Computer Network Performance Evaluation based on Datarate and Number of Clients PerServer using OMNeT++ Simulation Environment

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Abstract- We present the performance of Computer network using OMNeT++ network simulation framework and Nclient application module from INET framework for our experiment. Present paper is the study of how datarate in affecting the performance of Computer Network. Main aim of the study is to find out the best configuration network setup to get optimum Network throughput. The performance of the Network is measured in terms of throughput.

Keywords: *OMNeT++, throughput, datarate, server, clients, network, simulation, performance evaluation.*

GJCST-E Classification : *C.2.1*

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Strictly as per the compliance and regulations of:

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I. Introduction

Computer Networks have changed the human life at home and offices too. Innovations and improvements in the domain as well as related areas make various things possible which were never thought of the reality. Computer Networks make it all possible. As different network setups and different configurations are used by the organizations to make their networks functional. With the help of the study carried out in the current paper it is tested that what would be the best Network configuration to set up the efficient and effective network in the organization. The performance of the various Network configurations is measured using simulation environment. We preferred OMNeT++ (Objective Modular Network Testbed) object oriented modular discrete event network simulation framework with INET framework. There are two reasons why we proceed with this framework those are OMNeT++ is specifically suitable for modeling and simulation of discrete event approaches and another is OMNeT++ conveniently mapped into entities communicating by exchanges of messages. INET consists of several simulation application models. We use Nclients network application with basic HTTP network setup from INET to carry out our experiments. It consists of client server environment with variable number of clients.

Performance evaluation parameters are set through initialization (INI) and Network Description

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(NED) files and in our experiments those files are basic HTTP.ini and Nclients.ned and result of the experiment is collected through answer (ANF) file. We setup the experiment to evaluate the network performance in terms of effects of datarate on the network performance and effects of number of clients per server in the Network. The network performance is evaluated in terms of server throughput. Throughput is number of bits transferred per second from server or to the server.

II. Related Work

Much of the research work has been carried out to evaluate the performance of wired and wireless Computer networks using different parameters and different methodologies. Here we are considering contribution papers in the area of wired networks. One such paper "Real-time Performance Evaluation of Line Topology Switched Ethernet" is the paper published in International Journal of Automation and Computing" in October 2008 by Fan Cen, Tao Xing & Ke-Tong Wu present new procedure to calculate the end to end delay in switched Ethernet using network calculus. The researchers applied this procedure to assess the real-time performance of line topology switched Ethernet. The outcome of the paper shows that the results are matching with the result of simulations and the maximum end to end delay in the network linearly increases with the packet length and switch number. These are the key factors impacting the delay.

Research paper entitled "High Data Rate Video Transmission Using Parallel TCP Connections: Approaches and Performance Evaluation" by HON-HING WAN & YU-KWOK published in The Journal of Supercomputing, 35, 119-139, 2006 present a detailed quantitative study on Parallel multithreading TCP in that multiple connections, managed by a scheduler, are used to handle a single client request. Using simulation environment with NS-2 simulator research proved that there exists an optimal unlimber of TCP connections for handling a video streaming request. However, such an optimal values is critically affected by other factors such as the scheduling algorithm used and the network bandwidth available. A simple AIMD approach in

managing the parallel connections can lead to significant performance gains.

Esma Yildirim – Tevfik Kosar in their Research Paper titled "End-to-End Data-Flow Parallelism for Throughput Optimization in High-Speed Networks" published in Journal of Grid Computing (2012) 10:395-418 proved that the end-to-end transfer throughput in high-speed networks could be improved dramatically by using data parallelism that takes into account the end-system capacities such as the cpu load, disk access speed and NIC capacity over the nodes. The model presented in this study provides the parallelism parameters such as the optimal number of streams per stripe, number of stripe per node and number of nodes dynamically. The experimental results conducted using various settings indicate the accuracy of the model and close-to maximal throughput values. The model also gives very good results with immediate sampling especially for large file sizes.

"Development of Simulation Model in Heterogeneous Network Environment: Comparing the Accuracy of Simulation Model for Data Transfers Measurement over Wide Area Network" published by Mohd Nazri Ismail and Abdullah Mohd Zin in Information Technology Journal 7 (6): 897-903, 2008 evaluated network performance with delay parameter using simulation model. They showed that Network delay rate will directly affect the network performance. In network management, by monitoring and analyzing network delay one can monitor the performance of the network. It also proves that Network delay rate also plays an important role in benchmark setting and network troubleshooting.

III. RESEARCH METHODOLOGY

We are using Simulation environment with OMNeT++ framework to carry out our experiment. We have used Nclient application form INET to simulate our research. There are three basic setup provided under Nclients in INET those TelenetApp, File transfer and basicHTTP module. Out of these we choose basicHTTP module with TCPBasicCliApp and TCPGenericSrvApp modules. TelenetApp generates very low traffic.
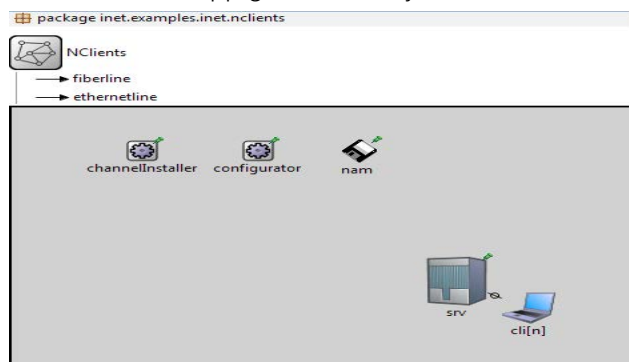
To measure the performance of the present network we use thruputMeter modules. This module is placed between TCP and TCPApp layer. We required two modules to collect result for incoming and outgoing traffic to the server. Our client and server are the StandardHost modules provided in the INET. We have modified the StandardHost with thruputMeter and modified structure of standardHost along with thruputMeter is show in figure 2 below. The result of the experiment is collected in excel file from the default .ans file. .ans file in OMNeT++ gives two types of results vector and scalar. Vector results are recording of time series data and scalar results are supposed to record a single value per simulation run. We have considered scalar result as avg. thruput for our analysis purpose, Throughput of both thruputMeter i.e. thruputFrom & thruputTo related to the server.
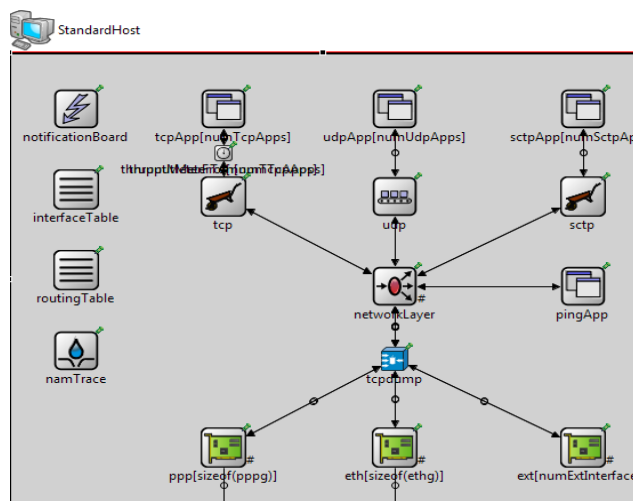

Figure 2 : StandardHost with thruputMeter module between tcpApp & tcp

We collect the reading of the simulation experiment by two ways:
1. We Kept datarate constant and changed the number of clients on the server and avg thruput scalar values are collected for respective experiments.
2. For specific client setup on a server we change the datarate and collect the scalar avg thruput in excel files.

For our experiment we kept datarate variation between 10Mbps to 100Mbps with the interval of 10Mbps and clients variance from 10 clients per server to 150 clients per server with the interval of 10 clients. We have kept the packet size=536bytes and delay= 0.1us unless and until mentioned. We have run each simulation experiment for n=500s (simulation seconds). We collected the throughput results by running the simulation experiment 10 (datarate variance from 10Mbps to 100Mbps with the interval of 10Mbps) ×15 (no of client variance from 10 clients to 150 clients with the interval of 10)=150 times.

IV.   Result Analysis

Throughput values of the simulation experiment is collected in excel file. We have collected results at 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 Mbps with 10, 20, 30…….130, 140, 150 clients per server. Our result shows that throughput values for the server and to the server both maximum and minimum are at 10Mbps. Maximum throughput value form the server is 7074.765479 bps (bits per second) at 10Mbps with 150 clients on a server while minimum throughput value from the server is 642.7703018 bps at 10Mbps with 10 clients on a server. Throughput value to the server is maximum at 10Mbps with 130 clients on a server and the value is 1394.613963 bps while minimum value is 108.6925672 bps which is at 10Mbps with 10 clients on a server.

a)   At Constant Datarate

We analyze the trend of throughput from the server by keeping datarate constant and changing the number of clients from 10 number of clients to 150 clients per server with the interval of 10 clients.

By analyzing the results of the experiments we can understand that average throughput from the server is increases with increase in the number of clients from 10 number of clients till 110 number of clients per server, it falls with 120 number of clients on a server. For remaining number of clients i.e 130, 140 and 150 number of clients on a server the throughput form the server is increases from 120clients to 130clients and it will be same for 150clients but shows down trend at 140clients. This trend of throughput from the server is same for all the datarate i.e. from 10Mbps to 100Mbps. Experimental readings shows that the highest throughput value from the server is with 150 clients on a server, it means at specific datarate if we increase the number of clients it will give the highest value at the maximum number of clients but at 100Mbps the highest throughput value is with 130 clients on a server.
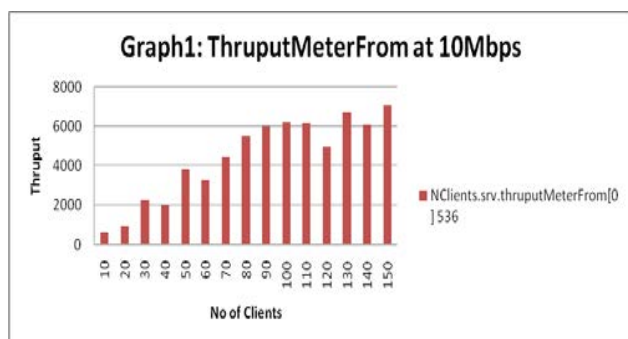

Figure 3 : Throughput From server at 10Mbps

By analyzing the experimental readings for throughput to the server we came to know that throughput to the server is increasing with increase in the number of clients on a server at specific datarate. Maximum throughput to the server at each datarate interval withing the range of 10Mbps to 100Mbps is given with the 130 number of clients.
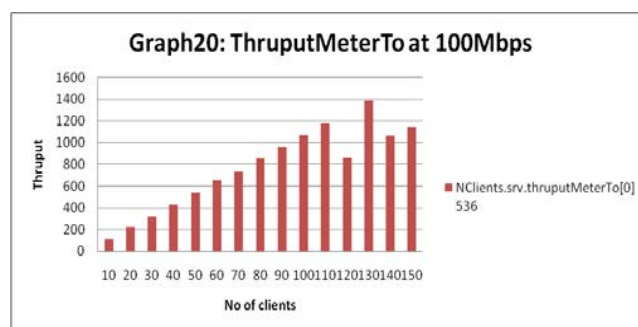

Figure 4 : Throughput To the server at 100Mbps

b)   With Constant Number of Clients

Now we analyze the trend of throughput from the Server by keeping number of clients constant and changing the datarate from 10Mbps to 100Mbps. Observations of the experiments shows that

i.   Throughput from the server with number of clients 10,20,30,40,50,60 are having the same type of throughput pattern; which is increasing with increase in the datarate; it is highest at 100Mbps and lowest at 10Mbps.

ii.   Number of clients 70, 80 & 90 the throughput form server shows the lowest throughput values at 10Mbps and it remain same for all next intervals of datarates i.e. 20, 30, 40, 50, 60, 70, 80, 90 & 100Mbps.

iii. With 100 number of clients on a server we got maximum throughput from server at lowest datarate i.e. at 10Mbps and for remaining datarates it shows same level of throughput which is less than 10Mbps readings.

iv.   Throughput from server with number of clients 110 on a server shows lowest throughput value at 10Mbps it will increase bit more with 20Mbps and remain same at 30 and 40Mbps, for next interval i.e. at 50Mbps it increase more and remain same till last datarate interval i.e. at 100Mbps.

v.   Throughput from server for number of clients 120 on server shows the same level of throughput pattern at 10Mbps,20Mbps & 30Mbps at 40Mbps it show increase in the throughput and remain same for next interval reading from 50Mbps to 100Mbps.

vi.   Throughput from the server with 130 number of clients on a server gives maximum throughput value at 10Mbps & lowest at 20Mbps; bit increase is there at 30Mbps and remains same like the reading at 30Mbps for rest datarate intervals.

vii. Throughput from the server with number of clients 140 on a server gives lowest value at 10Mbps and increases with bit stabilization in subsequent intervals giving highest throughput values at 60, 70, 80, 90 & 100Mbps.

viii. Throughput from server with number of clients 150 on a server gives highest value at 10Mbps and it decreases with increase in datarate value intervals from 20Mbps to 70Mbps and remain at same level for 80, 90 & 100Mbps.
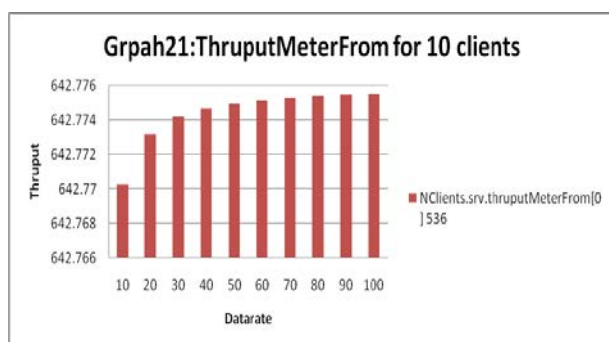
Figure 5 : Throughput From server for 10 number of clients on a server

By analyzing the experimental readings for throughput to the server we came to know that throughput to the server is showing following type of behavior.

i. The throughput to the server is increasing steadily with increase in datarate for the number of clients 10, 20, 30, 40, 50 & 60.

ii. Number of clients with 70 on a server gives maximum throughput to the server at 10Mbps, it falls down for 20Mbps and remains same for all datarate intervals from 30Mbps to 100Mbps.

Number of clients with 80 & 90 on a server gives exactly similar pattern of throughput to the server giving minimum value of throughput at 10Mbps; increase throughput at 20Mbps and shows the same level of throughput to the server from 30Mbps to 100Mbps.

iv. The throughput patterns of throughput to the server for number of client 100 on a server is same like the pattern of number of clients 70 on a server giving maximum throughput at 10Mbps and remain constant at 20Mbps to 100Mbps.

v. The throughput pattern to the server for the number of clients 110 is showing the lower value at 10Mbps and remain same for 20, 30 & 40Mbps after increase in the throughput value at 50Mbps it will remain same for rest of the datarate intervals.

vi. Number of clients 120 gives lowest throughput to the server at datarate 20Mbps & 30Mbps. Throughput to the server is higher than this which is recorded at 10Mbps while higher throughput to the server is recorded at 40Mbps and it remains the same for rest of the datarate intervals.

vii. Throughput to the server with 130 number of clients is giving maximum throughput at 10Mbps it decrease steadily till 30Mbps and remain same for next successive datarate intervals like 30Mbps.

viii. Throughput to the server with 140 number of clients on a server is giving minimum throughput value at 10Mbps and maximum value at 20Mbp; From datarate 30Mbps to 60Mbps it shows it shows decreasing throughput to the server and remain same like 60Mbps for 70,80, 90 & 100Mbps.

ix. With Number of Clients 150 the throughput to the server is maximum at 10Mbps and second highest values it gives at 30, 40, 50 & 60Mbps. It gives lowest value at 70Mbps and remain the same for 80, 90 & 100Mbp.
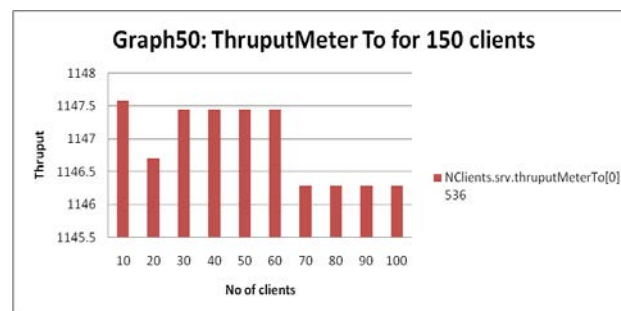

Figure 6 : Throughput To server for 150 number of clients on a server

V. CONCLUSION

Analysis of the result shows that the performance of the network evaluated through throughput of the server shows that maximum throughput from the server is with 150 clients on a server at 10Mbps datarate and minimum throughput is at 10Mbps with 10 number of clients. Through put value to the server is maximum at 10Mbps with number of clients 130 while minimum throughput is at 10Mbps with 10number of clients on a server. Throughput results from the server and to the server are varying on the basis of datarate changes and on the basis of network load interms of number of clients on the server.

VI. ACKNOWLEDGMENT

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