A Comparative Analysis of Transport Layer Protocols

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Abstract

NS-2 is a discrete event scheduler which works on the packet scenario and mostly used for networking projects for both wired and wireless network.NS-2 has many built-in tools such as TCL (Tool Command Language) used to write simulation script, XGRAPH and GNU PLOT for plotting graphs, Perl and AWK custom scripts which are used to calculate total throughput, end to end delay. It also support many protocols, topologies, and transport layer protocols TCP and UDP for transmitting data from source node to destination node in the form of packets. In this paper we did practical implementation by analysis packet flow and average rate of both transport layer protocols and compare them on the wired network of NS-2 with the help of TCL simulation script, GNUPLOT and Perl script.

Keyword: NS-2, TCP, UDP, Perl, GNU PLOT.

Introduction

NS-2 is the acronym of network simulator-2.NS2 source code is copyrighted but freely distributed and discrete event simulator which works on packet scenario [5] of networking projects for both wired and wireless network. NS-2 was developed at LBNL (Lawrence Berkeley National Laboratory) under VINT project (Virtual Internet Test bed) by LBL [2]. NS-2 is a portable tool that works on all UNIX, Linux and windows operating systems.

NS-2 has many built in libraries and functions which support many routing protocols, network topologies like bus, ring, hybrid, star topologies to design both wired and wireless network with the help of simulation scripts. Main advantage of NS-2 is that we can easily calculate total throughput, error rate, end to end delay, total number of packet send and received by destination with custom scripts AWK, Perl.[1]

Ns-2 support both transport layer protocols TCP and UDP to transmit data in the form of packets from source to destination [2] and Ns2 support mainly four type of traffic generators to generate data in the form of packets and send packets over

transport layer protocols. CBR (Constant Bit Rate), exponential traffic (poison traffic), Pareto traffic (poo traffic) and FTP are traffic generators. [11]

To run the TCL script NS2 use the NAM (network animator) which is a visualization tool which show the nodes and flow of packet written in the TCL script. [4] In this paper we worked on wired network and try to compare TCP and UDP protocols by calculating their total throughput and packet flow analysis and packet drop rate with GNU PLOT, TCL and Perl Scripts.

Related Work

In this paper Dr. Neeraj Bhargava, Dr. Ritu Bhargava, Anchal Kumawat, Bharat Kumar check out the performance of transport layer protocol TCP with the help of simulation tool NS-2 and many other tools such as Xgraph and GNUPLOT for plotting graphs of TCP trace file and CBR and VBR traffic trace file and AWK script for calculating total throughput and instant delay of simulation script. [1]

In this paper Ajay Singh, Dr. Pankaj Dashore did a comparative study of UDP and TCP based on NS-2 by calculating their individual bandwidth and analysis of their packet flow. [2]

Proposed Work
Write TCL Simulation Script

For writing the simulation script we use TCL (Tool Command Language) which is the part of OTCL (object Oriented Tool Command Language).In TCL script a NS Simulator object is created first which is used for many purposes such as creating nodes, for providing shapes and color to nodes, creating agents and links between them.

This script consist of 4 nodes which all have different color and shapes such as node no 0 and node no 1 acts as a source node and represented by circle but node no 0 represent by blue color and node 1 represent by red color, node no 2 assumes as a router which forward the packets coming from the source node 0 and 1 to the node no 3 which assumes the destination node. Node no 2 represent by hexagon and black in color and node 3 represent by square and green in color.
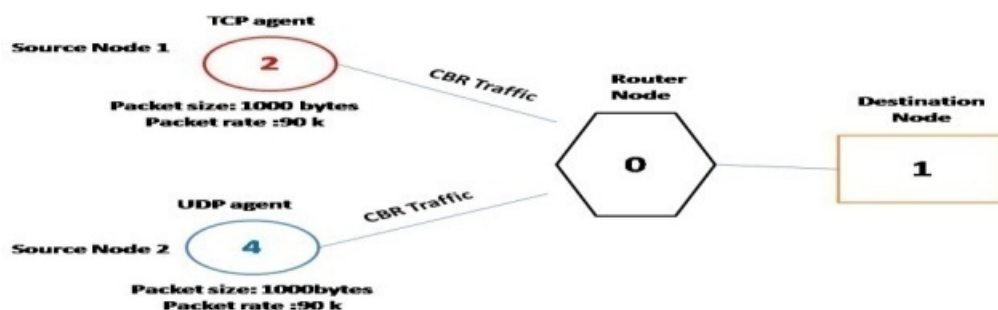

Fig 1: Simulation model

A duplex link is established between node no1 and node no 2, node no 0 and node no 2, node no 2 and node no 3 with bandwidth 1Mb and time delay is 20ms. All the nodes follow the RED (Random Early Drop) routing queue mechanism of which maximum size is 20.A TCP agent is attached to node no 0 and connection is established to node no 3 which is a destination node by attaching "sink" agent to it. Same as A UDP agent is attach to node no 1 and "null" agent attach to node no 3 for connection establishment.CBR traffic is generated on both the TCP and UDP agent. For this two agents of CBR is made, one is cbr0 which is attach to node no 0 and 2nd is cbr1 which is attach to node no1. The size of CBR traffic for both UDP and TCP is set to 512 bytes and packet rate is set to 1mb.cbr0 starts at 0.1 and stop at 4.0, same as cbr1 starts at 0.5 and ends at 4.5.
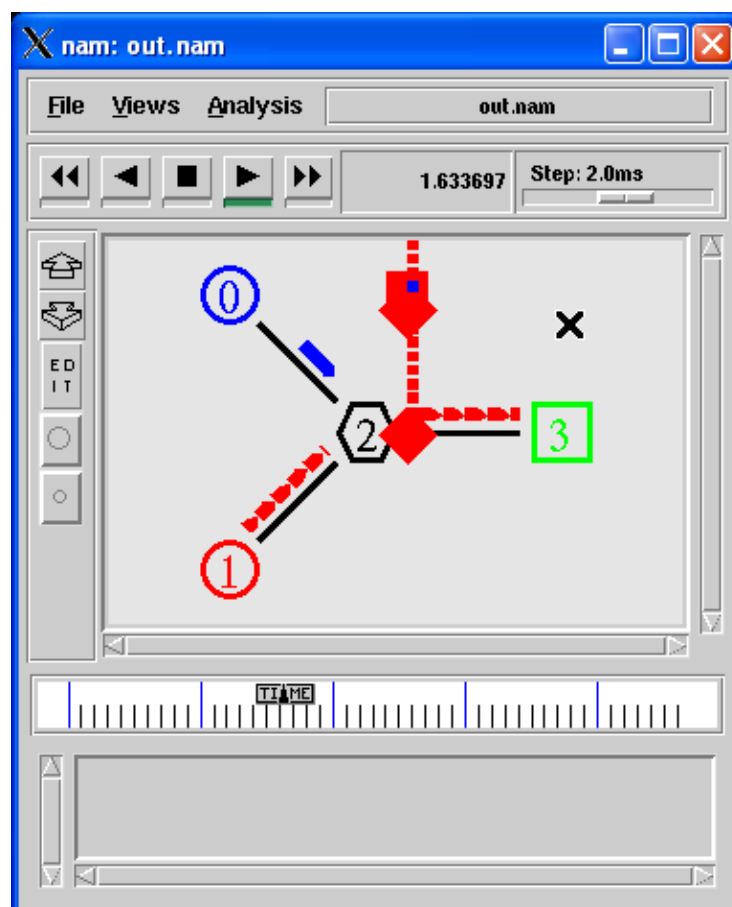
Fig 3: Flow of packets of both TCP and UDP protocols.

Generate Trace File of TCP and UDP
When this TCL script is run, it would generate two trace file one for UDP and 2nd for TCP which will include all the details of packets transfer by UDP and TCP such as packet id, packet sent time, and packet received time, packet size and end to end delay.

þ	0.500000	0.550496	0.050496	512
0	0.504096	0.562912	0.058816	512
0	0.508192	0.567008	0.058816	512
0	0.512288	0.579424	0.067136	512
0	0.516384	0.583520	0.067136	512
0	0.520480	0.595936	0.075456	512
0	0.524576	0.600032	0.075456	512
0	0.528672	0.612448	0.083776	512
0	0.532768	0.616544	0.083776	512
0	0.536864	0.628960	0.092096	512
0	0.540960	0.633056	0.092096	512
0	0.545056	0.645472	0.100416	512
0	0.549152	0.649568	0.100416	512
0	0.553248	0.661984	0.108736	512
0	0.557344	0.666080	0.108736	512
0	0.561440	0.678496	0.117056	512
0	0.565536	0.682592	0.117056	512
0	0.569632	0.695008	0.125376	512
0	0.573728	0.699104	0.125376	512
0	0.581920	0.711520	0.129600	512
0	0.590112	0.723936	0.133824	512
0	0.598304	0.728032	0.129728	512
0	0.606496	0.740448	0.133952	512
0	0.614688	0.744544	0.129856	512
0	0.618784	0.748640	0.129856	512
0	0.622880	0.752736	0.129856	512
0	0.626976	0.756832	0.129856	512
0	0.631072	0.760928	0.129856	512
0	0.635168	0.765024	0.129856	512
0	0.639264	0.769120	0.129856	512
0	0.643360	0.773216	0.129856	512

Fig 4: Trace file of TCP

1	0.140640	40
2	0.237920	1040
3	0.246240	1040
4	0.335200	1040
5	0.343520	1040
6	0.351840	1040
7	0.360160	1040
8	0.432480	1040
9	0.440800	1040
10	0.449120	1040
11	0.457440	1040
12	0.465760	1040
13	0.474080	1040
14	0.482400	1040
15	0.490720	1040
16	0.529760	1040
17	0.538080	1040
18	0.546400	1040
19	0.558816	1040
20	0.575328	1040
21	0.591840	1040
22	0.608352	1040
23	0.624864	1040
24	0.641376	1040
25	0.657888	1040
26	0.674400	1040
27	0.690912	1040
28	0.707424	1040
29	0.719840	1040
30	0.736352	1040
31	0.806112	1040
32	0.822624	1040
33	0.998880	1040
34	1.175136	1040

Fig 5: Trace file of UDP

Use Perl Script to Calculate Average Rate of TCP and UDP

Perl is a dynamic general-purpose programming language which can be used for wide

variety of task. Here we use Perl language to find out the throughput or average rate of both TCP and UDP trace file. We write two Perl script one for calculating TCP throughput and its throughput comes 900827.226118957 bps and 2nd for calculating UDP throughput and its throughput comes 124682.946971038 bps.

Fig 6: (a) Throughput of TCP

Fig 6: (b) Throughput of UDP

Draw Graphs with the help of GNU PLOT
GNU PLOT is a visualization Tool which is used for drawing graphs in ns2.Here we draw graphs for both UDP and TCP and try to show their comparison of packet end to end delay over packet sent time.
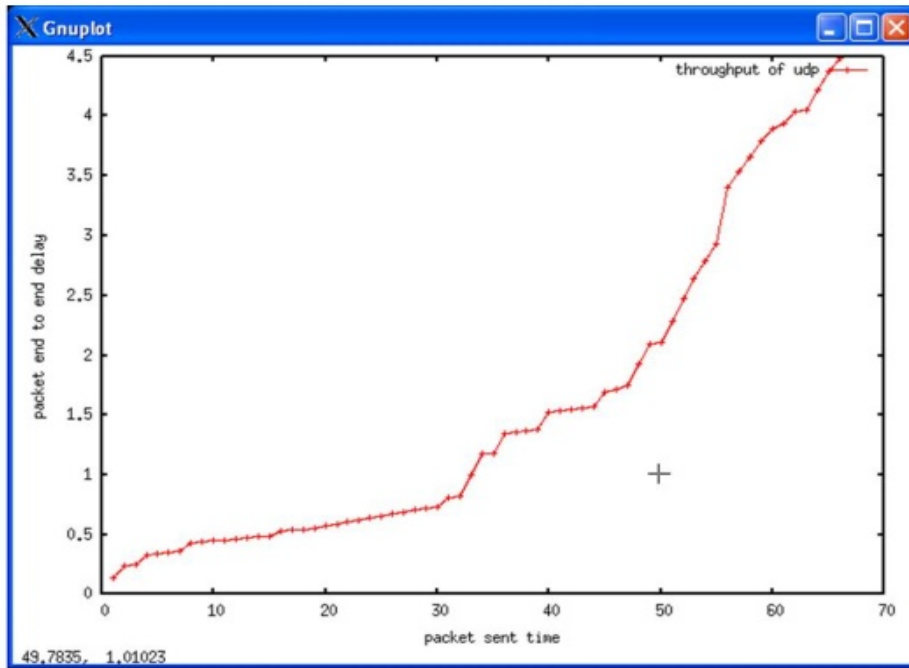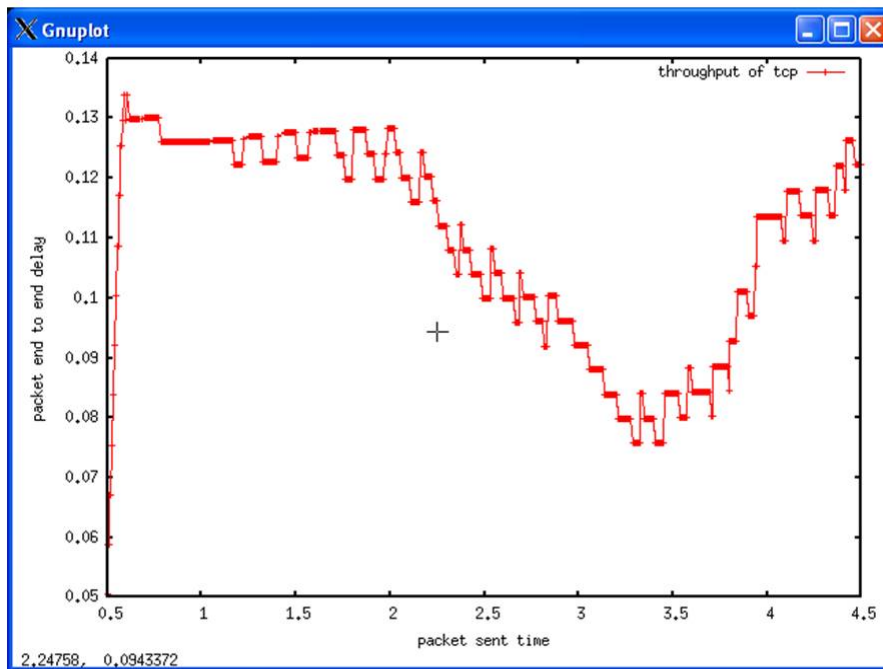
Fig 8: UDP throughput through GNU PLOT

Fig 9: TCP throughput through GNU PLOT

Conclusion

In this simulation script two source nodes are taken, source node1 is attached to TCP agent and source node 2 is attached to UDP agent. In our paper we compare both two transport layer protocols TCP and UDP on the basis of their total throughput of packet sent to destination node .Throughput is calculated with the help of Perl script, their trace file and with graphs through GNU PLOT.

As we provide same packet size of 512 bytes and packet rate of 90k in the TCL script for both UDP and TCP packets but average peak rate of TCP is more than UDP. That means TCP is more reliable than UDP. TCP throughput comes 900827.226118957 bps and UDP throughput and its throughput comes 124682.946971038 bps. This shows that TCP is more reliable than UDP because its packet loss rate is less than UDP as it sends.

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