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Assessing the Quality of Service of POX Controller in SDN

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ABSTRACT
Today Networks are found everywhere. In our day to day life we find ourselves almost always connected to internet. SDN is a new paradigm over traditional network systems to revolutionize the network and to overcome from its problem of vendor lock-ins. With the decoupling of 3 layers – Application Layer, Control Layer and Infrastructure Layer has ensured faster innovations and has broken vendor monopolies by supporting heterogeneity in the infrastructure. QoS parameters such as network reachability, bandwidth utilisation, packet loss and delays are the key solutions for measuring the performance of SDN. We take advantage of POX controller in SDN.
KEYWORDS: Software Defined Network (SDN), POX, Quality of Service (QoS), Network Rechability, Bandwidth Utilisation, Packet Loss, Delay

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I. INTRODUCTION

Software Defined Network (SDN) is a new programmable network over complex traditional network. In the old networks, all the complex functions were baked onto one device. Applications, Network Operating System Functions, and packet forwarding functions all were implemented by a single device. This device cannot dynamically change according to network situation. It works as closed equipment where software is bundled with hardware. It is a vendor specific device and changes in these devices used to take long delays.

SDN works on open flow architecture. It divides the network functionality into 3 layers- Application Layer, Control Layer and Infrastructure Layer. These layers offer abstraction that enable innovations. SDN supports heterogeneity in infrastructure. Infrastructure layer is responsible for mere forwarding the packets among the devices. Logically centralised control is implemented at the control layer. Any application like network virtualisation, security apps, load balancing, mobility management etc. can take advantage of SDN architecture. SDN controller manages the flow control tables through which switches take decisions whether to forward packet or discard it. It acts as an OS for network. Controller uses various protocols to configure network devices.

Northbound API is to management plane or Application plane. It is an open issue and no standardization has been done. It is software based eco system. Southbound API is to control plane and is for handling instructions from control plane. Westbound and Eastbound APIs are between distributed and centralised SDN controller at the control layer. Figure 1 depicts the SDN layers and its architecture.

SDN leverages the benefits of open flow protocol. Decoupling of 3 layers introduce the various abstractions at data, application, control and network level which supports faster innovations and reduces complexity.

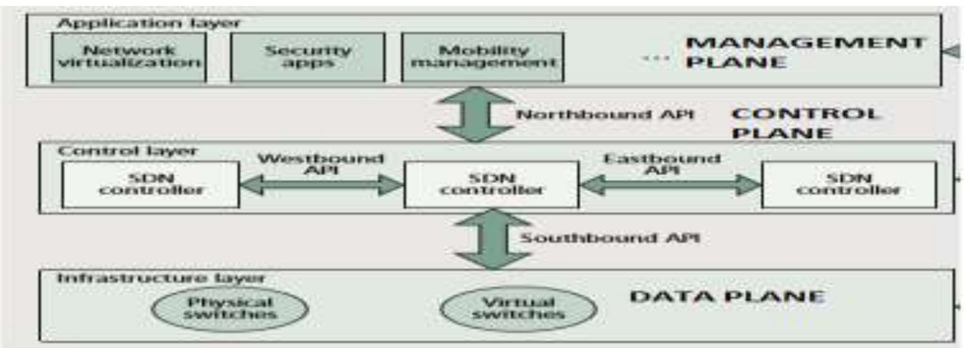

Fig 1. SDN Layers [1]

II. BACKGROUND

Software Defined Networking gained significant focus after the introduction of OpenFlow [2]. In [3], the authors proposed the measurements for each packet, a way to determine and enforce which slice (or slices) it belongs to, To isolate the bandwidth of one slice from another, and to allow the forwarding decisions for each slice to be controlled independently by its own control logic. Future solution is based on finding Optimal, general, or even practical solutions to virtual network resource allocation, management, and debugging have potential to be fruitful areas of research. In [4], the authors compared the present techniques in SDN focusing on their features related to QoS, Load Balancing (LB), Scalability and Security. In [5], the authors implemented Latency, Throughput, Traffic Management Check. This paper investigates the use of QoS-based routing over SDN.

There is a recent work [6] that used the SDN technology to deal with congestion in data centers. A rerouting mechanism was advised to avoid transferring packets through congested links. The direction of previous work is different from ours. Although many related work has been done in the area but they do not put “zero-packet-loss” as their most important goal

III. EXPERIMENTAL SETTINGS

We have mininet virtual machine installed on Ubuntu 14.04.4 OS, SSH is built using putty on windows platform to guarantee that secure network GUI is achieved. Table 1 depicts the used experimental setting for the performance evaluation of POX controller.

OS Type	Virtualisation Software	X Server	Terminal	Emulator
Windows 7	Virtual Box	Xming	Putty	Mininet on Ubuntu 14.04.4

Table 1: Experimental Setting

Mininet allows us to work with various topologies like minimal, single topology, reversed topology, linear topology and tree topology. We can have installer as per our requirements like POX, NOX, foodlight, Onix, Beacon etc. Each of these controllers support different platforms. We are using POX controller which supports python scripts.

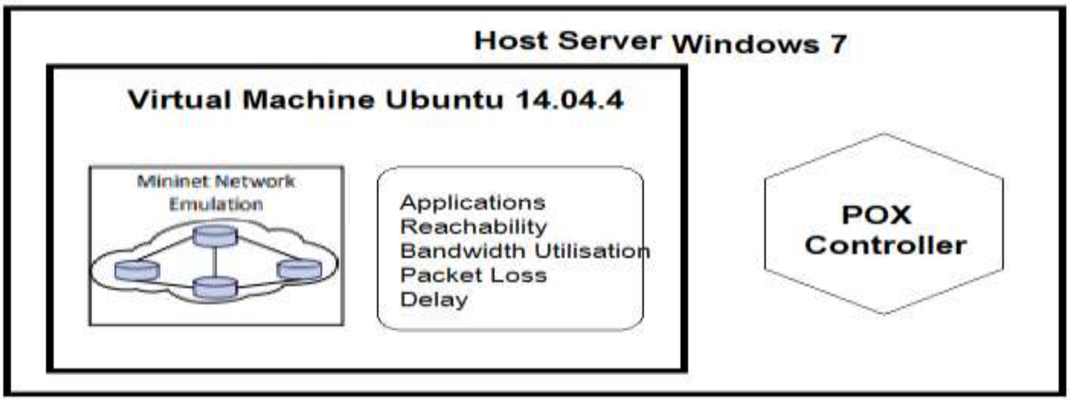

Fig 2. The assembled test configuration

We have build a simple network topology with 4 hosts, 1 switch, and 1 Pox controller as depicted in figure 3. Miniedit is used for the graphical representation of our topology. To use the Miniedit GUI, at the command line in the PUTTY terminal, type:

sudo ~/mininet/examples/miniedit.py

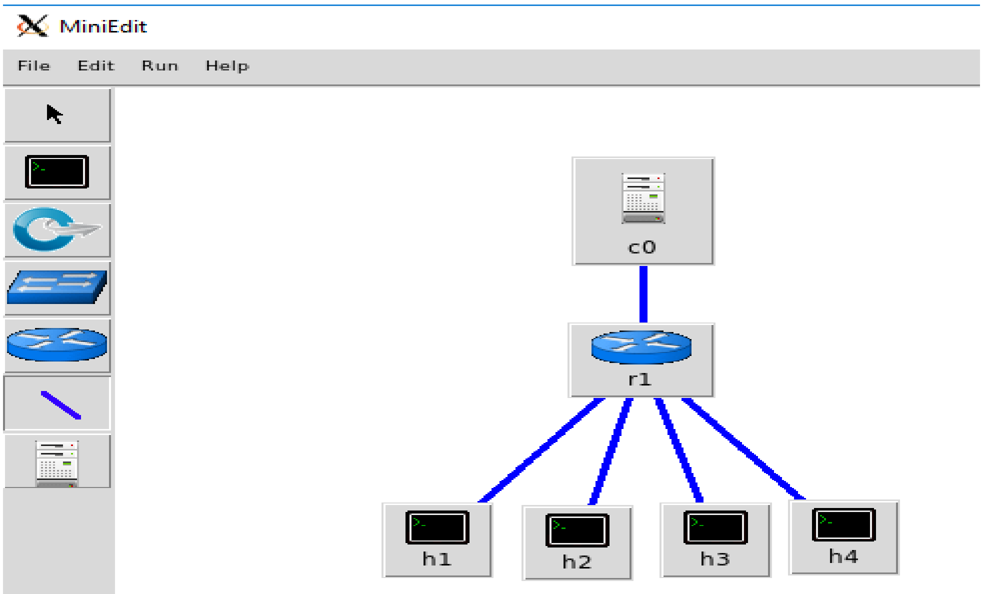

Fig 3. Simple Network Topology

IV. PERFORMANCE EVALUATION

We have created a simple topology over mininet and have set up a POX controller on the top of it. Different tests have been conducted to check the performance of SDN network.

Performance Metrics:

For the result analysis by keeping in mind the following metrics various tests have been conducted:

1. **Network Throughput**: Throughput is the number of data packets delivered from source to destination per unit of time.

$$T = \frac{1}{n}\sum_{i=1}^{n}\frac{b_i}{t_i}$$

Where, bi = Total amount of data
t_i = time taken for destination to get the final packet
n= total no of application traffic

2. **Packet Delivery Ratio**: It's a ratio of the number of packets received by the destination to the number of packets send by the source.

PDR = No of packet received/ No of packet sent

3. **Packet Loss**: It is the measure of number of packets dropped by nodes due to various reasons.

Packet lost = No of packet sent – No of packet received

4. **Average end-to-end delay**: It is defined as average time taken by data packets to propagate from source to destination across Ad hoc network.

End to end delay = ∑ (arrived time – sent time)

Performance Tests

a) Network Connectivity Test: Pingall stamen checks the connectivity among the created network. Connectivity among the hists ensures the data transfer is possible among them. Wget feature of Linux has been used for sending files among the reachable hosts. Figure 4 with different frames ensures that connectivity among the hosts differ depending on the congestion state at that particular time, frame 1 shows that h1 and h3 has connectivity to all other hosts, whereas from h2 there is no connectivity to h1and h4 has no connectivity to h1. Frame 2 shows that h2 has no rechability to h3 and h3 has no r echability to h4. These tests are taken at interval of 20 seconds.

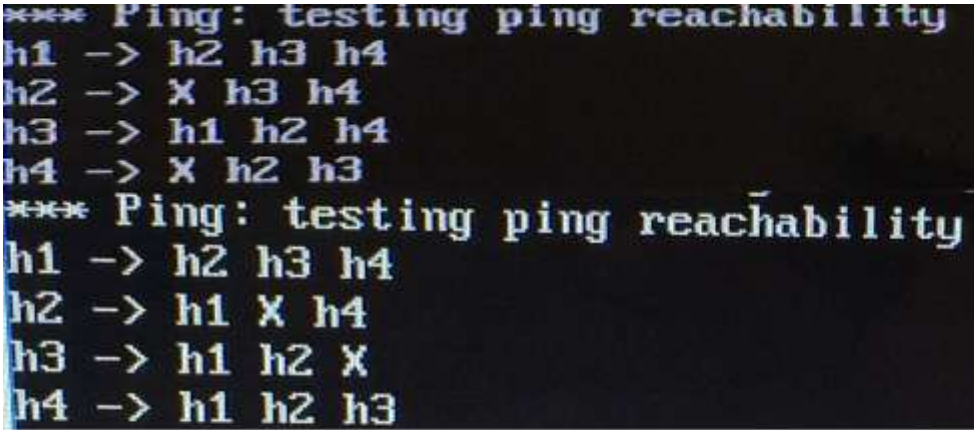

Fig 4. Pingall rechability test

b) SDN available bandwidth measurement: Bandwidth utilisation in a network serves as a key method for measuring QoS of network. Available bandwidth is an important component for both service provider and application perspective [7]. Figure 5, shows the two bandwidth frames taken at different amount of time.It measures the bandwidth between h1 and h4 at different available capacity links.

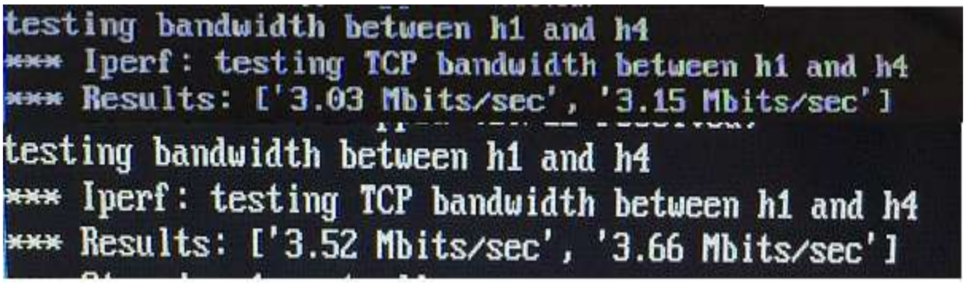

Fig 5: Available bandwidth measurement

c) Packet Loss and Delay Measurement: Another parameter on which we focused to measure the performance of network is packet loss ratio and packet delay. These measures will benefit many users and operators of network applications. In this paaper, we tried to find packet loss based on certain delay in the network, based on available bandwidth and delay due to certain traffic, different rate of packet loss has been identified. Figure 6 shows the packet loss and delay in our SDN Network.

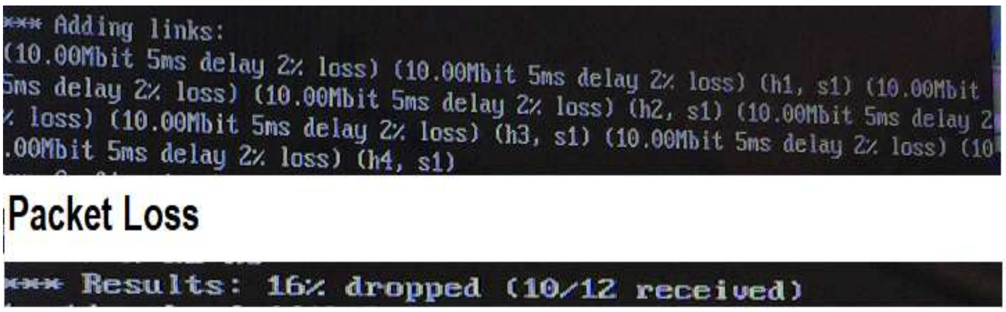

Fig 6. Packet Loss and Delay

V. CONCLUSION AND FUTURE SCOPE

In this paper we presented the approaches to measure the available bandwidth, network rechability, packet loss and delay in SDN. Our methods track the network utilisation of every link in network. We reported the results obtained with different network traffic at random times. These results constitute a reference for various applications like implementations for controlling traffic patterns, ensuring zero packet loss etc. SDN is high performance architecture which can sustain high traffic flow with less packet loss and low latency.

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