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Performance of TCP Variants in VANET

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ABSTRACT

The steady-state achievement of a bulk data transfer TCP may be characterized by the send rate, (i.e. the amount of data sent by the sender in unit time). In this Paper we analyze the TCP Variant for VANET Network to avoid congestion in dense network conditions. VANET is Vehicular Ad-Hoc Network which uses moving cars as nodes to create the network. Here we compare the TCP variants performances in VANET network and justify which TCP variant performance is better to transmit the data from sender to receiver.

KeyWords: TCP, VANET, Reno, New Reno

1. INTRODUCTION

VANET (Vehicular Ad-Hoc Network) is a wireless network which uses moving cars as nodes to form a network. It is a classification of mobile Ad-Hoc network (MANET). VANET makes every participating cars as nodes and data be transmitted from car to car communication and car to infrastructure communication [1]. The reliability and End-to-End delay are most important factors in VANET security applications. It is widely known that, V2V and V2I communication links tend to be short lived due to high-speed mobility. Recent developments in mobile ad hoc network (MANET) technology and ever-increasing safety requirements, as well as user interest in Internet access have made VANETs an important research oriented topic. Vehicle-to-vehicle and vehicle- to-roadside communications have become most important components of vehicle infrastructure unification. VANET research has focused on urban and suburban roadway conditions, where the numbers of vehicles are dense, the inter-vehicle spacing is minimum, terrain is not a considerable factor, and fixed communication infrastructure is available. In rural and scarcely populated areas, the conditions and constraints are significantly different. Node densities are low, inter-vehicle spacing can be large, terrain effects may be significant, and there is very little or no fixed communication infrastructure available [2]. The coverage provided by wireless carriers is most importantly in urban areas and along major highways, not in rural areas or along minor roadways. Although position awareness, based on a global positioning system (GPS) and other techniques, is becoming widespread in portable and vehicular systems, lack of infrastructure and the effects of the terrain limit its availability and utility in rural areas. Public safety and other applications rely or benefit from position awareness; however, making it a requirement for routing puts an unnecessary confinement on system design.

2. CONGESTION CONTROL

Every network results as congestion when a part of sub network (i.e. one or more network nodes in an area) gets overloaded. Congestion is control when sub network avoid extra data packets from entering the congested region up to processing the already transferred data packets [3]. In addition to that congested nodes must remove the queued data packets to make space for arriving packets. Some of the factors which cause congestion in network are exceeding of incoming data packet rate than outgoing link capacity, lack of memory space to store incoming data packets. Congestion control is an important aspect which involves every node within the sub network.
To avoid congestion collapse, TCP uses a multi-faceted congestion control strategy. For each connection, TCP maintains a congestion window, limiting the total number of unacknowledged packets that may be in transit end-to-end. This is somewhat analogous to TCP's sliding window used for flow control. TCP uses a mechanism called slow start to increase the congestion window after a connection is initialized and after a timeout. It starts with a window of two times the maximum segment size (MSS).

Although the initial rate is low, the rate of increase is very rapid for every packet acknowledged, the congestion window increases by 1 MSS so that the congestion window effectively doubles for every round trip time (RTT). When the congestion window exceeds a threshold ssthresh(slow start threshold) the algorithm enters a new state, called congestion avoidance. In some implementations (e.g., Linux), the initial ssthresh is large, and so the first slow start usually ends after a loss. However, ssthresh is updated at the end of each slow start, and will often affect subsequent slow starts triggered by timeouts.

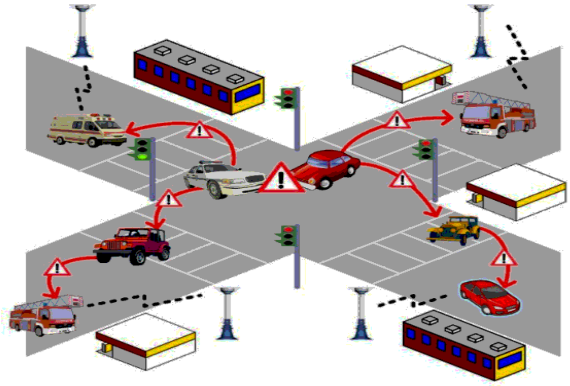

Figure 1 VANET Architecture

3. TCP CONGESTION CONTROL ALGORITHMS

Transmission Control Protocol (TCP) uses a network congestion avoidance algorithm that includes various aspects of an additive increase/multiplicative decrease (AIMD) scheme, with other schemes such as slow-start in order to achieve congestion avoidance. The TCP congestion avoidance algorithm is the primary basis for congestion control in the Internet.

Some of TCP congestion avoidance algorithms are TCP Reno, TCP New Reno, SACK, Tahoe[5]. Here we analyze the performance of above algorithm based on VANET network.

3.1 TCP Reno

TCP reno algorithm increase the congestion window for one single successful received ack and decrease the congestion window for each loss event per RTT(Round Trip Time). It detects congestion after the packet drop occurs[9]. As long as non-duplicate ACKs are received, the congestion window is additively increased by one MSS every round trip time. When a packet is lost, the likelihood of duplicate ACKs being received is very high (it's possible though unlikely that the stream just underwent extreme packet reordering, which would also prompt duplicate ACKs).

3.2 TCP Tahoe

The behavior of Tahoe and Reno differ in how they detect and react to packet loss. Triple duplicate ACKS are treated the same as a timeout. Tahoe will perform "fast retransmit", set the slow start threshold to half the current congestion window, reduce congestion window to 1 MSS, and reset to slow-start state. TCP retransmits the missing packet that was signaled by three duplicate ACKs, and waits for an acknowledgment of the entire transmit window before returning to congestion avoidance [6]. If there is no acknowledgment, TCP Reno experiences a timeout and enters the slow-start state. Both algorithms reduce congestion window to 1 MSS on a timeout event.

3.3 TCP New reno

TCP New Reno improves retransmission during the fast recovery phase of TCP Reno. During fast recovery, for every duplicate ACK that is returned to TCP New Reno, a new unsent packet from the end of the congestion window is sent, to keep the transmit window full. For every ACK that makes partial progress in the sequence space, the sender assumes that the ACK points to a new hole, and the next packet beyond the ACKed sequence number is sent[5,7]. Because the timeout timer is reset whenever there is progress in the transmit buffer, this allows New Reno to fill large holes, or multiple holes, in the sequence space - much like TCP SACK. Because New Reno can send new packets at the end of the congestion window during fast recovery, high throughput is maintained during the hole-filling process, even when there are multiple holes, of multiple packets each. When TCP enters fast recovery it records the highest outstanding unacknowledged packet sequence number. When this sequence number is acknowledged, TCP returns to the congestion avoidance state.

New Reno performs as well as SACK at low packet error rates, and substantially outperforms Reno at high error rates.

3.4 TCP SACK

The receiver explicitly lists which packets, messages, or segments in a stream are acknowledged (either negatively or positively [8]). Positive selective acknowledgment is an option in TCP that is useful in Satellite Internet access.

4. PERFORMANCE EVALUATION

To evaluate the performance of TCP variants some simulated results are performed. The experiments are performed using QUALNET Software. Throughput, End-to-End delay and Average Jitter of the VANET network are evaluated. We define throughput as the average number of packets processed per second and delay of data to receive destination is detected and average jitter is processed.

Table1: Simulation Parameters

Parameter	Specification
Total simulation time	3000Seconds
MAC protocol	IEEE 802.11b
Total number of nodes	1000
Simulation Area(Meters)	500*500
Mobility and Placement	Random Wave point
Routing Protocol	DSR
TCP Variants	SACK, Reno, New Reno, Tahoe

Table 1 show the specifications of network which is used for simulation in QUALNET scenario. In the performance evaluation figure-2 show the throughput of TCP variants. In which Tahoe algorithm has best throughput which process the data packets effectively.

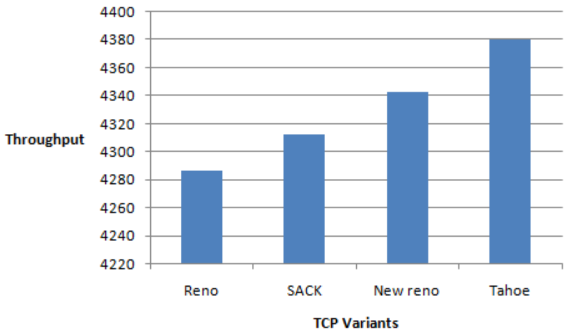

Figure 2. TCP Variants vs. Throughput

Reno is best algorithm in data transfer without less delay in congestion network than other variants. Figure 3 shows the evaluation of delay in VANET network. In the congestion control algorithm it has less throughput values than other variants with low delay measures respectively.

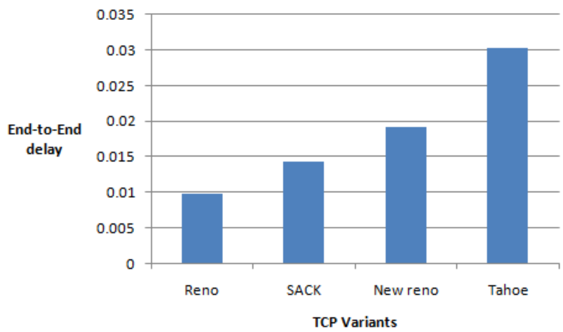

Figure 3. TCP Variants vs. End-to-End Delay

Reno algorithm is also good in average jitter as compared to other TCP algorithm.

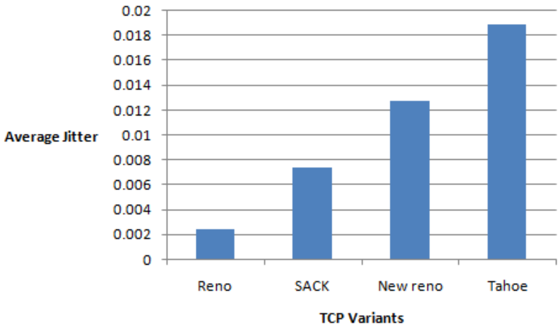

Figure 4. TCP Variants vs. Average jitter

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