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Research Article

A SURVEY ON TCP PERFORMANCE IN AD HOC WIRELESS NETWORKS

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A B S T R A C T

Routing means the movement of data from source node to destination node within the connected network. At transport layer, Transport Control Protocol (TCP) is needed for Mobile Ad hoc Network (MANET) as it is used widely in the current and future Internet. TCP has been smoothly integrated with the fixed Internet. To enhance the performance, TCP has been improvised as TCP-F or Feedback based TCP, Ad hoc TCP, Split TCP and TCP-ELFN. These method help to increase the throughput reduce the round trip delay time and improve performance. As the overall delay will be reduced so TCP-F is expected to perform better than the basic TCP.

INTRODUCTION

MANET consists of very complex distributed structure of static or wireless nodes that can self-organize in presence of changing topology. By using IEEE 802.11 Bluetooth and Hyperlan, it is possible to deploy wireless ad hoc networks for many commercial purposes [1]. The network provided can be unreliable. TCP (Transmission Control Protocol) [2] is a transport layer protocol which is designed for a wired network that can handle successfully network congestion. TCP faces few challenges due to lossy channels, hidden and exposed terminals, path asymmetry, partitions of networks, due to failures of routes and power conservation. It is a connection oriented transport layer protocol. It transports a considerable segment of Internet transmission such as e-mail (SMTP) file transfers (FTP) and WWW (HTTP). Distinguish between congestion and loss of packets due to errors of transmission or failure of routes not identified by TCP. It leads to performance degeneration in MANETs [3].

Lossy channels

The main reasons for errors occurrence in wireless channel is the signal attenuation due to a reduction in the intensity of the electromagnetic energy at the receiver due to lengthy distance, Doppler shift and Multipath fading.

Hidden and Exposed nodes

Idle channel identified by carrier sensing mechanism that is related to Hidden nodes problem as depicted in figure 1.

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The node A and the node C have a frame to send to node B. Node A cannot identify transmission range of C as it is outside the transmission range of C. Node C is "hidden" to node A and node A is "hidden" to C. The transmission from both A and C lead packet collision at B. To solve this problem, virtual carrier sensing has been introduced [4] that use two-way handshaking.

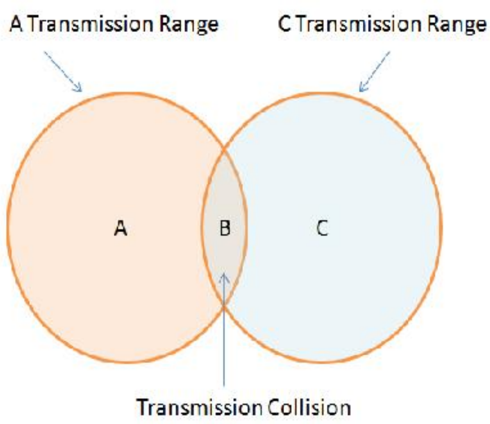

Fig 1 Hidden node problem. Packet sent by A and C to B collides at B as A is hidden to C and vice-versa

The exposed node problem depicted in figure 2, where node A and node C are within range of B's transmission, and A is outside the transmission range of C's transmission. If B is transmitting to node A, and C has a frame to transmit to D then C senses a busy channel because of transmission by B. The node C will not transmit to D, although this transmission would not cause interference at node A. In turn, the exposed node problem results in reduced channel utilization.

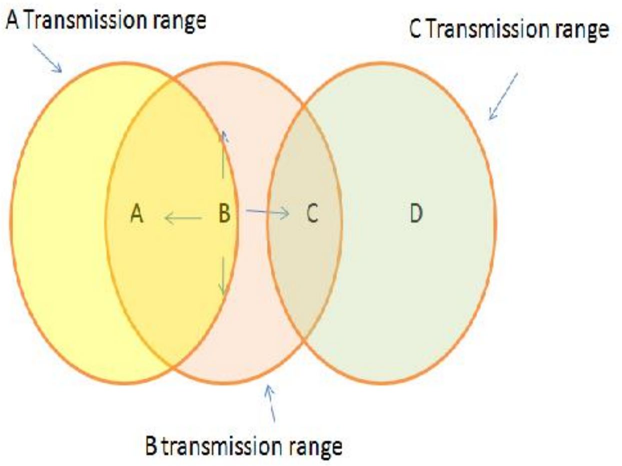

Fig 2 Exposed node problem. B's transmission to A makes C to refrains transmission to D.

Path asymmetry

In MANET path asymmetry may appear in numerous forms such as loss rate asymmetry, bandwidth asymmetry and route asymmetry.

- ***Bandwidth asymmetry:*** In wireless Ad hoc networks, bandwidth ratio range between 2 and 54 that implement the IEEE 802.11 version protocol. The asymmetry results from the exercise of dissimilar transmission rates. Because of this different transmission rates, even symmetric source destination paths may suffer from bandwidth asymmetry.
- ***Route asymmetry:*** TCP connections experience route failures due to mobility of node using distinct reverse and forward routes.
- ***Loss rate asymmetry:*** This type of asymmetry takes place when the backward path is more lossy than the forward path. In MANET, this type of asymmetry occurs as packet losses depend on local constraints.

Power constraints

In the Ad hoc networks, each node operate as an end system and also at same time as a router. Additional energy is required send and relay packets. TCP must use this scarce power resource in an "efficient" manner.

Routing failures

The key ground of route failure is nodes mobility. Other factor that can cause to route failures is the failure of link due to the contention on the wireless media channel, which in turn degrades TCP performance. The failure of route is overcome by TCP and network cross layer proposal [5], network and physical cross layer proposals [6], and network layer proposals [7].

With goal to improve performance in MANET, there is need to use TCP protocols with enhancement and also to avoid congestion control, packet loss rate and route failure.

The organization of paper is as follows: Section II deals with the related work. Section III presents various TCP performance improvement approaches. Section IV concludes the paper.

Related Work

By the study of various transport layer protocols in [8] it can be concluded that ATP (Ad hoc TCP) is appropriate for MANET as it overcomes the limitations of TCP and shows a improved performance than TCP, TCP-ELFN and ATP.

In [9] author has proposed ATCP method which diminishes the humiliating effect of host node mobility on TCP performance for two-way data transfer. Here the TCP sender is a mobile host node and fixed host. ATCP uses network layer feedback to indicate disconnection and connection signals, to adapt the congestion control mechanisms of TCP, in order to achieving enhanced throughput in MANET. The ATCP is compared with 3-dupacks (3DA), Freeze TCP and TCP Reno. ATCP realizes an enhancement over TCP Reno in WLAN environments and in WWAN environments for data transfer in both directions.

In [10] author presented technique to notify the source node by a (RFN) Route Failure Notification when the route has been interrupted. In this case the source node to freeze its timers and stop sending packets while the source cannot reach the end. When the route is re-established, the source, on being learnt through a (RRN) Route Re-establishment Notification, continues by un-freezing timers and continuing packet transmissions.

Recent research in MANETs gives the detrimental effect of multiple retransmission timeouts (RTOs) on TCP throughput. Various routing protocols like AODV, DSR and OLSR, produces insight into the different behavioral patterns of TCP during this event, and highlights the mechanisms of each routing protocol that affect it [11].

The recent research has explored many ways to improve TCP throughput in MANET by improving its interaction with the IEEE 802.11 medium access control (MAC) layer. The hidden terminal problem caused by interference affects TCP performance and have been overcome by the maximum sending window size. We have developed a TCP variant, which instead, adjusts the sending rate increase to achieve competitive good put for TCP connections. It is noticed that slower sending rate increase for congestion avoidance of TCP leads to improved performance for TCP Reno while eliminating the negative effects inherent in restricting the maximum sending window size [12].

TCP Performance Improvemnent Approaches

From the extensive literature survey, the following approaches to get better performance of TCP over wireless ad hoc network are classified as shown in figure 3.

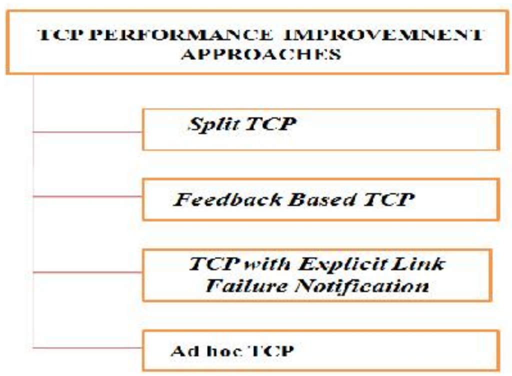

Fig 3 TCP Performance Improvement Approaches

The performance improvement can be enhanced using split TCP, feedback based TCP, TCP with explicit notification of link failure and ad hoc TCP.

Split TCP

The performance of TCP depends on path length. As the path length increases performance decreases and lead to unfair TCP sessions by allowing one session to obtain higher throughput than the other sessions. Split TCP overcomes this problem by splitting the transport layer objectives into Congestion control and End to End reliability. Long TCP connections are split into a group of short TCP connections that are concatenated. These short connections are known as segments. The number of intermediate selected as terminating points for these segments. The intermediate node store TCP packets after reading them into their its local buffer and then send an acknowledgement to the source or the previous intermediate node. The further delivery of packets is assigned to the node. This method provide improved throughput with high density of mobile nodes.

Feedback Based TCP

Feedback TCP (TCP-F) improves the performance of TCP in AD hoc networks by repair of the broken path within a short time. In TCP-F, as soon as path break detection done, the intermediate node called Failure point (FP) originates route failure notification (RFN) packet. This RFN packet is routed toward the sender of the TCP session. Intermediate nodes on receiving RFN checks for an alternate route to the same destination, and if found then it discards the RFN packet and uses the alternate path to forward further data packets. This results in reduced control overhead involved in the route reconfiguration process.

TCP sender on receiving an RFN packet, goes into a snooze state, stops sending any further packets to the destination, cancels the all timers, freezes its congestion window and freezes the retransmission timer. Then sets up a route failure timer and once route failure timer expires, the TCP sender changes from snooze state to connected state. After the route re-establishment, Route Reestablishment Notification (RRN) packet is sent by failure point to the sender and updates the TCP state as connected state.

TCP With Explicit Link Failure Notification

TCP-ELFN [13] improves TCP performance in wireless ad hoc network. In this, node on detecting a break in path, calls Explicit Link Failure Notification (ELFN). It is based on explicit link failure notification technique as TCP-F and upon DSR routing protocol. DSR route error message carry a payload for executing ELFN. TCP sender on getting an ELFN, stops its retransmission timers and enters a “stand-by" mode, similar to the TCP-F snooze state. In contrast with TCP-F, the exposure in ELFN is accomplished with the adapted route error messages, which are transmitted under the control of the routing protocol.

Ad hoc TCP(ATCP)

Ad hoc TCP [14] uses network layer feedback. It depends on the network to create correct ICMP host unreachable messages and circulate them to the sender of TCP. It handles bit error rate smoothly. The TCP sender can be put into a persist state, retransmit state or congestion control state. A TCP introduces a thin layer between TCP and IP.

Stream Control Transmission Protocol (SCTP)

The performance of TCP in MANETs is poor. To trounce this problem a transport layer protocol called (SCTP) [15] has been developed to achive multistreaming. It has additional overheads to support multistreaming. SCTP works in similar way to TCP congestion and flow control. It has coplexity and provide more features by support of other layers for efficient routing. It support improved performance when multistreaming is considered.

CONCLUSION

Various methods used to look up performance of TCP when used with MANET. The routing protocol is must repair the broken path without delay. This can be achieved by feedback mechanism used by TCP and performance improved by avoiding fast retransmission by the use of proper buffering, selective acknowledgement and sequence numbering. Also performance of TCP in MANET degrades throughput as path length increases. Split TCP provides a solution by splitting TCP connection that are too long into a set of short concatenated TCP connections.

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