Performance Analysis of TCP-IA for Multi-Hop Wireless Networks

Vani Chawla

Ph.D Scholar,Department of ECE,AFSET,Faridabad (India).+919650429921.

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ABSTRACT- In multi-hop wireless networks, there may be degradation of TCP due to the congestion in the network layer.   In this paper, performance of TCP-IA for   multi-hop wireless networks is analysed . TCP–IA is compared with simple TCP New Reno protocol. The performance is evaluated on the basis of Packet Delivery Ratio,Average end-to-end delay,Drop,Throughput,Bandwidth. By simulation results, we show that TCP-IA has better performance.

Keywords-TCP-IA,NS2,Bandwidth,Delay,Throughput.

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INTRODUCTION

In the applications of the sensor networks, mesh networks and home as well office networks, multihop ad hoc networks are usually found. The feature of shared queues, half duplex links, channel noise and mobility-induced property causes TCP protocol to undergo poor bandwidth utilization and network unfairness strategy. But most of the wireless applications depend on TCP for communication and hence it is vital to identify and enhance the TCP performance in the 802.11 networking environment.

The regular changes in the network topology cause complications in the end to end control of TCP for wireless ad hoc network. The issues such as routing loss, fading, noise, interference, hand-off and hidden terminal difficulty results in high BER (bit error rate). The dynamic topology of the network is configured from node mobility. The high BER value causes following problems.
- TCP performance affects asymmetric link and route

- The link and route are changed frequently at the time TCP connection.

- The time taken for process of rerouting exceeds the TCP time out and this may result in decrease of congestion window and degradation of TCP performance. [3]
  The high BER and re-estimation of the route on TCP performance result in the following effects.
- The packets become corrupted due to bit errors that results in lost TCP data portion or acknowledgements
- The routing protocol in the sender tries to find a new route to the destination in case of the unavailability of the old route. The new route discovery can take a long time and TCP sender may time out, and hence retransmits the packet and initiates congestion control mechanisms. [4]

The process of developing TCP performance for the requirements such as large bandwidth and delay variation, high packet loss and recurrent connectivity are major challenge. [7] The

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TCP recovers packet losses due to every factor via retransmission technique as TCP is an end-to-end reliable protocol. As window based congestion control and acknowledgements are utilized, the final throughput is very low.TCP depends on acknowledgements packets for ensuring reliability that is feedback from receiver to sender that sets up a bidirectional flow of data and acknowledgments. However this technique is very costly in multihop wireless networks.

INTELLIGENT ACKNOWLEDGEMENT TECHNIQUE

The sender initiates the data transmission by sending the TCP data packet to receiver. On receiving the data packet, the link layer of sender calculates the bandwidth and delay. The estimated bandwidth and delay values are added to the MAC header field. When data packet reaches the next node, its link layer computes the bandwidth and delay.The process is repeated till pre-assigned number of data packet reaches receiver. Among the received data packets, if packets with out of order conditions or a packet with minimum bandwidth and maximum delay prevails, the delaying window size at the receiver is reduced and acknowledgment is sent back to the sender. Otherwise receiver replies back the sender with single ACK indicating the successful data packets reception. After receiving TCP ACK packet from receiver, sender adjusts congestion window size based on the bandwidth and delay information.

(a) Bandwidth Estimation

The bandwidth is shared among the nodes which are situated in the range of the sender and receiver nodes. Thus the available bandwidth (AB) for transmitting certain amount of data can be achieved with the help of size of the data packet and time taken to transmit such data over a specific link [9].

$AB = P/t$ ------------ (1)

P = size of the data packet
t = time taken to transmit data packet

The algorithm for the above bandwidth computation is as follows

1. For every arrival of data packet, the time t_i is stored.
2. Before actual data frame transmission at time t_o, the time taken for packet delivery including queuing and packet transmission time t_t is computed using Eq. (2). t_o is the time during which the sender initiates the data frame transmission onto the physical medium.

The time required for the data packet delivery is estimated as follows

$t_t = t_d + SIFS + t_{ack} + DIFS$ --------(2)

t_d = time required for single data transmission

SIFS = Short inter-frame space
DIFS = Distributed Coordination Function Inter-Frame Space.
t_{ack} = time computed during the reception of ACK packets.

3. The bandwidth experienced by the packet is calculated using Eq. (1). [9]

(b)Delay Estimation

The delay is obtained by computing the difference between transmission of the packet and reception of the acknowledgement generated by the receiver upon receiving data packets. This value corresponds to the cumulative delay experienced in forward and backward directions of the connection path.

In the delay estimation technique, the dissimilarity between forward and backward delay is explained. Forward delay contains the length of the data pipe between sender and receiver nodes while backward delay measures the time required for the delivery of TCP ACK packets.

The forward delay is computed using the following equation (3) setting t_i to be equal to the time the packet leaves the queue preparing for actual transmission on the link layer.

$$t = t_i - t_o + t_t \qquad \text{--------------- (3)}$$

This avoids the insertion of the link layer queuing delay into the $(t_i - t_o)$ component.

In contrary to the forward delay measurement technique, TCP ACK delay includes both transmission and queuing delays. Thus the backward path delay is computed using the equation (3).

SIMULATION

We use NS2 [20] to simulate the improved TCP with intelligent acknowledgement (TCP-IA) protocol. In our simulation, the channel capacity of mobile hosts is set to the same value: 2 Mbps. We use the IEEE 802.11 for wireless LANs as the MAC layer protocol.

In our simulation, 11 mobile nodes are arranged as a line topology in a 1500 meter x 1500 meter region. All nodes have the same transmission range of 250 meters.

Our simulation settings and parameters are summarized in table 1

Table 1.Simulation settings and Parameters

No. of Nodes	11
Area Size	1500 X 1500
Mac	802.11
Radio Range	250m
Simulation Time	50 sec
Traffic Source	FTP
Packet Size	500
No. of Flows	4
Routing Protocol	AODV
Number of Hops	2,4,6,8 and 10
Time	5 to 25 Sec

RESULTS

We compare TCP –IA with simple TCP New Reno protocol. The performance is evaluated based on the following metrics:

Packet Delivery Ratio,Average end-to-end delay,Drop,Throughput,Bandwidth

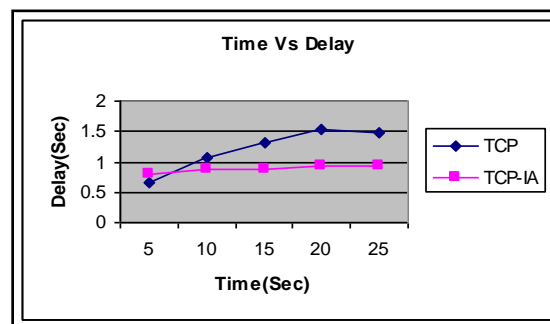We measure the above metrics in 5 seconds of time interval starting from 5 to 25 seconds.

Fig 1: Time Vs Delay

From figure 1, we can see that the end-to-end delay of our proposed TCP-IA is less than the existing TCP protocol.
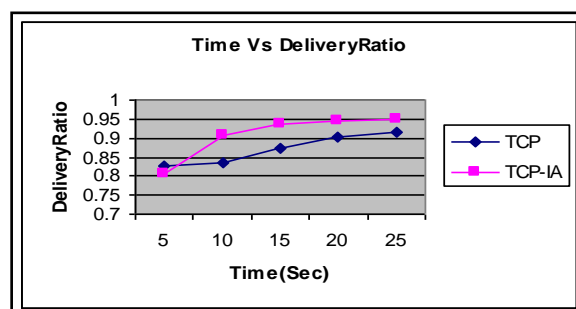

Fig 2: Time Vs Delivery Ratio

From figure 2, we can see that the delivery ratio of our proposed TCP-IA is higher than the existing TCP protocol.
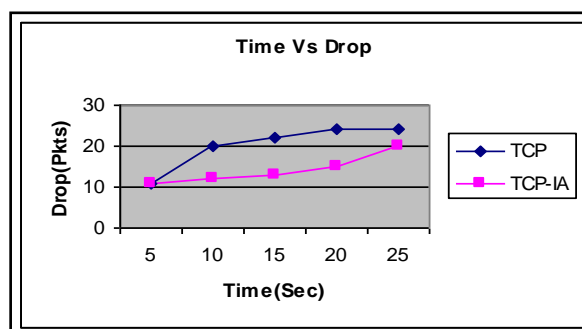

Fig 3: Time Vs Drop

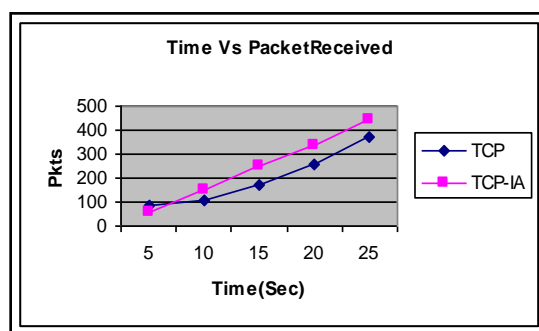From figure 3, we can see that the packet drop TCP-IA is less than the existing TCP protocol.
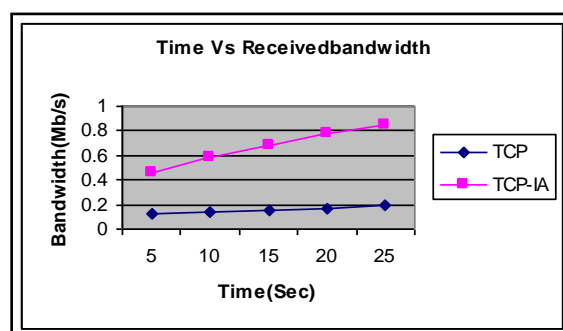

Fig 4: Time Vs Packets Received

Fig 5: Time Vs Received Bandwidth

From figures 4 and 5, we can see that the packets received and bandwidth received for TCP-IA is higher than the existing TCP protocol, respectively.

CONCLUSION

In this paper, we have compared TCP-IA with TCP new reno for multi-hop wireless networks., the performance is analysed In terms of Packet Delivery Ratio,Average end-to-end delay,Drop,Throughput,Bandwidth in 5seconds of time interval staring from 5 to 25 seconds. By simulation results, we have shown that TCP-IA has better performance. In future we can analyse the performance of TCP-IA in terms of changing number of hops in multihop wireless network .

ACKNOWLEDGEMENTS

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