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Buffer Sizing for Mixed TCP and UDP Traffic

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Abstract: A Packet switched networks consist of TCP and UDP traffic. In Recent years most of the internet traffic is open loop traffic i.e., UDP. The increase in streaming services like music, movies, video games and VOIP have in-turn increased the UDP traffic in a packet-switched network. A router is a device which forwards packets between source and the destination. The buffer is a small storage space which will store the incoming packets during the Transmission. The buffer size in routers play a vital role in transmitting packets from source to destination. An optimal buffer size will reduce the congestion and increase the throughput of a bottleneck link where else the opposite will lead to buffer overflow or underflow which will leads to packets loss and lower throughput etc. In previous studies researchers only considered TCP Traffic and ignored the UDP. We found that it is necessary to analyse both TCP and UDP so that we can present buffer sizes for routers which will increase throughput for open and closed loop traffic and also have minimal packet loss. Our results are confirmed with Network Simulator – 2.

Keywords: Buffer size, Network simulation, Throughput.

I. INTRODUCTION

Routers Plays a vital role in organizing internet traffic. Buffers in routers store the incoming packets during the times of transmission and congestion. An optimal buffer size is needed to minimize the packet loss and keep the link congestion free and full utilization of the link. When a buffer not configured properly it will affect the whole transmission and in worse it will have unavoidable packet loss and congestion in the link and degrading the network performance. The router also rearrange the packets using the packets sequence numbers. There can be many number of routers between a send and the receiver and each routers are responsible for successful packet transmission between sender and the receiver Router buffers are usually defined in MB (Mega Bytes) or GB (Giga Bytes). Fixing the size of the buffers is the important factor because a non-optimal buffer size leads to packet loss while congestion in the network. So the router manufacturer needs to take care of fixing the routers buffer size. Router buffer size can be of two types:

1. Fixed Size.
2. Dynamic Size.

1. Fixed Size:

Fixed size buffers are a predefined buffer size usually in MB or GB fixed by the respective router manufacturers. Sometimes the fixed size are not efficient i.e., high incoming traffic.

2. Dynamic Buffer Size:

Dynamic buffer will increase or decrease its size based on the incoming traffic. Dynamic buffer will suffer from wastage of buffer size when the incoming traffics are low.

Initially the buffer size for a router is determined by the Rule of thumb i.e. B = RTT x C, where B is the buffer size, RTT is the roundtrip time of the TCP flow and C is the bandwidth link size. The problem with this rule is that the manufacturing cost is too high because of the larger buffer size. In 2004, a new and updated rule was proposed by the Stanford research group i.e. $B = RTT \times C/\sqrt{n}$. where, $\sqrt{n}$ is the no of long lived TCP flows. The group also presented a theoretical solution that can avoid the congestion and a good amount of link utilization.

However, the rule of thumb is only for the TCP traffic and it's not really a feasible one considering most of the todays traffic is UDP. So, the existing rule of thumb is not a efficient one in calculating buffer size for a router which will have both TCP and UDP Traffic.

In this paper, we propose a new rule for determining the buffer size of the router which consider both the open loop UDP and closed loop TCP and also have a minimal buffer size with maximum throughput and minimal packet loss and maximum link utilization.

To find out the optimal buffer size we derived a equation as follows,

$W_{TCP} + W_{UDP} = Q + RTT * k_1 C + RTT/2 * k_2 C,$

To Find the TCP,

$W_{TCP} = Q + RTT * C [k_1 + k_2/2] – W_{UDP},$

On encountering congestion the window size of the TCP gets reduced to half, which can be derived as,

$$W_{TCP} = Q/2 + (RTT * C)/2 [k_1 + k_2/2] – W_{UDP}/2,$$

If we need to keep the bottleneck link at 100% utilization at all the times, we need to make the buffer size large enough to keep the bottleneck link busy. The new congestion window size after the loss event, must be larger enough so that the source will start sending packets. So to get the full link utilization,

$Q/2 + (RTT * C)/2 [k_1 + k_2] – W_{UDP}/2 \geq RTT * C [k_1 + k_2/2] – W_{UDP},$

Finally,

$$Q \geq RTT * C [k_1 + k_2/2] - W_{UDP} \quad .... \quad (1)$$

By varying the RTT we found out a distribution of buffer size.

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The rest of the paper is organised as follow, in section II we present a simulation model and in section III we analyses the results we got in section II and in section IV we summarized our work and obtained an experimental results and also discuss the future work.

II. RELATED WORKS

There have been many research on buffer sizing for routers but they all focus on only Considering TCP Source.

2.1. Impact of Buffer Structure for Mixed UDP and TCP Traffic. This paper provides a analysis of buffer sizing fixing i.e. whether to use buffer unit in terms of packets or bytes and the impact that made on open loop and closed loop Traffics.

2.2. Optimal Choice of Buffer Size in Routers In this paper they proposed an analytical framework for the optimal choice of the router buffer size. Furthermore they formulated a multi-criteria optimization, in which the Lagrange Function Corresponds to a linear combination of the average sending rate and average delay in queue.

III. SIMULATION METHODOLOGY

3.1. The Model

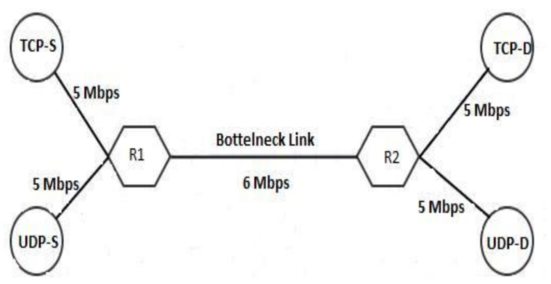

Fig. 1 NS-2 Simulation Model

For, our simulation we are using the classic Dumb-bell Topology. The topology consist of 100 node for source and destination respectively. There are 99 nodes for TCP and 1 node for UDP. The bottle neck link uses the default TCP-Agent and drop tail queue management.

3.2. Buffer Size

For our simulation to find the optimal buffer we derived an equation,

$Q \geq RTT \times C\, [\, k_1 + k_2/2] - W_{UDP}$

Where, RTT is the long lived TCP flows, C is the bottleneck bandwidth link, k is a constant i.e. $k_1 + k_2 = 1$ and W_{UDP} is the total no of UDP Packets. Using the equation we found out varying no of buffer size for our simulation.

In our simulation we are using TCP and UDP with limiting UDP usage to 5% of the link. The traffic is generated using the TCP and UDP agents with TCP packet size of 40 and UDP packet size of 1000 with constant bitrate

VI. SIMULATION RESULT ANALYSIS

4.1. TCP and UDP Simulation:

We first simulate with both TCP and UDP source with buffer size got from our equation. Fig .2. Show the throughput analysis we got from the simulation. During the simulation we found that the throughput is constant for TCP and varying in UDP when we increase the RTT and also we found that the packet loss is less in UDP than TCP.

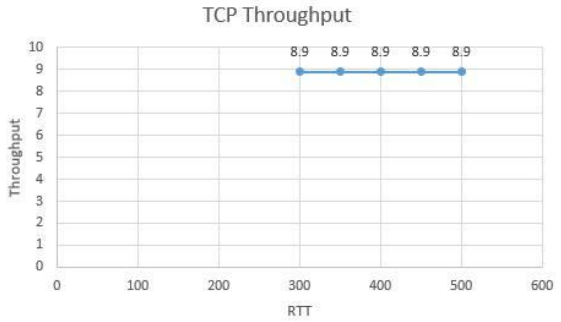

Fig 2. TCP Throughput Analysis

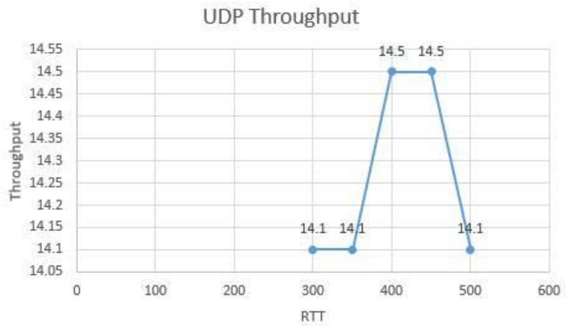

Fig 3. UDP Throughput Analysis

4.2 TCP Simulation:

Now we simulated with only TCP Source and with the buffer size we got from the existing rule of thumb. From Fig .3. We can see that the throughput of the simulation is varying throughout out the sample data. We also found that the TCP packet loss is negligible.

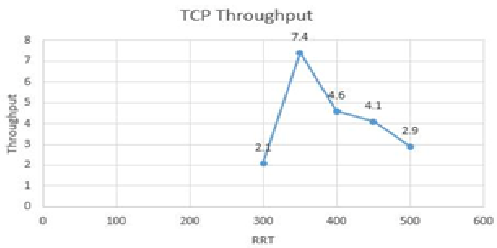

Fig 4. TCP Throughput Analysis

V. CONCLUSION AND FUTURE WORK

We proposed an equation, that it can be used to determine the buffer size for mixed open (UDP) and closed (TCP) loop traffic. In Future, we will determine buffer size for network's that have multiple TCP flows by modifying the equation we derived, and by dropping the TCP flow when it reaches a particular buffer size which can be fixed for TCP flows.

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