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Performance Analysis of ONOS and Floodlight SDN Controllers based on TCP and UDP Traffic

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***Abstract*-Software-Defined Networking (SDN) is newly originated network architecture. SDN characterizes by flexible, dynamic, cost-effective, and convenient to manage. This article essentially provides two OpenFlow-enabled controllers, i.e., Floodlight controller and ONOS controller. A performance comparison of both controllers is tested over different network topologies (single, linear and tree). The analyzing of controllers based on some metrics such as transfer, Delay, bandwidth and jitter using an efficient network simulator called Mininet. The ONOS show better performance compared to Floodlight in both TCP and UDP traffic in network.**

Keywords—SDN, openflow, floodlight, ONOS, mininet

I. INTRODUCTION

Recently, the core companies of the global network and Internet Services Providers (ISPs) have been notice the limitation such as architecture, packet headers, router configuration, etc. in the network infrastructure because of fast growing in applications and users[1, 2]. These challenges and problems motivate researchers and scholars mining in to figure out solutions. In this aspect many proposals have been introduce and the SDN is the proper can be used to fix the current networks'connectivity problems. It changes the way we design and manage networks [2]. Fig. (1) gives schematic diagram for SDN layers. SDN has two main defining characteristics are describe in [3]. OpenFlow is a famous illustration of such an API, it validates the SDN approach, and many network architectures, and systems. As defined in an OpenFlow switch has one or more tables of packet-handling rules.

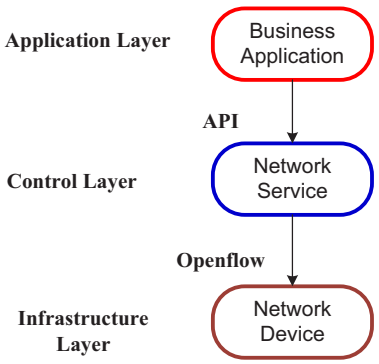

Figure .1 SDN Architecture[4]

Each rule goes with a subset of traffic and achieves certain events on the traffic that matches a rule; actions contain dropping, forwarding, or flooding. Depending on the rules set up by a controller application, an Open Flow switch can act like a router, switch, firewall, network address translator [5], [6]. The main idea is to collect several performance metrics (delay, bandwidth, jetter and transfer) for the network communication system and used SDN coordination's protocols to accurately address the network limitations.

The outline of this paper is: Section II presents related work, Section III deals with Methodology, Section IV shows platforms setup and the fifth section is about results and evaluation. Finally, section IX states the conclusion and future work.

II. RELATED WORK

M. Z. A. et al, [5] has been conducted an extensive simulates to analyze the performance analysis of congestion control mechanism in SDN by implementing Link Layer Discovery Protocol (LLDP) under congested network. This simulation is carried out on mininet by creating four different fannout the data was analyzed based on different matrix performances. Accordingly, there were saved matrix performances that were being analyzed to measure the performance of the proposed method. There matrix performances include Packet Loss Rate, Packet Delivery Ratio and Throughput for this experiment; they tested one variable parameter which is the number of fannout in SDN topology. The result demonstrated that the packet loss and throughput reduction were observed when number of fanout in the topology was increased. By using LLDP protocol, huge reduction in packet loss rate has been achieved while maximizing percentage packet delivery ratio.

For the purpose of new Approach for SDN Performance Enhancement simulated four SDN controllers, namely, NOX, POX, Beacon, and Floodlight and represented the results with necessary recommendations for SDN implementation and deployment in enterprise network. The authors have been obtainable a performance driven packet scheduler for SDN controllers. They have observed significant performance enhancement in Beacon, POX, NOX and FloodLight controller [4].

In order to analyze and performance modeling of software defined network under bursty Multimedia Traffic. The authors in [7] have been proposed design a novel analytical model to comprehensively investigate the performance of the SDN networks with the input of bursty and correlated traffic. This article has planned a systematic model for the Software SDN

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architecture in the company of Markov-Modulated Poisson Process (MMPP) arrivals capturing the traffic characteristics of multimedia applications. The article considers the performance metrics of average network throughput and average latency. The tool that utilized is OMNET++ simulation to validate the system through extensive experiments. The validation results have detected that the average latency and the average throughput observed by the developed analytical model rationally equivalent those get from the simulation experiments.

III. METHODOLOGY

This article used to assess open flow controllers performance measures, Authors orchestrate several performance tools to figure out the problem. To address the communication link bottle and speed up packets exchange three different topologies used particularly single, linear, tree. Many simulators used to evaluate performance criteria for open flow controllers and the mininet simulator is the first candidate to be used under Ubuntu operating system platform. Platforms configure the network model to include one controller connected to the OpenFlow switch. Mininet can be used to emulate the network; allow SDN simulations to develop SDN solutions, in addition to creating and managing the system prototype. Mininet can create SDN network elements such as host, switch, connectors and console in a standard Linux environment. In our work, a simple network can be created by using a command-line tool; that is "mn" as in follow:

i. **Single topology:** The single topology in Mininet environment consists of a single OpenFlow-enabled switch and number of host's. The switch in turn gets connected with a control plane available on the topology. To create a single topology and connect a floodlight controller or ONOS controller as shown in Fig. (2) with 5-hosts follow the structure command below:
Sudo mn --topo single, 5 –controller remote,ip=127.0.0.1,port=6653

ii. **Linear Topology**: Is including linear connection between switches and hosts. Each host connects with its particular switch and the switches are connected with each other linearly. All the OpenFlow-enabled switches in turn gets connected with a remote controller. A linear topology having 5-hosts connected with Floodlight controller or ONOS controller as shown in Fig. (3).

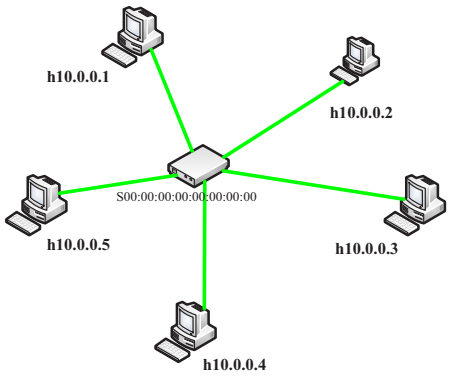


Figure 2.Single Topology

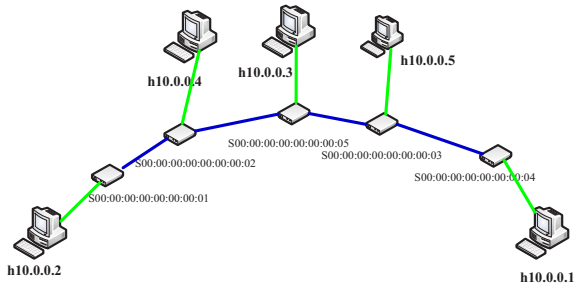


Figure 3.Linear Topology

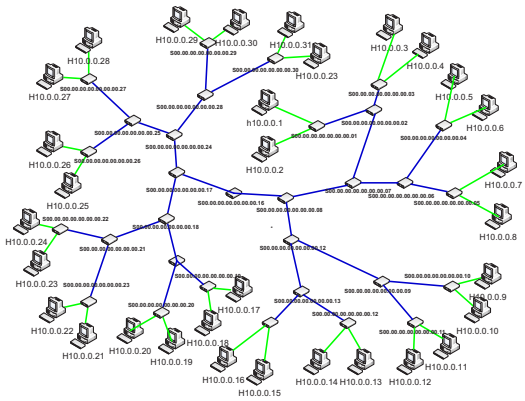


Figure 4.Tree Topology

To create linear topology as in Fig. (3) follows the command below:
Sudo mn –topo linear, 5--controller remote,ip=127.0.0.1,port=6653

iii. **Tree Topology: A**ll OpenFlow-enabled switches and hosts are linked with each other in a hierarchical fashion. A tree topology having 32-hosts in floodlight controller or ONOS controller as shown in Fig. (4). In order to launch a tree network topology, executed the following command in Mininet CLI:
sudo mn--topo tree, 5--controller remote,ip=127.0.0.1,port=6653

IV. RESULTS AND DISCUSSION

This section illustrated the performance of the Floodlight and ONOS controllers by using Iperf Tool that generating TCP Traffic. Protocols to be examine base on floodlight and ONOS protocols the simulation was carried out and the findings are presented. ***Iperf tool*** used to generate traffic between two hosts in our network model. One of the hosts used as client while the second one used as servers. Generate traffic of the TCP with 85.3 Kbyte window size and UDP with buffer size of 208 Kbyte. The data are collected from Iperf benchmark tool that used in this study in 10 different shots. Transfer, Bandwidth, Delay and Jitter are more important performance major to be used in evaluation for the SDN controller's architecture. The test values of Transfer, bandwidth and delay have been collected in our simulation with interval time 1 sec. The performance based on UDP and TCP respectively.

A. Performance based generating TCP Traffic:

This subsection illustrates the performance of the Floodlight and ONOS controllers that generating TCP Traffic according to single, linear and tree topologies, respectively.

1. Single Topology:

The following section provides the results obtained by testing the Floodlight and ONOS controllers in simulation environment that implemented in Mininet. Single topology reflects the simple way for evaluating controller behavior. Fig. (5), Fig. (6) and Fig. (7) are shows the transfer, bandwidth and delay over a single topology, respectively. Its clear that ONOS controller gives performance better than floodlight controller.

The traffic Transfer of floodlight ranged is from 244 to 423 MB and the highest value of the transfer is 423 MB, On the other hand the transfer of ONOS ranged is from 126 to 596 MB and the highest value of the transfer is 596 Mbytes.

The Bandwidth of floodlight ranged is from 2.05 to 3.55 Gbits. The highest value of the Bandwidth is 3.55 Gbits. On the other hand the Bandwidth of ONOS ranged is from 1.06 to 5Gbits. The highest value of the Bandwidth is 5Gbits.

The Delay of floodlight ranged is from 0.132 to 25ms. The highest value of the Delay is 25, On the other hand the Delay of ONOS ranged is from 0.153to 0.216 ms. the highest value of the Delay is 0.216 ms.

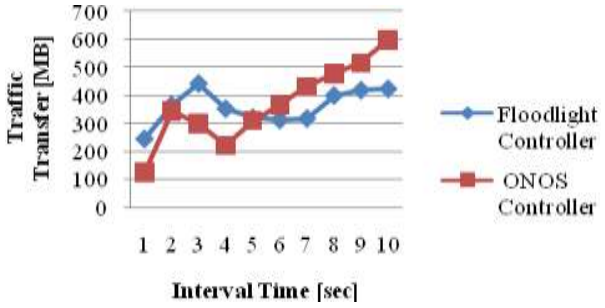


Figure 5. Traffic Transfer of Single Topology

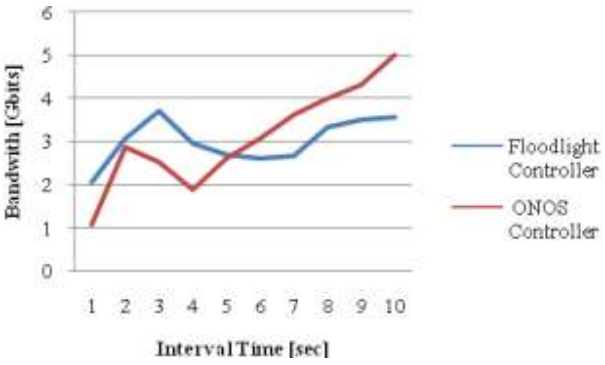


Figure 6. Bandwidth of Single Topology

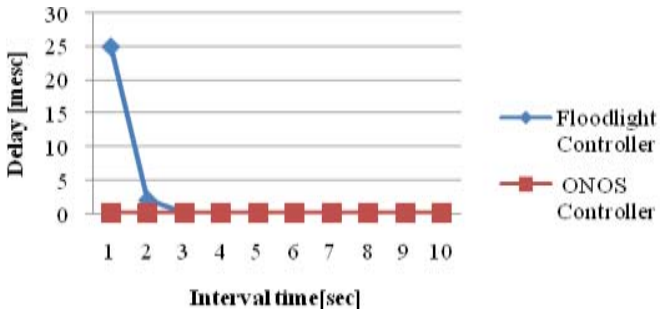


Figure 7. Delay of Single Topology

2. Linear Topology:

Fig. (8), Fig. (9) and Fig. (10) are displayed the results of linear topology based on transfer, bandwidth and delay respectively. The Transfer of floodlight ranged is from 139 to 737 Mbytes.

The highest value of the Bandwidth is 737 MB, On the other hand the transfer of ONOS ranged is from 142 to 558 MB. The highest value of the transfer is 558 MB.

Fig. (9) displayed the results of the bandwidth of floodlight ranged from 1.62 to 5.55 Gbits. The highest value of the Bandwidth is 5.55, On the other hand the Bandwidth of ONOS ranged is from 1.19 to 4.68Gbits. The highest value of the Bandwidth is 4.68Gbits.

The delay time is high when you start the transmission because when you start the network for the first time, the network is in a state of initialization so it takes a long time. The Delay of floodlight ranged is from 0.209 to 135ms as in Fig. (10). The highest value of the Delay is 135ms, On the other hand the Delay of ONOS ranged is from 0.217 to 0.354 ms. the highest value of the Delay is 0.354 ms.

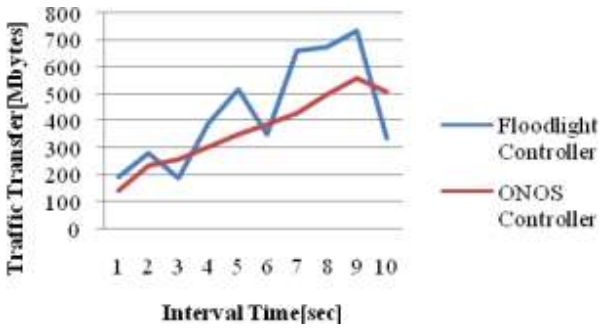


Figure 8. Traffic Transfer of Linear Topology

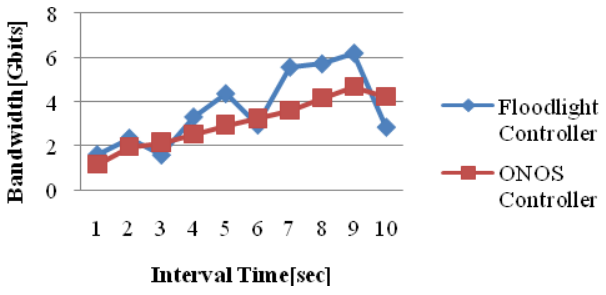


Figure 9. Bandwidth of Linear Topology

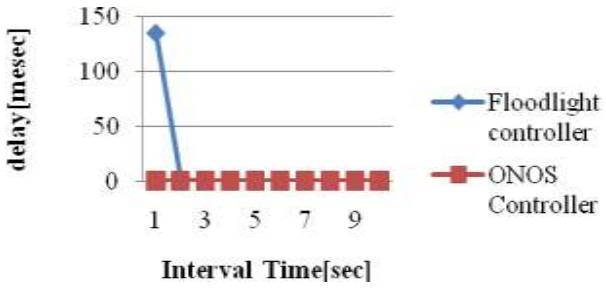


Figure 10. Delay of Linear Topology

3. Tree Topology:

Fig. (11), Fig. (12) and Fig. (13) are illustrates the outcome of tree topology based on transfer, bandwidth and delay respectively. The Transfer of floodlight ranged is from 154 to 392 Mbytes. The highest value of the Bandwidth is 392Mbyte as in Fig. (12). On the other hand the transfer of ONOS ranged is from 128 to 456 MB. The highest value of the transfer is 456 MB. Fig. (12) present the Bandwidth of floodlight ranged from 1.47 to 3.29 Gbits. The highest value of the Bandwidth is 3.29 Gbits. On the other hand the Bandwidth of ONOS ranged is from 1.08 to 3.67Gbits. The highest value of the Bandwidth is 3.67Gbits. The Delay of floodlight ranged is from 0.314 to 113ms as in Fig. (13). The highest value of the Delay is 113, On the other hand the Delay of ONOS ranged is from 0.32 to 0.497 ms. the highest value of the Delay is 0.497 ms.

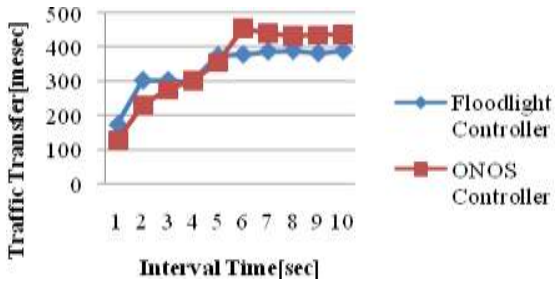


Figure 11. Traffic Transfer of Tree Topology

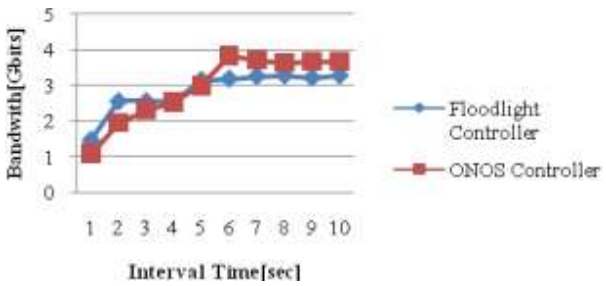


Figure. 12. Bandwidth of Tree Topology

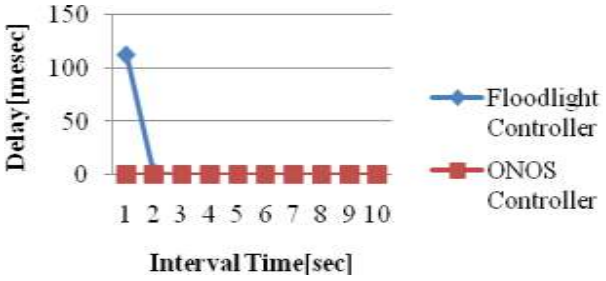


Figure 13. Delay of Tree Topology

B. Performance based generating UDP Traffic:

This subsection demonstrates the performance of the Floodlight and ONOS controllers by using ***Iperf*** Tool that generating UDP Traffic according to single, linear and tree topologies, respectively.

1. Single Topology

Fig. (14) provides the Transfer of floodlight ranged from 128 to 131 Mbytes. The highest value of the Bandwidth is 131MB, On the other hand the transfer of ONOS ranged is from 128 to 129 Mbytes. The highest value of the transfer is 129 MB.

Fig. (15) displayed the results of the Bandwidth of floodlight ranged in range of 1.05 to 1..07 Gbits. The highest value of the Bandwidth is 1.07Gbits. On the other hand the Bandwidth of ONOS ranged is from 1.05 to 1.06Gbits. The highest value of the Bandwidth is 1.06Gbits.

Fig. (16) presents the results of the Jitter of floodlight ranged from 0.071 to 0.227 ms. The highest value of the Jitter is 0.227ms, On the other hand the Jitter of ONOS ranged is from 0.04 to 0.88ms. The highest value of the Jitter is 0.88ms.

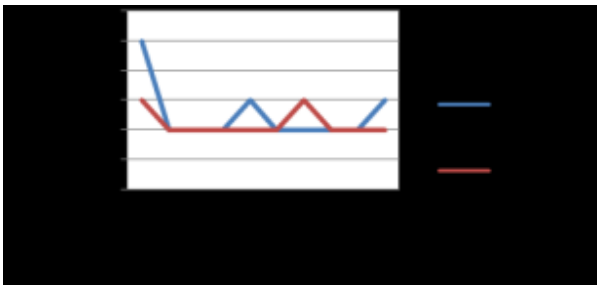


Figure 14. Traffic Transfer of Single Topology

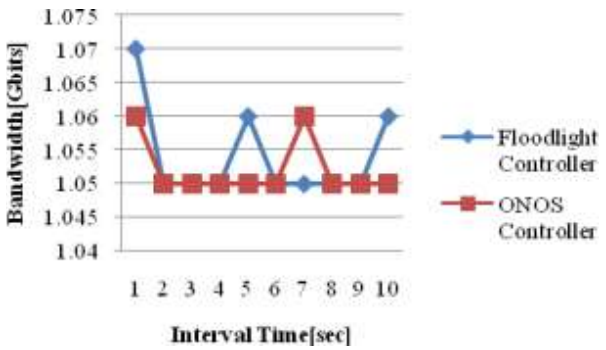


Figure 15. Bandwidth of Single Topology

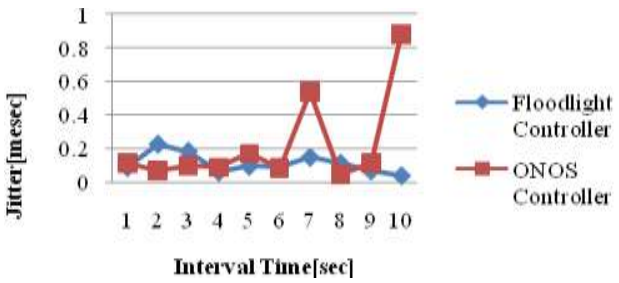


Figure 16. Jttter of Single Topology

2. Linear Topology

Fig. (17) provide the results of the Transfer of floodlight ranged from 128 to 129 Mbytes. The highest value of the Bandwidth is 129Mbyte.

On the other hand the transfer of ONOS ranged is from 128 to 129 Mbytes. The highest value of the transfer is 129 Mbytes.

The Bandwidth of floodlight ranged is from 1.05 to 1.06 Gbits display in Fig. (18). The highest value of the Bandwidth is 1.06Gbits. On the other hand the Bandwidth of ONOS ranged is from 1.05 to 1.06 Gbits. The highest value of the Bandwidth is 1.06 Gbits.

The Jitter of floodlight ranged is from 0.086 to 0.136 ms illustrate in Fig. (19). The highest value of the Jitter is 0.136ms; On the other hand the Jitter of ONOS ranged is from 0.116 to 0.361ms. The highest value of the Jitter is 0.361ms.

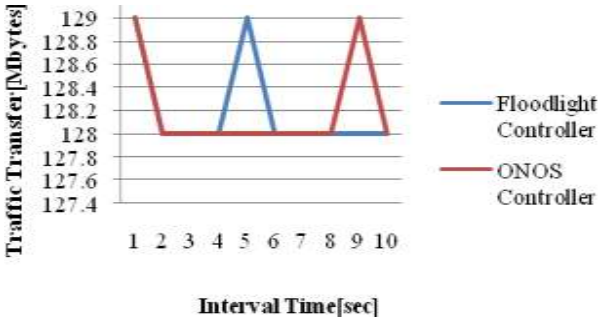


Figure 17. Traffic Transfer of Linear Topology

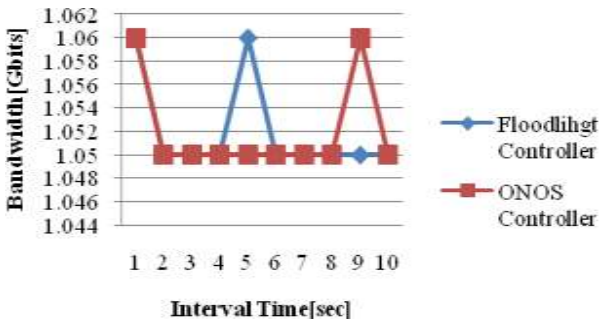


Figure 18. Bandwidth of Linear Topology

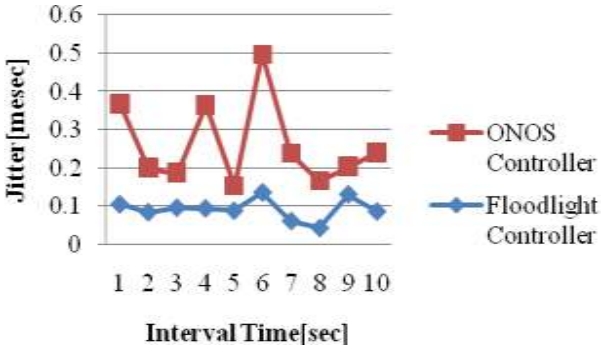


Figure 19. Jttter of Linear Topology

3. Tree Topology

The Transfer of floodlight ranged is from 128 to 129 Mbytes display in Fig. (20). The highest value of the Bandwidth is 129Mbyte.

On the other hand the transfer of ONOS ranged is from 128 to 132 Mbytes. The highest value of the transfer is 132 Mbytes.

The Bandwidth of floodlight ranged is from 1.05 to 1.06 Gbits. The highest value of the Bandwidth is 1.06Gbits. On the other hand the Bandwidth of ONOS ranged is from 1.05 to 1.08 Gbits. The highest value of the Bandwidth is 1.08Gbits as in Fig. (21).

The Jitter of floodlight ranged is from 0.09 to 0.386 ms display in Fig. (22). The highest value of the Jitter is 0.3866 ms. On the other hand the Jitter of ONOS ranged is from 0.07 to 0.397ms. The highest value of the Jitter is 0.397ms.

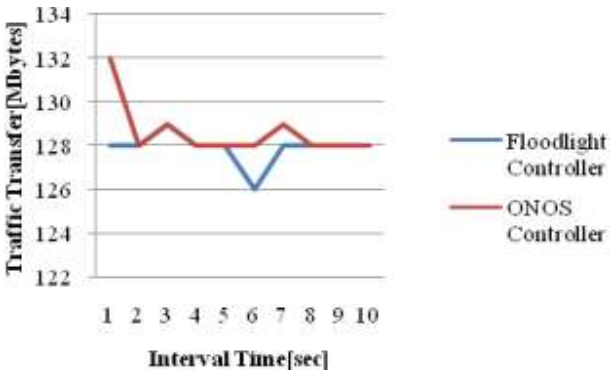
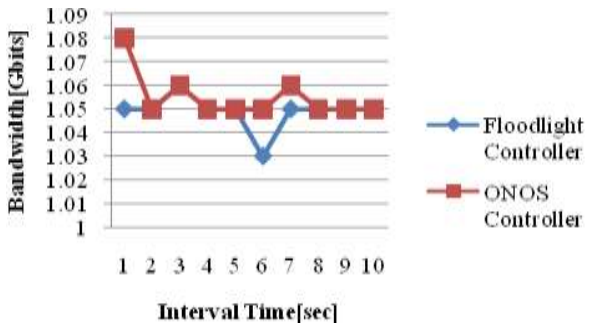


Figure 20. Traffic Transfer of Tree Topology



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igure 21. Bandwidth of Tree Topology

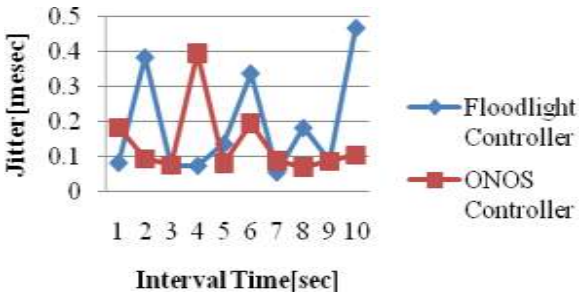

Figure 22. Jitter of Tree Topology

V. CONCLUSION

The SDN based on OpenFlow-enabled networks are a hopeful technology for future Internet. Many approaches are considered for an efficient performance of the SDN controllers. The study was focus into most popular SDN controllers: Floodlight and ONOS. We configured network model that manage by one controller and connected to one two OpenFlow switch. We used Mininet simulation; the SDN simulation allows developing SDN solutions. We are compared between two controllers in terms of transfer, bandwidth, jitter and delay. The ONOS show better performance compared to Floodlight in both TCP and UDP traffic in network. This study can help companies to choose the best controller that can be used in environment. In future work, the calculation of all parameters will consider.

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