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IDENTIFICATION OF IMPORTANT SAMPLING PARAMETERS IN EXTRAPOLATING THE PERFORMANCE OF TCP IN MANETs

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ABSTRACT

MANET (Mobile Ad hoc Network) refers to an array of wireless mobile nodes that actively and temporarily forms a network with no particular support from the principal or main administration. TCP offers reliable and secure transfer of data in MANETs and the performance of TCP is much better in wired networks whereby loss of packets is as a result of congestion. Based on existing literature survey, this research reviews parameters identified earlier by previous researchers to evaluate and establish the performance of any algorithm designed to improve performance of TCP in Mobile Ad hoc Networks. Based on this secondary research, authors have concluded that the four parameters of Throughput; Delay / Latency; Packet Delivery Ratio; and Signal to Noise Ratio suffice in most cases to sufficiently evaluate and extrapolate the different methods used for measuring the performance of TCP in MANETs.

Key words: Parameters, TCP performance, Mobile Ad hoc Networks, TCP, Packet Delivery Ratio, Throughput, Signal to Noise Ratio and delay

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1. INTRODUCTION

Mobile Ad hoc Network refers to an autonomous collection of mobile users, which communicates over moderately bandwidth via a limited wireless link. TCP performance over MANETs is usually hindered by congestion. Hence to deal with congestion, TCP superfluously reduces the transmission rate by minimizing the window sizes, and performs the required re-transmissions. Transmission Control Protocol in its current stated is, however, not well-suited for MANETs where packet losses as a result of broken routes could lead to the counter-productive invocations of the congestion control mechanisms of TCP [1].Because TCP is one of the mostly used transport protocols in the world of networking and subsequently got adopted in Ad-

Hoc Networks as well as MANETs, numerous research studies have focused on developing network protocols for MANETs over recent years [2, 3]. Conversely, most researchers have recently focused to on TCP performance over MANETs [4, 5, and 6]. The key issues affecting TCP performance over ad-hoc network include route failures, high bit errors, path asymmetry, network partitioning, TCP Congestion Window Size, energy constraint, multipath routing, interaction between MAC (Media Access Control) and TCP, intra-flow and inter-flow contention, and the TCP instability and delay spikes.

There are several parameters that are used to evaluate and establish performance of any algorithm designed to improve performance of TCP in MANETs. These parameters include: Packet Delivery Ratio; Throughput; Delay/latency; Signal to Noise Ratio (SNR); Good-put Ratio; Mobility of nodes; the Number of nodes; Retry Limit; TCP Losses; and bandwidth..Therefore, this research briefly discusses these parameters and also seeks to prove or justify why the 4 parameters: Throughput, Delay / Latency, Packet Delivery Ratio and Signal to Noise Ratio are sufficient to get a near accurate proof of how TCP is performing for a particular MANET protocol. The justification will be based on the importance of these parameters in extrapolating the overall performance of TCP with sufficient accuracy compared to the other parameters included in research.

2. LITERATURE SURVEY AND ANALYSIS

Multiple authors have in the past, tried to study different techniques that could be used to evaluate the performance of TCP in MANETs. As part of their evaluation procedures, they have adopted various parameters like Throughput, Delay, Latency, SNR, PDR, Good put, Node Mobility, etc. that they found suitable and relevant to their studies. Below paragraphs summarize the some of these evaluation criterion based on the past research works.

2.1. Throughput

Zahid et al. conducted a simulation based study and found that throughput is efficient in evaluating Transmission Control Protocol performance in the Mobile ad hoc network since the network is directly proportional to the nodes in the network (both in sparse as well as dense networks) [7].Throughput works equally well to matter the condition of the network. When the numbers of nodes in a throughput network are added, the transmission also improves and is of good quality.[7] Further stated that other networks such as the User Datagram Protocol (UDP), when the nodes are increased, the performance rate of throughput decreases significantly. Thus it is very advantageous when using the network throughput in Transmission Control Protocol, since it performs as good in a mobile network as in the immobile network. This is because in a highly mobile environment the nodes are likely to leave the transmission range that leading towards loss of data when not using the TCP. It has been suggested that there are less cases of buffering in the network and the receiving rate of the receiver is good since it has a good pausing time and thus not prone to losing data [8]. When using the network throughput, the amount of data transmitted is fairly high and accurate and hence it tends to be reliable.

MANETs' metrics or parameters that collect the bottleneck of link usage or application as the cumulative throughput of the link, observed that the throughput solely comprises of valuable transmitted traffic as well as useful re-transmitted traffic [9].Thus, the throughput can be used to evaluate and establish the performance of any algorithm designed to improve performance of TCP in networks.

2.2. Packet Delivery Ratio (PDR)

PDR refers to the ratio between the number of packets transmitted by a traffic source and the number of packets received by a traffic sink. Manickam, P. et al. stated that Packet delivery Ratio is used to measure the rate of loss as observed in a transport protocol [1]. Packet delivery Ratio symbolizes the efficiency as well as the correctness of mobile ad-hoc routing protocols or it used in characterizing the performance of any algorithm designed to improve performance of TCP in MANETs. Additionally, higher packet delivery ratio is required in various networks such as MANETs.

The PDR of the initiated requests' data packets of all the protocols that is able to deliver at different times are illustrated in Fig.1, Fig.2 and Fig.3 as per Table 1 below. Packet delivery ratio demonstrates the wholeness as well as the precision of the routing protocol and it measures of efficiency the Packet delivery ratio value of Ad Hoc On-demand Distance Vector Routing (AODV) protocol is higher compared to other protocols designed to improve performance of TCP in MANETs. The values of Packet delivery Ratio of AODV and Dynamic Source Routing are higher compared to that of Destination-Sequenced Distance-Vector Routing. The Packet delivery Ratio value of Destination-Sequenced Distance-Vector Routing is worst in lower pause time but it grows gradually when the pause time is increased. From this research, regarding the packet delivery ratio, reliability of DSR (Dynamic Source Routing) and AODV protocols is superior to Destination-Sequenced Distance-Vector Routing protocols. Therefore, PDR can be used as a parameter to evaluate and establish performance of any algorithm designed to improve performance of TCP in MANETs.

Table 1 Packet Delivery Ratio

Pause Time (Sec.)	Protocol								
	DSDV			AODV			DSR		
	50 N	75 N	100 N	50 N	75 N	100 N	50 N	75 N	100 N
20	97.6169	96.8661	80	99.0667	99.061	99.1886	99.1919	99.1909	99.1896
40	98.8569	98.5653	96.6102	99.1201	99.1093	99.1795	99.2434	99.2213	99.2031
60	98.4053	98.1191	96.4844	99.3528	99.3466	99.3854	99.4335	99.4166	99.404
80	98.8518	97.9306	97.2525	99.488	99.4843	99.5086	99.5467	99.5335	99.5233
100	98.4413	98.0971	97.4224	99.5764	99.5739	99.5907	99.6223	99.6113	99.6028

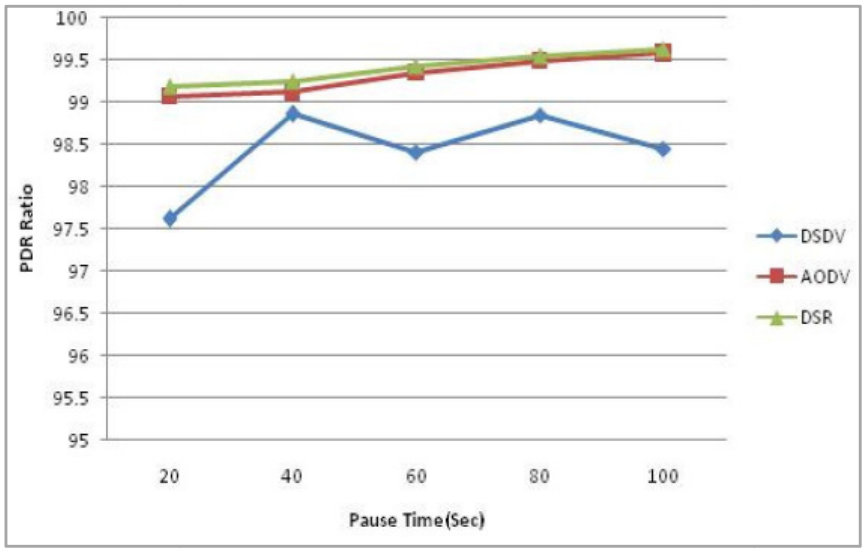

Figure 1 Scenario 1 for Pause Time versus PDR ratio

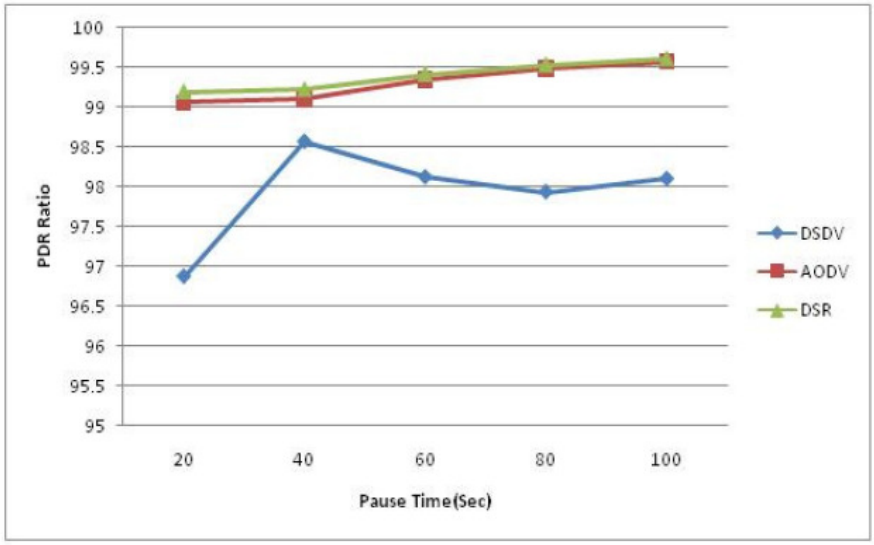

Figure 2 Scenario 2 for Pause Time versus PDR ratio

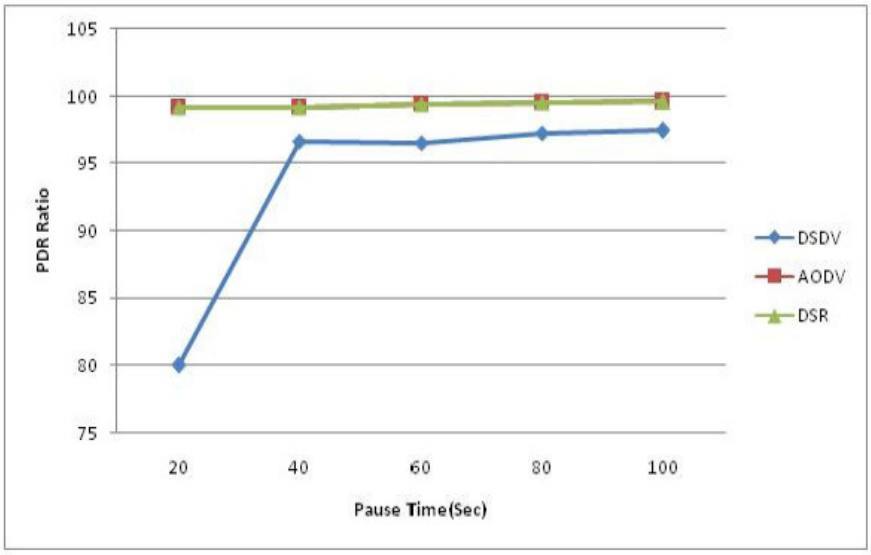

Figure 3 Scenario 3 for Pause Time versus PDR ratio

2.3. Delay/Latency

This is the delay that is there between the sender and the receiver. Also referred to as the end-to-end delay, is the time between sent packets and received packets of data by the sender and receiver respectively. According to Dyer, Thomas D., et al, in Transmission Control Protocol, delays are brought about when packets are lost due to the temporary breaking of routes in wireless networks can cause serious effects[10]. This could lead to a counter-productive result of congestion control mechanisms that are put in place. Therefore, delay/ latency is what overly generates the speed of sending and receiving of data. It's important to therefore note that delay affects efficiency of TCP in MANET. This is mainly caused by the travel time of signals as well as the processing time of information at the nodes. Other delays occur when there is queuing of data when packets are switching networks or when the data or packets encounter intermediate nodes. It's important to therefore note that delay affects efficiency of TCP in MANET; thus, it can be used as a parameter to evaluate and establish the performance of any algorithm designed to improve performance of TCP in MANETs.

On the other hand, to improve the performance of TCP in MANETs, study by González Rafael C. et al. used bottleneck queue size to indicate the queuing delay in a given bottleneck over MANETs [11]. Apart from the maximum or minimum statistics of queue sizes and the mean, percentile queue size [11] also used to show the length of the queue in the course of provided timeframe. To get the MANET's statistics, the bottleneck queue loss rate was measured during definite intervals. The web traffic and FTP loss rates were not collected since they less influenced by this parameter (delay). For streaming and interactive traffic, higher rates of packet losses caused the receiver(s) to fail in decoding or receiving the packets [11]. If the delay exceeds predetermined threshold, the received packets are assumed to be lost. González Rafael C. et al. suggested that delay/latency can be used to evaluate and establish the performance of any algorithm designed to improve performance of TCP in MANETs. Moreover, latency affects the TCP performance over MANETs [11].

2.4. Signal to Noise Ratio (SNR)

SNR detects the link reliability [5]. In MANETs or wired modes, timeouts are considered as a congestion loss; therefore, congestion in MANETs can be avoided by using the typical Transmission Control Protocol start-slow algorithms [5]. Nevertheless, in MANETs or wireless modes, two scenarios that are based on Signal to Noise Ratio are potential cause for packet timeouts: When the Signal to Noise Ratio is higher, for example, when it is larger than 5.0dB, it will mean that the packet loss could be as a result of congestion and the link could also be reliable; hence, the typical congestion mechanism of Transmission Control Protocol can be performed to slow down the packets' bursts. On the other hand, when the Signal to Noise Ratio is low, for example, if it is below 5.0dB, it will mean that the loss could be due to errors and the link is not reliable; thus, the timed-out packets are then re-transmitted by the sender [12]. Therefore, the SNR ratio can be used as a parameter to evaluate and establish the performance of any algorithm designed to improve performance of TCP in Mobile ad hoc networks.

Moreover, Xu K. et al. stated that for bytes to be successfully commuted from the source to destination, the Signal to noise ratio has to be higher to the advantage of signal level traversing the noise level [13]. This way the clarity of information is achieved as well as speed; but, instances of low ratio results in the poor relay of bytes/ data lowers performance of the TCPs. They also recommended the use of signal to noise ratio along with latency in evaluating the overall general TCP performance over networks.

2.5. Goodput Ratio

This shows the effectiveness of a particular combination of routing protocols and transport in data delivery. Goodput affects the performance of TCP in MANETs as it reflects the rate of traversal of useful data and should be as close as possible to the Throughput. For example, the higher goodput ratio improves performance of TCP in MANETs [14].

2.6. Mobility of Nodes

This is another parameter that needs to be considered in evaluating and establishing the performance of any algorithm designed to improve performance of TCP in MANETs [15, 16, and 17]. Node mobility contributes to the degradation of performances of TCP in MANETs. Mobility of nodes regularly results in the connectivity breakdown among nodes; this leads to losses of TCP packet(s) and eventually the decrease of the TCP performance. Therefore, considering the effect of node mobility the loss of packets [16], it is essential to evaluate the use of node mobility as parameter (Wand α) to establish TCP performance of any algorithm designed to improve performance of TCP in MANETs

2.7. Number of Nodes

Hamrioui, S., et al. found that the number of nodes is a parameter that could be used to evaluate and establish performance of any algorithm designed to improve performance of TCP in networks [15]. Hamrioui, S. et al. found that TCP performance deteriorates in the networks or mobile ad hoc networks

when the number of nodes is increased. The deterioration of the TCP performance is caused by frequent incidences of collisions/impacts between these nodes in the networks or mobile ad hoc networks [16].

2.8. Retry Limit

Lohier et al. [18] proposed the use of the RL (Retry Limit) parameter to minimize the decreased performance of TCP in the networks or mobile ad hoc networks as a result of incorrect or improper triggering of control mechanisms of TCP congestion. Thus, adoption of retry Limit will increase the performance of TCP over the mobile ad hoc networks.

2.9. TCP Losses

Each route failure causes approximately a TCP-window value of packet losses. Losses of TCP packets have an absolute and direct impact on the performance degradation; also, TCP sources react to the loss of packets by carrying out congestion control to reduce packets losses and improve the performance of TCP [19].

2.10. Bandwidth

Bandwidth defines the capacity and speed of TCP performance in MANETs or networks. Bandwidth is the quantity data sent per second and generally expressed as bits/sec. Bandwidth affects TCP performance in MANETs [20].

3. SUMMARY OF FINDINGS AND OBSERVATIONS

Altman and Jimenez [21] stated the improvements for performances of TCP in networks by delaying three-four ACK packet(s), and concluded that delay can be used to evaluate and establish performance of any algorithm designed to improve performance of TCP in networks. Similarly, Kherani & Shorey [22], proposed that delay or latency can be used to establish improvements in TCP performance in MANETS. On the other hand, Liu and Singh [23] proposed the ATCP protocol; it tries to deal with the problem of high Bit Error Rate (BER) and route failures. Moreover, Fu et al. [24] examined TCP improvements in networks through the use of several end-to-end metrics rather than one metric and found that Throughput and delay parameters can provide accurate results in evaluating performance of any algorithm designed to improve performance of TCP in MANETs.

4. CONCLUSION

This study examined nearly ten different parameters that are used to evaluate and establish performance of any algorithm designed to improve performance of TCP in networks. Based on the reviewed literature, this study concludes that a combination of four parameters including Packet Delivery Ratio, Throughput, Delay and Signal to Noise Ratio can be used to reliably evaluate, extrapolate and establish performance of any algorithm designed to improve performance of TCP in MANETs. These four parameters are better in extrapolating the overall performance of TCP with sufficient accuracy and there is no need to monitor /measure any other parameter in most cases unless it is idealistic and thorough work. Throughput, Delay / Latency, Packet Delivery Ratio and Signal to Noise Ratio are therefore sufficient to get near accurate proof of how is the TCP performance for a particular protocol MANET better than any other parameters.

4.1. Areas for Future Research

This study recommends further study of few other parameters at lower layers of OSI model such as HEC (Header Error Correction) and CRC (Cyclic redundancy check) metrics that could be used to better predict and effectively determine the causes of transmission timeout and improve performance of TCP in Mobile Ad hoc Networks.

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