Performance Analysis of Virtual Network Topology and Functions Using Mininet

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Introduction

Virtualized networks have become important to meet the challenge of deployment and installation of new hardware each time a new service is required and offer advantages like reduced CAPEX and OPEX costs, shared resources and consume less power compared to traditional network system.

The project primarily presents the emulation of virtualized network topologies and deployment of different network functions like Routing and Firewall using tools like Mininet, Virtual Machines, OpenFlow and RYU Controller. Virtualization technologies like NFV and SDN are considered in this project and focus is also laid on the other virtualization scenarios like creation of Virtual LANs and enabling communication between the hosts using the controller.

Finally, the performance evaluation of these network functionalities is carried out using Iperf tool and various parameters like Bandwidth, Latency, Jitter, Response time, TCP/UDP traffic, CPU Utilization, and Number of hops are compared and analyzed graphically.

Advantages of Network Virtualization

- Services can be dynamically deployed without any changes in the hardware
- Low cost for the deployment of virtualized network function
- Power consumption is much low when compared to the traditional physical networks

RYU Controller

RYU means “flow” of packets in a network. The project makes use of RYU controller for the implementation for network functions. The main advantage of RYU Controller is it supports the latest OpenFlow v.1.0, 1.2, 1.3 and also supports for the creation of VLANs for accommodating the hosts.

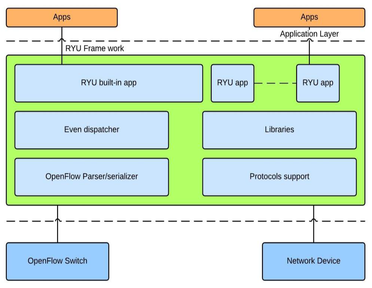


Figure: RYU Architecture

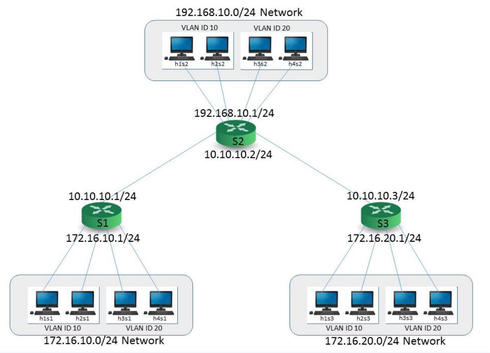
The RYU Architecture mainly consists of Applications, RYU frame work and Open flow switch. RYU provides support for all SDN applications and can be modified and implemented depending on the requirement.

Design Approach

Key Points

- Creation of Topology
- Configuration of Network Devices
- VLAN Setup
- Enabling Network Functions & Testing

Network Topology used for routing function



Methodology

The project is implemented in a Virtual Machine environment on an Ubuntu system where required packages like Mininet, RYU controller, Iperf, Wireshark are installed and the test environment is setup. Then a Multi-Tenant topology is emulated to deploy the network functions.

First, the custom topology is created in the Mininet using 3 switches and 4 hosts as shown above and an OpenFlow based RYU controller is started in a different terminal.

Once the Topology has been created, the IP address of the network nodes (switches/hosts) is changed according to the requirement. Switches are set to use the OpenFlow version 1.3 that support VLANs.

Then the routing is established and the connectivity between different hosts of different switches is tested by using PING command. Switch flow tables and the Wireshark packet captures are analyzed and compared.

Switch Flow tables:

- Match fields – Source/destination parameters
- Counters – Updates match field parameters
- Instruction – Action to take as packet arrive

Input Port	Ether Src	Ether Dest	Ether Type	VLAN ID	IPv4 Src	IPv4 Dst	IPv4 Proto. Type	TCP/ UDP Src	TCP/ UDP Dst	Meta data	Egress Port

Flow table fields

Performance Evaluation

Performance evaluation involves the analysis of the network topology and functions deployed. Iperf tool is used to analyze various parameters like bandwidth, response time, number of hops, latency and graphs are plotted.

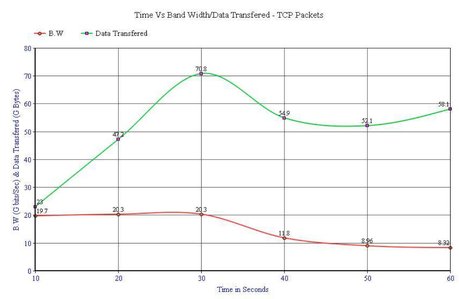
Results

After the successful design and implementation, the connectivity between the hosts is tested using ping and Iperf tools.

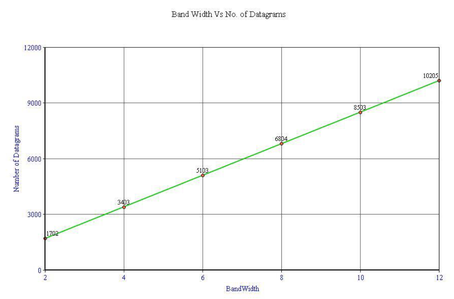
Graphical Analysis

Using Iperf tool, TCP/UDP packets are transmitted between the hosts, that is client and server and the changes in data transferred and B.W are observed with time.

From the graph it can be visualized that the amount of the data transferred between the nodes of the network gradually increases and reach a maximum level, here 70 and then again decreases gradually. Similar fashion may also be observed in case of B.W.



Graph: Time Vs Bandwidth based on TCP Traffic



Graph: B.W Vs Number of Datagrams – UDP Packets

Conclusions

This project presented a virtual network model with VLANs and also dealt with the deployment of different network functions like routing and firewall. RYU controller is used to achieve the desired network functionalities. It supports the OpenFlow version 1.3 that is required to enable Virtual LANs in the network.

Finally, after the successful design and deployment of the network functions, performance analysis is presented that addresses the issues of the network with respect to different parameters. Iperf test results are used for graphical analysis.

Key References

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[2] RYU: SDN framework and python experience, presentation by Isaku Yamahata, Pycon APAC dated Sep 14, 2013
[3] A blog on “Basic Network testing with iperf” by JK Benedict dated Nov 10, 2014, http://xenserver.org/blog/entry/basic-network-testing-with-iperf.html
[4] RYU 1.0 Documentation, RYU SDN Framework, source: http://osrg.github.io/ryu-book/en/html/

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