An analysis of ADTCP, I-ADTCP AND Cross- Layer Based Protocol For Improving Performance Of TCP In Mobile Adhoc Network

Miss Ashwini D. Bhople
ME Student, CSE Department, Sipna's college of Engineering Amaravati
ashwinibhople@gmail.com

Prof. P. A. Tijare
Assistant Professor, CSE Department, Sipna's college of Engineering Amaravati,
pritishtijare@rediffmail.com

ABSTRACT

Wireless communications are playing a key role in todays and future communication systems. The advantages of wireless networks in comparison with their wired counterparts include flexible mobility management, faster and cheaper deployment, and ultimately easier maintenance and upgrade procedures. In addition to this, the users are also starting to use the Ad Hoc mode of 802.11 in which multiple wireless hops are used to connect two distant nodes. In this mode, nodes can communicate directly to each other (without a central coordinator) and should relay data to each other in a self-organizing fashion. This configuration is commonly referred to as multihop wireless Ad Hoc networks or simply multihop wireless networks. As the Transmission Control Protocol (TCP) is designed to provide reliable end-to-end delivery of data over unreliable networks (wireless network). In practice, most TCP deployments have been carefully designed in the context of wired networks. Hence to improve TCP performance in wireless mobile adhoc network is ultimately improve the overall performance of communication system. In this paper we have discussed some methods to improve TCP performance in mobile adhoc network. Firstly I-ADTCP method and Secondly Crossed layered based protocol.

Keywords

Mobile Adhoc Networks (MANETs), Transmission Control Protocol (TCP);IEEE 802.11 MAC, congestion window limit (CWL)

1. INTRODUCTION

Wireless networks are becoming popular among corporate and home users worldwide. Users are looking forward to new technologies that allow them to communicate anytime, anywhere, and using any communication device. Toward this end, wireless communications are foreseen to play a key role in future communication systems. . Multihop wireless networks have several characteristics different from wired networks. The primary advantages of wireless networks in comparison with their wired counterparts include flexible mobility management, faster and cheaper deployment, and ultimately easier maintenance and upgrade procedures. In a typical wireless network that uses IEEE 802.11 MAC, packets may be dropped due to either buffer overflow or link-layer contention caused by hidden terminals such losses directly affect TCP window adaptation. Secondly, wireless channel is a scarce, shared resource. Improving channel utilization through spatial channel reuse is highly desirable. Multiple nodes that do not interfere with each other should be encouraged to transmit concurrently. In this paper we will discuss two methods to improve performance of TCP in mobile adhoc network, Improved-ADTCP (I-ADTCP) it is an improvement on ADTCP. To improve the performance of ADTCP we consider following: ensure sufficient bandwidth utilization of the sender-receiver path; avoid the overloading of network by limiting TCP's congestion window below the Upper Bound of Bandwidth Delay Product (BDP-UB) of the path; check for incipient congestion by calculating inter-packet delay difference and short term throughput using Relative Sample Density (RSD) technique. Another method is Cross layered based protocol.

1.1 Why TCP is used in mobile adhoc network?

TCP is an [5]adaptive transport protocol that controls its offered load (through adjusting its window size) according to the available network bandwidth. The TCP is connection oriented protocol in communication network. As the TCP is designed to provide reliable end-to-end delivery of data over unreliable networks (wireless network).TCP provides reliable, full-duplex, byte-stream service to an application program. It is not vendor specific Why TCP is used in mobile adhoc network the answer is that TCP provide sequencing error control, and flow control. Flow control assures that the sender does not overwhelm the receiver by sending data at a rate faster than the receiver can process the data. This is also called as pacing. A byte stream service does not provide any record boundaries to the data stream. The converse of this feature is a message oriented service that preserves the sender's message boundaries for the receiver. And a full-duplex connection allows data to be transferred in both directions at the same time between the two peer entries. There are many methods have been proposed to improve TCP's performance in MANETs.

1.2 TCP for multihop Wireless Networks

In addition to the infrastructure mode, users are also starting to use the Ad Hoc mode of 802.11 in which multiple wireless hops are used to connect two distant nodes. In Ad Hoc mode, nodes can communicate directly to each other (without a central coordinator) and should relay data to each other in a self-organizing fashion. [4]This configuration is commonly referred to as multihop wireless Ad Hoc networks or simply *multihop wireless networks.* The topology of these networks can change rapidly and unpredictably as the mobile nodes change position or the wireless channel condition fluctuates. Such features require robust, adaptive communication protocols that can handle the unique challenges of these multihop networks smoothly. In practice, most TCP deployments have been carefully designed in the context of wired networks. Hence to improve TCP performance in wireless mobile adhoc network is ultimately improve the overall performance of communication system. Hence many methods have been proposed to improve TCP's performance in Mobile Adhoc Networks (MANETs). Among them Ad hoc TCP (ADTCP) uses an end-to-end approach which requires minimal changes at the sender and receiver, provides the flexibility for backward compatibility, maintains end-to-end TCP semantics and is TCP-friendly. It uses end-to-end measurements to detect congestion, disconnection, route change, and channel error, and each detection result triggers corresponding control actions.

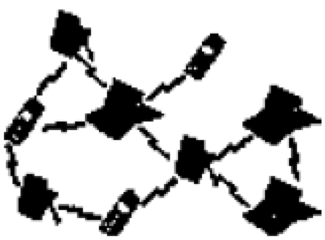

Fig: 1 Ad hoc networks

1.3 Performance degradation of TCP:

In traditional networks (wired) TCP are tuned to perform well where packet losses occur due to congestion. In wireless networks losses can results from bit errors, fading and handoffs. There have been many schemes proposed to improve the performance of the TCP over network that have high BER wireless link[9]. There have been many schemes proposed to improve the performance of the TCP over network that have high BER wireless link. Authors[10] have been proposed and simulated by various authors and we give analytical reviews on these proposals. These schemes are link layer protocol that provides local reliability; and split connection protocol, that break the end to end connection into two parts at the base station.

TCP degradation in multihop networks is mostly caused by the mismatch between TCP and the MAC protocol. Even though the IEEE 802.11 standard has capability to work on Ad Hoc mode allowing the setup of a completely infrastructure less network, it is not optimized for scenarios with large number of hops. In fact,[7] the standard specifies short RTS/CTS control frames to ensure that scenarios relaying on at most three hops are not impacted by the well-known hidden node problem. For more than three hops, contention collisions may arise degrading the channel quality. In general, the overhead of RTS/CTS combined with the lossy nature of the wireless channel as well as mobility can lead a TCP connection to experience very low performance. The reason is that TCP was originally designed for wired networks where such constraints do not exist. We summarize next the key challenges for TCP over multihop wireless networks. The performance of TCP degrades in Ad Hoc networks, Because TCP has to face some challenges due to several reasons specific to these networks: lossy channels, hidden and exposed stations, path asymmetry, network partitions, route failures, and power constraints. That are explain below.

1.3.1 Lossy channels:

The main causes of errors in wireless channel are the Signal attenuation, Doppler shift and Multipath fading.

1.3.2 Hidden and Exposed stations:

The transmission range is the range, with respect to the transmitting station, within which a transmitted packet can be successfully received. A typical hidden terminal situation is depicted in Figure 2. Stations A and C have a frame to transmit to station B. Station A cannot detect C's transmission because it is outside the transmission range of C. Station C (resp. A) is therefore "hidden" to station A (resp. C). Since A and C transmission areas are not disjoint, there will be packet collisions at B. These collisions make the transmission from A and C toward B problematic. To alleviate the hidden station problem, virtual carrier sensing has been introduced However, as pointed out in the hidden station problem may persist in IEEE 802.11 Ad hoc networks even with the use of the RTS/CTS handshake. This is[7] due to the fact that the power needed for interrupting a packet reception is much lower than that of delivering a packet successfully. Stations A and C have a frame to transmit to station B. Station A cannot detect C's transmission because it is outside the transmission range of C. Station C (resp. A) is therefore "hidden" to station A (resp. C). Since A and C transmission areas are not disjoint, there will be packet collisions at B. These collisions make the transmission from A and C toward B problematic. To alleviate the hidden station problem, virtual carrier sensing has been introduced. However, as pointed out in the hidden station problem may persist in IEEE 802.11 Ad Hoc networks even with the use of the RTS/CTS handshake. The exposed station problem results from a situation where a transmission has to be delayed because of the transmission between two other stations within the sender's transmission range. Let us assume that A and C are within B's transmission range, and A is outside C's transmission range. Let us also assume that B is transmitting to A, and C has a frame to be transmitted to D. According to the carrier sense mechanism, C senses a busy channel because of B's transmission. Therefore, station C will refrain from transmitting to D, although this transmission would not cause interference at A. The exposed station problem may thus result in a reduction of channel utilization.

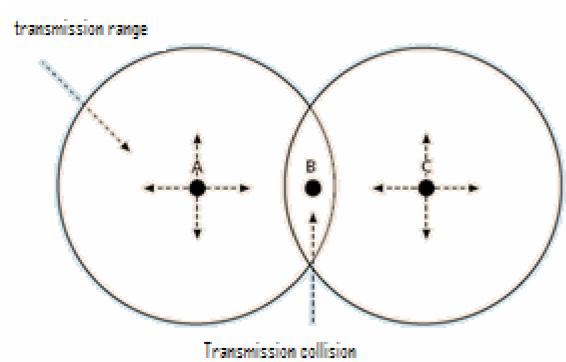

Fig 2.Hidden terminal problem: packets sent to B by A

and C will collide at B.

By examining TCPs performance studies over MANETs and SANETs. We identified the following four major problems:

• TCP is unable to distinguish between losses due to route failures and losses due to network congestion.

• TCP suffers from frequent route failures.

• The contention on the wireless channel.

• TCP unfairness.

We note that the problems are the main causes of TCP performance degradation in MANETs and SANETs; Based on these four problems, the proposals that aim to improve TCP performance over ad hoc networks are regrouped in four sets.

1.3.3 Path asymmetry

Path asymmetry in Ad Hoc networks may appear in several forms like bandwidth asymmetry, loss rate asymmetry, and route asymmetry.

Bandwidth asymmetry:

Satellite networks suffer from high bandwidth asymmetry, resulting from various engineering tradeoffs (such as power, mass, and volume), as well as the fact that for space scientific missions, most of the data originates at the satellite and flows to the earth. The return link is not used, in general, for data transferring. For example, in broadcast satellite networks the ratio of the bandwidth of the satellite-earth link over the bandwidth of the earth-satellite link is about 1000 **.** On the other hand in Ad Hoc networks, the degree of bandwidth asymmetry is not very high. For example, the bandwidth ratio lies between 2 and 54 in Ad Hoc networks that implement the IEEE 802.11 version g protocol **.** The asymmetry results from the use of different transmission rates.

Loss rate asymmetry: This type of asymmetry takes place when the backward path is significantly more lossy than the forward path. In Ad Hoc networks, this asymmetry is due to the fact that packet losses depend on local constraints that can vary from place to place. Note that loss rate asymmetry may produce bandwidth asymmetry.

Route asymmetry:

Unlike the previous two forms of asymmetry, where the forward path and the backward path can be the same, route asymmetry implies that distinct paths are used for TCP data and TCP ACKs[8]. This asymmetry may be artifact of the routing protocol used. Route asymmetry increases routing overheads and packet losses in case of high degree of mobility. Because when nodes move, using a distinct forward and reverse routes increases the probability of route failures experienced by TCP connections. However, this is not the case of static networks or networks that have low degree of mobility, like the case of a network with routes of high lifetime compared to the session transfer time.

1.3.4 Network partition

An Ad Hoc network can be represented by a simple graph G. Mobile stations are the "vertices". A successful transmission between two stations is an undirected "edge". Network partition happens when G is disconnected. The main reason of this disconnection in MANETs is node mobility. Another factor the can lead to network partition is energy constrained operation of nodes. An example of network partition illustrated in Figure 3. In this figure, dashed lines are the links between nodes. When node D moves away from node C this results in a partition of the network into two separate components.

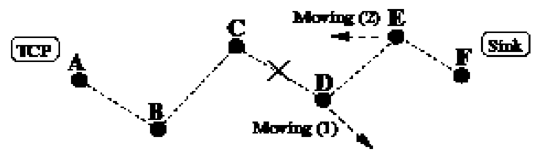

Fig: 3 Network partition

1.3.5 Routing Failures

This occurs due to mobility or contention. Reestablishment after route failure depends on underlying routing protocol, mobility pattern of mobile nodes and traffic characteristics.

1.3.6 Power constraint

Batteries carried by mobile node have limited Power supply. Since each node acts as a system and router it needs additional energy to forward and relay packets.

2. TCP BASED FLOW AND CONGESTION CONTROL

TCP is a window-based flow and congestion control protocol that uses a sliding window mechanism to manage its data transmission. The purpose of this scheme is to guarantee that the sender adjusts its transmission rate to meet both sender and receiver needs. Thus, the TCP sender contains a variable denoted window determining the amount of packets it can send into the network before receiving an ACK. [3]This variable changes dynamically over time to properly limit the connection's sending rate. The sending rate of a TCP connection is regulated by two distinct mechanisms, the flow control and the congestion control. Although these mechanisms are similar, in the sense that both attempt to prevent the connection from sending at an excessive rate, they have specific purposes.

Flow control is implemented to avoid that a TCP sender overflows the receiver's buffer. Thus, the receiver advertises in every ACK transmitted a window limit to the sender. This window is named receiver advertised window (rwin) and changes over time depending on both the traffic conditions and the application speed in reading the receiver's buffer. Therefore, the sender may not increase its window at any time beyond the value specified in rwin.

In contrast to flow control, congestion control is concerned with the traffic inside the network. Its purpose is to prevent collapse inside the network when the traffic source (sender) is faster than the network in forwarding data. To this end, the TCP sender also uses a limiting window called congestion window (cwnd).[8] Assuming that the receiver is not limiting the sender, cwnd defines the amount of data the sender may send into the network before an ACK is received. Considering both flow control and congestion control, the sender faces two limiting factors for its window size, namely the rwin and the cwnd. To conform with both control schemes, the TCP sender adjusts its window to the minimum between rwin and cwnd. In general, however, cwnd is considered the limiting factor of a TCP sender because the receiver's buffer is mostly large enough not to constrain the sender's transmission rate. TCP congestion control has been evolving over the years to detect congestion inside the network and promptly react to that by properly slowing down. In an incipient congestion condition, we reduce CWL to half, which limits the packets send by the sender and does not allow the congestion to build up. Thus the algorithm tries to remain in congestion avoidance phase at all times by detecting and reacting to incipient congestion. I-ADTCP performance is superior to that of ADTCP for all levels of traffic intensity in the network. We focus on another aspect of improving TCP performance: how to properly set TCP's CWL to achieve optimal performance. TCP's CWL is the upper bound of its congestion window size that cannot be surpassed. Within this limit, TCP adjusts its congestion window according to its normal congestion control algorithm. It has been observed that setting TCP's CWL to a large value in MANET would adversely affect its performance TCP/IP is the natural choice for multihop wireless networks because most of today's applications such as HTTP, FTP, SMTP, and Telnet are developed to this protocol suite. Besides, the use of TCP/IP facilitates inter operation with the Internet.

3. ADTCP

In case of ADTCP's congestion window should never exceed the path's BDP-UB, because that is the maximum packet carrying capacity of the path. [1]Considering this, the CWL of a chain is obtained through simulation as follows: Among the simulation results we select the largest number of successfully transmitted packets, and consider its CWL as the optimal CWL, which reflects the true BDP-UB of the path. For instance, in the longest chain with 15 hops, the ADTCP flow achieves the best performance when its CWL is set at 5 packets; hence we consider 5 packets as the BDPUB for the 30-hop round-trip path over the 15-hop chain. Using this method, we are able to identify the achievable BDP of each path. For long chains (more than 2 hops) the MAC layer transmission interference problem and the ADTCP's data and ACK packets interference increases with the number of contending nodes. Hence the actual simulated result decreases more than the theoretical bound for longer chains.

4. I-ADTCP:-

The Improved-ADTCP is proposed to overcome the pitch falls of ADTCP by following algorithm. For this tune the maximum congestion window considering network status adaptively; detect and react to incipient congestion.[1]The changes introduced are simple with respect to implementation complexity and do not break the end-to-end TCP paradigm.

At the Sender Side For all the network states viz. proper congestion identification, channel error due to high BER, route changes due to mobility and disconnections

1. Whenever ACK is received, set the CWL to the value send by the receiver

At the receiver Side Upon packet arrival

1. Process data and generate ACK packet

2. Compute sample value for four metrics: IDD, STT, POR and PLR

3. Estimate RSD based HIGH/LOW for each metric

4. Identify network state from the metric values

5. Set network state bits in option field of out-going ACK packet

6. Obtain the RTHC of the sender-receiver path from the counter in IP header

7. If RTHC <= 4 hops,

let CWL=2

8. if the RTHC > 4 hops,

calculate CWL=1/5 RTHC

9. If congestion threshold > 0.55 then an incipient congestion condition,

let CWL=CWL/2

11. Add CWL in the ACK packet

12. Transmit ACK

5. CROSSED LAYERED BASED PROTOCOL

A set of mechanisms can be proposed in TCP using a cross-layer approach to address the above challenges. It pursues better interaction between TCP and the 802.11 protocol to effectively enhance end-to-end performance. [2]The design mechanism enables the TCP congestion control mechanism to determine the cause for a packet loss. This scheme is used at each node. That monitors the TCP packet flows over the wireless links. Then it detects wireless packet losses and provides feedback to the TCP sender using a special flag. In this protocol, each forwarding node determines the inter-node and intra-node fair channel resource allocation and allocates the resource to the passing flows by monitoring and possibly overwriting the feedback field of the data packets according to a) cumulative bandwidth and delay on the path towards the destination and b) measured channel busyness ratio. The feedback is then carried back to the source by the destination along with the acknowledgment. Finally, the source adjusts the sending rate accordingly. When a packet is received, the data link layer of a node say n1 measures the bandwidth and delay for its link , along with channel busyness ratio. Then it includes this measured information along with the MAC header and forward it to the next node. The receiving node say n2 will also do the same measurements[2] for its link and determines the minimum value of both the measurements. It then updates this bandwidth information in the MAC header. The cumulative delay of both the links is calculated and updated by n2. When the TCP packet finally reaches the destination node say r, the MAC header contains the cumulative bandwidth and delay information of all the links along the path. The receiver r sends this information along with the acknowledgement packet to the sending node n1, encapsulated by link and physical layer headers.

6. PERFORMANCE COMPARISON

6.1 Good put And Number of Hops

The good put varying the number of hops from 1 to 15 for ADTCP, I-ADTCP and Crossed layered . Good put decreases as the hop count is increased. The I-ADTCP performs better than ADTCP. This is because of decreased packet dropping, queuing and frequent RTO for I-ADTCP. Further I-ADTCP detects incipient congestion and reacts by reducing the CWL to half. The Crossed layered based protocol determine the cause for a packet loss. That monitors the TCP packet flows over the wireless links.

Total transmitted packets for concurrent flows

As I-ADTCP is able to set CWL to optimal value resulting in improved packets transmission than ADTCP. It detects wireless packet losses and provides feedback to the TCP sender using a special flag.

Congestion window variation:-

It is observed that ADTCP with unbounded CWL often causes timer out and retransmission. The large congestion window causes packet collision and dropping which invokes RTO, packet retransmission and congestion window reduces to one. Thus the congestion window size at the sender frequently reduces to one, thereby resulting in low TCP throughput. Crossed layered based using feedback system

Average congestion window:-

In case of ADTCP, the average congestion window is too large window size compared with the optimal value 6. But in case of the I-ADTCP, average window size is less than 6, a value close to the optimal window size. This increases the number of packets transmitted in I-ADTCP. Crossed layered based protocol is tries to minimize above mentioned challenges of TCP over wireless network.

7. CONCLUSION

A limitation imposed on the value of congestion window, implies a limitation on the sending window and as such decreases the packet dropping, queuing which results in increased throughput. There are fewer packet drops due to packet collision, fewer link layer drops due to interference, which leads to less spurious route breakages.

I-ADTCP tries to remain in congestion avoidance phase at all times by detecting and reacting to incipient congestion. This serves to keep the network uncongested, and reduces the number of congestion related packet losses. Hence The I-ADTCP performs better than ADTCP at all levels of traffic intensity. As the assumption made by TCP that any packet loss is due to network congestion is no longer valid in wireless networks, TCP performs poorly in such networks. Given the reasons, almost all the proposed schemes attempt to achieve better TCP performance with either of the two ideas: TCP should be capable of distinguishing no congestion related packet losses from congestion caused packet losses such that corresponding actions can be taken to deal with the losses; or non-congestion-related losses should be reduced such that TCP can work normally without any modifications. Interestingly enough, there seems little study attempting to combine these two ideas.

In the realm of multi-hop wireless networks, there are also three groups of schemes, namely, TCP with feedback approaches, TCP without feedback approaches, and lower layer enhancement approaches. In conclusion, feedback based schemes seem to be able to react more quickly to non-congestion-related packet losses, thus to bemore effective in enhancing TCP performance .

8. REFERENCES

[1] Sachin Gajjar, and Hari M. Gupta , Improving performance of Adhoc TCP in Mobile Adhoc Networks.

[2] Mrs S. Thangam, and Dr.E.Kirubakaran, A Survey on Cross-Layer Based Approach For Improving TCP Performance In Multi hop Mobile Adhoc Networks, International coference on education technology and computer, 2009, IEEE computer society.

[3] Kai Chen, Yuan Xue, Klara Nahrstedt, On Setting TCP's Congestion Window Limit in Mobile Ad Hoc Networks.

[4] Zhenghua Fu, Petros Zerfos, Haiyun Luo, Songwu Lu, Lixia Zhang, Mario Gerla, The Impact of Multihop Wireless Channel on TCP Throughput and Loss.

[5] W. Richard Stevens, UNIX network programming.

[6] Ahmad Al Hanbali, Eithan Altman, And Philippe Nain, Inria Sophia Antipolis France, A Survey Of TCP ove rAd Hoc Networks,IEEE conference, third Quarter2005, Volume 7, No. 3

[7] Zhenghua Fu, Petros Zerfos, Haiyun Luo, Songwu Lu, Lixia Zhang, Mario Gerla,The Impact of Multihop Wireless Channel on TCP Throughput and Loss, UCLA Computer Science Department.

[8] Ruy de Oliveira and Torsten Braun,,A Smart TCP Acknowledgment Approach for Multihop Wireless Networks, IEEE Transection On Mobile Computing, VOL. 6, NO. 2, FEBRUARY 2007

[9] Walse, K.H. and D.R. Dhotre, 2007. Wireless network: Performance analysis of TCP. Inform. Technol. J., 6: 363-369.**DOI:**10.3923/itj.2007.363.369**URL:** http://scialert.net/abstract/?doi=itj.2007.363.369

[10] Walse, K.H.; Dhotre, D.R.; "Study of Techniques to Improve the Performance of TCP in Wireless Network," *Ad Hoc and Ubiquitous Computing, 2006. ISAUHC '06. International Symposium on* , vol., no., pp.188-189, 20-23 Dec. 2006 doi:10.1109/ISAHUC.2006.4290672
URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4290672&isnumber=4290631