Global Journal of Computer Science and Technology: C
Software & Data Engineering
Volume 18 Issue 1 Version 1.0 Year 2018
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Performance Analysis of Different Openflow based Controller Over Software Defined Networking

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Abstract- Software Defined Networking (SDN) is a new networking paradigm where control plane is separated from data plane. Over the past several years, SDN has emerged as a compelling paradigm for developing and deploying new network capabilities and services. OpenFlow is the most commonly deployed Software Defined Networking architecture. Multiple networking switches can be controlled by a single centralized controlled OpenFlow controller. Different Python and Java based OpenFlow controller are available for Software Defined Networking. This paper implements Ryu, POX and Pyretic OpenFlow based Python controller in tree networking topology over Software Defined Networking. The result of this paper shows that these Python based OpenFlow controller performs well over SDN. All the implementation of different controller has been done using Mininet Emulator.

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GJCST-C Classification: *C.2.6*

Strictly as per the compliance and regulations of:

Performance Analysis of Different Openflow based Controller Over Software Defined Networking

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I. Introduction

Software-defined Networking [1, 2, 3] (SDN) has emerged as a new paradigm of networking that enables network operators, vendors, and even third parties to innovate and create new capabilities at a faster pace. This SDN paradigm shows potential for all domains of users. SDN played an important role in increasing the capabilities of traditional networking system [4]. Software-Defined Networking (SDN) has recently gained an unprecedented attention from industry and research communities. SDN provides us a simplified network management by enabling network automation, fostering innovation through programmability. Different types of controller in SDN technology are being used for observing the performance of networking system.

SDN provides some great features that allow the network providers and administrators to act as fast as possible to access, interchange and update any system easily [5]. It consists of decoupling the control and data planes of a network. It relies on the fact that the simplest function of a switch is to forward packets according to a set of rules. However, the rules followed by the switch to forward packets are managed by a software-based controller. One motivation of SDN is to perform network tasks that could not be done without additional software for each of the switching elements [6]. It allows abstracting the underlying infrastructure and program and open flow of data into the network by separating the control plane and the data plane. It has been gaining a great popularity both in the research communication & industry. Most network operators and owners are actively exploring SDN. For example, Google has switched over to Open Flow and SDN for its inter-datacenter network [7]. Different types of controller in SDN technology are being used for observing the performance of networking system. This paper analyzes performance of different OpenFlow based controllers in Software Defined Networking.

The structure of this paper is as follows. Section II, the research methodology is described. In Section III, proposed model Test Bed Setup is illustrated. Section IV, evaluates the results after the experiment. Section V; conclude the paper with future work.

II. Research Methodology

A literature review is performed to find out details about the routing algorithm over Software Defined Networking. After studying required software tools and hardware equipment are selected for implementing the different controller. Then software tools have been selected for the experiment. After then a preliminary experiment setup is designed which include the hardware setup and software configurations. Various software tools have been performed among OFNet [8], Maxinet [9], EstiNet [10], NS-3 [11], OMNET++ [12] and Mininet [13, 14]. Above discussion appears that for simulating Software Defined Networking open source networking Simulator Mininet has good potential.

Mininet is the most widely used open source networking Simulator. It can construct a vast network with the collection of networking elements such as switches, end-hosts, routers based on Linux kernel. Complicated network topology can be designed to virtualizes using Mininet. Most popular examples for

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developing SDN controller are Open Daylight, NOX, POX, Floodlight, and Beacon, Ryu and Pyretic. Ryu Controller is an open, software-defined networking (SDN) Controller designed to increase the agility of the network by making it easy to manage and adapt how traffic is handled. Pyretic controller is Python based controller that works on the control layer of SDN. Controllers are distinct from the switches in SDN. This separation of the control from the forwarding allows more sophisticated traffic management. OpenFlow communication protocol gives access to the forwarding plane of a network switch or router over the network.

III. Test Bed Setup

All the simulation has been done over Software Defined Networking using Mininet Emulator. In order to simulate tree networking topology has been used which shows on Figure-1. Mininet creates virtual hosts by using a process-based virtualization method and the network namespace mechanism, which is a feature supported since Linux version 2.2.26, to separate network interfaces, routing tables, and ARP tables of different virtual hosts.

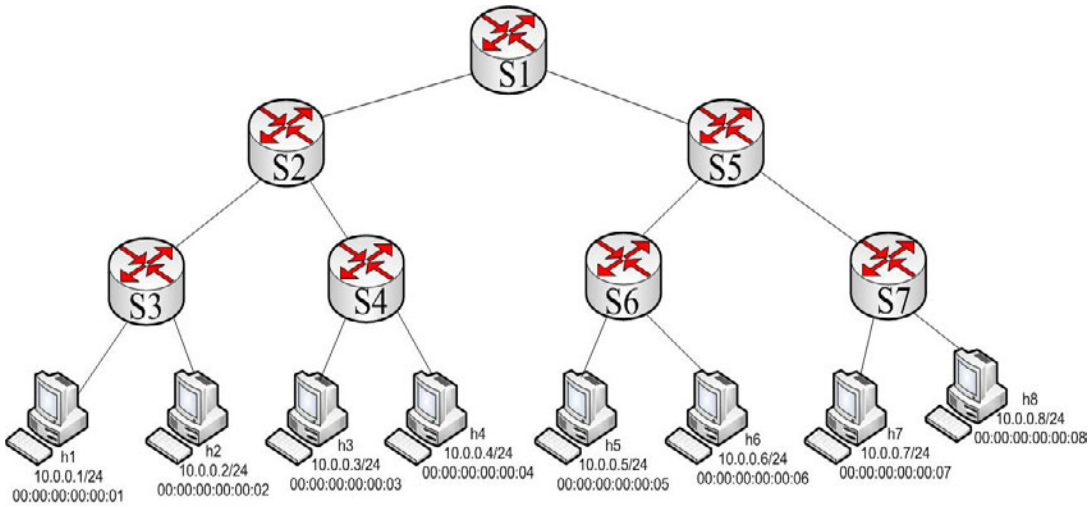
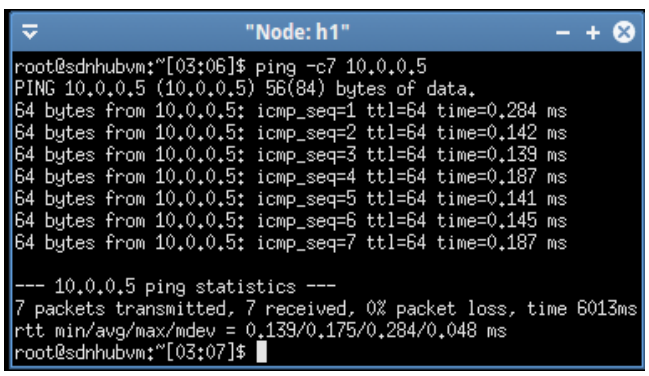


Fig. 1: Designed Network Topology

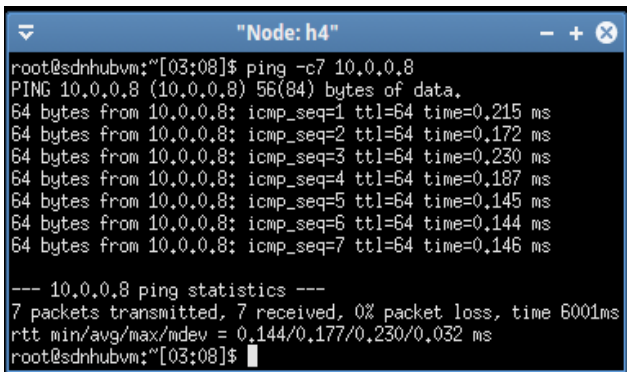
Designed tree networking topology consists of seven OpenFlow switch and eight hosts where two hosts is connected each of the switch. Host h1, h2 is connected to switch S1 and host h3, h4 is connected to switch S2. In addition, host h4, h5 is connected to switch S3 and host h5, h6 connected with switch S4.

IV. Result and Analysis

Different Python based OpenFlow controller has been implemented separately over Software Defined Networking. Firstly, Ryu controller has been implemented in designed tree network topology. In the designed network topology Ping executed from host h1 to host h5 and host h4 to host h8. Figure 2 shows the corresponding Ping result with statistics.



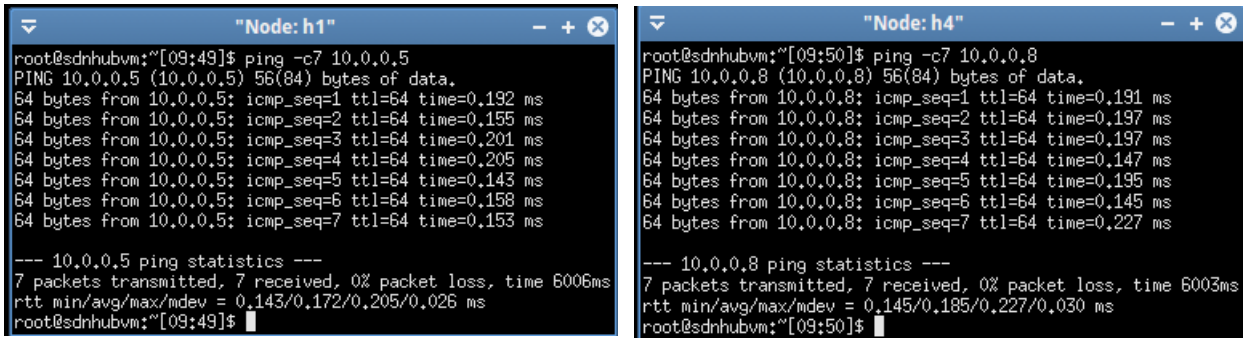
(a) Ping Message from h1 to h15



(b) Ping Message from h4 to h8

Fig. 2: Ping Test Result for OpenFlow Controller

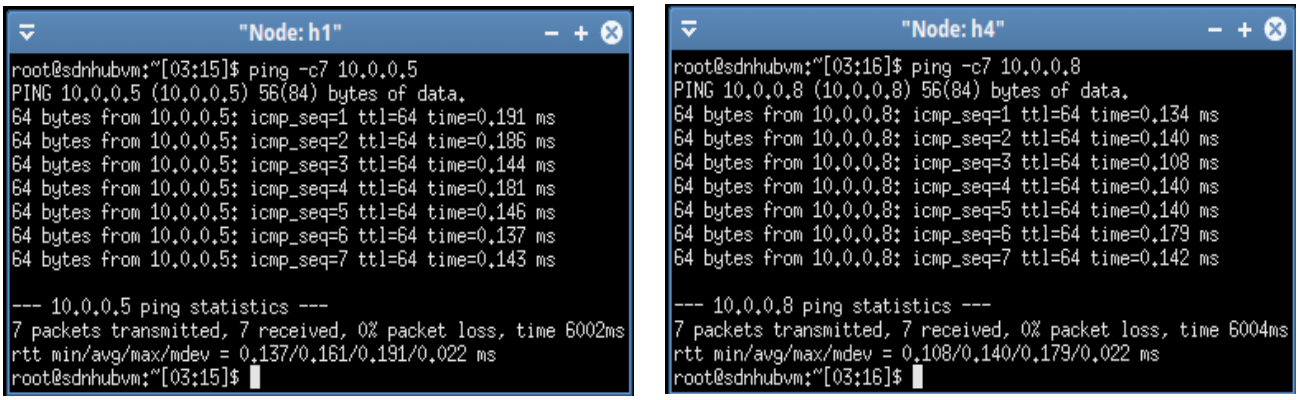
Secondly, OpenFlow POX controller performance has been implemented. For the designed network topology two Ping have been performed from host h1 to host h5 and host h4 to host h8. The obtained result has been shown in Figure 3 with Ping statistics.



(a) Ping Message from h1 to h5 (b) Ping Message from h4 to h8

Fig. 3: Ping Test Result for OpenFlow POX Controller

Finally, OpenFlow based controller Pyretic have been implemented over Software Defined Networking using Mininet Emulator. Similarly in previous two Ping message has been executed from host h1 to host h5 and host h5 to host h8. The result obtained for Pyretic controller has been shown in Figure 4 with Ping statistics.



(a) Ping Message from h1 to h5 (b) Ping Message from h4 to h8

Fig. 4: Ping Test Result for OpenFlow Pyretic Controller

Each of the OpenFlow based controller perform well over Software Defined Networking. The performance analysis graph has been drawn for Ping message from host h1 to host h5 in Figure 5.

Fig. 5: Performance Analysis Graph while Ping from host h1 to host 5

Round Trip Time (RTT) is the length of time it takes for a signal to be sent plus the length of time it takes for an acknowledgment of that signal to be received. This time delay therefore consists of the propagation times between the two points of a signal. Smallest Round Trip Time is always expected for analyzing networks performance. While Ping from host h1 to host h5 corresponding minimum, maximum and average Round Trip Time for each controller has been shown in table-1.

Table 1

Name of Controller	Minimum RTT (ms)	Maximum RTT (ms)	Average RTT (ms)
Ryu	0.139	0.284	0.175
POX	0.143	0.205	0.172
Pyretic	0.137	0.191	0.161

From table-1, Pyretic controller has smallest minimum RTT 0.137ms, maximum RTT 0.191ms and average RTT 0.161ms. Ryu controller has largest maximum RTT 0.284ms and largest average RTT 0.175ms. Since average RTT larger for Ryu controller compare to other controller, it has the lower performance. Performance analysis graph for Ping Message from host h4 to host h8 is shown in Figure 6.

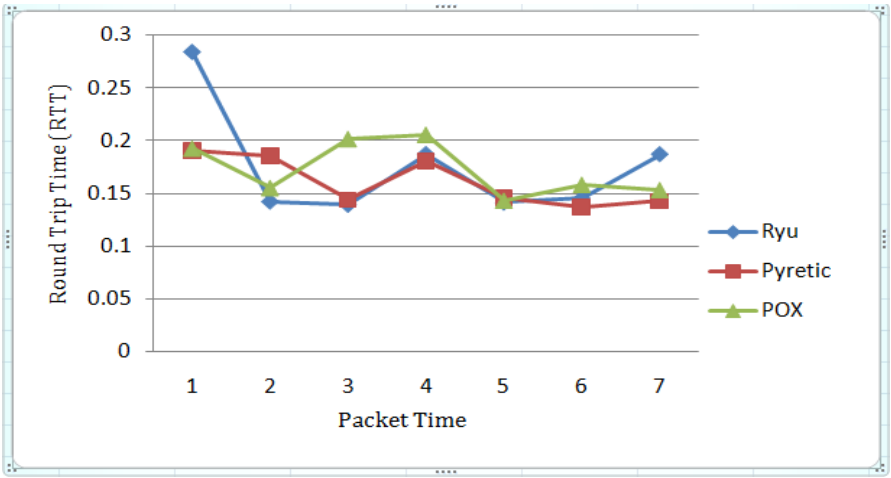


Fig. 6: Performance Analysis Graph while Ping from host h4 to host 8

Table-2 shows the corresponding minimum, maximum and average Round Trip Time for Ping message from host h4 to host h8.

Table 2

Name of Controller	Minimum RTT (ms)	Maximum RTT (ms)	Average RTT (ms)
Ryu	0.144	0.230	0.177
POX	0.145	0.227	0.185
Pyretic	0.108	0.179	0.140

From the table-2, OpenFlow POX controller has largest average RTT 0.185ms and largest minimum RTT 0.145ms while Ping from host h4 to host h8. Among the three OpenFlow based controller, Pyretic controller has smallest minimum RTT 0.108ms, maximum RTT 0.179ms and average RTT 0.140ms. From the network performance analysis graph Figure 4 and Figure 5, Pyretic controller has better performance over Software Defined Networking compare Ryu and POX controller.

V. Conclusions

For the Next Generation Networks (NGN) and future internet technologies, Software Defined Networking using OpenFlow protocol will be the most deployed networking architecture. OpenFlow protocols provide standards for routing and delivery of packets on a switch. OpenFlow Controller uses the OpenFlow protocol to connect and configure the network devices in order to determine the best path for application traffic. In this paper, several OpenFlow based controller has been implemented separately over Software Defined Networking. All the evaluation has been done using Mininet Emulator. The result of this paper shows Pyretic controller shows better performance over Software Defined Networking compare to Ryu and POX controller. Future works involves performance analysis of different OpenFlow based controller over Software Defined Wireless Networks (SDWN).

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