International Journal of Advance Research in Engineering, Science & Technology(IJAREST),
ISSN(O):2393-9877, ISSN(P): 2394-2444,
Volume 2, Issue 10, October- 2015, Impact Factor: 2.125

Effectiveness of Transport layer Protocols in congestion less and congested scenarios

Patel Kaushika[1], Dr. J. M. Rathod[2]
[1]Department of Electronics Engineering, BVM Engineering College, VV Nagar, India, kdpatel@bvmengineering.ac.in
[2]Department of Electronics Engineering, BVM Engineering College, VV Nagar, India, jmrathod@bvmengineering.ac.in

Abstract

Web is extending quickly over the whole globe, TCP/IP is as one piece of Internet. The expanded utilization of remote connections for giving availability in remote territories and encouraging portability in Internet drew out a few genuine execution issues of TCP, which was intended for wired links. Behaviours of different TCPs have been broke down over wired and wireless connections. How they initialize their congestion window during slow start and congestion avoidance phase and what is the effect in the performance in wired and wireless networks. Here the investigation of TCP rendition called TCP Westwood which alters the congestion window is incorporated. It controls the congestion window by utilizing end-to-end data transfer capacity estimation. TCP Westwood persistently evaluates the end to end accessible transmission capacity on the premise of ACK entry rate that is utilized to reset the window to coordinate the accessibility of data transfer capacity. The algorithm is called bandwidth estimation algorithm. This makes TCP Westwood very powerful to the sporadic losses as a result of remote channel issues. In this paper execution of TCP Westwood has been assessed in the vicinity of more widely used variants of TCP over wired systems utilizing a system test system apparatus, NS-2.35. It is seen from the simulations that TCP Westwood uses the accessible bandwidth in most proficient way.

Keywords- ACK-Acknowledgement, congestion window, NS-2.35, TCP Westwood, Wired and wireless links

I.INTRODUCTION

TCP/IP is a well-understood transport layer convention, which is actualized in any system for procedure to-process correspondence. It is a well-demonstrated and acknowledged convention suite, which has effectively guaranteed steady and vigorous system operations. TCP gives the solid correspondence to web searching and for file and email Transfer. TCP/IP is a transport layer convention, which is actualized in any system for making procedure to-process correspondence conceivable [1]. It's a well-demonstrated and generally acknowledged convention suite, which has effectively guaranteed the steady and vigorous system operations. TCP gives the solid correspondence to web scanning and for email and document exchange. TCP fundamentally gives some of basic services [20].

- Full duplex service
- Stream data service
- Connection oriented service
- Reliable services

In any case, there are a couple execution issues when the customary TCP is utilized in the Internet to work over wired or remote systems, substantial inactivity and channel commotion debilitate the execution of remote Internet. As per a few explores, it takes around 90% of all Internet traffic. TCP convention was composed and adjusted expecting the wired association in Network on the grounds that it gives blunder free association and in addition a little defer. So the losses and the server over-burden were considered as the fundamental purposes behind the packet losses. The packet losses are identified in TCP by utilizing a clock that triggers after the time which is double the system's rtt (round outing time). Still in current TCP likewise there is no bifurcation between congestion or random loss [13].

II. OBJECTIVE OF THE STUDY

The main objective of the study is to analyse different version of TCP implementation in case of Wired and Wireless Trends.

III. STUDY CONTEXT: TCP WESTWOOD

In order to improve the performance over the above factors, a few mitigation techniques have been suggested over standard TCP versions like New Reno and SACK TCP. Some of the proactive schemes like, TCP Veno, TCP Westwood [8], [9] and TCP New Jersey are designed to improve flow control and avoid packet losses from estimation of certain network parameters. By improving the basic TCP i.e. Tahoe other versions were invented. TCP Tahoe consists of slow start, congestion avoidance and fast retransmission algorithms. TCP Reno adds "fast recovery" to the TCP Tahoe as additional feature. TCP New Reno is a modification made in TCP Reno. It is selective acknowledgement which will give information about safe reaching of the packets out of order by SACK option [5-7].

In TCP Westwood the sender continuously computes the Connection Bandwidth Estimate (BWE) which is defined as the share of bottleneck bandwidth used by the connection. Thus, BWE is equal to the rate at which data is delivered to the TCP receiver. The estimate is based on the rate at which ACKs are received after a packet loss indication, (i.e. reception of 3 duplicate ACKs, or timeout expiration). , the sender resets the congestion window and the slow start threshold based on BWE. This BWE varies from flow to flow sharing the same bottleneck; it corresponds to the rate actually achieved by each INDIVIDUAL flow. Thus it is FEASIBLE (i.e. achievable) rate by definition. Consequently, the collection of all the BWE rates, as estimated by the connections sharing the same bottleneck, is a FEASIBLE set. When the bottleneck becomes saturated and packets are dropped, TCPW selects a set of congestion windows that correspond exactly to the measured BWE rates and thus reproduce the current individual throughputs. Another important element of this procedure is the RTT estimation. RTT is required to compute the window that supports the estimated rate BWE.

An important distinguishing feature of TCP Westwood with respect to previous wireless TCP "extensions" is that it does not require inspection and/or interception of TCP packets at intermediate (proxy) nodes. TCPW fully complies with the end-to-end TCP design principle. The key innovative idea is to continuously measure at the TCP sender side the bandwidth used by the connection via monitoring the rate of returning ACKs. The estimate is then used to compute congestion window and slow start threshold after a congestion episode, that is, after three duplicate acknowledgments or after a timeout. The rationale of this strategy is simple: in contrast with TCP Reno which "blindly" halves the congestion window after three duplicate ACKs, TCP Westwood attempts to select a slow start threshold and a congestion window which are consistent with the effective bandwidth used at the time congestion is experienced. This mechanism is called faster recovery [9].

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IV. TCP WESTWOOD IMPLEMENTATION [8][9]

After 3 DUPACKS

If receiving 3 DUPACKS
Set ssthresh=(BWE*RTTmin) /seg_size;
and if cwnd>ssthresh then
setcwnd = ssthresh ;
Enter congestion avoidance

After Timeout

If RTO then set
ssthresh = (BWE*RTTmin) /seg_size;
if (ssthresh< 2) ssthresh =2;
end if ;
cwin = 1;
end if
enter slow start;

V. APPROACH FOR BANDWIDTH ESTIMATION

The TCPW sender uses ACKs to estimate BWE. More precisely, the sender uses the following information: (1) the ACK arrival times and, (2) the increment of data delivered to the destination. Let assume that an ACK is received at the source at time tk, notifying that dk bytes have been received at the TCP receiver. We can measure the sample bandwidth used by that connection as bk=dk/(tk–tk–1), where tk−1 is the time the previous ACK was received. Letting tk=tk– tk–1, then bk=dk/Δtk. Since congestion occurs whenever the low-frequency input traffic rate exceeds the link capacity, we employ a low pass filter to average sampled measurements and to obtain the low-frequency components of the available bandwidth. More precisely, we use the following discrete approximation of the low pass filter due to Tustin.

Let bk be the bandwidth sample, and bk the filtered continuous first order low-pass filter using the Tustin estimate of the bandwidth at time tk. Let α k be the time-varying exponential filter coefficient at tk. The TCPW filter is then given̂ by [4]

$$bk = \alpha k\ bk\text{-}1 + (1\text{-}\ \alpha k)\ (bk\text{+}\ bk\text{-}1)/2 \text{ where,}$$

$$\alpha k = (2\tau\text{-}\ tk)/\ (2\tau+\Delta tk)$$

$1/\tau$ is the filter cut-off frequency

Note the coefficients αk depend on tk to properly reflect the variable inter-arrival times.

The approach chosen has taken care of two issues [8]: The source must keep track of the number of DUPACKs received by it before new data is acknowledged. The source should be able to detect delayed ACKs and act accordingly. TCP Westwood was designed with its Reno implementation and Newreno implementation which are mentioned as TCP Westwood and TCP WestwoodNR

VI. EXPERIMENT ANALYSIS

It is said that a single set of experiments using one testing method is not enough evidence to get a mechanism widely adopted [10]. So always the simulation based experiments must be verified on real network or using the network emulator, which can implement delay, drop, bandwidth restriction etc in the topology set up. Linux based network simulator NS-2 [11] was used to introduce delay, drop, bandwidth restriction etc in the topological set up. The main focus was on the analysis of transport layer protocol TCP, with its Westwood implementation. TCP implementations were compared with respect to different performance measures. Some of the results are included here. Performance evaluation of TCP Westwood is carried out in different tends:

- Point to Point Network
- Congested Network
- Bottleneck without random errors
- Bottleneck with random errors introduction

A. Point to Point Network

Point to Point Network where the inflow and outflow as same data rate. Here there is no possibility for dropping of any data because of congestion. The behaviour of different TCPs can be observed for random drops only. Fig. 1 shows the experimental setup for a point-to-point connection in congestion free environment with a pair of source and destination. Inflow and outflow set are 10Mbps with 10ms delay. There is no possibility for drops because of congestion but only random drops can occur. The results are discussed for the most happening error rates in satellite link.

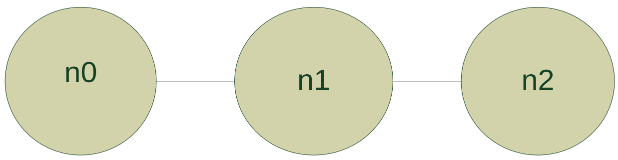

Fig. 1: Point to Point Network

Throughput comparison for TCP sack, TCP Reno and TCP Westwood in Point to Point Network with Error rates 0.001, 0.01 and 0.1 was done. The results as in Table 1, show comparison for different TCP variants. The performance is comparable in case of low error rate. When error rate is increased, throughput of TCP Reno and TCP SACK degrades compared to TCP Westwood. This became possible because, in the presence of high error rate TCP Reno and other TCP variants cannot utilize its fair share of available bandwidth because they cannot predict the network capacity. So when packet loss occurs, they simply reduce the congestion window to half that is unnecessary so throughput of other TCP variants degrades more compare to TCP Westwood in presence of losses.

Further it is observed that increase in the error rate results in throughput degradation for all other TCPs but TCP Westwood performance is better than all other TCP variants.Performance of TCP Westwood was also evaluated in presence of different delays. These delays and error rates are the most happening conditions in satellite links [2, 3]. Average throughput was calculated using awk script. Simulations were done for multiple time to check consistency of results. The results were plotted using xgraph as a tool

TABLE 1 COMPARISON OF RENO, SACK AND WESTWOOD IN POINT TO POINT SCENARIO

Error Rate	Measurement parameters	Sack	Reno	Westwood
0.001	Average_throughput (Mbps)	2.47	2.60	2.61
	Average_ssthresh	9	10	28
	Average_cwnd	39	45	54
	No of retransmission	24	26	34
	No of time out	25	1	1
0.01	Average_throughput (Mbps)	1.71	2.96	3.00
	Average_ssthresh	5	5	28
	Average_cwnd	13	14	31
	No of retransmission	152	220	366
	No of time out	128	22	7
0.1	Average_throughput (Mbps)	0.312	0.796	1.01
	Average_ssthresh	1	1	14
	Average_cwnd	4	4	12
	No of retransmission	268	448	1271
	No of time out	176	129	122

The Table 1 shows the average throughput for TCP Reno Sack and TCP Westwood. Comparison was also done for average congestion window and average ssthresh. It is very clear that utilization of congestion widow and ssthresh for all the three implementation. The nos. of time out occurrences are less in case of TCP westwood.

B. Congested Network

In the congested Network, the full-duplex Link between n0 to n3, n1 to n3, and n2 to n3 with 5mb of Bandwidth and 0 second of Delay created. Full-duplex Link between n3 to n4 with 2mb of Bandwidth and 0 second of Delay has been created as shown in Figure 2. Total Simulation Time is 50 second.

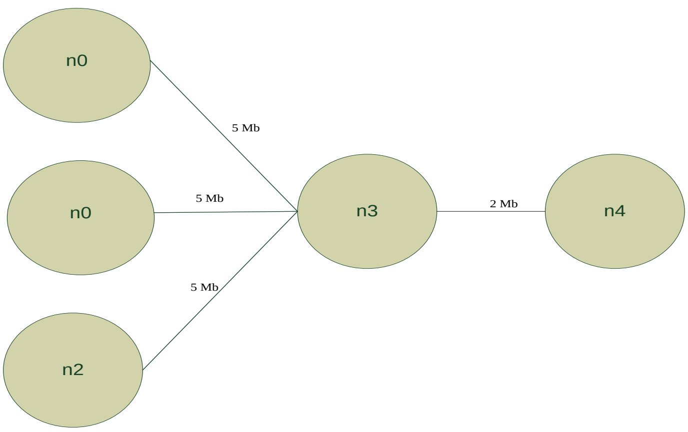

Fig. 2: Congested Network

The experiments were done in two parts. One that is in presence of TCP traffic and another is in presence of UDP traffic. The consideration was done also for error rate introduction. First the analysis was done for TCP implementations comparisons. Then the TCP WestwoodNR and Reno were compared to UDP traffic.

B.1 Bottleneck Link Without Error Rate

Analysis of the throughput of TCP Agent of SACK, Westwood and WestwoodNR has been done as shown in Figure 3.

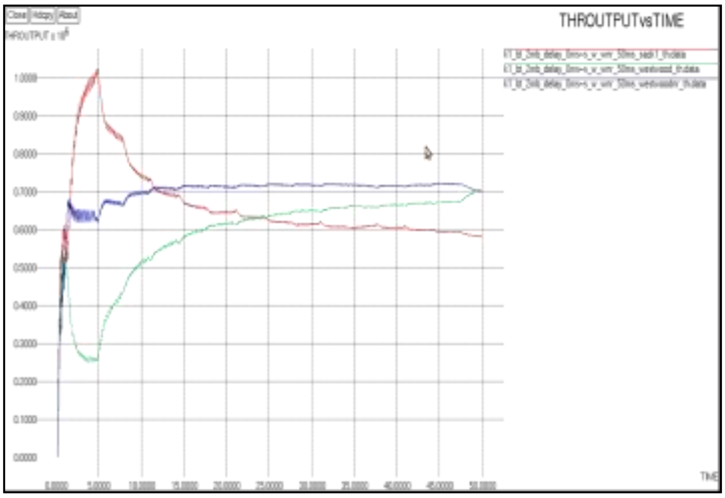

Fig. 3: Bottleneck link Without Error Rate

To create the congestion the inflow initiated was more than the outgoing capacity. Congestion has been introduced by creating bottleneck of 2 mbps. Drops are all because of congestion only. It has been observed that TCP westwoodNR gives the most stable performance and it performs best. In case of tradition TCP the flow will be reduced drastically whereas in case of TCP Westwood NR the bandwidth is effectively utilised. Results also show the stability of operation in case of TCP WestwoodNR. The next section discusses the performance in presence of random errors.

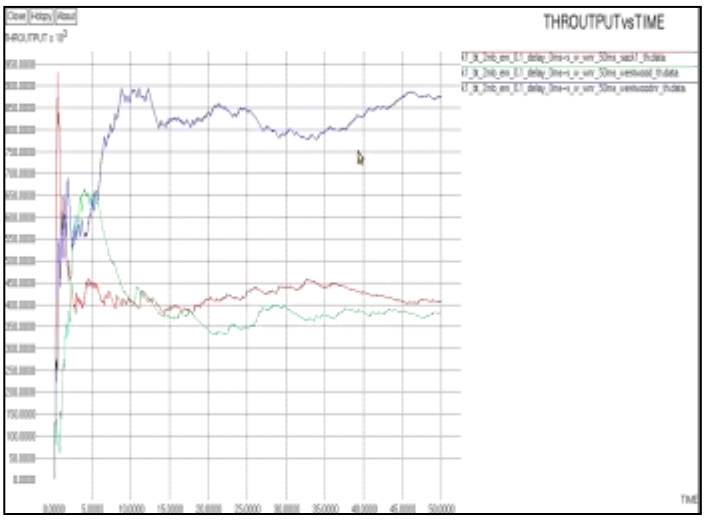

Fig. 4: BottleNeck link With 0.1 Error Rate

Analysis of the BottleNeck link with 0.1 Error Rate was done. Throughput of TCP Agents SACK, Westwood and WestwoodNR have been evaluated. It is observed from the figure 4, as per

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introduction of error rate with bottleneck the performance difference of TCP WestwoodNR compare to the other two versions is very high.

B.3 Bottleneck LinkWith UDP Traffic

Bottleneck link With UDP Traffic has been created by Duplex Link between n0 to n2 with 1mb of data rate and 0 second of Delay and n1 to n2 with 10mb of data rate and 0 second of Delay with full Duplex Link between n2 to n3 with 5mbps of data rate and 0 second of Delay. Total Simulation Time is 50 second.

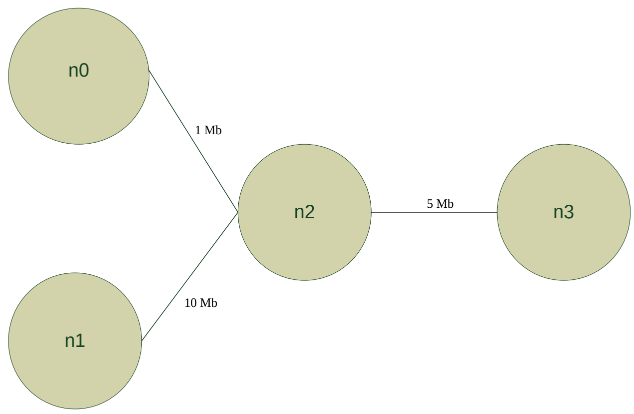

Fig. 5: Bottleneck Link With UDP Traffic

B.1.1 Bottleneck Link With UDP Traffic Without Error

Analysis of TCP Reno with UDP Traffic without given any Error Rate has been done. From Fig it is seen that the throughput of Reno in this simulation is around 4.2 mbps. It is observed that the throughput of TCP Wetwood in this simulation is around 4.5 mbps.

B.1.2 Bottleneck Link With UDP Traffic With 0.1 Error Rate

Analysis of TCP Reno with UDP Traffic for given Error Rate of 0.1 was done. From Fig. 6 It has been observed that the throughput of Reno in this simulation is around 0.8 mbps. Analysis of TCP WestwoodNR with UDP Traffic with given Error Rate of 0.1.

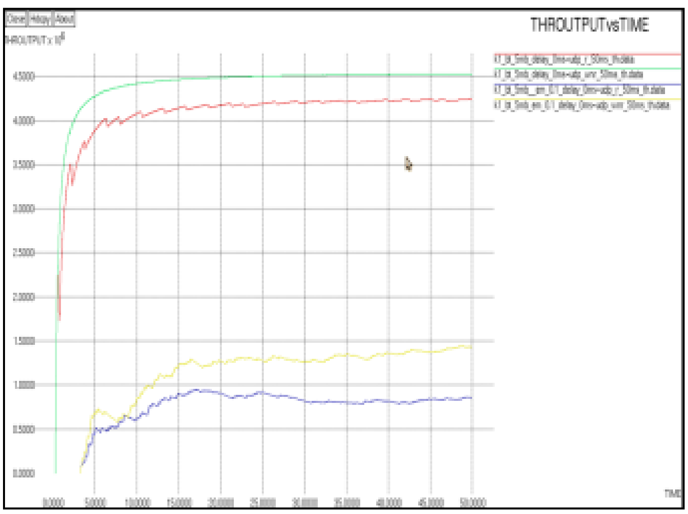

Fig.6: Analysis of Throughput in presence of UDP traffic

From Fig. 6, it has been analysed that the throughput of TCP Westwood in this simulation is around 1.42 mbps. Fig.6 includes the performance of TCP WestwoodNR and TCP Reno in presence of busty traffic. Utilisation of available bandwidth is high compared to the other implementation.

VII. CONCLUSION AND SCOPE

TCP Westwood measures transmission capacity and changes the cwnd and ssthresh after any loss identification. TCP Westwood sets it to the available bandwidth to particular connection. Instead of utilizing the traditional Multiplicative Decrease plan. TCPW handles the losses created by connection lapses. In vicinity of blunders TCP Westwood beats without taking substantial division of contending TCP. The Bandwidth Estimation examining system "overestimates" the association decent amount at bottleneck in the event of lossless systems with bursty traffic. All in all Bandwidth Estimation is more compelling in situations where amicability (to other TCP associations) is not of concern. The performance of TCP Westwood can be evaluated on wireless links for more efficiency. The experiments can be further expanded on real test bed.

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