A Review on Techniques for Enhancing the Performance of TCP for Wireless Transmission

Maya Diwakar[1], Anita Yadav[2]

[1]*Research Scholar, Computer Science and Engineering Department, HBTU, Kanpur, India*

[2]*Associate Professor, Computer Science and Engineering Department, HBTU, Kanpur, India*

mayadiwakar0208@gmail.com
anitacse7@gmail.com

Abstract

TCP is globally used protocol for reliable data transfer from source to destination. TCP stands for Transmission Control Protocol which is used for wired and wireless networks both. In general when a packet is lost TCP understands that it is happen just because of congestion in the network. By knowing the actual reason of packet loss we may increase the performance of TCP. This paper presents the various performance enhancement techniques for TCP.

Keywords: *Sender Based, receiver based, cross-layer, TCP.*

1. Introduction

Now a day's almost everyone is using the internet and users are using the portable computers and TCP is on demand protocol. TCP is one of the important and mostly used protocols.

Almost all the application uses the TCP protocol at the transport layer .Most important reason of using TCP protocol is that it have already in build the congestion control and congestion avoidance algorithms[1].

TCP was basically designed for wired network; it does not work effectively over wireless network [10]. In Wired network TCP having the packet loss due to congestion, but in wireless network TCP it is not correct. There are some other reasons for the packet loss.

2. Factors Affecting the Wireless TCP Performance

There are various other reasons of packet loss in wireless network. In wired networks generally we consider the congestion as a reason of packet loss. List of reasons for packet loss is given below:

- Random loss
- Larger Round Trip Time(RTT)
- Bandwidth Limitation
- Handoffs

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- Asymmetric Channel Allocation
- Short Flows
- Power Consumption

2.1. Random loss:

Most packet loss due to modem, faulty router, channel fading, poor Wi-Fi signal etc in wireless networks. Random loss may also occur due to interference like distance, thick wall etc. then packet loss occurs.

2.2. Larger Round Trip Time (RTT):

Over the wireless networks, there are higher link latencies. Higher Link Latencies significantly affects the total RTT and max value fixed for retransmission timeouts which directly affects the TCP performance.

2.3. Bandwidth Limitation:

Wireless networks having very less bandwidth in comparison to wired networks which leads towards the low TCP throughput.

2.4. Asymmetric Channel Allocation:

Sender side had more channel time or bandwidth as compared to receiver side [12]. Result of this is queuing up the acknowledgements and Larger Round Trip Time at sender side and the nature of the traffic is busty in nature.

2.5. Handoffs:

When the device is mobile then process of transferring an active call or data session from one domain to another domain for providing the uninterrupted connectivity. These handoffs increased the delay and reduce the TCP throughput.

2.6. Short Flows:

TCP flows which would last less than one RTT(Round Trip Time) without the overhead of TCP congestion control is known as Short Flows.

2.7. Power Consumption:

Wireless devices are operated on battery power. Battery power plays a major role in wireless transmission. Energy efficiency is incorporated with the design of their hardware and software. In transmission of data if power off (battery discharge) so the packet is going to be lost.

3. TCP Performance Techniques

There are lots of techniques for enhancing the TCP performance. TCP mechanism is divided into three parts-

- Sender based Techniques
- Sender and Receiver based Techniques
- Proxy based Techniques

Above mentioned techniques are used to enhance the wireless TCP performance. Description of the mechanism is given below.

3.1. SENDER BASED TECHNIQUES:

There are various Senders based approaches for TCP performance enhancement. Approaches are discussed below.

3.1.1. Serialized Timer Approach:

Chendgi Lai and other [15] proposed a newer TCP variant which is called as TCP for Non-Congestive-Loss (TCP-NCL). In the TCP-NCL a fresh timer is initiated before initiating the congestion avoidance mechanism after the Retransmission Time(RTO) is over, new timer is known as Congestion decision Timer. Description of congestion decision timer is given below in the figure no.1.. New packet P_i comes in the network, Retransmission Decision Timer RD_i is started. RD_i will be cancelled when TCP sender received ACK_i before RD_i expires. Apart from that, Pi will be retransmitted and response timer of congestion CD_i will be started.

CD_i will be ended if ACK_i arrives before it ends, apart from that congestion control mechanism will be activated upon the end of CD_i So TCP Sender will get more time to finalized whether to initiate the congestion control algorithm before the expire of CD_i . And it will consider as no congestion in network. So, it will exempt to initiate the congestion control algorithm. Here in the TCP- NCL, obtained steady signals for packet loss and network overload separately with the use of two Serialized timers. With the help of these two serialized timers TCP-NCL getting network overload and packet loss separately.

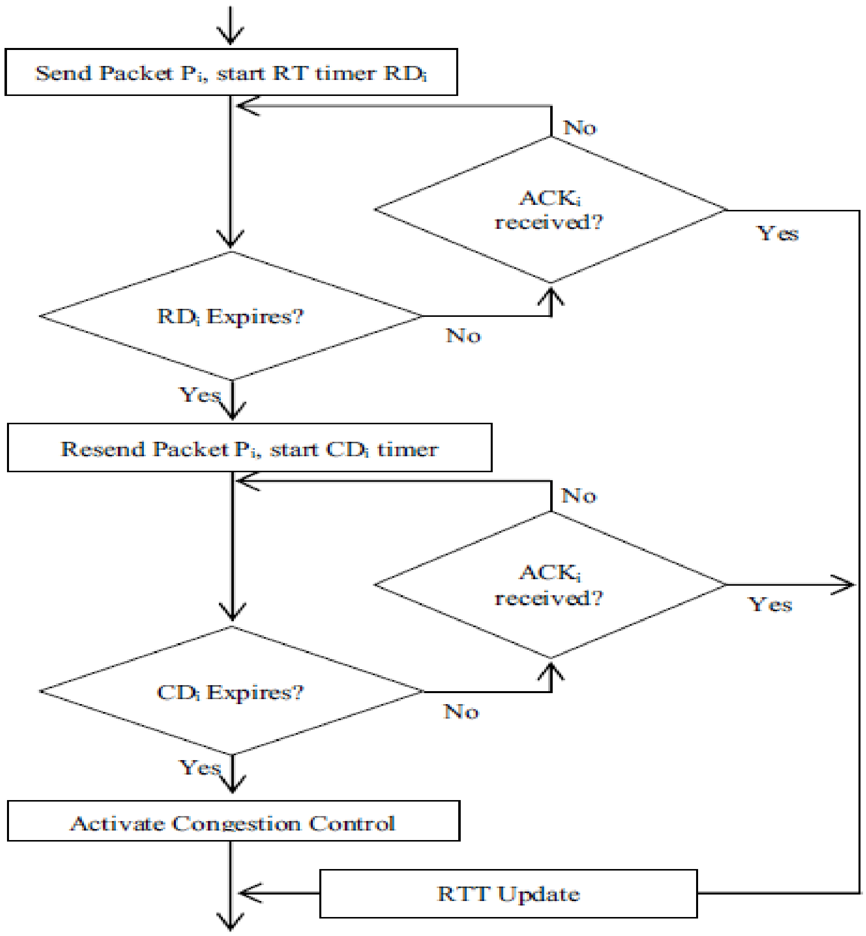

Figure-1 Flow chart for Serialized Timer Model (STM)

3.1.2. Fast Retransmission:

Fast retransmission did the retransmission of lost packets quickly [8]. When the retransmitted packet is also lost in the network then sender waits for retransmission timeout. After the duplicate ACK received by the sender it will resend the packet.

3.1.3. Congestion Control Mechanism:

Congestion control [2] is used to adjust the sender side window in such a way that is able to prevent the buffer overflow at receiver side window, but also in the intermediate routers. TCP uses one more window called congestion window. TCP represents a variable cwnd for congestion control. Congestion Control consisting of three algorithms in it that are Slow- Start, Congestion Avoidance and Congestion Detection.

A new TCP congestion control mechanism was proposed by Fun Lin [3] for wireless network using double window. Here the congestion window is divided into two parts dispose congestion window [dcwnd] and dispose error- code window [decwnd]. It focuses on sending rate of sender's packet by the corruption and congestion both to reduce the energy consumption of mobile hosts. When the rate of corruption loss become high, dispose–error code window size is decreased and holds the value of slow start threshold size. DW- TCP throughput is high and delay is shorter in comparison to traditional TCP.

3.1.4. Cross Layer Approach :

When TCP is used in wireless network then there are so many problems comes that are less reliable, time – variant, behavior fading and shadowing problem, limited bandwidth, large RTTs and node mobility. In such problems TCP handles the unsuccessful packet delivery with the help of congestion control mechanism so lots of research done for this which is mainly focused either on transport layer or link.

In [4] Dzmitry Kliazovich proposed a new approach to enhance the performance of TCP in a wireless network. Collaboration of Cross Layer was obtained by the initiation of an AQR snoop agent. Collaboration is accomplished within the protocol stack of a wireless host. It will create the possibility for the exploitation of link layer ARQ message with in the TCP acknowledgement scheme to achieve the throughput.

Cross Layer algorithm is used to improve the TCP performance. Sathya Priya.S [5] proposed a new cross layer approach TCP [L^2CLAMP TCP] to avoid TCP Acknowledgment (ACK) and packet transmission. Saved time will using by the nodes for data packet delivery in the network. Base station generates the ACK (Acknowledgment). Here the measurement of congestion is calculated at the base station. On the basis of congestion measure the receiver advertised window (AWND) is calculated.

3.1.5. TCP Throughput Stability Mechanism:

Packet drop in Wireless Networks is because of exposed node problem. When a node ‘A’ sends a RTS to the node ‘B’, if node ‘B’ is in the interference range of other node, then it simply ignores the RTS. After every 7 reattempts, if node ‘A’ don’t get a reply, it considers node ‘B’ to be down or node ‘B’ moved out of range and update to the higher layer of link failure.

Yahya M. Omar[13] they proposed a solution to improve the throughput stability in TCP. Fast retransmission and fast recovery is used the sender. Here the TCP is not restoring the coarse grained RTO(Retransmission Time Out). They also had done the changes in the DSR routing protocol. They told about the repeatedly dropping of TCP throughput due to exposed node problem. When the size of sender window is large then more than one node trying to transmit and DSR routing protocol having root request timers and the analysis showed that at the 20-30 seconds time interval throughput falls to zero and this is the main reason of exposed node problem. They found good result in simulation after the changes in DSR.

3.2. Sender and Receiver Based TCP Approaches

TCP performance can be improved by both the sides of transmission sender and receiver. Here the mechanisms for increasing the throughput of TCP in wireless networks are discussed below.

3.2.1. TCP congestion control Mechanism:

There are two types of wireless networks first is symmetric and second one is asymmetric. In the asymmetric network data and ACK (acknowledgment) packets may take different paths in the network. Due to different paths of the data and ACK there was delay in rate of sending the packet and drop of packet in both forward and backward directions [8]. So TCP fully based on received ACK to send new data packet [9,12,8]. Due to delay in backward direction TCP performance gone slow down. In the duration of retransmission timeout, if the ACK is lost, congestion control mechanism will be started and TCP throughput decreased, considerably acknowledgment was treated differently.

Lin Yun [7] in this paper new algorithm for wired and wireless both networks. Algorithm is used for TCP performance enhancement. Here the ratio of the queuing packets to the buffer size in bottleneck link was estimated. And the algorithm used the ratio as a parameter to determine the level of congestion. They used the 4 sub phases to improve TCP Reno congestion avoidance phase with respect to the congestion level. In TCP-RQB congestion avoidance phase used faster rate for achieving max capacity of the network after that slowing down the sending rate and making the sending rate stable at higher rate. They use the ratio of the number of queuing packet to buffer size in bottleneck link as a parameter, and use for sub phases to change the congestion window. In the paper the use 4 congestion level B1=2, B2=1, B3=0.3 & B4= -0.6 according the value of congestion level congestion window changes. Result shows the TCP Reno having more packet loss. Packet loss rate obtained by TCP Reno is 76.40% and by TCP-RQB is 31.46%, So TCP-RQB improved the performance of TCP.

KaANG Qiaoyan[14] in this paper they used multicast congestion control algorithm in wireless networks. VEMCC(TCP Vegas-like expert controlled multicast congestion control) mechanism was proposed and it uses TCP Vegas throughput model. The state of congestion in network was detected by the queuing delay and packet loss. Packet loss was differentiated by link errors over wireless networks and congestion. VEMCC results given high throughput rate and TCP-friendly in wireless networks.

3.2.2. Controlling on Traffic to Improve TCP:

G. Leerujikul [6] investigated the traffic shaping to make the congestion problem so easy to handle. They used the shaping of traffic before the packet entering into the Satellite network. They used NoQ (Network of Queue) and congestion avoidance algorithm. Research is worked with the NoQ and TCP over Satellite network. Here there are two main situations first TCP over Satellite without NoQ and TCP over Satellite with NoQ. In each situation the generated traffic rate and advertised window size are varied and performance of each situation was evaluated for each TCP like Tahoe TCP, Reno TCP, and SACK TCP at congestion control algorithm and the result showed that 33 percent improvement was achieved in throughput. It preferred that when the propagation delay and service rate is low as compared to propagation delay, then the use of only existing TCP congestion control algorithm is good to increase throughput. In above situation all the queues are almost filled always up to the max capacity. On average performance gain in throughput is 8 percent.

3.3. Proxy Based TCP Approach

Split connection is known as proxy based approach. Proxy based approaches are using intermediate intelligent devices to reduce the serious issues arises due to congestion or packet loss. Proxies are doing the task of ending the previous connection and starting the new proxy connection to the destination. For this TCP perform the independent error and flow control, packet size and retransmission timeouts etc. for the individual connection separately. For a lost packet recovery is done by two ways either from the source or from the most recent proxy. Lost packet recovery increases parallelism and reduces the bandwidth in retransmission. When the wired and wireless networks both are connected is known as heterogeneous networks. Below figure shows the working of proxies in wireless network.

LACK- Local Acknowledgement

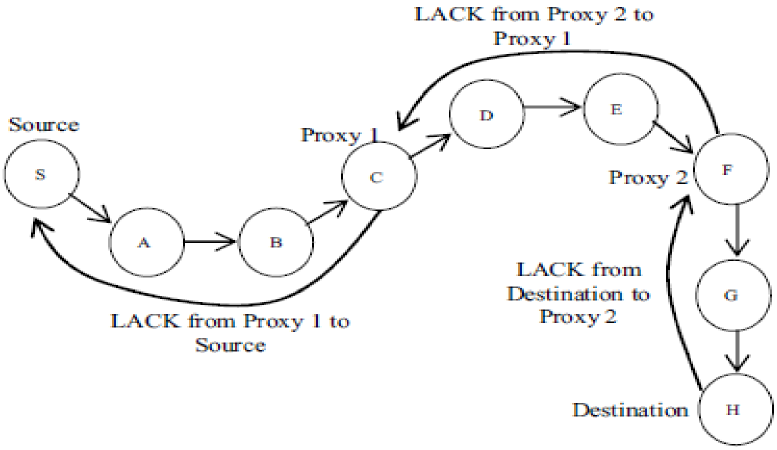

Figure-.2: TCP Proxy

After, introducing proxies in network result is loss of end-to-end semantics of TCP and increase in delay because of buffering. Buffers at intermediate proxies are prone to get exhausted if the link succeeding it is a slower link [8]. Buffered data are lost at proxy if proxy fails

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4. CONCLUSIONS

In this paper we discussed about the TCP performance enhancement techniques to maximize the throughput of TCP in Wireless networks and it also covers the three basic types of techniques first is Sender based second is sender and receiver based and last is proxy based techniques. This is basically a review of the various techniques of TCP to enhance the performance. Some techniques are worked on the sender side of the transmission and some are worked on the sender and receiver both sides and some techniques are working at the proxy level to enhance the TCP performance in wireless networks.

Further in future we can do the analysis on the above described mechanism on the variants of TCP's in wireless networks.

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REFERENCES

1. Shenoy, Sharada U., et al. "Performance analysis of different TCP variants in wireless ad hoc networks." *I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC), 2017 International Conference on*. IEEE, 2017.
2. Abed, Ghassan A., Mahamod Ismail, and Kasmiran Jumari. "A survey on performance of congestion control mechanisms for standard TCP versions." *Australian Journal of Basic and Applied Sciences* 5.12 (2011): 1345-1352.
3. Lin, Fu, Xuefei Li, and Wenhai Li. "Research on TCP protocol in wireless network and network simulation." *2008 4th International Conference on Wireless Communications, Networking and Mobile Computing*. IEEE, 2008.
4. Kliazovich, Dzmitry, and Fabrizio Graneill. "A cross-layer scheme for TCP performance improvement in wireless LANs." *IEEE Global Telecommunications Conference, 2004. GLOBECOM'04.*. Vol. 2. IEEE, 2004.
5. Priya, S. Sathya, and K. Murugan. "Cross layer approach to enhance TCP performance over wireless networks." *2010 IEEE Students Technology Symposium (TechSym)*. IEEE, 2010.
6. Leerujikul, G., and C. Jittawiriyanukoon. "Performance evaluation for TCP with traffic shaping over satellite communications." (2005): 163-163.
7. Yun, Li, et al. "An improved TCP congestion control algorithm over mixed wired/wireless networks." *2009 2nd IEEE International Conference on Broadband Network & Multimedia Technology*. IEEE, 2009.
8. Francis, Breeson, et al. "Techniques for enhancing TCP performance in wireless networks." *2012 32nd International Conference on Distributed Computing Systems Workshops*. IEEE, 2012.
9. Sengottaiyan, N., Rm Somasundaram, and S. Arumugam. "A modified approach for measuring TCP performance in wireless adhoc network." *2010 International Conference on Advances in Recent Technologies in Communication and Computing*. IEEE, 2010.
10. Henna, Shagufta. "A throughput analysis of TCP variants in mobile wireless networks." *2009 Third International Conference on Next Generation Mobile Applications, Services and Technologies*. IEEE, 2009.
11. Jun, Jangeun, and Mihail L. Sichitiu. "Fairness and QoS in multihop wireless networks." *2003 IEEE 58th Vehicular Technology Conference. VTC 2003-Fall (IEEE Cat. No. 03CH37484)*. Vol. 5. IEEE, 2003.
12. Chiasserini, Carla-Fabiana, Michele Garetto, and Michela Meo. "Improving TCP over wireless by selectively protecting packet transmissions." *4th International Workshop on Mobile and Wireless Communications Network*. IEEE, 2002.
13. Omar, Yahya M., et al. "Improving TCP throughput stability in wireless multi-hop Ad hoc networks." *2009 3rd International Conference on Signals, Circuits and Systems (SCS)*. IEEE, 2009.
14. Qiaoyan, Kang, Wang Jianfeng, and Meng Xiangru. "TCP Vegas-like Expert-Controlled Multicast Congestion Control Algorithm for Wireless Networks." *2009 International Conference on Artificial Intelligence and Computational Intelligence*.
15. Lai, Chengdi, Ka-Cheong Leung, and Victor OK Li. "Enhancing wireless TCP: A serialized-timer approach." *2010 Proceedings IEEE INFOCOM*. IEEE, 2010.