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Simulation of Network with Cloud Servers Using OPNET Modeler

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ABSTRACT

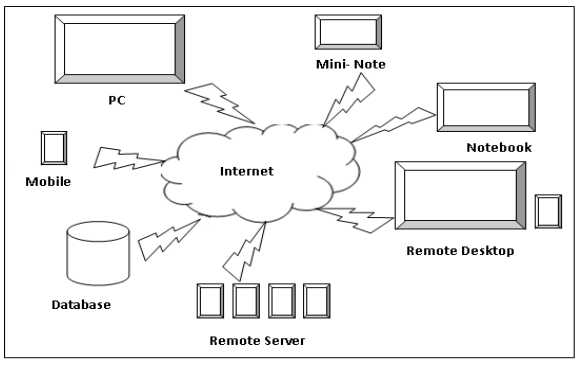
A multi-hop network consists of wired nodes. In this paper multi-hop wired network setup with multiple subnet and cloud internet connections would be simulated using OPNET Modeler. There will be four servers named File server, HTTP server, Email server and Database server. Also performance of this network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

Keywords: *Cloud Computing; Opnet Modeler; Performance Metrics; Performance Parameters*.

1.0 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

Table 1: Performance Metric and Parameters of Multi-Hop Network

Global Statics
DB Query • 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. • Traffic Received (Bytes/Sec) Average bytes per second forwarded to all Database Query Applications by the transport layers in the network.

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• Traffic Received (Packets/Sec) Average number of packets per second forwarded to all Database Query Applications by the transport layers in the network. • Traffic Sent (Bytes / Sec) Average bytes per second submitted to the transport layers by all Database Query Applications in the network. • Traffic Sent (Packets / Sec) Average number of packets per second submitted to the transport layers by all Database Query Applications in the network.
Email • 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 • Traffic Received (Bytes/Sec) • Traffic Received (Packets/Sec) • Traffic Sent (Bytes / Sec) • Traffic Sent (Packets / Sec)
FTP • 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 • Bit error rate • Bit error rate per packet • Busy • Packet loss ration
Point- to- point • 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_ maleshiya, 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.

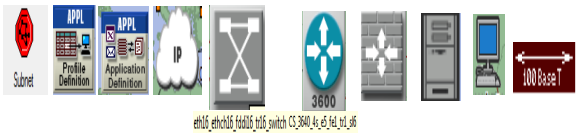
The other two subnets namely subnet_branch_china and subnet_branch_maleshiya consists of ten nodes.

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.

2.0 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

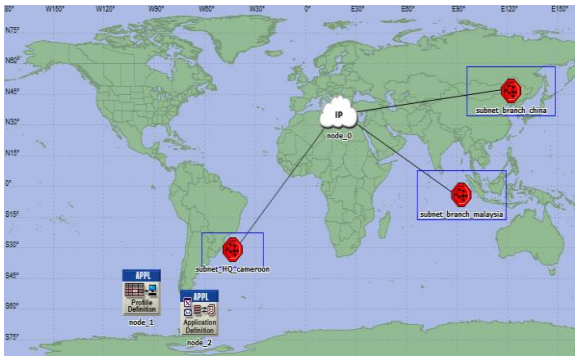
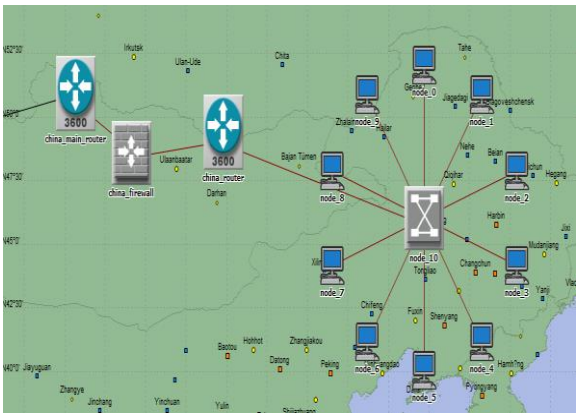


Fig 4: Wired Fixed Node in Subnet



As shown in Figure 5 the headquarter subnet consists of four servers connected with wired LAN, namely File server, Email 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

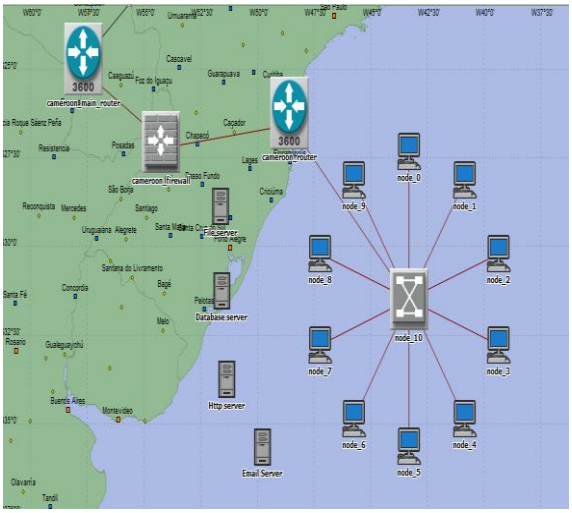
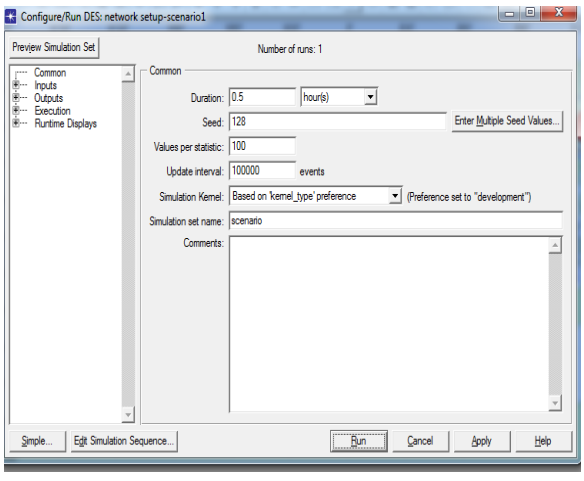


Fig 6: Simulation Configuration Window



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

Fig 7: Simulation Speed

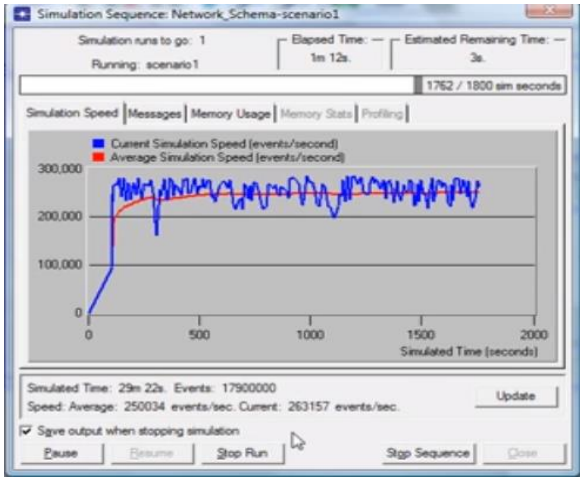
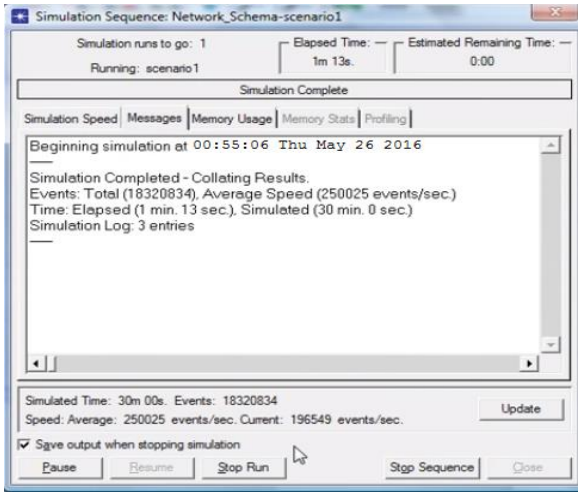


Fig 8: Simulation Message



3.0 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)

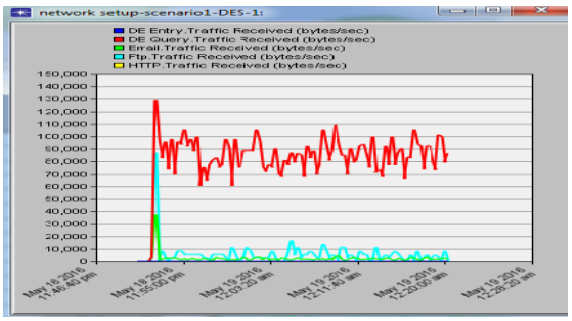


Table 2: Traffic Received (Bytes/Sec)

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)

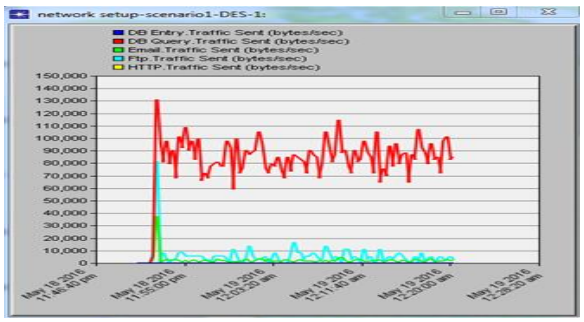


Table 3: Traffic Sent(Bytes /Sec)

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)

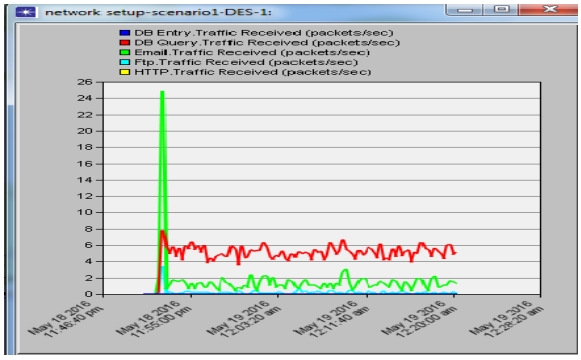


Table 4: Traffic Received(Packets /Sec)

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)

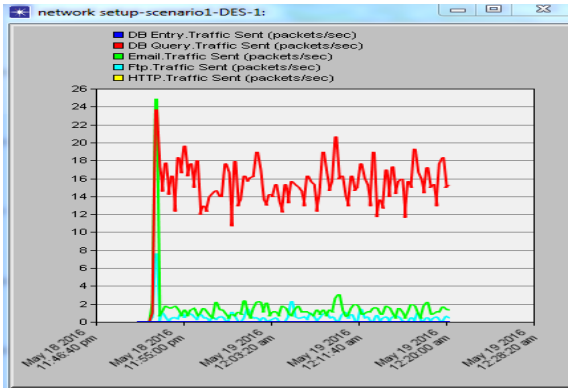


Table 5: Traffic Sent(Packets /Sec)

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

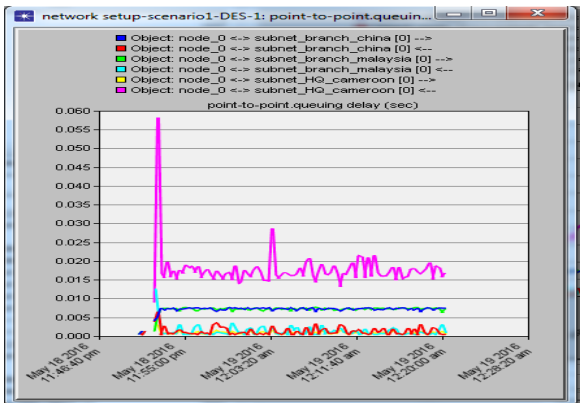
The delay of packets arriving at the switch or router will wait in the queue for processing and the waiting time will create a delay.

This is called point-to-point queuing delay. According to the Figure 13 and Table 6, the highest average point to point Quening 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

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)

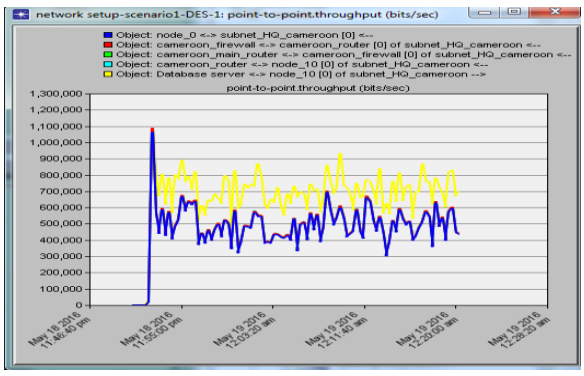


Table 7: Point to Point Throughput (Bits/Sec)

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)

Similarly it is being obseved 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)

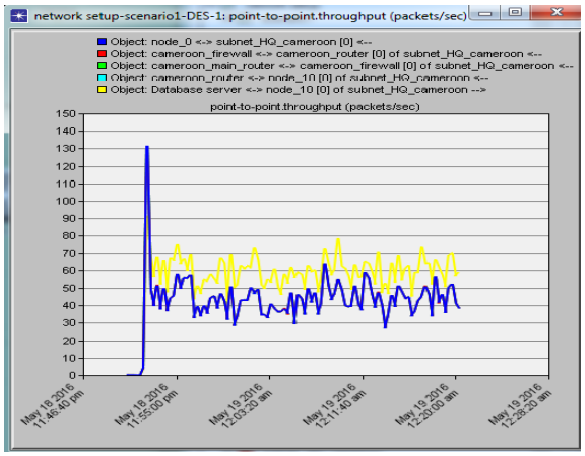


Table 8. Point to Point Throughput (Packets/Sec)

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

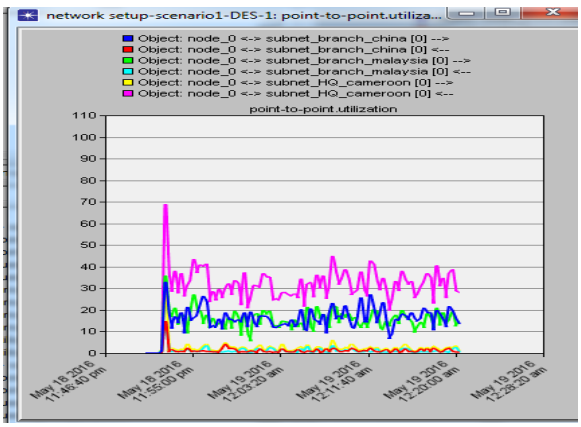
Now according to the Figure 16 and Table 9 highest average point-to-point Utilization and also peak point-to-point Utilization is via link node_0 <-> subnet_HQ_cameroon [0] <-- i.e. 30.060 and 69.049 respectively.

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



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

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