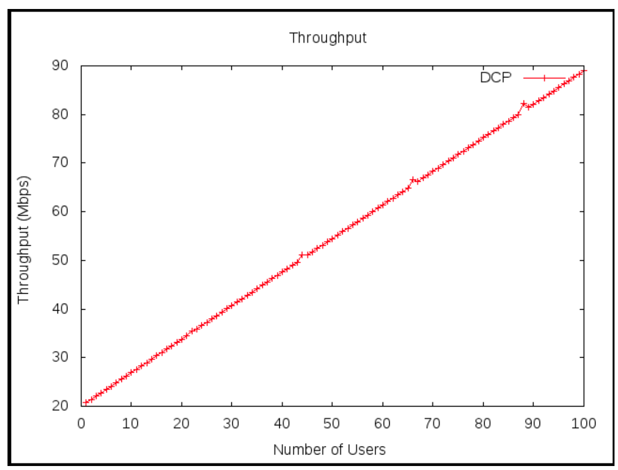


Fig.16: scenario-2, result of Latency vs. no. Of users.





Consequence graph for Energy consumption vs. no. Of users. Consequence graph for throughput vs. no. Of users.

Fig.17: scenario- 2, result of Energy consumption vs. no. Of users.

Fig.18: scenario-2, result of throughput vs. no. Of users.

As was explained before, there is a direct proportion between the number of users and all performance metrics (packet delivery ratio, latency, throughput, and energy consumption); the only difference is that the starting values for each metric are different. It is because of the varied quantities of devices and kinds of networks (how many controller and the type of SDN models).

In scenario 3, create a Network, it consists of 100 user nodes, 8 Switches (Label Switching Routers) and 1- Global/central controller (CCP)

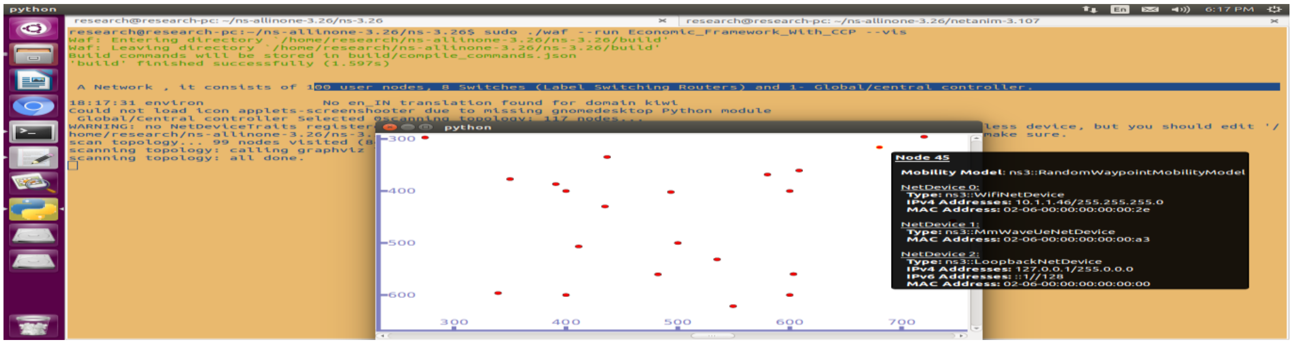
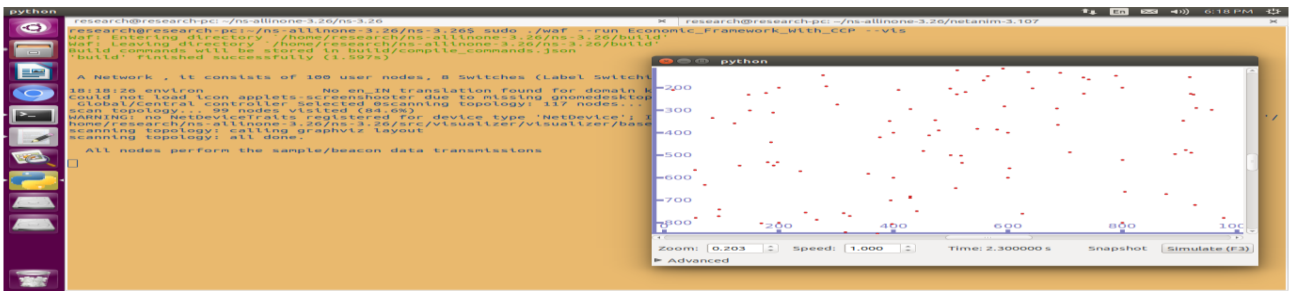


Fig.19: scenario 3, network consists of 100 user nodes, 8 Switches (Label Switching Routers) and 1- Global/central controller.



Initially, all nodes perform the sample/beacon data transmissions.

Fig.20: scenario 3, all nodes perform the sample/beacon data transmissions.

Select the optimal path between the nodes based on the (MPLS-Traffic Engineering) model process by using RSVP-TE.

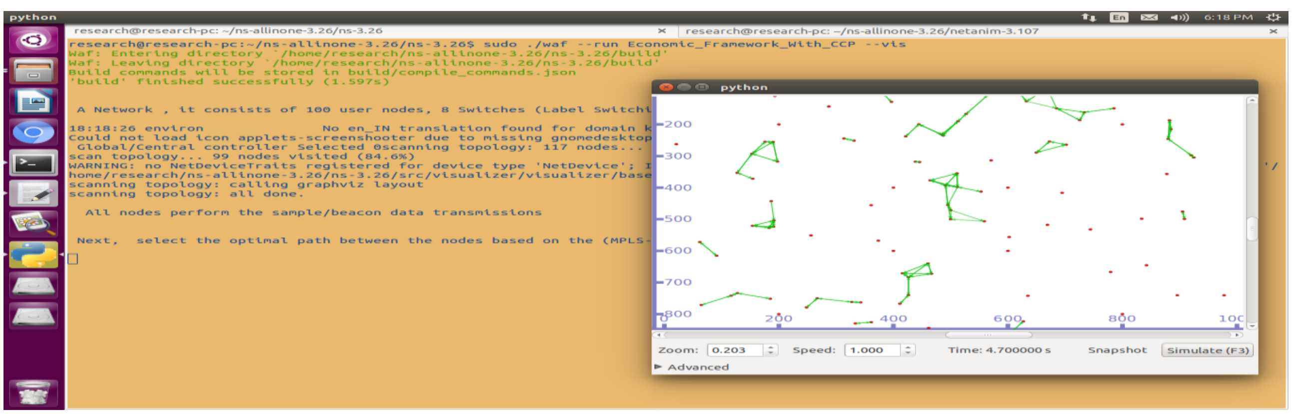


Fig.21: scenario 3, the optimal path between the nodes based on the (MPLS-Traffic Engineering) model process by using RSVP-TE.

Perform the request and response communication based on the number of interaction between the switches [this flow is based on the OPEX process].

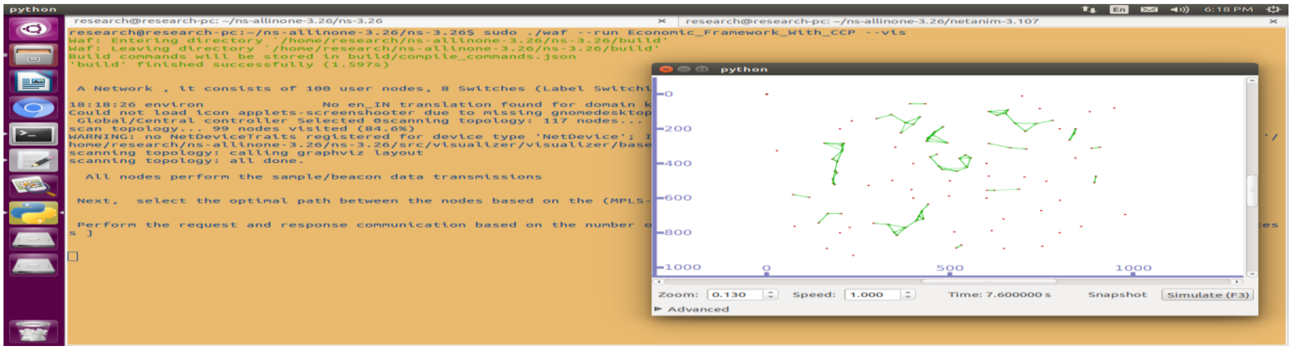
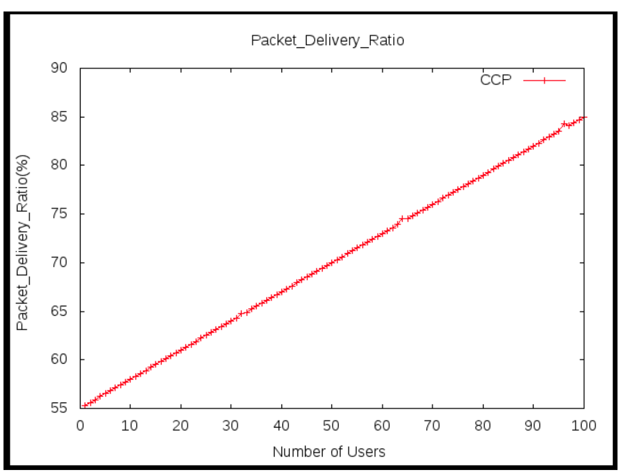


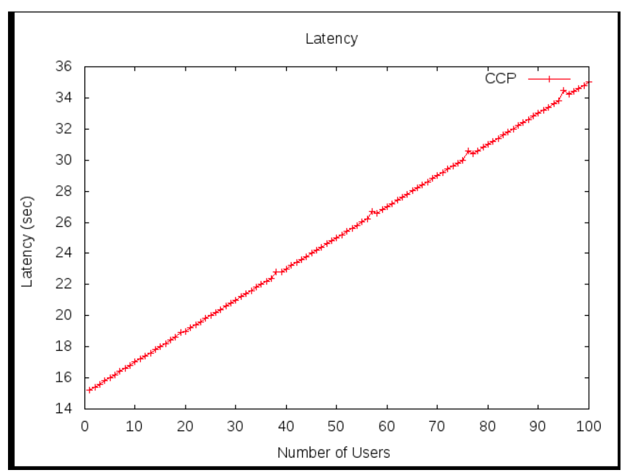
Fig.22: scenario 3, communication based on the number of interaction between the switches.

Get the simulation

Fig.23: scenario 3, simulation the communication based on the number of interaction between the switches.



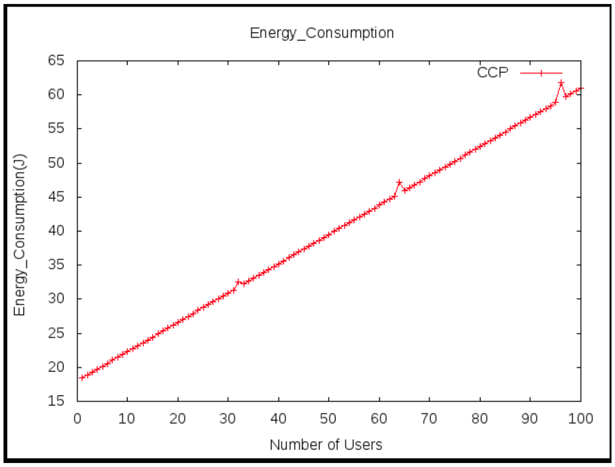
Consequence graph for Packet Delivery Ratio vs. no. Of users.



Consequence graph for Latency vs. no. Of users.

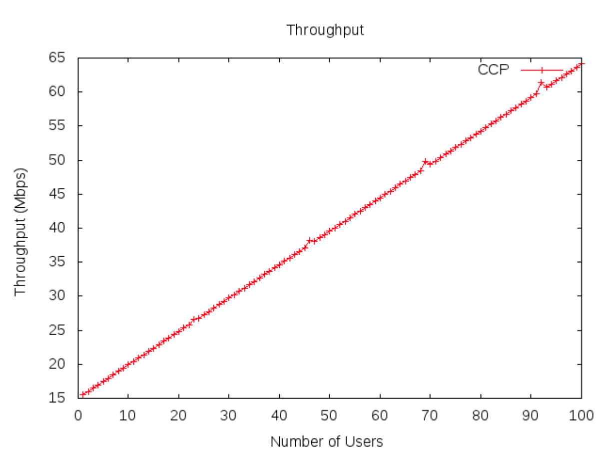
Fig.24: scenario-3, result of Packet Delivery Ratio vs. no. Of users.

Fig.25: scenario-3, result of Latency vs. no. Of users.



Consequence graph for Energy consumption vs. no. Of users.

Fig.26: scenario-3, result of Energy consumption vs. no. Of users.



Consequence graph for throughput vs. no. Of users.

Fig.28: scenario-3, result of throughput vs. no. Of users.

V. CONCLUSION

Have to compared and contrasted the various SDN models, with one another so that we can gain a better explain of the economic impact that each of these models has. Because of this separation, network operators and administrators are able to make more efficient use of the network's resources and have an easier time provisioning those resources. Through the programmability that it brings to the table, it makes it much simpler to alter the properties of the entire network.

The software-defined networking (SDN) paradigm possesses a number of important characteristics that, when combined, have an effect on the CAPEX and OPEX equations of a network. These characteristics include: Because of the networking features it promises, it has attracted the attention of researchers from both academia and industry as a potential avenue that could be exploited to bring about a reduction in the costs of maintaining networks and the generation of revenue for service providers. This is because it is a potential avenue that could be exploited to bring about these benefits. These two models show an increase as the switch number increases due to an increase in total connections, which results in more OPEX being incurred in the network for each switch case. This increase is due to the fact that there are more connections overall. MPLS has been shown to have a higher unit service cost than SDN models do. This is due to the fact that MPLS has a lower number of satisfied requests and a higher total cost of ownership when compared to SDN models. The results have shown this to be the case, Because of this, MPLS results in a higher cost for each individual unit of service that is utilized. This is how things are due to the fact that MPLS cannot be easily automated or programmed. The amount of time necessary to introduce a service is cut down, and this reduction is independent of the number of devices that are in use because SDN is automated and programmable.

VI. APPENDIX

- ✓ **“A SURVAY- RESOURCES MANAGEMENT IN 5G MOBILE NETWORKS”, AL-IRAQI JOURNAL FOR SCIENTIFIC ENGINEERING RESEARCH.**

- ✓ **“ECONOMIC SCALABILITY OF 5G MOBILE NETWORK BY SDN & MPLS, INTERNATIONAL JOURNAL ON “TECHNICAL AND PHYSICAL PROBLEMS OF ENGINEERING” (IJTPE) PUBLISHED BY INTERNATIONAL ORGANIZATION OF IOTPE.**

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