

Performance Evaluation of Exclusive Handover Message TCP in Mobile IP Based Networks During Handover

Padma Bonde*, Bhavana Jharia*, A. K. Shrivastav**

*Department of Electronics & Telecommunication,
Jabalpur Engineering College, Jabalpur (M.P.)-INDIA

**Directorate of Technical Education,
Government of Madhya Pradesh, Bhopal (M.P.)-INDIA
pjyash2004@yahoo.com, bhavanajharia@yahoo.co.in

Abstract

Transmission Control Protocol (TCP) is known to suffer from performance degradation in mobile wireless environments, as such environments are prone to packet losses due to high bit error rates and mobility induced disconnections. Proposed scheme is a true end-to-end approach, based on the idea of exclusive handover message and is used for alleviating the degrading effect of host mobility on TCP performance.

Keywords - Mobile Host, Exclusive Handover Message, Time Out

I. INTRODUCTION

The most popular transport layer protocol TCP on the Internet offers reliable byte stream service. In this, packets are cumulatively acknowledged (ACK) as they arrive in sequence and out of sequence packets will cause generation of duplicate ACKs. The sender detects a loss when multiple duplicate ACKs (usually 3) arrive, implying that packet was lost [1]. TCP was basically developed for implementing on wired networks where it has less bit error rates (BER) and hence less packet losses without considering mobility factors. For better performance of TCP in a mobile network, loss due to wireless link error must be detected immediately and transmission resumed as quickly as possible. TCP performance degrades, when a Mobile Host (MH) moves between networks and some packets are dropped or lost during handover. There were number of solutions proposed to improve the performance of TCP in wireless environment [2-10].

In proposed scheme, we have calculated timeout (TO) at the base station so that (BS) quickly sends exclusive handover message (EHM) to fixed host (FH) to avoid retransmission at FH. This can be easily achieved as MH gets router solicitation signal from new base station when mobile host does handover. Freeze TCP [2] works on the measurement and prediction of signal strength. However, with Freeze TCP, the time before which actual disconnection happens; in other words warning period; is quite a critical issue to be predicted. In fact,

performance improvement of this scheme is totally dependent on accurate prediction of disconnection by the MH. In M-TCP [3], Base station waits for certain time for ACK and then assume that disconnection has occurred.

II. RELATED WORK

A good amount of research is being done to improve TCP performance in the unpredictable mobile and wireless environments where link disconnections, packets losses and delays are common. To handle the temporary disconnections caused by handoff, fading or other reasons, most of the recent solutions employ the idea of putting sender into the persist mode. M-TCP and Freeze-TCP both adopt this idea. Freeze-TCP uses similar approach of forcing sender into persist mode; but sending zero window size (ZWS) is prior to the real disconnection through signal strength measurements at the wireless antenna. Another method [4] is proposed to alleviate the performance degradation as a result of disconnections due to handoffs. In [5] if the sender receives an ACK with EHN (Explicit Handover Notification) indication, it resets the retransmission timer and adjusts its send window in response to the sequence number of this ACK. ATCP [6] assumes that network layer sends a connection event signal to TCP when MH gets connected to the network and a disconnection event signal when the MH gets disconnected from the network. In Proactive-WTCP [7] MH monitors its receiving signal strength. A threshold of receiving signal strength is set to predict the impending disconnection. When the signal strength is lower than the threshold, MH predicts disconnection. To enhance traditional TCP performance with handoff loss [8], they propose the concept of active-mobile-host, which maintains the original end-to-end semantics. They assume the MH has the knowledge of RTT (Round Trip Time), which may not be practical since RTT is often measured very coarsely by the sender instead of the MH itself. The idea of active-mobile-host is to let the MH actively advertise a ZWS ACK to the sender just at the time

instant of crossing the boundary of Core Area. Upon receiving ZWS, the sender will freeze all retransmission timers and enter a persist mode. But the sender keeps sending zero-window-probe packets to the MH until the MH's windows opens up.

III. MOBILE IP

Mobile IP (Internet protocol) [9] is primarily concerned with the maintenance of mobility. It allows MH to move from home network to the foreign network. It solves the primary problem of routing IP packets to mobile hosts. Handover occurs when the mobile host moves from its present location to a new location. If it moves from home network to foreign network, MH must register its new location through registration request and registration reply.

IV. EXCLUSIVE HANDOVER MECHANISM

There are only two assumptions in exclusive handover message. Firstly, a mobile host can immediately know that its handover has occurred. This knowledge can be acquired easily by receiving signal from new base station [5]. Secondly, α (equation 1) is considered in the range of 50msec to 100msec [5] because round trip time and its variation between BS and MH is small, typically in the order of milliseconds as there is only one hop between base station and mobile host [10]. EHM extends TCP by using reserved bit of TCP header shown in Figure 1. It negotiates through setting first reserved bit of TCP header to one in the EHM ACK.

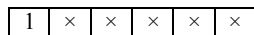


Figure1. Reserved bits of TCP header

In our approach, connection is split into two segments at BS, FH uses unmodified TCP while BS uses EHM concept. MH keeps records of last ACK it has sent to FH.

Calculation of Time Out at Base Station

BS maintains its own timer to determine the time, when to send EHM ACK to avoid unnecessary retransmission and going into congestion avoidance and slow start phase at FH, when MH does handover. BS sends EHM ACK to FH after time out, then no congestion control or timeout operations are performed by FH. The choice of when to send a EHM ACK to avoid performance degradation is very important. Our approach uses timer-based method, where, the BS uses a timer granularity that must be smaller than the FH timer granularity, so that it can timeout before the FH time out. Smooth round trip time estimation used in the traditional TCP is not considered in this approach because as only one hop is involved in the base station-mobile host link. After handover MH generally receives Mobile IP router advertisements from the base station with the interval of 0.1sec. Therefore, the mean time at which a MH may detect its own movement is 50msec [5]. We estimate TO at base station is two times round trip time (rtt) between base

station and mobile host [3] and extra time α (range of 50msec to 100msec [5]). From [3][5][11] estimated TO at base station is

$$TO = 2rtt + \alpha \quad (1)$$

The complete operation of EHM scheme flow is shown in Figure 2.

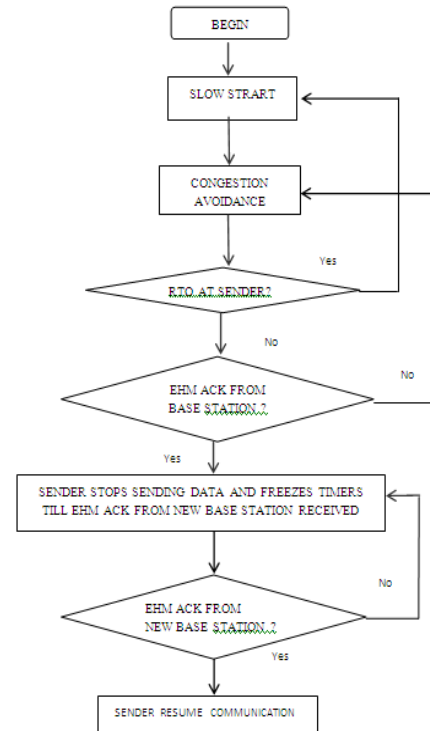


Figure 2. Flow Chart of EHM scheme

V. SIMULATION MODEL

NS-2 network simulator [11] is used to evaluate the performance of presented work and compared with TCP Tahoe and TCP Reno. Table 1 shows parameters including packet error rate (PER) used in the simulation. Figure 3 shows the network topology used in the simulation.

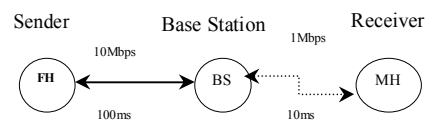


Figure 3. Simulation Topology

FTP is used for transferring the data. MH and FH both use window option [1] to increase the window size. Assumption has been made that no losses on the wired link. We consider burst error model for errors on the wireless link. This error model is

characterized by two state Markov Channels, where the channel is in the good state or bad state.

Parameters	Value
Packet size	1KB
ACK size	40B
Size of file	1 MB
Wired link	
Bandwidth	10 Mbps
Delay	100msec
Wireless link	
Bandwidth	1 Mbps
Delay	10msec
Good State	
Good state Duration	1 sec
PER in Good State	0.8×10^{-2}
Bad State	
Bad state duration	10 ms to 100 ms
PER in Bad State	0.8×10^2

Table 1. Parameters used in Simulations

Figure 4 shows an example of handover of MH from BS to BS_{new}. At first, MH attaches to BS. FH will send packets 1-6, MH receive packet 1-4 and returns ACK upto packet 4 only and BS will wait for ACK of packet 5 and 6 upto TO then BS assumes that MH moves from BS to BS_{new}. Now, BS will send EHM ACK to FH. When FH receives EHM ACK, it does not start congestion avoidance phase. As soon as the MH receives advertisement from BS_{new}, MH registers with BS_{new} and BS_{new} will send EHM ACK to FH. When FH receives this ACK it resumes communication with the same rate.

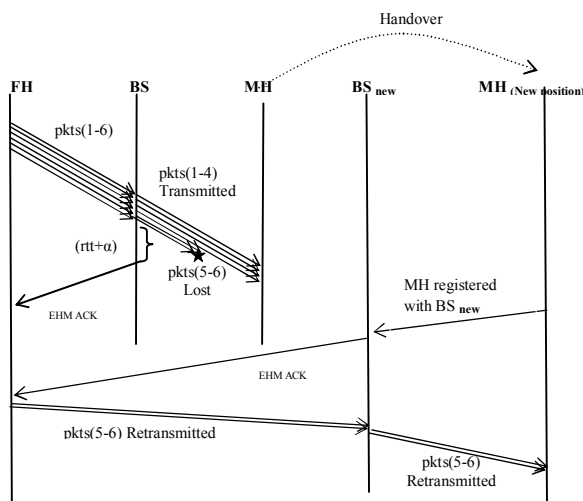


Figure 4. Handover mechanism of Mobile Host

VI. RESULT AND DISCUSSION

Figure 5 graphically illustrates the increased throughput, when EHM mechanism prevents sender side window from dropping and regrowing. Also, due to increase in the disconnection time, the proposed scheme makes throughput decline more gently than the rapid decrease as observed in TCP Tahoe and TCP Reno. The throughput of TCP Tahoe drops by 88.86%

and in case of TCP Reno drops by 78.83% at the disconnection time of 100 msec in comparison with our scheme. EHM TCP achieves throughput values 4-8 times higher than TCP Tahoe and TCP Reno.

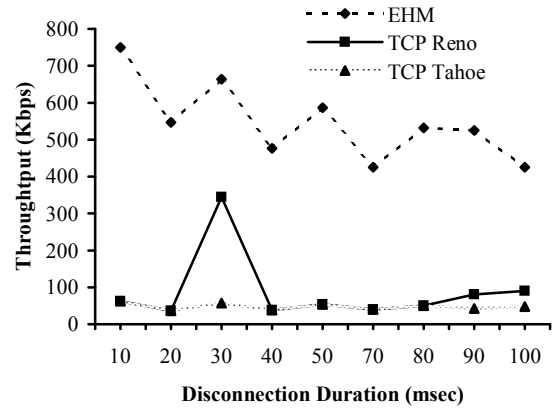


Figure 5. Throughput comparison for TCP Tahoe, TCP Reno and Exclusive Handover Message scheme

VII. CONCLUSION

The highlight of EHM scheme are: end-to-end semantics are maintained, it does not interfere with regular TCP algorithm, which runs over wired link and also, it does not require major modifications at FH and BS. The resulting performance of the TCP EHM scheme is greatly enhanced with compared to TCP Tahoe and TCP Reno. Though, we have used split connection still it supports encrypted traffic. Proposed scheme is a true end-to-end approach, based on the idea of exclusive handover message and is used for alleviating the degrading effect of host mobility on TCP performance. Factor $(rtt + \alpha)$ has been considered in place of arbitrary certain time at BS [3][9]. Our scheme does not need impending disconnection prediction like [2] when MH is being moved; as Freeze-TCP suffers from severe performance degradation when the prediction fails. Also, it has no suggested buffering at BS [10][12] as buffering and local retransmission by the BS can affect the round trip time of the sender [6]. In our approach BS is not required to forward the socket buffers to BS_{new} and resulting in significant gain in throughput. The result shows that the proposed scheme has lower packet loss than the conventional scheme, when tested in the same environment. EHM ACKs are sent to make the sender stop and resume the transmission at full rate as soon as possible results in without degradation of efficiency of TCP due to handover. Since sender is prevented from going into exponential back off and slow start. There are certain modifications are required to handle burst error problems, which is not considered in proposed approach.

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