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The Survey of Packet Loss Differentiation Techniques in TCP

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ABSTRACT

In wireless network packet loss occurs due to congestion, Wireless channel error and link failure. Here Transmission control protocol cannot respond the packet loss properly. It degrades its performance by presuming the loss due to congestion. So it has become important to find the reasons behind these losses for improvement in TCP's performance. Many researchers have worked in this area and evaluated algorithms which differentiate the cause of packet losses. This paper surveys about various techniques mitigate Packet Loss Differentiation as well as focuses on certain open areas for future research. Most of the surveyed reveals that researchers have worked for the congestion loss only, handful schemes cannot identify the link failure loss. The TCP's performance can be improved with proper loss recovery technique, suitable congestion avoidance scheme and there can be mechanism to switch between suitable Loss Recovery Algorithm (LRA) or congestion avoidance scheme automatically as per identified loss.

Keywords: ECN-Explicit Congestion Notification, - Estimated Relative One Way Trip Time, LDA-Loss Differentiation Algorithm, ROTT-Relative One Way Trip Time,RTT-Round Trip Time, EROTT, TFRC-TCP friendly rate control.

1. INTRODUCTION

The Transmission Control Protocol (TCP) performs well in the traditional network. Martignon et al. [9], the wireless network and the adhoc network and MANET too. TCP is reliable transport protocol which can deal with congestion. Congestion is the main problem of wired network which causes loss.TCP also do have same problem in wireless and MANET network. These networks are rapidly growing networks. Martignon et al. [9] Seddiki et al. [13] The reason of congestion may be due to limited resources, and it may happen during data transmission. It can occur when the incoming packet rate is higher than the outgoing rate. Frequent change in topology may also cause congestion. A primary goal to control the congestion is to improve the performance of a network, reduce packet loss, to reduce delay, minimize buffer overflow and to provide reliable communication. By controlling congestion, the loss may be controlled.

TCP often makes a wrong decision in case of congestion by slowing down burst of packets while it should instead retransmit packets. It has been observed that TCP suffers the problem in identification of congestion related loss transmission error and route failures. This may cause the drastic decrease in TCP throughput. Amin et al.[1] Fard et al.[4]Ye et al. [5]Park et al. [11] Bregni et al. [2]

This paper surveys various Loss differentiation techniques and estimation related to the causes of losses .We surveyed the various parameters used by different LDAs ,techniques for classifying packet losses and the outcomes. Analysis of general policy for identification of packet loss is summarized and compared in this paper.From the survey ,we identified the parameters which are used to differentiate loss and improvement in TCP.Paper surveys the identification techniques to identify 1) congestion loss 2) wireless loss and 3) link failure loss.

2. LITERATURE SURVEY

Packet loss differentiation techniques are surveyed ,which are based on above mentioned three types. Authors Seddiki et al.[13] Amin et al.[1]Fard et al.[4]Ye et al.[19]Lim et al.[7]Goswami et al.[5] classified losses using 1) Queue usage estimation. 2) Threshold based classification 3) Random early loss differentiation based on RTT and ECN 4) End to end loss differentiation. Different types of loss with reasons are classified in fig.1.It is desirable for TCP to identify loss and inform the sender about the cause of packet loss and should take correct action accordingly. Primarily ,TCP is designed to let the sender know about loss cause and it blindly performs the congestion control operation by adjusting the congestion window. So using these techniques TCP may have an idea of cause and can take proper action to improve performance.Su et al.[10] TCP may also provide reliability by retransmitting the lost packets .Fard et al.[4]

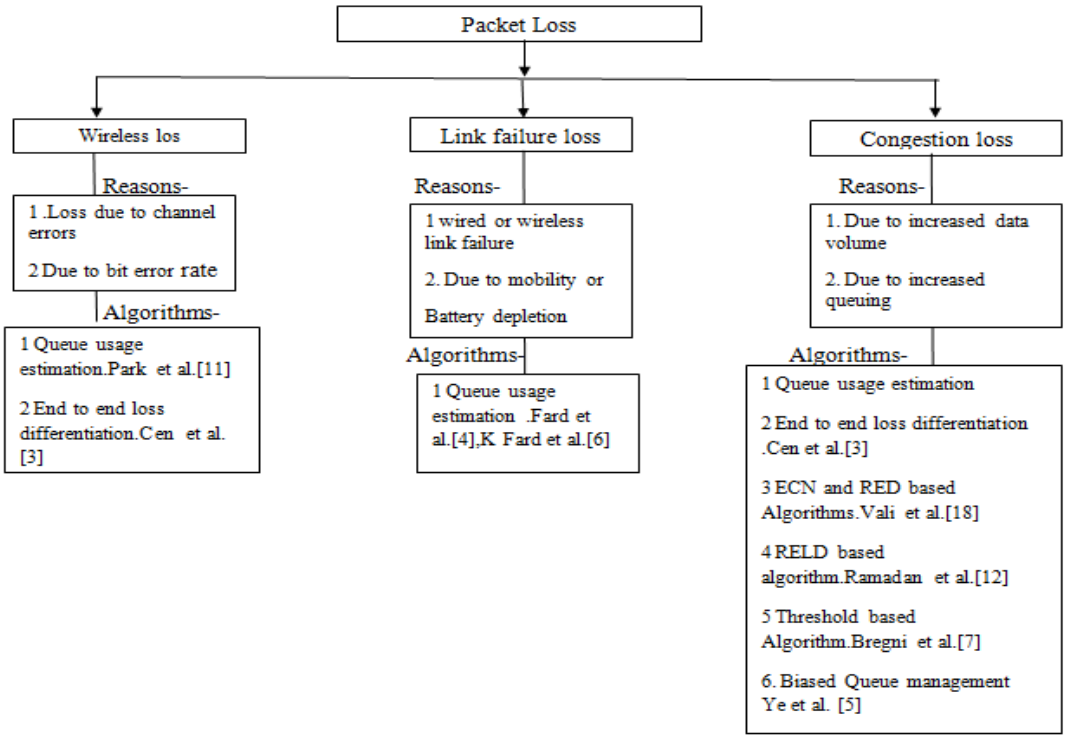

Figure 1. Types of Packet losses and Reasons with studied algorithms.

A. LOSSES CLASSIFIED BY QUEUE USAGE ESTIMATION AND THE THRESHOLD

Queue usage rate is used to evaluate the state of intermediate queues when this rate exceeds a threshold it is used to happen loss and it is generally assumed congestion loss. Park et al.[11]

Chang -Hyeon and Ju-wook Jang [7] found the cause of packet loss using RTT values. Their scheme sets the threshold for classification .With the help of it, the minimum and current RTT is calculated, later it is used to adjust itself for congestion level. As the level increases the threshold for packet loss which is used to classify congestion loss is increased. The differentiation is based on the exponentially weighted moving average of RTT and the deviation. The scheme encountered whether the loss is due to congestion or not. The scheme was evaluated under different network conditions, with different network configurations, workload, error rates of the wireless medium, and different wireless error models. Accuracy of loss differentiation depends on network parameters like threshold and RTT. The scheme can be made more accurate using the moving threshold to detect congestion loss without using parameters.

Mi Yonk Park et al [11] has also worked on the same problem and classified packet loss as wireless or congestion .Authors also used the estimated queue usage and threshold and got positive results in terms of accuracy. Additionally authors used EROTT (estimated Relative one way trip time) to improve a result. The scheme identified the congestion when one of these two condition arise 1) Queue usage is larger than 50% of threshold 2) EROTT is measured .In either case ,the scheme assumes wireless loss. Authors achieved good accuracy and stability as a result.

Mohammad Amin et al [4]Amin et al.[1]worked on same problem ,but they classified the loss as 1) congestion ,2) wireless and 3) link failure loss additionally. Authors have also used the technique which estimates queue usage and classify the loss whether congestion or non congestion. For the Enhancement in accuracy of classification, later authors worked on Threshold based classification algorithm. For that authors Fard et al.[4] have worked to operate on a transport layer of Mobile Adhoc network(MANET)to explore the end to end threshold based algorithm, which improves congestion control to deal with a loss due to link fail in MANET .It works in two phases 1)loss Classification based on threshold which identifies link Failure loss by estimating queue usage and that is calculated using ROTT 2) Based on RTO for a new route for the broken route

using ROTT and number of hops. Authors concluded that algorithm works to address Link failure loss in MANET which consists two parts threshold based Loss classification algorithms for congestion or non congestion loss.Authors obtained the results in terms of three accuracies 1) AC(Accuracy of congestion loss classification) 2) AL(Accuracy of link failure loss classification) 3) AW(Accuracy of wireless loss classification) which outperforms than other approaches.Authors concluded that after detecting link failure loss ,RTO should be adjusted for a new route using the information at transport layer .This improves the performance of congestion control as packet transmission continues when the route is recovered ,this avoids the problem of being idle as TCP didn't use that idle time previously for packet transmission and it was wasted unnecessarily. In the future the throughput can be increased by minimizing this idle time. To work on this and Link failure and congestion loss authors later. K Fard et al. [6] suggested that RTO becomes too long after link breakage and the sender becomes idle unnecessary during this period. So authors worked on the approach which manages a history of queue usage rate. If the queue usage rate increases it indicates congestion loss and from a fixed value of queue usage ,the link failure loss is identified. The sender may have two ways to enhance TCP performance 1)With increased RTO to prevent packet retransmission overhead 2)With reduced RTO to resume transmission. This creates the problem of retransmission overhead which leads degradation in performance ,which can be solved in the future.

Jin YE et al[5]worked on technique based on Biased Queue Management to differentiate loss efficiently. The dropping pattern on routers is tracked and authors found the result with high accuracy. BQM was unfit for dynamic network states so authors worked on Adaptive BQM. This algorithm improves the performance of TCP for wireless as well as wired or hybrid network. Here congestion loss impact on BQM in terms of decreased accuracy and impact on probability to identify wireless loss is less related to congestion loss.

All Authors have used threshold and queue usage rate to differentiate packet loss with good accuracy and throughput.

B. END TO END LOSS DIFFERENTIATION

Some researchers have worked on end to end approach to differentiate loss.

Song Cen et al [3] explored End to end loss differentiation Algorithm. Authors extended TFRC(TCP friendly rate control).They evaluated different LDAs under different topologies and found that Zigzag and Hybrid performs well among all LDAs because it includes mean and values of standard deviation of delay and number of packet losses during computation of delay threshold. This threshold is used to identify congestion or wireless loss state of a receiver. Authors found that these both algorithms would be investigated in future using queuing policy like RED other than Droptail.

Sandeep Goswami et al.[5] have also worked on end to end loss differentiation scheme for wired and wireless network. Authors measured RTT's values and used it to differentiate loss.The scheme set threshold for classification for the function of minimum RTT and current sample RTT and also adjusts for congestion level.The level of congestion is also used to set the threshold.This improved TCP's throughput as the scheme avoids unnecessary reduction in congestion window when loss is due to other reason than congestion. Moving threshold can be used to get more accuracy in future.

C. Loss differentiation based on ECN & RED

ECN is used as notification for congestion so that the sender may avoid congestion avoidance phase in the network. RED is a queue management technique which is also used to supervise the network for congestion. Authors Ramadan et al.[12]Vali et al.[18] here used ECN and RED to differentiate congestion loss.

Wasim Ramadan et al [12] targeted the problem of wireless loss classification. Authors found that ECN is used in wired Network through queue management like RED and also worked for RELD(Random early loss detection) based on RTT and ECN. This prevents network congestion and maintain sending rate in case of wireless loss. Authors found the solution in the form of optimized congestion control and increased performance of a transport layer as classification accuracy .Authors concluded that if a loss is classified correctly than the congestion

control works more efficiently for the wireless network. The future scope of this method can be 1) Analyzing this method with different environment conditions and more competitive traffic. 2) Results for this loss differentiation method with different propagation models on NS2 3) As the reception rate in RELD is high its performance can be also evaluated for transmission of real video.

S.P Vali and K.M.Mehata[18] also targeted the drawback of TCP to classify congestion or non congestion loss and provided the solution using an ECN and RED technique and gain enhanced performance in terms of throughput and peak queue size. Authors suggested to enhance this approach by using various topology and increased number of routers. This Work can be done for other layers such as MAC to enhance the performance of TCP in the adhoc network.

D. DIFFERENTIATION BASED ON OTHER TECHNIQUES.

Authors Seddiki et al.[13]Lu et al.[8]Serdang et al.[14]Goswami et al.[5]Melinkoski et al.[10]Sharma et al.[15] also worked for non-congestion loss and used inter arrival time and one way delay to differentiate loss.

Yi Lu et al[15]compared packet loss in AODV and DSDV related to congestion and showed the preliminary results for a fractal model which describes packet loss in the adhoc network. They provided guidelines for design of routing and flow control and to choose proper parameters. They found that mobility is the dominant cause of packet loss , always sending packets via the shortest path may cause congestion at a few node and packet loss over time exhibits some pattern.They suggested to relate the shortest path and Congestion and looked for working on fractal characteristics of packet loss to get enhancement in Loss sensitive routing protocol.They also wanted to solve about distribution of packet loss ,distribution at host and distribution on host over what time it happens.

Stefano Bregni et al [2] compared accuracy of several LDA like always congested and always wireless scheme,flip-flop scheme, vegas predictor and NCPLD schemes and found that these schemes performed not well in the estimation of the cause of packet loss. Because of this

authors worked for enhancement in non congestion packet loss detection(NCLPD) and the Vegas scheme to get high accuracy. Authors suggested that schemes to detect congestion loss can be enhanced and could provide more accurate bandwidth estimator.

Above authors identified loss but Liw Jia Seng et al[14] worked not only for algorithm to classify packet loss, but also invoke a proper correction mechanism .This classification shows improvement in TCP performance. Their approach identifies the cause of wireless loss or congestion loss. The algorithm was working on the parameters like Inter arrival time and IAD(Inter arrival deviation).When it detects congestion loss the congestion window is managed accordingly. This approach gives good result than selective TCP and TCP NewReno.IAD scheme can be used to improve bandwidth utilization and increase goodput in the future with other TCP variants.

Like the same Shilpa Sharma et al[15]also worked for modified loss discrimination algorithm which differentiate s packet loss cause and took proper action .It decreases the congestion window size in case of congestion loss and maintain the size in case of Wireless loss,so it improves the performance of a network. Calculated throughput is better than before. The algorithm analyzed the packet inter arrival time and ROTT for loss differentiation .In a new model ,there is an improvement in the end to end delay and packet delivery ratio. The performance of Wifi and WiMax can be analyzed using this algorithm in the future.

Aleksandar Milenkoski et al.[10] discussed three congestion schemes 1)delay-based, 2) bandwidth estimation and 3) AIMD(Additive increase Multiplicative Decrease),with one TCP variant and congestion schemes. Authors evaluated schemes with Integrated loss differentiation algorithm. This algorithm works ideally and without errors. They targeted on inefficiency of LDA. They tried to provide unbiased misclassification. Authors observed following congestion schemes,

1) TCP Westwood produced inverted throughput for congested and non congested network.
2) TCPVegas produced complementary throughput,
3) AIMD scheme is done by TCP newreno and TCP NewRenoLDA which gives linear characteristics of throughput. From which the relationship between error and congestion loss can be concluded.

4) LDA like TCPWestwood considered bandwidth estimation and got improved behavior in terms of throughput.

5) In delay based scheme time out variable must be increased irrespective of loss type.

They also noticed that for a complex congestion scheme there should be the way to integrate LDA in a congestion scheme and switching mechanism would have been designed.

Minsu shin[16] also worked for packet loss differentiation algorithm which distinguishes the nature of losses and congestion control accordingly. Since the performance of TCP depends on packet losses over the forward path ,authors gave online Loss differentiation algorithm which uses one way delay on the forward path(FOTT-forward one way delay) .They also considered the possibility of wireless loss during network congestion. Their algorithm is working in two phases .In the first phase it uses the ratio of the average one way delay in a lossless period and lossy period to decide the existence of congestion. In second phase it uses statistical property of one-way delay for congestion loss. Authors showed better accuracy for both losses. Delay on forward path ,they introduced detection and removal of a clock offset existing between sender and receiver and calculate an accurate one way delay on the forward path. They found that their algorithm gives low accuracy for more congested network ,that can be enhanced in the future in this regard to work with other TCP variants.

Alla Ghaleb Seddik et al[13]targeted the problem of misbehavior of TCP against losses which may cause degradation in performance and resource waste .Except congestion and wireless channel loss, the other loss is also common in MANET. Here they designed LDA to deal with link failure loss .It is new TCP variant called TCP WELCOME for 1)to identify loss cause by coupling loss and delay information 2) to take proper action to recover loss depend on it's type .TCP Welcome can work with existing TCP variants. It identifies loss with the help of RTT samples of sent packets at sender side. They stated that if RTT samples over connection is relatively constant and RTO expiration than identifies loss that it is of link failure. They worked on RTO adaptation algorithm to recover loss. Their LRA adjusts transmission rate according to identified loss.It adjusts the rate by adjusting or decreasing CWND according to congestion control algorithm. They implemented algorithm in both Linux kernel and NS2 and compared it with

different loss scenario like congestion ,interference, link failure and signal loss. As a result authors showed improved energy consumption and throughput.

All algorithms and techniques are summarized in the table 1.

3. CONCLUSION -

From above mentioned literature review we can monitor that major work is done for the problem of loss differentiation in TCP in the wireless network handles congestion and wireless loss and handful work is done for link failure . Authors have worked on queue usage estimation ,the threshold based algorithms, queuing policies , ECN and RED based algorithms, Packet inter arrival time ,RTT and ROTT based algorithms and forward one way delay to differentiate the packet loss.

Loss differentiation algorithms work for defined congestion scheme. There should be some switching required to integrate suitable LDA for a congestion scheme to recover the loss.LDA can be also integrated with suitable loss recovery techniques to improvement in TCP's performance .From all surveyed algorithms TCP Welcome[2]detects the link failure loss also and provides loss recovery by taking proper action.

4. REFERENCES

[1] F. Martignon and L. Fratta, “Loss Differentiation Schemes for TCP over Wireless Networks,” pp. 586–599, 2005.

[2] A. Ghaleb-Seddik, Y. Ghamri-Doudane, and S. M. Senouci, “Coupling Loss and Delay Differentiation to Eenhance TCP Performance within Wireless Multi-hop Ad-hoc Networks,” *J. Commun.*, vol. 7, no. 12, pp. 859–872, 2012.

[3] M. Amin, K. Fard, S. Karamizadeh, and M. Aflaki, “Enhancing Congestion Control To Address Link Failure Loss Over Mobile Ad-Hoc Network,” *Int. J. Comput. Networks Commun.*, vol. 3, no. 5, pp. 177–192, 2011.

[4] M. A. K. Fard, S. Karamizadeh, and M. Aflaki, “Packet loss differentiation of TCP over mobile ad hoc network using queue usage estimation,” *2011 IEEE 3rd Int. Conf. Commun. Softw. Networks, ICCSN 2011*, pp. 81–85, 2011.

[5] J. Ye, J. Wang, and H. Liu, “An adaptive loss differentiation algorithm based on queue management,” *Int. Conf. Commun. Technol. Proceedings, ICCT*, no. 60673164, pp. 2–5, 2006.

[6] M. Y. Park, S. H. Chung, and P. Sreekumari, “Estimating rate of queue usage to differentiate cause of packet loss in multi-hop networks wireless,” *Proc. - Int. Comput. Softw. Appl. Conf.*, vol. 1, pp. 500–508, 2009.

[7] S. Bregni and D. Caratti, “Enhanced loss differentiation algorithms for use in TCP sources over heterogeneous wireless networks,” …, vol. 00, no. C, pp. 2–6, 2003.

[8] C. Lim and J. Jang, “An Adaptive End-to-End Loss Differentiation Scheme for {TCP} over Wired/Wireless Networks,” *IJCSNS Int. J. Comput. Sci. Netw. Secur.*, vol. 7, no. 3, pp. 72–83, 2007.

[9] S. Goswami, “END TO END LOSS DIFFERENTIATION SCHEME FOR IDENTIFICATION OF PACKET LOSSES IN TCP OVER WIRED & WIRELESS NETWORKS,” no. 03, pp. 166–174, 2015.

[10] J. Su, “Loss differentiation algorithms in heterogeneous networks,” *2011 Int. Conf. Electr. Inf. Control Eng. ICEICE 2011 - Proc.*, pp. 1450–1452, 2011.

[11] M. A. K. Fard, K. A. Bakar, S. Karamizadeh, and R. H. Foladizadeh, “Improve TCP performance over mobile ad hoc network by retransmission timeout adjustment,” *2011 IEEE 3rd Int. Conf. Commun. Softw. Networks*, pp. 437–441, 2011.

[12] S. Cen, P. C. Cosman, and G. M. Voelker, “End-to-end differentiation of congestion and wireless losses,” *IEEE/ACM Trans. Netw.*, vol. 11, no. 5, pp. 703–717, 2003.

[13] W. Ramadan, E. Dedu, D. Dhoutaut, and J. Bourgeois, "RELD, RTT ECN Loss Differentiation to optimize the performance of transport protocols on wireless networks," *Telecommun. Syst.*, vol. 52, no. 4, pp. 1797–1817, 2013.

[14] S. P. Valli and K. M. Mehata, "A Cross-Layer Approach for TCP Packet Loss Differentiation in Adhoc Networks," vol. 23, no. 9, pp. 2278–2287, 2015.

[15] Y. Lu, Y. Zhong, and B. Bhargava, "Packet Loss in Mobile Ad Hoc Networks," pp. 1–8.

[16] U. P. M. Serdang, "Loss Discrimination Algorithm for Wired / Wireless Networks Liw Jia Seng , Mohd Noor Derahman and Azizol Abdullah Department of Communication Technology and Network , Faculty of Computer Science and Information Technology ," vol. 7, no. 12, pp. 1798–1804, 2011.

[17] A. Milenkoski and B. Stojcevska, "L OSS D IFFERENTIATION A LGORITHMS VS. C ONGESTION C ONTROL S CHEMES : D YNAMICS," vol. 1, no. 1, pp. 13–30, 2010.

[18] S. Sharma and M. Kumar, "Improvement in Wireless TCP Using Modified Loss Differentiation Algorithm," vol. 4, no. 10, pp. 14605–14608, 2015.

[19] M. Shin, M. Park, B. Kim, J. Lee, and D. Oh, "Online Loss Differentiation Algorithm with One-Way Delay for TCP Performance Enhancement," *Ijcsns*, vol. 11, no. 4, p. 26, 2011.

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TABLE 1.

SUMMARY OF DIFFERENT LOSS DIFFERENTIATION ALGORITHMS.

Ref.No	Authors, Year	Differentiation Method	Parameters evaluated	Network type and Loss type	Findings	Possible Improvement
[1]	Mohammad Amin Kheirandish Fard , et al. ,2011	The End to end threshold based algorithm	ROTT, RTO and numberof HOP	Adhoc network,Link failure loss	Loss results obtained in the term of three 1) AC 2) AL 3) AW Which outperforms other approaches	Accuracy can be enhanced more
[2]	Stefano Bregni ,et al., 2003	Enhanced LDA	RTT and total pipesize, accuracy	Heterogeneous wireless network,No congestion packet loss	Enhancement achieved High accuracy than the flip flop algorithm	The approach is less accurate to detect congestion loss so it can be improved
[3]	Song Cen, et al. ,2006	Zigzag Bias Spike the hybrid Algorithm	throughput,Congestion loss, Misclassification rates	Wireless network,wireless loss or Congestion loss	ZBS performed well across different topologies .It will match or improve the performance of any proper scenario.	Other queuing policy can be used rather than Drop tail.

[4]	Mohammad Amin Kheirandish Fard , et al. ,2011	Estimated Queue usage technique .	ROTT,RTO,Queue usageRate	Adhoc network congestion or non Congestion,Link failure	Loss classification assists TCP for the different cause of packet loss Queue estimation technique helps to classify packet loss if it is non Congestion or congestion.	This approach can be enhanced with higher accuracy among others.TCP welcome can be added.
[5]	Sandeep goswami et al.,2015	End to end LDA	RTT,Tdev,k Tp	Wireless network,Congestion and non congestion loss	The moving threshold helps this scheme to detect congestion loss accurately	Accuracy can be enhanced.
[6]	Mohammad Amin Kheirandish Fard , et al. ,2011	The end to end approach in Transport layer	CNWD,RTT, ROTT,No of hops	MANET,Link failure loss from Congestion loss	Ascending growth of queue usage and averaged or fixed value of queue usage is a sign of Congestion and link failure loss respectively.	Transmission overhead problem can be solved in future
[7]	Chang Hyeon et al.,2007	Adaptive End to end LDA	RTT,deviation Ac,Aw	Wired/wireless network,Congestion and wireless loss	Accuracies of LDA depends on network parameters.Under many network conditions this scheme is more stable.	Accuracy can be enhanced more.
[10]	Aleksandar Milenkoski et al., 2010	Observed congestion control scheme to provide improvement	Packet sequence no. ,Flow ID	Congestion and non congestion loss	The integration of LDA in the congestion scheme is required for a complex Congestion scheme and switching mechanism would have been designed .	appropriate LDA for each congestion scheme can be designed
[12]	Wasim Ramadan et al., 2011	RELD,RTT ,ECN loss differentiation	RTT,Avg RTT, Dev RTT,RED	Wireless network	If the loss classification is correctly made congestion control is more efficient on the	RELD can be evaluated for real video transmission

					wireless network	
[13]	Alla Ghaleb seddik et al.,2012	TCP welcome for Loss classification and Loss Recovery	RTT ,average RTT	Multi hop adhoc network	TCP's performance will increase because of loss classification and LRA that reacts appropriate action.	Automatic switching between LDA would be required .
[14]	Liw Jia Seng et al., 2011	Loss discrimination algorithm baesd on Inter arrival deviation	Inter arrival time ,deviation	Wireless or congestion loss	This approach identifies the cases wireless loss or congestion loss and improves TCP performance	This approach can be used to improve bandwidth utilization and increase good put
[15]	Shilpa sharma et al.,2015	Modified LDA	Packet inter arrival time,ROTT	Wireless,wireless loss	It improves TCP performance by identifying the cause of loss than do necessary.	This can be implemented on Wifi and WiMax
[16]	Minsu Shin et al.,2011	LDA with one way delay	Cs,Cr,tir,tis, dir,dis RTTi,Theta	Wired/wireless network,Congestion and wireless loss	They proposed Two phase LDA that uses the ratio of the average one way delay in the loss-less period and lossy period to decide the existence of congestion	The work can be enhanced using other TCP variants
[18]	S P.Valli ,et al., 2015	Cross layer approach	peak queue size and threshold	Adhoc network,	The approach is given to improve congestion control	The approach can be enhanced for various topology and MAC layer
[19]	Jin YE, et al.,2006	Algorithm based on Biased queue management	Pc,Pw (Probability Congestion and wireless	Wired/wireless network,Congestion and wireless loss	The approach works by analyzing the loss pattern onRouters	The work can be enhanced