International Journal of Academic Research & Technology (IJART)
Volume: 01 Issue: 01

ENHANCING TCP RETRANSMISSION IN WIRELESS NETWORKS TO EASE NETWORK DELAY

Dr. Niraj Kumar, Associate Professor Faculty of Commerce and Management Studies. St. Xavier's University, Kolkata, West Bengal, India.

Abstract

Transmission Control Protocol (TCP), which is a transport layer protocol, is responsible for managing the majority of internet traffic. Therefore, the efficiency of TCP is very important since it has an influence on the performance of the internet. Because random packet faults and packet rearrangement are considered to constitute congestion in cellular networks, the end-to-end throughput of TCP suffers significantly when it is used in these types of networks. Because of the high bit error rates and different degrees of congestion in wireless networks, it is unavoidable for retransmission timeouts to occur for packets that are lost during the transmission process. This failure is incorrectly read as congestion by the transmission control protocol, which subsequently commences congestion management by triggering quick retransmission and recovery, which underutilizes the resources available on the network. The problem that occurs when using the TCP/IP protocol suite to enable Internet access via mobile terminals while simultaneously creating 802.11 wireless transmission control protocol networks is addressed and a solution is presented in this article. We explore and evaluate the issue of frequent disconnections that result in serial timeouts by using in-depth simulations, taking into account the fast shift of mobile terminals to intermittent wireless connectivity. After conducting an in-depth investigation into the mechanisms for failure recovery in wireless communication and determining the nature of the issues that need to be addressed, it is recommended that the plan be changed to include adjustments at the link and transport levels.

Keywords: Wireless transmission control protocol, Transmission control protocol, Serial Timeouts, Loss recovery, Fast Retransmit, quick retransmission,, Bit Error Rate.

1. Introduction

When two or more network computers are linked, TCP eliminates congestion and duplication while providing brisk and reliable data transmission. Due to the problems of uncontrolled interference, retransmission, and timeout that are inherent in wireless topologies, efficiency has emerged as the most reliable transport layer protocol for internet/intranet-reliant wired and wireless communication systems. When the round-trip time (RTT) is too long, wireless networks face timeouts and retransmission. RTT timeouts are rather common as a result of the unpredictability of wireless networks, which may have an effect on throughput even when the network is functioning normally. Researchers are looking at more effective ways of retransmitting data in order to keep the throughput of wireless networks consistent.

Wireless networks, ranging from Wireless Local Area Networks (WLANs) to Mobile Ad hoc Networks (MANETs), have lately gained popularity due to advancements in wireless technology and the proliferation of 802.11-focused hand-held wireless terminals. Data and video communications are completed from beginning to end all the way via the existing Internet backbone in highly developed systems that combine WAN, LAN, and 3G cellular networking. Mobile hosts are able to interact with one another inside WLANs (Wi-Fi networking that makes use of 802.11) by way of an Access Point (AP) or Base Station (BS) that is linked to the wired networks. When using wired networks, all that is required for communication between a mobile host (MH) and a fixed host (FH) that is permanently installed is a wireless connection with just one hop. TCP traffic makes up the vast majority of the data traffic carried over the WLAN. This traffic comes from a variety of sources, including site visits, emails, bulk data transfers, remote terminals, and others [3-6]. TCP/IP, on the other hand, would take care of the challenges brought up by the wireless network so that it would be compatible with the wired network and deliver trustworthy Internet services.

In this piece of research, ns-2 simulations are used to investigate TCP efficiency problems that arise in a network that has ongoing connection problems. When difficulties are detected, a more advanced TCP method that reduces the negative effect of idle time is offered as a solution. The proposed strategy allows for the usage of the channel as soon as the allotted period for its disconnection has expired. Additionally, the method stores the current working directory (candy) at the sender until the connection is re-established. The superiority of the recommended plan may be shown by contrasting its success from beginning to finish with that of the original concept. The remaining portions of the essay are structured as follows: The effectiveness of TCP in dealing with wireless losses caused by link disconnections is shown to have been enhanced as a result of previous work. The writers often bring the reader's attention to urgent problems that have not yet been resolved. a trace-file that provides a description of the issue, which is cantered on an inquiry of the performance of TCP loss recovery and the accompanying issues. The conclusion of the study provides a summary of the findings and focuses on areas that need further investigation. The recommended enhancements, which rely on cooperation between two levels, (i) decrease the idle time before transmission at TCP, and (ii) divorce congestion management from the recovery of connection failure losses. Both of these improvements may be accomplished by removing timeouts. Experiments that were based on simulations showed that the suggested changes performed much better than the regular TCP in terms of efficiency when a wireless transmitter had frequent connection issues.

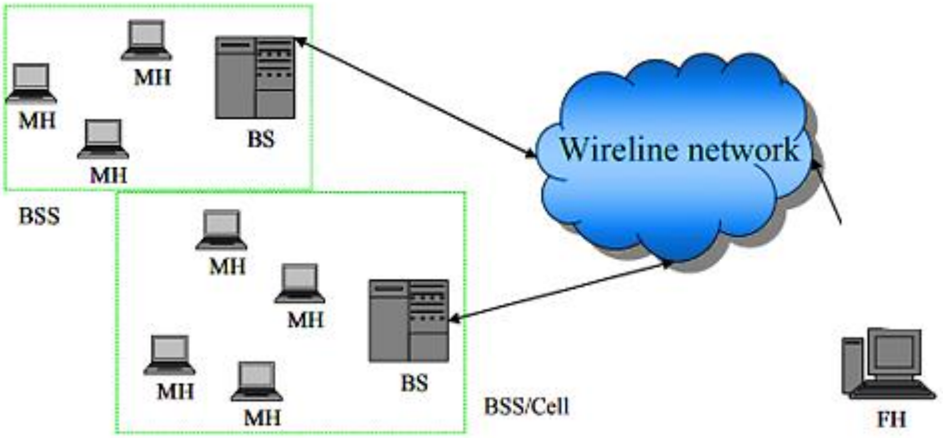

Figure 1: Network architecture.

The network architecture shown in Figure 1 is either a wireless local area network (WLAN) or a cellular network. A TCP connection between a mobile host (MH) and a fixed host (FH) is established when a mobile host (MH) uses a base station (BS), which is an edge node in the wireless network. TCP packets are transmitted from the FH to the MH by way of the BS, and the MH certifies that it has received each data packet that is provided. TCP data may be either a long-lasting FTP connection with a great deal of data traffic or a rapid HTTP connection with a great deal less data traffic on average. Both of these connections can be quite different from one another. We use the assumption that the mobile device moves between cells, mobile applications have a limited capacity for storing data, and the status of the wireless connection may change over the course of a session (which will result in fluctuating wireless link latency).

2. Review Of Literature

Transmission Control Protocol (TCP) is the transport layer protocol that manages the majority of internet traffic; therefore, transmission control protocol efficiency is critical, since it affects internet performance. TCP's end-to-end turnout, on the other hand, degrades noticeably as used in cellular networks, since random packet errors and packet rearrangement are considered congestion. Retransmission timeouts for packets lost in transmission are unavoidable in wireless networks due to large bit error rates and fluctuating levels of congestion. The transmission control protocol misinterprets this failure as congestion and triggers congestion control by causing fast retransmission and quick recovery, resulting in network resource under-utilization. The solution to the problem that occurs when the TCP/IP protocol suite is used to provide Internet access via mobile terminals over evolving 802.11 wireless transmission control protocol links is presented in this paper. Using detailed simulations, the issue of repeated disconnections causing serial timeouts is studied and analysed, taking into account the intense movement towards wireless Intermittent connectivity by mobile terminals. Following a thorough examination of wireless communication failure recovery mechanisms and the discovery of relevant issues, a new scheme with changes at the link and transport layers is proposed.

Transmission control Protocol (TCP) is the transport layer protocol handles the maximum internet traffic, thus maintaining performance of transmission control protocol is important, which impacts the performance of internet. However, end-to-end turnout in TCP degrades notably when operated in wireless networks, since random packet losses and packet rearrangement area unit thought of as congestion. In wireless networks, because of high bit error rate and changing level of congestion, retransmission timeouts for packets lost in transmission is inevitable. transmission control protocol misinterprets this loss to congestion and invokes congestion control by triggering quick retransmission and quick recovery, resulting in under-utilization of the network resources. This paper presents numerous performance improvement mechanisms by that transmission control protocol doesn't take into account each packet loss as congestion. These mechanisms facilitate transmission control protocol to distinguish between congestion and packet loss and increase throughput performance.

Presented in this paper is the solution to the problem that arises when the TCP/IP protocol suite is used to provide Internet connectivity through mobile terminals over emerging 802.11 wireless links. Taking into consideration the strong drive towards wireless Internet access through mobile terminals, the problem of frequent disconnections causing serial timeouts is examined and analysed, with the help of extensive simulations. After a detailed review of wireless link loss recovery mechanism and identification of related problems, a new scheme with modifications at link layer and transport layer is proposed. The proposed modifications which depend on interaction between two layers (i) reduce the idle time before transmission at TCP by preventing timeout occurrences and (ii) decouple the congestion control from recovery of the losses due to link failure. Results of simulation-based experiments demonstrate considerable performance improvement with the proposed modifications over the conventional TCP, when a wireless sender is experiencing frequent link failures.

This paper studies the TCP performance with delayed ack in wireless networks (including ad hoc and WLANs) which use IEEE 802.11 MAC protocol as the underlying medium access control. Our analysis and simulations show that TCP throughput does not always benefit from an unrestricted delay policy. In fact, for a given topology and flow pattern, there exists an optimal delay window size at the receiver that produces best TCP throughput. If the window is set too small, the receiver generates too many acks and causes channel contention; on the other hand, if the window is set too high, the burst transmission at the sender triggered by large cumulative acks will induce interference and packet losses, thus degrading the throughout. In wireless networks, packet losses are also related to the length of TCP path; when traveling through a longer path, a packet is more likely to suffer interference. Therefore, path length is an important factor to consider when choosing appropriate delay window sizes. In this paper, we first propose an adaptive delayed ack mechanism which is suitable for ad hoc networks, then we propose a more general adaptive delayed ack scheme for ad hoc and hybrid networks. The simulation results show that our schemes can effectively improve TCP throughput by up to 25% in static networks, and provide more significant gain in mobile networks. The proposed schemes are simple and easy to deploy. The real testbed experiments are also presented to verify our approaches. Furthermore, a simple and effective receiver-side probe and detection is proposed to improve friendliness between the standard TCP and our proposed TCP with adaptive delayed ack. 2007 Elsevier B.V. All rights reserved.

In this paper, we propose packet control algorithms to be deployed in intermediate network routers. They improve TCP performance in wireless networks with packet delay variations and long sudden packet delays. The ns-2 simulation results show that the proposed algorithms reduce the adverse effect of spurious fast retransmits and timeouts and greatly improve the goodput compared to the performance of TCP Reno. The TCP goodput was improved by ~30%

in wireless networks with 1% packet loss. TCP performance was also improved in cases of long sudden delays. These improvements highly depend on the wireless link characteristics.

3. Performance evaluation

In this section, the TCP-DCA performance on wired, wireless, and hybrid networks is compared and contrasted. We start out by demonstrating the performance of TCP-DCA on static multichip wireless networks, and then we compare it to TCP-DAA in [3]. In the second part of this article, we will demonstrate the performance of TCP-DCA over a mobile ad hoc network as well as many other ad hoc routings. Third, in order to further improve TCP-DCA in hybrid wired/wireless networks, we extend the hop count based method to an end to end delay based strategy. This was done in order to reduce the amount of time it takes for data to travel from one point to another. In conclusion, we provide a simple solution to the compatibility problem that exists between TCP-DCA and TCP-New Reno by using the usual delayed option.

➢ Static ad hoc network

In this section, we show TCP-DCA performance in static ad hoc networks. Meanwhile, we compare TCP-DCA with TCP-DAA and TCP-New Reno (with and without standard delayed ack option. More specially, we use the name “original TCP” for TCP-New Reno without standard delayed option, and TCP-STD-DA for TCP-New Reno with standard delayed option. AODV routing is used unless otherwise stated. TCP-DAA is an interesting extension of and has shown good performance in static ad hoc networks. It is the most recent work and the major differences between TCP-DAA and TCP-DCA are listed in Table 1. For fair comparison, most simulations scenarios presented in this subsection were shown in . Each result is the average of five simulation runs.

	TCP-DAA	TCP-DCA
Sender	CW upper limit is 4, duplicate acks threshold to initiate retransmission is 2, Retransmission (RTO) timer has been multiplied by five.	places CW in the field for the advertised window in the packet header.
Receiver	Adaptive delay window from 2 and 4 depending on loss event	Adjustable delay according on the distance travelled.

Table 1: Design difference

- **Mobile ad hoc network**

In a previous article, we shown that implementing a delayed ack mechanism improves TCP performance in a static network. In this article, we show how the same strategy may achieve the same results in a mobile network. We show that our delayed ack strategy is successful in mobile environments despite the fact that it was not developed specifically for the TCP in mobile networks.

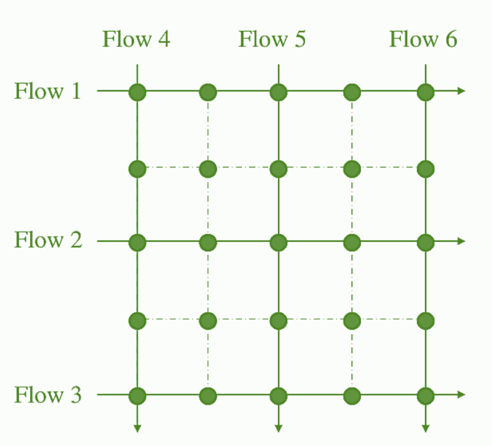

Figure2: Grid Topology

We also present results on the grid's topology. The structure of the grid is shown in Figure 9a, along with six flows that are linked to the grid. In Figure 9b, a comparison is made between the performance of the original TCP, TCP-STD-DA, TCP-DAA, TCP DCA-CWL, and TCP DCA, and the results are the same as those found in the previous figure. TCP-DCA, TCP-DCA CWL, and TCP-DAA all manage to obtain the highest performance, and the variations between them are negligible. When compared to standard TCP, they provide speed improvements of 10 to 25 percent (both with and without the delayed ack option).

- **Lossy network**

When working with wireless networks, the wireless connection itself may begin to exhibit unreliable or inaccurate behaviour at some point. After examining how well TCP-DCA performs in mobile networks with packet losses, we now examine how well it operates across wireless connections that experience packet losses. The BER, or bit error rate, is used as the loss metric for the wireless connection, and the errors associated with each link are regarded as being evenly distributed and independent. When a packet is received with a bit error, the IEEE 802.11 MAC layer will attempt to recover from packet loss by repeating transmissions up to a maximum retransmission limit or until retransmission is successful. It is vital to take notice of this feature, as it aids in recovering from packet loss and it is crucial to remember. As a consequence of this, the MAC retransmission approach is able to swiftly recover the packet and will not create an excessive number of issues for TCP when BER is low. The high amount of packet loss would have a severe influence on the performance of the TCP protocol, despite the fact that the BER is big.

4. Research Methodology

Through our simulations, we discovered that the single-hop scenario, which is shown in Figure 4, often resulted in an improvement in throughput of between 3 and 5%. The Congestion Window, on the other hand, has greatly increased because to the fact that it is now kept on average 35 to 40% higher than TCP New-Reno. This is because enabling a TCP connection's retransmission timeout to run for a little longer period of time prevents the shrinking of the congestion window when delay is anticipated for the connection. Although the congestion window in the multi-hop situation (shown in Figure 5) is around 45–50% larger than what is observed with TCP Reno, throughput was on average 4–10% higher. This is because the multi-hop case involves more hops.

Scenario	**Congestion window size (in bytes)**	**Throughput (Packets/sec)**	**Percentage Improvement**	
			Throughput	**Congestion Window**
Single-hop	5500	0.46	04-Jun	36-56
Multi-hop	5200	0.12	05-Nov	44-65

Table.2: illustrates the comparison of congestion window and throughput

➢ Design Considerations and Tradeoffs

Those packet control filters designed to mitigate the delays associated with wireless connections need to have an easy implementation.

- ***TCP option:*** Instead of being a change to the TCP protocol itself, packet control was developed as an additional option for the TCP protocol. As a direct consequence of this, the process of deployment inside an existing network is streamlined.
- ***A link layer solution in BS:*** In order to control packets, just the BS has to be updated. The final consumers do not need to make any adjustments to the settings. It is also possible to implement it gradually since it does not need any changes to be made to the protocol stack.
- ***Scalable:*** When properly built, packet control filters only need to retain a limited number of constant state variables, which necessitates a relatively little increase in the amount of memory available in the BS.
- ***Handoff:*** Packet control does not need any additional handoff processes, such as message exchanges or higher memory requirements, and it does not have any unfavorable consequences on handoffs either.

5. Analysis and Interpretation

This section examines the impact of relation disconnections on TPAUSE using simulation-based investigations. The increase in TCP efficiency that results from implementing the previous methods' advice is then assessed.

Parameter	Value
MAC data rate	24 Mbps
MAC buffer size	256 KB
MAC Long Retry Limit	5
MAC Short Retry Limit	6
Routing Protocol	AODV
TCP Version	New-Reno
TCP Duplicate ACK Threshold	4
Initial RTO	3 seconds

Table 1 Simulation setup parameters

It is important to keep in mind that each iteration of TCP makes adjustments to the same loss recovery algorithm and uses methods that are conceptually equivalent. On the other hand, the TCP New Reno baseline approach is the one that is used in this research project since it is the one that is generally recognized across the research community. Both a single-hop and a multi-hop strategy were used for the whole of the simulation's execution. The following table lists the NS2 simulation parameters as well as the values that are used by default.

6. Result and Discussion

Table 1 contains a comparison of the number of TCP packets lost at the MAC layer in both scenarios. The purpose of this comparison is to highlight how the performance has improved as a result of the modifications that have been proposed by this research.

Loss Duration in RTT (RTT = 210 ms	**TCP packets (total 12 dropped at MAC identical losses)**	
	Normal MAC	**Normal MAC**
0.5 RTT	23	13
1.0 RTT	36	18
1.5 RTT	56	25
2.5 RTT	142	41
4.0 RTT	180	83
5.0 RTT	179	92
6.0 RTT	172	103

Table 2: TCP packet drops at MAC layer

The table demonstrates that the behaviour of the default MAC suffers from a high frequency of packet losses upon disconnection. This is caused by i) a lower RL and a maximum data-rate that is too high for the connection. ii) an exponential back-off in RTO, which leads to meaningless TCP broadcasts as a consequence of the problem. On the other hand, in the event that the proposed enhancements are implemented, the loss recovery at the link layer will benefit from a larger RL that utilizes a lower data rate. The quantity of MAC drops has been reduced because to the revised scheme's extended MAC loss recovery for each and every packet. It is obvious that a reduction in the number of packets lost at the MAC layer would result in a need for TCP retransmission attempts in order to recover lost data. TCP becomes more efficient when the number of retransmissions that it does is decreased since this allows it to examine and utilise the capacity of the network to a greater extent.

7. Conclusions

The ever-increasing demand for a variety of resources across the Internet has made it absolutely necessary to enhance the core protocol of the Internet, known as TCP, with new capabilities that have the potential to solve difficulties associated with the mobility of wireless networks. We observed that an excessive number of serial timeouts and congestion management led to a reduction in performance as a result of frequent connection failures brought on by mobility. This was the case because excessive serial timeouts were used. In this paper, we offer two different ways to make TCP wirelessly adaptable while simultaneously improving its end-to-end efficacy. When the network has a high number of connection failures, several evaluations show that implementing the suggested adjustments results in a significant improvement in TCP efficiency compared to using regular TCP. The results of the simulation indicate that the strategies that were proposed reduced the number of TCP spurious rapid retransmits and timeouts. They enhance the amount of bandwidth that is used by TCP as well as its throughput and goodput. The goodput of TCP Reno rises by a factor of 100 percent in networks with variable latency, and it increases by a factor of 30 percent in networks with 1% wireless connection packet losses. Depending on the conditions of the route, the performance of TCP may also be improved in circumstances when there are considerable sudden delays. Packet control filters might be included in intermediate routers in order to provide straightforward management of the transmission of TCP segments and ACKs. In the future, there may be the possibility of adding delay generators that are more exact as well as multi-connection simulation scenarios that contain actual wireless traffic traces for performance evaluations.

8. References

1. Arun Manohar U, Neela Madheswari A, "*Wireless Lighting System with Zigbee, Scope International Journal of Science, Humanities*", Management and Technology, Vol.2, February 2016
2. Chunxue Wu, Fengna Zhang, Hongming Yang," A Novel QoS Multipath Path Routing in MANET", doi: 10.4156/jdcta.vol4.issue3.13.
3. Suresh Kumar A, Kannan M, "Wireless Sensor Networks: Pattern of Ambiguity Protecting Three-Factor Substantiates Access for Transaction Code", *International Journal on Recent Researches in Science, Engineering & Technology*, Vol.3, December 2015

4. N. Prem Kumar, Kannan M, Prasanna D, "Optimal Fast Handover Algorithm to Reduce Handover Latency in Wireless Communication System", *International Journal of Advanced in Engineering*, Vol 2, February 2015
5. D.B. Johnson, D.A. Maltz, in: in: T. Imielinski, H. Korth (Eds.), Dynamic Source Routing in Ad hoc Wireless Networks, Mobile Computing (chapter 5).
6. Z. Zhizhao, H. Zhengzhi, 2002, "Improving TCP performance over wireless links using link-layer retransmission and explicit loss notification", *Journal of Systems Engineering and Elec-tronics*, pp. 17-23.
7. A. M. Al-Jubari, M. Othman, B. Mohd Ali, and N. A. W. Abdul Hamid, “TCP performance in multi-hop wireless ad hoc networks: challenges and solution,” Eurasip J. Wirel. Commun. Netw., vol. 2011, no. 1, 2011, doi: 10.1186/1687-1499-2011-198.
8. K. Xu, Y. Tian, and N. Ansari, “TCP-Jersey for Wireless IP Communications,” *IEEE Journal on Selected Areas in Communications*, vol. 22, no. 4, May 2004.
9. P. Sreekumari, S. Chung, W. Kim, 2011 "A Timestamp based Detection of fast retransmission loss for improving the performance of TCP NewReno over wireless networks", in Proc. of 7th IEEE International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob), pp. 60-67.
10. K. Chandran, S. Raghunathan, S. Venkatesan, R. Prakash, A feedback-based scheme for improving TCP performance in ad hoc wireless networks, IEEE Personal Communications Magazine 8 (1) (2001).