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Computer Network Performance Evaluation Based on Different Data Packet Size Using OMNeT++ Simulation Environment

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Abstract
with this research paper we are investigating the effect of different Data Packet Sizes on the Computer network Performance. The performance of the Network is evaluated on the basis of Throughput. To investigate the problem we are using OMNeT++ network simulation framework and Nclient application module from INET framework. We have considered four different types of data packet sizes i.e 256, 536, 1072 & 2144bytes for our experiments. The performance of the Network is measured in terms of throughput.

Keywords
OMNeT++, NClient, INET, Network Performance, Throughput, Data Packet Size, Datarate, Simulation, Server, Clients.

I. Introduction

The performance of the Network configurations is measured using simulation environment. We preferred OMNeT++ Version 4.2 (Objective Modular Network Testbed) object oriented modular discrete event network simulation framework with INET framework for OMNeT++ with 2.2.0-ae90ecd release. Development of OMNeT++ is started in 1992, since then many people contributed to OMNeT++ with several models. It is primarily used to simulate the communication networks and other distributed systems. It is used for academic as well as Industrial research purposes. OMNeT++ runs on Windows, Mac & Linux Operating Systems. Here are the features of OMNeT++ which makes it different from other simulation environment:

1. OMNeT++ is designed to support network simulation on a large scale.
2. Modular structure.
3. The design of NED (Network Description).
4. GUI Interface with Graphical Editor.
5. Separation of Model and Experiments.
6. Simple Module Programming Model.
7. Design of the Simulation Library.
8. Parallel Simulation Support.
9. Real-Time Simulation, Network Emulation.
10. Animation and Tracing Facility.
11. Visualization of Dynamic Behaviour.
12. Enriched Result Analysis Mechanism

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 (NED) files and in our experiments those files are basicHTTP.ini and Nclients.ned and result of the experiment is collected through answer (ANF) file. We setup the experiment to evaluate the network performance by changing the Data Packet Sizes. To investigate the problem How Data Packet size affecting the Network Performance? We use **.tcp.mss (Maximum Segment Size) parameter from basicHTTP.ini file. We took reading by changing Data Packet Size to 256bytes, 536bytes, 1072bytes & 2144Bytes and collect the readings. We evaluated Network performance in terms of Server Throughput. Throughput from the server is evaluated through ThruputFrom module while throughput to the server is evaluated through ThruputTo module. Throughput is number of bits transferred per second from server to the client or vice versa.

II. Related Work

Number of Researchers has contributed their efforts for the performance evaluation of wired as well wireless Computer Networks. These research papers evaluated performance on the basis of different parameters and methodologies. Here we are considering contribution papers in the area of wired networks.

Research Paper entitled "A general communication performance evaluation model based on routing path decomposition" shows that High-level modelling and simulation methods are necessary for the evaluations of various options in Network on Chip (NoC) architectures, in order to meet the stringent requirements of the increasing complicated future MPSoCs (Multi-processor system-on-chips). An analytical solution is proposed and a performance model based on the routing path decomposition and the traditional queuing system in presented in detail. The analytical model features comprehensive and elaborate performance estimation for a variety of networks under different configurations. Research validate the reliability of the proposed model through extensive experiments and demonstrate its usefulness in performance prediction, including computation of the overall packet latency for the network and the latency distribution in different channels.

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.

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

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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.

III. Research Methodology

As mentioned in the Introduction section 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.

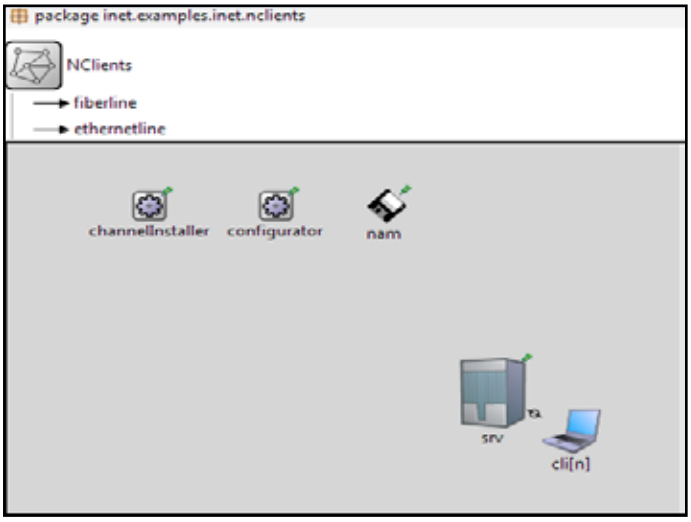

Fig. 1: Nclients.Ned: Client Server experimental setup configuration

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. Modified structure of standardHost along with thruputMeter is show in figure 2 below. The results of the experiments are 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.

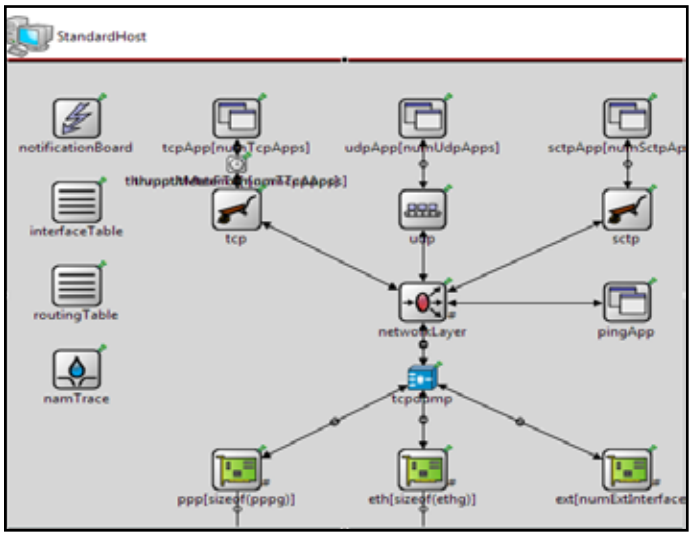

Fig. 2: StandardHost with thruputMeter module between tcp & tcpApp

We collect the readings of the simulation experiment by two ways:

1. We Kept datarate constant and changed the number of clients on the server and average throughput scalar values are collected for respective experiments.
2. For specific setup on a server we change the datarate and collect the scalar average throughput 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 took these reading with four packet sizes i.e. at 256bytes, 536bytes, 1072bytes and 2144bytes with 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) × 4 (packet sizes i.e. 256, 536, 1072 & 2144 bytes) =600 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, 100Mbps with 10, 20, 30…….130, 140, 150 clients per server. These results are collected for four packet sizes i.e. 256, 536, 1072 & 2144 byte. Our result shows that throughput values from the server and to the server for four data packet sizes are minimum at 10Mbps with 10 number of clients per server and maximum are at 10Mbps for packet sizes 536, 1072 & 2144. For packet size 256 both throughput from the serve and throughput to the server are maximum at 100Mbps with 150 clients per server and at 20Mbps with 130 clients per server respectively.

A. With Constant Datarate

We analyze the trend of throughput by keeping datarate constant and changing the number of clients from 10 number of clients to the 150 clients per server for all four data packet sizes.

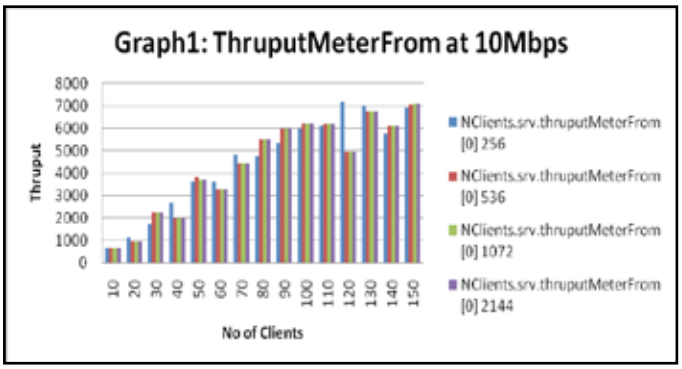

Fig 3: Throughput From server at 10Mbps

By analysing the experimental readings for throughput From the server we came to know 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 for all the data packet sizes, it falls with 120 number of clients on a server for all data packet sizes except data packet size with 256bytes. Throughput from the server for all the data packet sizes is maximum with 130 number of clients amongst the interval of clients ranging from 10 number of clients to 150 clients per server on the server. Throughput readings with 140 number of clients decrease from the value with 130 number of clients and it increases with 150 number of clients in compare to throughput from the sever with 140 number of clients. This throughput patter is same at all datarate intervals i.e. form 10Mbps to 100Mbps.

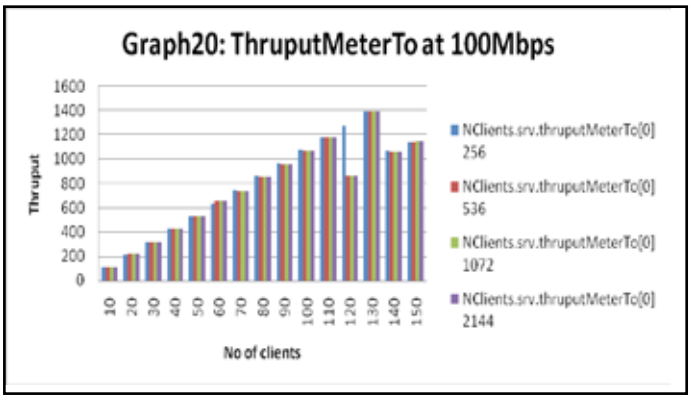

Fig. 4: Throughput To the server at 100Mbps

When we observe the throughput to the server from 10 number of clients to 150 number of clients at specific datarate from 10Mbps to 100Mbps with the interval of 10Mbps we get same level of output trend for all the data packet sizes at each datarate interval. Throughput values to the server are increasing with increase in the number of clients till 110 number of clients, throughput values to the server are decreases at 120 number for all the data packet sizes except 256byte packet size it shows increase in the trend. Throughput values to the server with 130 number of clients is maximum amongst all client intervals from 10 number of clients to 150 clients. Throughput value at 140 clients decreases from 130 clients and it increases slightly from 140 clients to 150 clients. Throughput from the server and throughput to the server at specific datarate with variations in number of clients per server gives maximum values with smaller datapacket size i.e. 256bytes, amongst 256bytes, 536bytes, 1072bytes & 2144 bytes.

B. With Constant Number of Clients

Now we analyse the trend of throughput from the Server by keeping number of clients constant and changing the datarate from 10Mbps to 100Mbps.

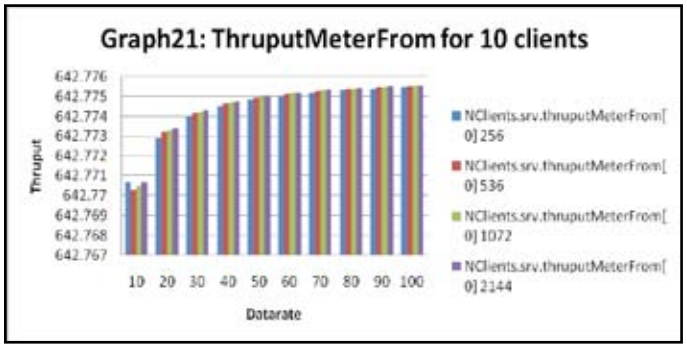

Fig. 5: Throughput From the server for 10 No of Clients on a server

Observations of the experiments shows that

I. The throughput from the server with constant Number of clients 10, throughput from the server is increasing with increase in the datarate from 10Mbps to 100Mbps for all the four data packet sizes.
II. For Number of clients 20 on the server the throughput form the server shows that at all the datarate the throughput from the sever is constant but it is higher with smaller packet size i.e. 256bytes and for remaining other data packet sizes it is same i.e.536bytes, 1072bytes and 2144bytes.
III. Throughput from the server with number of clients 30 on a server gives same level of throughput from the server at all the datarates but gives lower throughput with smaller data packet size i.e. 256bytes and for remaining data packet sizes i.e. 536bytes, 1072bytes & 2144bytes it is same but bit higher than data packet size 256bytes.
IV. Throughput from server with 40 number of clients on server gives throughput which is constant for all the datarates from 10Mbps to 100Mbps & for all the data packet sizes but gives higher throughput at all the datarates with smaller data packet sizes i.e.256bytes.For other data packet sizes i.e. 536bytes, 1072bytes and 2144bytes gives lower than smaller data packet size and same for all other data packet sizes.
V. Throughput from the server for number of clients 50 on a server shows same level of throughput at all the datarates but having variations with respect to data packet sizes. For smaller data packet sizes i.e. 256bytes it gives lowest throughput, for data packet size 536bytes it gives highest throughput and for remaining two data packet sizes i.e. 1072bytes and 2144bytes it gives same level of throughput which is higher than throughput with 256byte packet sizes and smaller than throughput with 536byte data packet size.
VI. Throughput form the server with number of clients 60 & 70 on a server gives same level of throughput at all the datarate and gives maximum throughput with smaller data packet size i.e.256btes while for other data packet sizes i.e.536bytes, 1072bytes and 2144bytes it gives same level of throughput from the server and which is much lower than the value with smaller data packet size.
VII. Throughput from the server with number of clients 80 & 90 on a server gives similar type of throughput form the server pattern at all the datarates and for different data packet size

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it gives lowest throughput with smaller data packet size i.e. 256bytes and for other data packet sizes i.e.536bytes, 1072byytes and 2144bytes it gives same level of throughput which higher than the value recorded at 256bytes data packet size.

VIII. Throughput from server with number of clients 100 on a server gives highest throughput from the serve at 10Mbps and for other datarate intervals it gives lower value than 10Mbps which is similar for the data packet sizes 536Mbps, 1072Mbps & 2144Mbps and for data packet size 256Mbps it gives lower values at all datarate intervals in compare to other data packet sizes.

IX. Throughput form the server with 110 number of clients on a server gives lower throughput at 10Mbps for all the data packet sizes, among the tested data packet sizes it gives lowest throughput with data packet size 256bytes. Throughput at 20Mbps, 30Mbps and 40Mbps is similar for all the data packet sizes. Throughput at 50Mbps is higher than throughput at 40Mbps for all data packet sizes except 256bytes packet size, it remain same like previous throughput with same data packet size. Throughput from server at datarate 60Mbps, 70Mbps, 80Mbps, 90Mbps & 100Mbps it shows similar throughput pattern for all the data packet sizes; amongst data packet sizes, it gives maximum throughput with smaller data packet size i.e.256Bytes.

X. Throughput with 120 number of clients on a server is giving same level of throughput at all the datarate and for all the data packet sizes; amongst the tested four data packets sizes, maximum throughput we received with smaller data packet size i.e.256bytes, for other remaining data packet sizes it gives same level of throughput.

XI. Throughput with 130 number of clients on a server is recorded maximum at 10Mbps and minimum at 20Mbps it remain at same level at other data rate which is higher than 20Mbps and lower than 10Mbps this is for all data packet sizes; amongst all data packet sizes maximum throughput is recorded at smaller data packet size i.e.256byte.

XII. Throughput from the server with number of client 140 on a server at 10Mbps to 40Mbps is similar while at 50Mbps to 100Mbps is similar and slightly higher than throughput at 40Mbps; this throughput is same for all data packet sizes except 256bytes data packet size which gives lower throughput than other data packet sizes.

XIII. Throughput from the server with number of clients 150 on a server gives similar throughput patter at 30, 40, 50, 60, 70, 80, 90 & 100Mbps for all four data packet sizes; we have received maximum throughput with smaller data packet size i.e. 256Bytes and minimum throughput with 536byte data packet size for other data packet size i.e.1072bytes and 2144byte it gives same level of throughput at above datarates. Throughput at 10Mbps for data packet sizes gives minimum throughput with smaller data packet size i.e.256bytes and maximum throughput with 1072bytes and 2144bytes while at 20Mbps throughput is lower with smaller datapacket size while maximum throughput is with 536byte data packet size.

By analysing the experimental readings for throughput to the server we came to know that throughput to the server is showing following type of behaviour

1. The throughput to the server is increasing steadily with increase in datarate for the 10 number of clients on a server, it gives same type of throughput pattern like throughput from the server with 10 number of clients.
2. Throughput to the server with 20number of clients on server gives same level of throughput at all data rates for all the data packet sizes; minimum throughput is recorded with smaller data packet sizes i.e. 256bytes while for other data packet sizes i.e.536bytes, 1072bytes and 2144bytes it gives maximum throughput.
3. Throughput to the server with 30, 40, 70, 80 & 90 number of clients on a server gives same level of throughput at all data rates for all the data packet sizes, recorded maximum throughput with smaller data packet size i.e.256bytes and minimum throughput is recorded with all other data packet sizes i.e. 536bytes,1072bytes & 2144bytes.
4. Throughput to the server with 50 number of clients on a server gives same level of throughput pattern at all datarate intervals with all four types of data packet sizes; recording maximum throughput to the server with both 1072bytes and 2144bytes data packet sizes while minimum throughput recorded is at smaller data packet size i.e with 256bytes.
5. Throughput to the server with 60 number of clients gives exactly same throughput level of patters like throughput pattern with 20number of clients.
6. Throughput to the server with 100 number of clients on a server gives maximum throughput to the server at 10Mbps for all data packet sizes. Amongst all these data packet sizes it gives maximum throughput to the server with smaller data packet size i.e. 256bytres at all data rates and for remaining data packet sizes i.e. 536bytes, 1072bytes and 2144bytes it gives same level of throughput which is smaller than the throughput with 256bytes data packet size at 20Mbps to 100Mbps datarates.
7. Throughput to the server with 110 number of clients at 10Mbps, 20Mbps, 30Mbps & 40Mbps is giving same level of throughput with all four types of data packet sizes; amongst these data packet size minimum throughput is recorded with smaller data packet size i.e. 256bytes and for other data packet sizes i.e. 536bytes, 1072bytes and 2144bytes it gives same level of throughput to the server. Throughput to the server at 50, 60, 70, 80, 90 & 100Mbps gives same level of throughput to the server for all data packet sizes except 256bytes at 50Mbps data rate, which gives same level of throughput like at 40Mbps.
8. Throughput to the server with 120 number of clients gives same level of throughput to the server at all data rates i.e. from 10Mbps to 100Mbps for all data packet sizes; amongst these data packet sizes it gives maximum throughput with smaller data packet size i.e. 256bytes and for all other data packet sizes it gives same level of throughput.
9. Throughput to the server with 130 numbers of clients gives maximum throughput at 10Mbps with data packet sizes 536bytes, 1072bytes and 2144bytes, at same datarate & with 256bytes data packet size we received less throughput. Second highest throughput we have received at 20Mbps with all data packet sizes; amongst all these data packet sizes we have received highest throughput with 256byte data packet size. At datarates 30,40,50,60,70,80,90 & 100Mbps we have received same level of throughput for all data packet sizes.
10. Throughput to the server with 140 number of clients gives maximum number of throughput with smaller data packet size i.e.256bytes at all datarates and for other data packet

sizes i.e. 536bytes, 1072bytes & 2144bytes it gives lower but same level of throughput at 50, 60, 70, 80, 90 & 100Mbps; at 30 & 40Mbps it gives same level of throughput while at 20Mbps it gives maximum throughput with all the mentioned data packet sizes.

11. Throughput to the server with 150 number of clients gives exactly same level of throughput for all data packet sizes at 70,80,90 & 100Mbps; maximum throughput with all data packet sizes is recorded at 10Mbps.

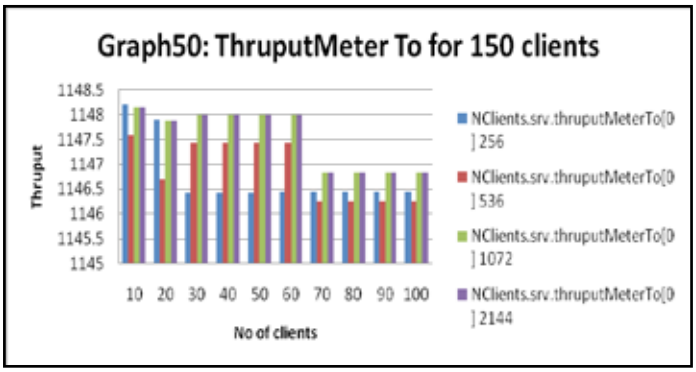

Fig. 6: Throughput To server for 150 number of clients on a server

V. Conclusions

By analysing the throughput values of the simulation experiment we came to know that

Maximum throughput we have received with smaller data packet size. Maximum throughput from the server for our experiment amongst all four data packet size is recorded with 256byte data packet and minimum throughput from the server is recorded with 536byte data packet size while maximum throughput to the server is recorded with 2144byte data packet size and minimum throughput to the server is recorded with 536byte data packet size.

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