ENHANCED APPROACH FOR TCP-WESTWOOD OVER WIRELESS NETWORK

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Abstract - To avoid or to reduce the complexity and congestion occurred due to the mobility of nodes in the mobile Ad hoc network, TCP provides several mechanisms named as: TCP Tahoe, TCP Reno, TCP New Reno, TCP Sack, and TCP Westwood. The mechanism Westwood uses modified congestion control algorithms to minimize the delay based congestion and also gives comparatively better results. The parameters like throughput, packet date rate, end to end delay can be improved with the modified algorithm of Westwood. But still some further modification is required to improve some parameters like delay jitter, fairness etc. This paper includes various modified algorithms of Westwood like Westwood-A, Adaptive Westwood, Arta Westwood. As compared to Westwood the Arta Westwood gives better results to improve fairness of bandwidth.

Index Terms - Mobile ad-hoc network, TCP, TCP Westwood, fairness of bandwidth.

I. INTRODUCTION

The connection oriented protocol of transport layer is Transmission control protocol. The features taken from the TCP are flow control, reliability, congestion control and management of network. Basically TCP is evaluated for wired networks but also it will give better performance with wireless network. Wireless network is suffered from the sudden topological changes. When we relate TCP to ad hoc networks it attends the packet losses due to failure of links packet losses due to congestion and in the instance of a time out, backing-off its retransmission timeout. This problem results in degradation of throughput of the whole network. TCP reacts to packet loss due to the connectivity problem of mobile nodes and high bit error rates of wireless links as it would in wired network.

The simple meaning of congestion is overcrowded. The response time slows with reduced network throughput in a congested network. The main reasons behind the occurrence of congestion are insufficient bandwidth and when the network data traffic exceeds capacity. In [1] the analysis of various congestion avoidance algorithms of TCP is included. To avoid the congestion there are various algorithms provided by TCP are additive increase multiplicative decrease, slow start, fast retransmission, fast recovery.

When the size of congestion window reaches to the congestion window advertised by the receivers it will stop the procedure to increase the congestion window. When the loss occurs half of the current cwnd (Congestion Window) is saved as a slow start threshold and slow start begins from its initial end. After appearing the missing segments TCP performs a retransmission without waiting for a retransmission timer to expire. In fast recovery algorithm there is no any performance of slow start, only fast retransmission is done. After receiving the three duplicated acknowledgements in row the fast recovery algorithm is performed. This results in reduction in the links bandwidth utilization, which degrades the performance in the poor throughput.

TCP introduced different variants like TCP Tahoe, TCP Reno, TCP New Reno, TCP Sack and TCP Westwood. Referred to [2] Tahoe suggests that whenever a TCP connection starts or re-starts after a packet loss it should go through a procedure known as slow start. In Tahoe there is no any measurement happened of bandwidth while Westwood accurately measure the available bandwidth and that's why it use network resources effectively. With the help of TCP Reno, only one packet is detected and retransmitted before timeout. The congestion window is reduced without any type of maturity as compared to Westwood. Utilization of bandwidth is better than Tahoe but not as better as Westwood.

In New Reno there is no need to wait for 3 duplicate acknowledgments before it retransmits a lost packet. To denote congestion, Sack uses packet loss. TCP Westwood flattens out its sending rate at the optimal bandwidth utilization point thus including stability. So in this way the Westwood is definitely better than other mentioned variants of TCP.
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This paper is organized as follows: Introduction is provided in Section I. The overview of basic algorithm of Westwood is described in Section II. Section III includes the literature survey on Westwood. Finally section IV presents the conclusion.

II. OVERVIEW OF THE BASIC ALGORITHM OF TCP WESTWOOD

Westwood is an unconventional implementation that interoperates with any other valid implementation of TCP, and all changes are restricted to the sender side. The key algorithms that were announced in [1] by Westwood are:

A. Westwood - New retransmission mechanism

The calculation of RTT is done using the recorded time when the packet is sent and when an ACK arrives. The accurate RTT and retransmission is decided as follows:

- After receiving the duplicate acknowledgement, if the new RTT is found greater than RTO, the retransmission is occurred by the Westwood without having wait for the third duplicate acknowledgment.
- After receiving non duplicate acknowledgement Westwood treats the receipt of certain ACKs as a trigger to find if a timeout should happen.

B. Westwood – New congestion avoidance mechanism

The essential indication of TCP Westwood was using packet delay as congestion indicator instead of packet loss which has been used for congestion sign in loss based congestion control algorithms. The adjustment of congestion window is done in TCP Westwood by given set of rules:

C. Westwood – Modified slow start mechanism

During slow start to be able to detect and avoid congestion, the exponential growth is allowed by Westwood only every other RTT. In between, the congestion window stays fixed so a valid comparison of the expected and actual rates can be made. The γ threshold – Westwood changes from slow start made to linear increase/decrease mode when the actual rate falls down to expected rate by certain amount.

III. REVIEW OF LITERATURE

In this we will discuss about the research work of different authors, how they use the protocol to solve the problems like unfairness, bandwidth consumption and long delay which degrades its performance.

In [3] authors proposed an end host adaption to the congestion avoidance mechanism of original TCP Westwood. TCP Arta Westwood, attains a better concert than TCP Westwood in both simultaneous and non-simultaneous scenarios. Authors also looked at the fairness problem associated with TCP-Westwood. The simulations indicated that TCP-Arta Westwood is able to compete better against TCP Reno, while at the same time not only recalled the throughput advantage of TCP Westwood, but also to increased it.

As described in [4] to develop the compatibility and fairness of Westwood, Adaptive Westwood which is based on the adaptive parameters, has been presented. By the experiment results the authors illustrated the fairness of adaptive Westwood algorithm coexisting with Reno in actual network scenario. As compared to Westwood the compatibility of Adaptive Westwood is better than Westwood, while the main features of Westwood on packet loss rate, delay and delay jitter remain.

In [5] authors analysed the problems when TCP Westwood is applied in mobile ad hoc network, offered a new algorithm TCP Westwood-HA which includes the modified congestion control algorithm based on TCP Westwood, TCP Westwood-HA can significantly increase the network throughput. The empirical values may be changed due to the different network scenario which means there is a requirement to test and gain the empirical values for each particular network before the application of TCP Westwood-HA, so TCP Westwood-HA will be more perfect if an automatic test scheme is designed. A new measurement method of base RTT using the empirical value is evaluated. The result of simulation show that the algorithm has good adaptability with route buffers changing while hops varies, and can effectively increase the TCP Westwood throughput in mobile ad hoc network.

In [6] due to the need for accurate Base RTT estimations in MANETs, we proposed TCP-Westwood-*ad hoc*. It allows a TCP sender to acquire a new base RTT without the use of additional explicit control messages whenever an RC occurs. When an intermediate node detects an RC, its occurrence is piggybacked into the IP header of an on-the-fly packet toward the TCP receiver. It enables the TCP receiver to inform the TCP sender of the RC through its TCP ACK, which finally allows the TCP sender to acquire a new Base RTT. Through simulations using ns-2, our TCP-Westwood-*ad hoc* showed a better performance than the standard TCP-Westwood. In particular, it improved the performance greatly (up to 20%) at high node mobility. Although our work evaluated TCP Westwood- *ad hoc* by using OLSR and AODV as its underlying proactive and reactive routing protocols.

In [7] authors proposed the simulation results taken from evaluating of TCP Westwood over large bandwidth delay network model with different parameters. According to several studies, TCP Westwood does not achieve higher efficiency than other TCP variants, causes much fewer packet retransmissions, and is not based against the connections with longer RTTs. The authors proved that the important parameters of congestion window algorithm for TCP Westwood could not produce a competitor performance with default parameters values, especially in high bandwidth large delay networks, but when the values of alpha and beta changed, the high performance notified to the degree of vulnerability.

IV. PROPOSED WORK

Typically in slow start congestion control algorithm, sender sends one packet then waits for its reply that is known as **ACK** (Acknowledgement). When ACK is received **cwnd** (Congestion Window), is increased by two then sender sends two packets. At threshold level cwnd reaches at maximum level and packet loss will trigger and sender goes into **CA** (Congestion Avoidance) mode.

In CA, sender assumes that packet loss because of congestion when DUPACK received. So sender immediately decreased cwnd by half. That is not idle solution for handle the congestion or packet drop. Other reason may be possible for packet drop. Like as bit-error, collision, hand-off etc.

So in our proposed approach, find the actual reason of packet loss with the help of **ECN** (Explicit Congestion Notification) flag of TCP header. We use 1 bit ECN of TCP header for strong indication of congestion.For improving the congestion using RED (Random Early Detection), In RED, ECN technology is using for drop indication. RED is using for modified queue method. RED is using in real time scenario. RED indicates at sender when first packet will be drop but in our proposed approach modified **Adaptive RED**.

In this RED, we find average length of queue when queue length reaches at above average length then send ECN notification for reduce cwnd.Whenever sender send the packet to receiver computing the router's queue length. Now QL **(Queue Length)** is compared to 2 thresholds.1. Minimum threshold 2. Maximum threshold.

Three different scenarios can be possible.

1. QL < min. threshold
2. min.threshold < QL < max.threshold
3. QL > max.threshold

Here, we differentiate drop of packets using ratio of timeouts and 3 **DUPACK** (Duplicate Acknowledgement). Base on this rate, we can find reason of dropping packets. Timeout is occurred because of congestion at router side and 3 DUPACK is received at receiver side because of bit-error. Calculate the ratio of total no. of events by timeouts and total no. of events by 3 DUPACK.

If ratio is lower so sender assumes that packet loss is occurred due to bit error then cwnd will not reduce and enter into CA phase and ratio is higher so sender assumes that packet loss is occurred due to congestion and retransmits the packets.

V.SIMULATED RESULT

We simulate our result with the help of NS-2.35 and we have considered different parameter to analyze the result. Parameters given in following table I.

No.	Simulation Environment	Parameter
1	Simulator Used	NS-2.35

2	Number of Nodes	100
3	Dimension of simulated area	500 m * 500 m
4	Routing Protocol	AODV
5	Simulation Time	100 sec.
6	Transport Layer	TCP
7	Packet Size	512 bytes
8	Number of traffic connections (max_conn)	5

TABLE I: SIMULATION PARAMETER

We observe the comparison of throughput ,goodput and PDR in different TCP variants that are followings : In figure 1, identified throughput comparison between Westwood and modified Westwood. In figure 2, specified goodput comparison between Westwood and modified Westwood. Other parameter like PDR also increase their result in modified Westwood.

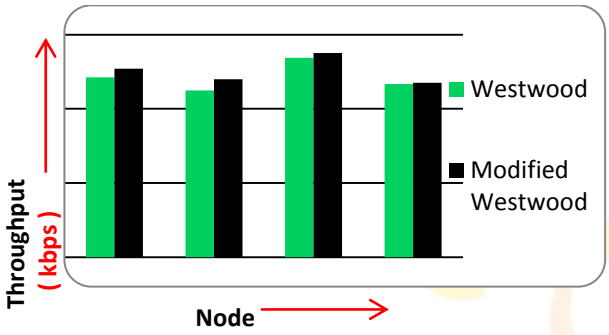

Figure.1: Throughput Analysis

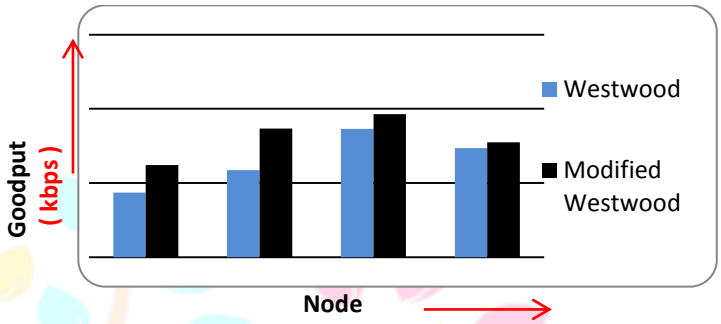

Figure 2: Goodput Analysis

Whenever sender sends the packet to receiver computing the router's queue length. So queue length is compared to 2 different threshold. In algorithm, we defined the minimum threshold (min.th.) of the queue and maximum threshold (max.th.) of the queue. So using this strategy modified Westwood's parameters results are improved and better than the traditional TCP Westwood. Using RED approach, find average length of queue. Then send ECN notification for reduce the congestion on ratio.

Identify the packet drop and also differentiate the reason of packet drop like as congestion or bit error. Define the actual reason, we are using ratio of total number of events timeouts and total number of events by 3 DUPACK.

- Ratio clearly indicates the proper reason of packet dropping. Ratio indicates timeouts/3 DUPACK.
- Ratio is lower = Reason : bit error
- Ratio is higher = Reason : congestion

VI. CONCLUSION

This paper includes survey on various modification methods for the better results over an original Westwood. From literature survey we can conclude that overall the performance of existing Westwood can be enhanced by doing some modifications. Some issues including fairness have been identified with the algorithm of Westwood. Adaptive Westwood shows a better compatibility with Reno than that of Westwood, while it retains the advantages of Westwood on performance of packet loss rate, delay, and delay jitter. Also implements the sender-receiver path flow that results are also specified in fig. 1 and 2. i.e. remove congestion and identify the bit error in sender-receiver path flow with using ratio of timeouts and 3 DUPACK.

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