

Simulation of Network With Cloud Servers Using OPNET Modeler

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Abstract

A multi-hop network consists of wired nodes. In this paper multi-hop wired network setup with multiple subnet and cloud internet connections would be simulated using OPNET Modeler. There will be four servers named File server, HTTP server, Email server and Database server. Also performance of this network will be analyzed.

1. Introduction

Cloud computing is originated from the network diagram that represents the internet as a cloud. According to the NIST definition, cloud computing is considered as a model that enables easy ,on-demand network access to share various computer resources, application, services, networks, storage[19].

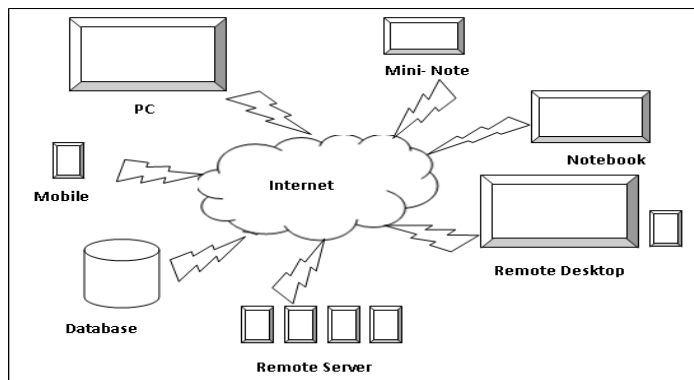


Fig.1: The term cloud computing seems to originate from computer network diagram that represents the internet as a cloud etc. that can be provided to the user with minimum management effort

According to the study done in paper [21] based on various other papers [1] - [18], and recommendation by RFC 2501[20], it had been concluded that:-

The most effective performance metrics are

- Throughput
- End to End Delay
- Packet delivery ratio
- Routing message overhead

The important parameters that highly influence the performance of these three network are

- Traffic type
- Traffic received/ sent (packets/s, bytes/s)
- Response time
- Application
- Number of nodes
- Mobility type

The most effective factors and issues are

- Storage capacity
- Security
- Workload
- Scalability
- Location
- Network bandwidth

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Table 1: Performance Metric and Parameters of Multi-hop network

| Global Statics | |
|-----------------------|---|
| DB Query | <ul style="list-style-type: none"> • Response Time (Sec) Time elapsed between sending a request and receiving the response packet. Measured from the time when the Database Query Application sends a request to the server to the time it receives a response packet. Every response packet sent from a server to a Database Query application is included in this statistic. |
| | <ul style="list-style-type: none"> • Traffic Received (Bytes/Sec) Average bytes per second forwarded to all Database Query Applications by the transport layers in the network. |
| | <ul style="list-style-type: none"> • Traffic Received (Packets/Sec) Average number of packets per second forwarded to all Database Query Applications by the transport layers in the network. |
| | <ul style="list-style-type: none"> • Traffic Sent (Bytes / Sec) Average bytes per second submitted to the transport layers by all Database Query Applications in the network. |
| | <ul style="list-style-type: none"> • Traffic Sent (Packets / Sec) Average number of packets per second submitted to the transport layers by all Database Query Applications in the network. |
| Email | <ul style="list-style-type: none"> • Download Response Time (Sec) • Traffic Received (Bytes/Sec) • Traffic Received (Packets/Sec) • Traffic Sent (Bytes / Sec) • Traffic Sent (Packets / Sec) • Upload Response Time (Sec) |
| HTTP | <ul style="list-style-type: none"> • Traffic Received (Bytes/Sec) • Traffic Received (Packets/Sec) • Traffic Sent (Bytes / Sec) • Traffic Sent (Packets / Sec) |
| FTP | <ul style="list-style-type: none"> • Download Response time • Traffic Received (Bytes/Sec) • Traffic Received (Packets/Sec) • Traffic Sent (Bytes / Sec) • Traffic Sent (Packets / Sec) • Upload Response Time (Sec) |
| Link Statics | |
| Low level point-point | <ul style="list-style-type: none"> • Bit error rate • Bit error rate per packet • Busy • Packet loss ration |
| Point- to- point | <ul style="list-style-type: none"> • Queuing delay (Request / Response sec) • Throughput (Request / Response bits/ sec, Request / Response packet/sec) • Utilization (Request / Response) |

In this paper the performance metric and parameters considered are given below in Table 1. In this paper the multi-hop network consist of three subnets which are located at different locations. Subnets are named as subnet_branch_china, subnet_branch_mareshiya, and subnet_HQ_cameroon. Out of which subnet_HQ_cameroon contains four dedicated servers. Dedicated applications are run on each server namely File Server, HTTP Server, Database Server and Email server. All these servers run on cloud. The other two subnets namely subnet_branch_china and subnet_branch_mareshiya consists of ten nodes. This multi-hop network is implemented using a network simulator named OPNET Modeler 14.5. Based on this simulation the performance metrics and parameters are observed, analyzed and presented through graphs.

2.Simulation Model

The OPNET models used in these simulations are fixed subnet, profile configuration, application configuration, Ip32_cloud, Ethernet switch, router, firewall, Ethernet server, Ethernet Workstation and 100 BaseT Link respectively as shown below in Figure 2.

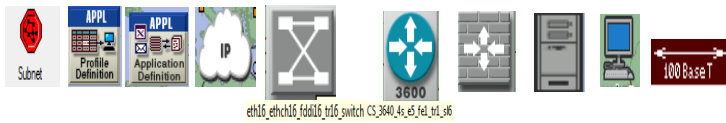


Fig. 2 - OPNET Model Used

As shown in Figure 3, the multi-hop network consists of three subnets located at different locations and are connected to IP32_cloud with 100 BaseT link. Each subnet consists of 10 wired nodes as shown in Figure 4.

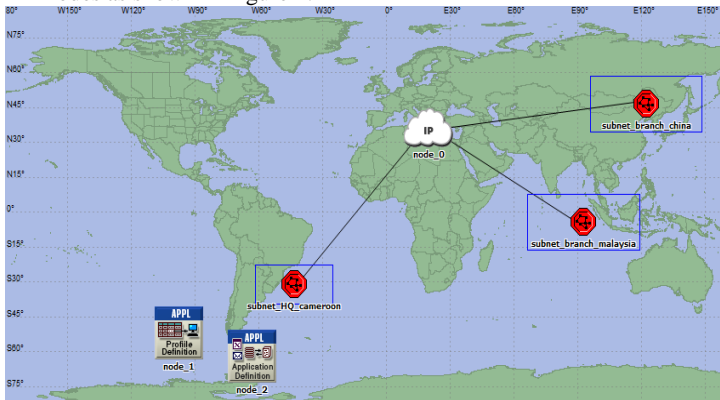


Fig. 3 - Parent subnet multi-hop network having three Subnets

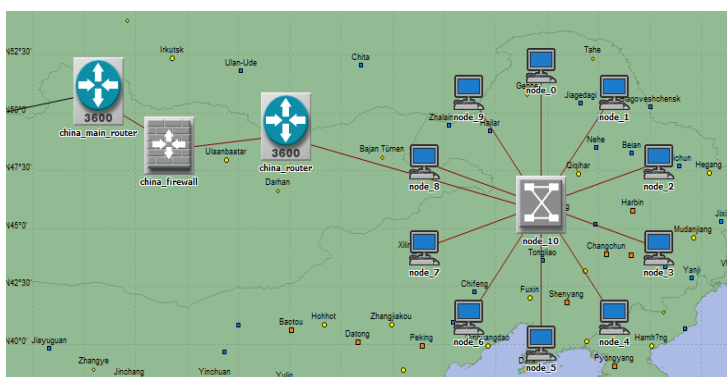


Fig. 4 - Wired fixed node in subnet

As shown in Figure 5 the headquarter subnet consists of four servers connected with wired LAN, namely File server, HTTP Server and Database Server. Since the profile has been created, each server performs their respective tasks efficiently. Simulation configurations taken in this simulation scenario (as shown in Figure 6) are: - Duration is 0.5 hours; Seed is 128; Values per Statics are 100; Update interval is 100000 events; Simulation Kernel is Based on 'kernel_type' preference; Simulation set name is scenario.

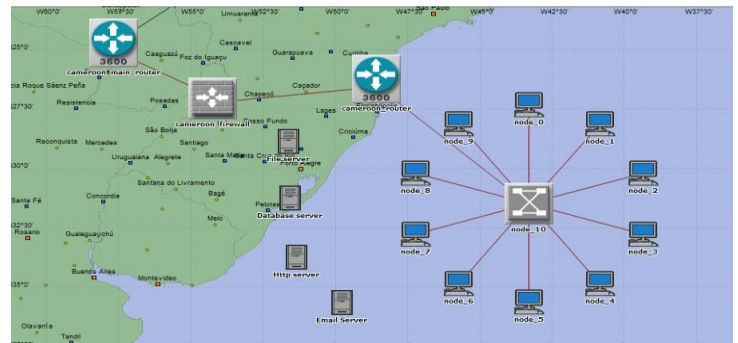


Fig. 5-Servers in Head quarter subnet

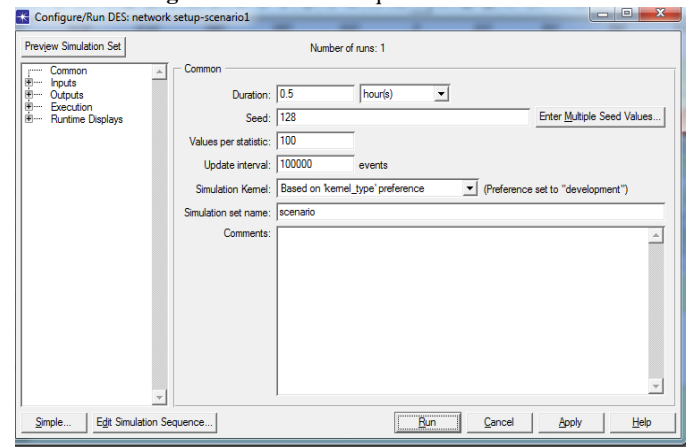


Fig. 6 - Simulation Configuration Window

Also Figure 7 and Figure 8 show the simulation speed and simulation message respectively for the scenario.

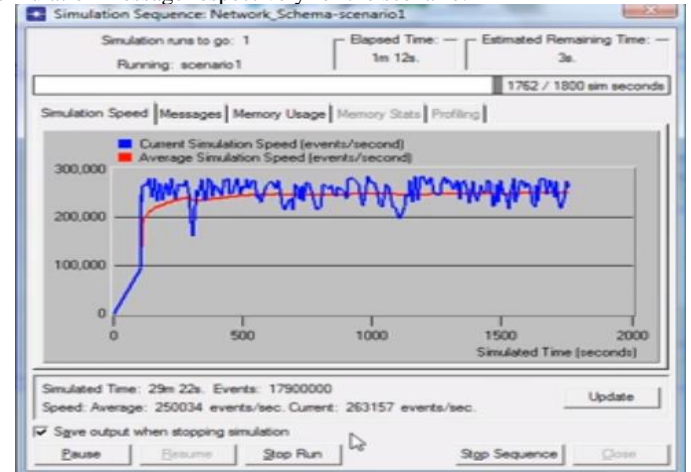


Fig.7- Simulation Speed

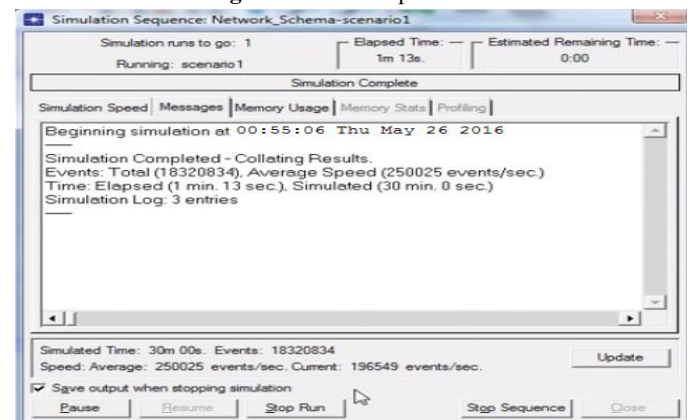


Fig. 8- Simulation Message

3.Simulation Graph and Results

According to the simulation performed based on the simulation scenario 1 shown in Figure 6, the graphs are generated and analyzed. Also the tables show their average, maximum and minimum values.

3.1 Traffic Received and Traffic Sent

Traffic received is average bytes or packets per second forwarded to all Database Query Applications by the transport layers in the network. Traffic sent is average bytes or packets per second submitted to the transport layers by all Database Query Applications in the network.

3.1.1 Traffic Received (bytes /sec) and Traffic Sent (bytes/sec)

As shown in Figure 9, maximum traffic received (bytes/sec) under DB Query i.e. 129,451 (bytes/sec). Also average traffic received under DB Query is highest i.e. 80,427(bytes/sec) than any other statics. The values of the network model with their statics, average, maximum and minimum are given in Table 2.

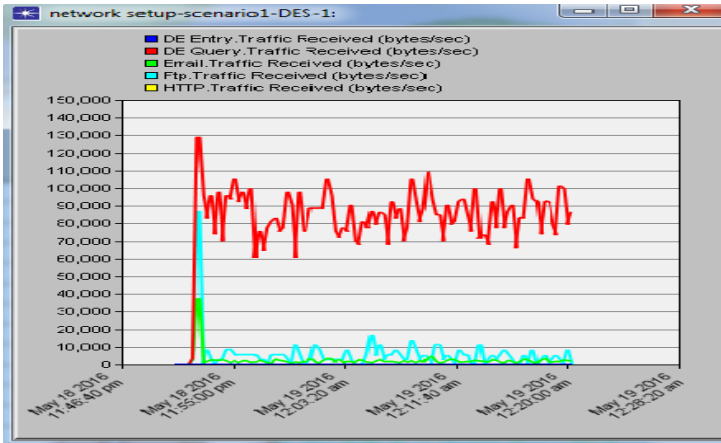


Fig. 9 - Traffic Received (bytes /sec)

Table 2: Traffic received(bytes /sec)

| Statics | Average | Maximum | Minimum |
|----------|---------|---------|---------|
| DB Entry | 0 | 0 | 0 |
| DB Query | 80,427 | 129,451 | 0 |
| Email | 2,149 | 37,433 | 0 |
| Ftp | 5,023 | 86,993 | 0 |
| Http | 0 | 0 | 0 |

According to graph shown in Figure 10, maximum traffic sent (bytes/sec) under DB Query i.e. 131,300 bytes/sec. Also average traffic sent under DB Query is highest i.e. 80,464 bytes/sec than any other statics. The values of the network model with their statics, average, maximum and minimum are given in Table 3.

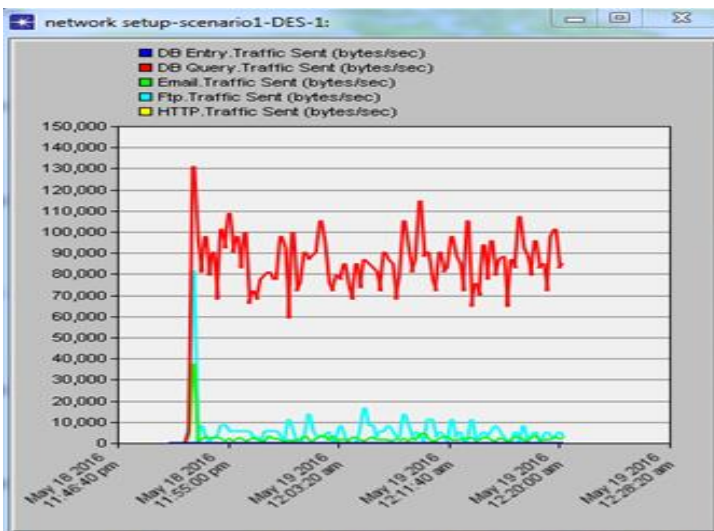


Fig. 10 - Traffic Sent (bytes /sec)

Table 3: Traffic sent(bytes /sec)

| Statics | Average | Maximum | Minimum |
|----------|---------|---------|---------|
| DB Entry | 0 | 0 | 0 |
| DB Query | 80,464 | 131,300 | 0 |
| Email | 2,149 | 37,433 | 0 |
| Ftp | 5,051 | 81,437 | 0 |
| Http | 0 | 0 | 0 |

3.1.2 Traffic Received (packets /sec) and Traffic Sent (packets/sec)

As shown in Figure 11, maximum traffic received (packets/sec) is under Email i.e. 24.889 packets/sec. But average traffic received under DB Query is highest i.e. 4.8344 packets/sec than any other statics. The values of the network model with their statics, average, maximum and minimum are given in Table 4.

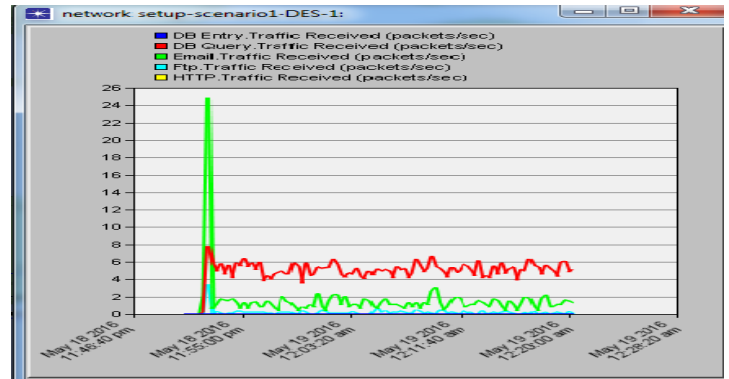


Fig. 11: Traffic Received (packet/sec)

Table 4: Traffic received(packets /sec)

| Statics | Average | Maximum | Minimum |
|----------|---------|---------|---------|
| DB Entry | 0 | 0 | 0 |
| DB Query | 4.8344 | 7.8333 | 0.0000 |
| Email | 1.429 | 24.889 | 0.000 |
| Ftp | 0.1994 | 3.4444 | 0.0000 |
| Http | 0 | 0 | 0 |

Again according to Figure 12, maximum traffic sent (packets/sec) is under Email i.e. 24.889 packets/sec. But average traffic received under DB Query is highest i.e. 14.507 packets/sec than any other statics. The values of the network model with their statics, average, maximum and minimum are given in Table 5

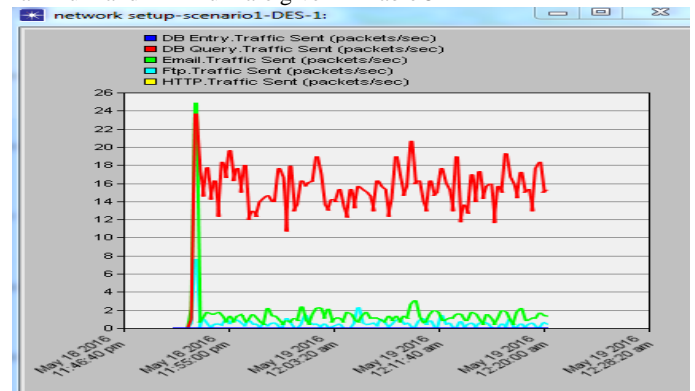


Fig. 12 - Traffic Sent (packet/sec)

Table 5: Traffic sent(packets /sec)

| Statics | Average | Maximum | Minimum |
|----------|---------|---------|---------|
| DB Entry | 0 | 0 | 0 |
| DB Query | 14.507 | 23.722 | 0.000 |
| Email | 1.429 | 24.889 | 0.000 |
| Ftp | 0.4967 | 7.6667 | 0.0000 |
| Http | 0 | 0 | 0 |

3.2 Point-to-Point

Point to point link refers to a communication connection between two nodes. Here we will consider point-to-point queuing delay (sec), point-to-point throughput (bits/sec), point-to-point throughput (packets/sec) and point-to-point utilization.

3.2.1 Point-to-Point Queuing Delay

The delay of packets arriving at the switch or router will wait in the queue for processing and the waiting time will create a delay. This is called point-to-point queuing delay. According to the Figure 13 and Table 6, the highest average point to point Queuing delay (sec) and maximum value(peak) is via link node_0 <-> subnet_HQ_cameroon [0] <-> i.e. 0.016984 sec and 0.058170 sec respectively.

Table 6: Point to point Queuing Delay (sec)

| Link | Average | Peak |
|---|----------|----------|
| node_0 <-> subnet_HQ_cameroon [0] <-> | 0.016984 | 0.058170 |
| node_0 <-> subnet_branch_china [0] --> | 0.007077 | 0.007637 |
| node_0 <-> subnet_branch_malaysia [0] --> | 0.007040 | 0.007666 |
| > | | |
| node_0 <-> subnet_branch_malaysia [0] <-> | 0.001259 | 0.012709 |
| <-> | | |
| node_0 <-> subnet_branch_china [0] <-> | 0.001231 | 0.006456 |

Similarly it is being observed in the Figure 15 and Table 8 that highest average point-to-point throughput (packets/sec) is via link subnet_HQ_cameroon.Database server <-> node_10 [0] --> i.e. 55.903 (packets/sec) but peak point-to-point throughput(packets/sec) is via link node_0 <-> subnet_HQ_cameroon [0] <-> i.e. 131.83 (packets/sec).

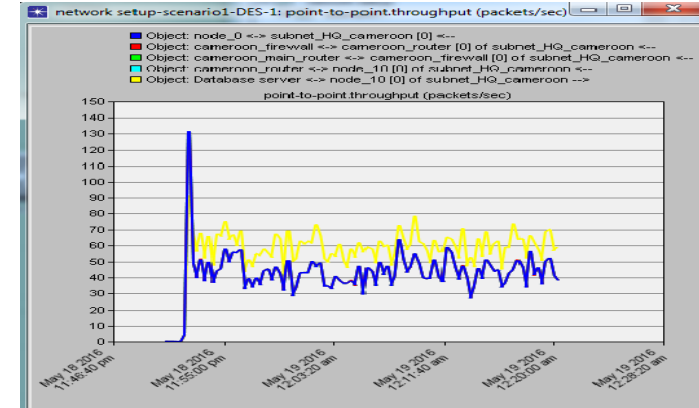


Fig. 15: Point to point Throughput (packets/sec)

Table 8: Point to point Throughput (packets/sec)

| Link | Average | Peak |
|---|---------|--------|
| node_0 <-> subnet_HQ_cameroon [0] <-> | 41.758 | 131.83 |
| subnet_HQ_cameroon.Database server <-> node_10 [0] --> | 55.903 | 91.44 |
| subnet_HQ_cameroon.cameroon_firewall <-> cameroon_router [0] <-> | 41.758 | 131.83 |
| subnet_HQ_cameroon.cameroon_main_router <-> cameroon_firewall [0] <-> | 41.758 | 131.83 |
| subnet_HQ_cameroon.cameroon_router <-> node_10 [0] <-> | 41.757 | 131.78 |

3.2.4 Point-to-Point Utilization

Now according to the Figure 16 and Table 9 highest average point-to-point Utilization and also peak point-to-point Utilization is via link node_0 <-> subnet_HQ_cameroon [0] <-> i.e. 30.060 and 69.049 respectively.

Table 9: Point to point Utilization

| Link | Average | Peak |
|---|---------|--------|
| node_0 <-> subnet_HQ_cameroon [0] <-> | 30.060 | 69.049 |
| node_0 <-> subnet_branch_china [0] --> | 15.323 | 33.199 |
| node_0 <-> subnet_branch_malaysia [0] --> | 14.736 | 35.772 |
| > | | |
| node_0 <-> subnet_HQ_cameroon [0] --> | 2.384 | 28.924 |
| node_0 <-> subnet_branch_china [0] <-> | 1.211 | 15.019 |

3.3 Other Important Instructions

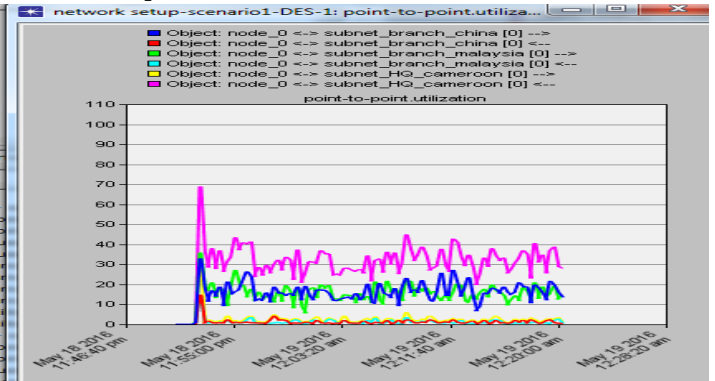


Fig. 16 - Point to point Utilization

4. Conclusions

In this paper implementation, simulation and analysis of multi-hop network is analyzed. The network consisted of three subnets, each have 10 nodes. In the headquarter subnet there are four servers. The performance metrics considered were traffic received and traffic sent (bytes/sec and packets/sec), point-to-point queuing delay,

Fig. 13- Point to point Queuing Delay (sec)

3.2.2 Point-to-Point Throughput (bits/sec)

Now it can be seen in the Figure 14 and Table 7 that highest average point-to-point throughput (bits/sec) is via link subnet_HQ_cameroon.Database server <-> node_10 [0] --> i.e. 663,149 (bits/sec) but peak point-to-point throughput(bits/sec) is via link subnet_HQ_cameroon.cameroon_firewall <-> cameroon_router [0] <-> i.e. 1,087,687 (bits/sec).

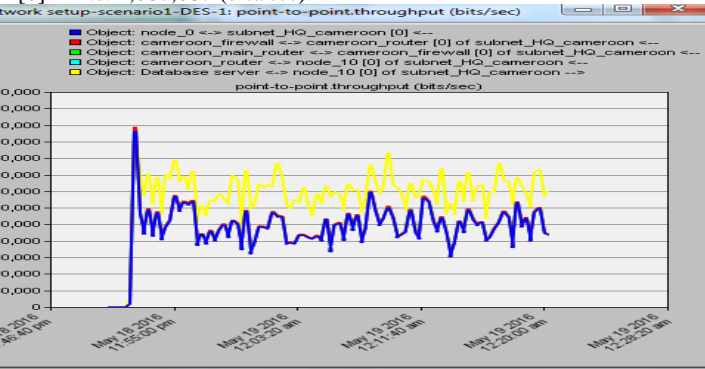


Fig. 14 - Point to point Throughput (bits/sec)

Table 7: Point to point Throughput (bits/sec)

| Link | Average | Peak |
|---|---------|-----------|
| node_0 <-> subnet_HQ_cameroon [0] <-> | 464,127 | 1,066,122 |
| subnet_HQ_cameroon.Database server <-> node_10 [0] --> | 663,149 | 1,070,431 |
| subnet_HQ_cameroon.cameroon_firewall <-> cameroon_router [0] <-> | 470,566 | 1,087,687 |
| subnet_HQ_cameroon.cameroon_main_router <-> cameroon_firewall [0] <-> | 470,566 | 1,087,687 |
| subnet_HQ_cameroon.cameroon_router <-> node_10 [0] <-> | 470,564 | 1,087,655 |

3.2.3 Point-to-Point Throughput (packets/sec)

point-to-point throughput (bits/sec), point-to-point throughput (packets/sec) and point-to-point utilization.

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