A Proposal for Improving Performance of TCP in MANET's Employing SADCA (Smart Acknowledgement Distributed Channel Access) Scheme

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Abstract

Background/Objectives: The working of TCP upon Wireless Networks is the most difficult issue, as a result of arbitrary misfortunes and ACK impedance. TCP likewise experiences execution declination as far as making postponement and overhead in system due to the poor attributes of the Wireless channel. Keeping in mind the end goal is to beat these issues and to enhance the performance of TCP in MANETs. **Methods/Statistical Analysis:** The Congestion Control in Multi – Hop Mobile Ad – Hoc Networks Using Cross – Layer Based TCP Protocol Approach, the mechanism triggers congestion whenever the Channel Occupied Ratio (COR) reaches a maximum threshold value and the received signal strength is less than a minimum threshold value. Following it, congestion control scheme controls the data sending rate of the sender by determining the available bandwidth, delay of its link and COR. Further, a fair resource allocation scheme is put forwarded. **Findings:** A Smart Acknowledgment Distributed Channel Access (SADCA) is proposed, where a different Access Category (AC) for data less TCP acknowledgement packets is utilized and after that it is relegated with the highest priority. Along these lines, the postponement amid the transmission of packet can be lessened and furthermore the affirmation for the packet can be sent instantly. Keeping in mind the end goal to increase the performance of TCP, delay window size can likewise be balanced by considering the parameters, for example, transmission rate, number of jumps, and Channel Occupied Ratio (COR). Thus, the proposed plan helps in staying away from any sort of postponement and overhead to send the TCP acknowledgements. **Applications/Improvements:** The delay during the transmission of packet is decreased and the packet is recognized instantly. To expand the performance, the delay window size can be balanced for improvement purpose by considering the parameters, for example, transmission rate, number of jumps, and COR. The proposed scheme improves delay and overhead to send TCP acknowledgement.

Keywords: Access Category, Distributed Channel Access, MANETs, Smart Acknowledgement, TCP

1. Introduction

Portable Ad - Hoc Networks or MANETs is a self - ruling framework - less structure with remote connections interfacing the versatile nodes. Every portable node works as an end framework and in addition as a switch to forward the packets and is allowed to move and shape a system with no base stations. As the portable nodes correspondence is speedier, it has a wide application in military, emergency operations, individual electronic gadget systems administration, and for applications like a ad – hoc meeting or an ad – hoc classroom. The unique qualities of MANETs resemble dynamic topologies, data transmission restrained, variable capacity links, energy compelled operation, restricted physical security; make it more powerless to different assaults. Notwithstanding this, congestion happens in unreliable remote connections and listening stealthily because of their inalienable communication nature. The mobile phones transmission capacity, registering force and battery power imperatives

are the reasons for application – specifics between the gadgets security and asset utilization. The conduct oddities like publicizing false routes are hard to recognize because of its characteristic for versatility[1].

The Transmission Control Protocol (TCP) is the most usually utilized transport protocol as a part of the web, which gives end - to - end dependable transmission and also reasonable congestion control in order to share the system assets proficiently[2]. Congestion control is the need for MANETs, since MANETs work on data transmission capacity conditions.

In today's situation of the web, the performance of TCP is poor and the performance of TCP in MANETs is running downhill by contention with expanded UDP - based high priority for multimedia transmission. The class separation presented in the present Quality of Service (QoS) conventions additionally result in TCP starvation and expanded spurious timeouts[3]. The use of TCP over remote systems has issues because of the diverse qualities of remote connections as for the wired ones. The qualities are as far as less dependability and time - variation conduct, blurring/shadowing issues, node portability, and hand - offs, constrained accessible transfer speed and expansive RTTs[4]. The TCP performs dependably in the conventional wired systems and stationary systems, however, influences network congestion. Additionally, if the switches holding up the links are full or about full, the packets get dropped, and accordingly wired system losses are seen as a sign of congestion. In remote systems, the misfortunes happen regularly for different causes, for example, conflicts, node portability or poor connection quality.

In MANETs, the data transmission collapses are because of the nodes portability, conflicts and poor connection quality. This frequently prompts the congestion control initiation by TCP convention pointlessly, and which reduces the performance of TCP in MANETs[5,6].

The TCP dependability ensures that the TCP sender will forward each and every packet issued by it to the recipient node by an arrangement of acknowledgements. In TCP convention, aggregate acknowledgements (ACKs) are sent by the TCP recipient. The TCP sender decides the loss of bundles or packets either by the receipt of a few copy ACKs or on the receipt of several identical ACKs, setting off a quick retransmission, or by the non - arrival of an ACK within a time - out interim. The sender TCP retransmits the lost bundles or packets and at the same time summons the congestion control by with-drawing its congestion window size and decreasing its retransmission time, in this way adjusting for packet loss. These lessen the level of congestion on the intermediate connections[7].

The TCP acknowledgments may in - turn conflict with their correlating data packets, if the quantity of system nodes gets critical. Subsequently, a substantial number of TCP ACK packets come into conflict with the TCP bundles or packets and may prompt intra - stream contention.

In the past work[8], A Proposal for Congestion Control in Multi - Hop Mobile Ad - Hoc Networks Using Cross - Layer Based TCP Protocol Approach was proposed. Whenever Channel Occupied Ratio (COR) achieves a greatest threshold and the signal strength is always less than the minimum threshold, the mechanism initiates congestion. Tailing it, congestion control controls the data transfer sending rate of the sender by deciding the accessible data transfer capacity, deferral of its connection and COR. Further, a reasonable resource allocation scheme is suggested. As an expansion to the work, it propose a Smart Acknowledgment Distributed Channel Access (SADCA) Scheme for TCP keeping in mind the end goal to lessen the delay and overhead of sending TCP acknowledgements.

2. Existing Work

In Combo Coding, a novel coding strategy joining of intra - and inter - stream coding and a new loss adaptation algorithm. Combo Coding diminishes the data and ACKs obstruction inside a TCP session exploiting the advantages of both sorts of codes, and furthermore presents the power to high connection losses. 2 Mbps goodput is accomplished by Combo Coding effectively with 30 % per link packet loss rate; while TCP - New Reno with no coding conveys just 200 Kbps. Combo Coding provides a lower goodput over two paths than that over a solitary path because of a higher overhead and because of additional contentions as in the 20s - 50s interims[2].

A novel TCP – friendly approach, IEDCA, for upgrading IEEE 802.11e Enhanced Distributed Channel Access (EDCA) strategy, by allocating the highest preference to TCP acknowledgement packets. The proposed approach enhances TCP performance very much while having nominal impacts on voice data. However, the voice data was dropped by buffer overflow or when the retry threshold is surpassed, it is higher in EDCA[11].

A change in Transmission Control Protocol (TCP) called Improvement of the Acknowledgment TCP (IA - TCP) for MANET's better execution, in terms of the quantity of nodes, versatility and their communication distance between these nodes. IA - TCP delays TCPs affirmation packets. Be that as it may, just throughput and end - to - end delay parameters are concerned. In any case, there is deterioration of the TCP performance.

In an end - to - end sender - side methodology which points to organize congestion failure, wireless channel loss and connection failure loss using queue usage estimation. Queue usage is determined by using utilizing Relative One - Way Trip Time. Congestion failure is assessed by utilizing packet loss with queue usage rate which is greater than the predefined threshold. While, non - congestion failure occurs, when queue usage is less than the threshold. Non - congestion failure is perceived by three duplicate ACKs loss because of wireless channel loss, because it is sign of route present in the communicating end point that duplicate ACKs moved along. In spite of accomplishing performance enhancement amid a handoff, Freeze - TCP deployment in genuine environment is troublesome because of the difficulty in distinguishing exact handoff time and the vulnerability of high inequalities in the Round Trip Time (RTT). The proposed scheme TCP - PRN, rapidly recoups the lost packets by reestablishing the congestion window, evading congestion window to lessen or promptly initiate a slow start algorithm. The proposed approach demonstrates better performance in a more practical environment, where the handoff expectation is troublesome and the inequalities of RTT is higher[13].

This methodology safeguards the end - to - end TCP semantics since end point changes are only made. Dissimilar to different networks, using transport or network layer alone without much Cross - Layer participation, this methodology empowers mobility information in TCP. However, RTO is decreased when contrasted with the standard TCP/MIPv6 when the handover ends[10].

Evaluation of Cross - Layer result for a node for quicker adaption of lower - layer attributes like coding rate and local ARQ retransmissions threshold taking into account the detected TCP flavor, in order to improve the end - to - end performance of the download for that used flavor is proposed. The proposed plan can possibly enhance the general download throughput, without overloading the server and requiring no alterations to the existing TCP implementations. However, the end - to - end throughput diminishes with expanding propagation distance[12].

Another scheme called delay - ACK algorithm for TCP performance improvement over Multi - Hop Wireless Networks is proposed. As per the characteristics like TCP startup stage, transmission rate, packet failure occasion, and number of jumps, the ideal delayed ACK window is accomplished effectively as formerly. The dynamic adaptive technique's goal is empowering TCP receiver to attune itself regarding the data to the ACK ratio. This strategy improves the TCP performance, achieving up to 233 % performance increase, over Multi - Hop Wireless Networks when contrasted with the normal TCP. Yet, the burst transmission happens at the sender, activated by delayed ACK. The burst raises the packet loss and probably influences TCP performance[14].

3. Proposed Solution

3.1 Overview

The delay in packet transmission prompts to the loss of packet and in addition throughput deterioration. A different Access Category (AC) is utilized for data less TCP acknowledgement packets and assign highest preference to them[11]. Subsequently, the delay in packet transmission can be lessened and the packets are acknowledged immediately. A higher value for congestion window is accomplished than achieved by TCP over Enhanced Distributed Channel Access (EDCA) approach. Further changes can be made by altering the delay window size by considering channel conditions like transmission rate, slow start rate, number of jumps and packet lost occurrences[14]. In this proposal, the quantity of acknowledgement packets can be decreased by provoking the acknowledgement packets after accomplishing optimal dynamic delay window. Hence, the receiver can adjust accordingly to different delays.

3.2 Estimation of Metrics

3.2.1 Probability of Successful Transmission

The vast majority of the past studies suggested that the likelihood of successful transmission depends on analytical skills to evaluate delay and throughput that can be achieved by various traffic classifications in IEEE 802.11e for which they regarded the Markov Model. In this kind of model, the successful transmission is given as:

$$\gamma = \frac{2}{1 + V + pV\sum_{i=0}^{n-1}(2p)^i} \qquad (1)$$

where, V speaks about the initial contention window amid backoff stage, p speaks about the conditional collision probability, and n speaks about to the maximum backoff stage. Likewise, the transmission probability γ_k of a station of Access Category, k can be given as:

$$\gamma_k = \frac{2}{1 + V_k + p_k V_k \sum_{i=0}^{n_k-1}(2\,p_k)^i} \qquad (2)$$

Taking into account the above equations, a comparative expression can be acquired for the throughput T_k which is achieved by an Access Category k as exhibited underneath:

$$T_k = \frac{n_k \gamma_k (1-p_k)l}{p(t)H_{(t)} + p(c)H_{(s)} + p(e)\phi} \qquad (3)$$

where, l speaks about the average transmission time of payload for Access Category 'k'. The probabilities of a slot time contain successful transmission, collision, and channel being inert distinguished by $p(t)$, $p(c)$ and $p(e)$ correspondingly. $H_{(s)}$, $H_{(t)}$ and ϕ speaks tells about average slot length of successful transmission, collision and channel being idle correspondingly. From the above expressions, it can be seen that the probability of successful transmission for any Access Category (AC) is inversely proportional to the contention window V.

As a consequence, stations with traffic in high preference, the Access Category (AC) will have low estimations of V which thus will have higher possibility of transmitting their information than stations with best effort and will have better throughput. Yet, this is not appropriate for TCP traffic. For TCP traffic, a packet is thought to be effectively transmitted subject to that TCP ACK is received by the sender before the retransmission time is over. Based, on the probability of successful transmission as shown in equation (2), successful transmission probability subject to TCP traffic is a blend of probability of successfully transmitted data packets and probability of successfully received ACK packet. As a consequence, for TCP traffic having Access Category (AC1), the probability of successful transmission can be given as:

$$\gamma_{TCP} = \frac{4}{\left\{1 + V_1 + p_1 V_1 \sum_{i=0}^{n_1-1}(2\,p_1)^i\right\}^2} \qquad (4)$$

Consider data and ACK have the same transmission probability, since they are in the same Access Category. In addition, presume that delayed ACK is not utilized. Subsequently, TCP throughput is not the same as other best throughput which is available from the equation (3), as it relies on upon the value γ_{TCP} which is given in the equation (4).

3.2.2 Channel Occupied Ratio (COR)

COR is characterized as the proportion of aggregate lengths of busy periods to the aggregate transmission time. Consider that T_T is the aggregate transmission time and T_b is the aggregate length of busy periods. Subsequently, COR can be given as:

$$COR = \frac{T_b}{T_T} \qquad (5)$$

Consider channel utilization factor and threshold value Th_{COR}, COR can be stated as:

$$COR \approx C_U \ (COR \leq Th_{COR}) \qquad (6)$$

where, C_U signifies channel utilization factor and is measured as the proportion of channel busyness time for successful transmissions to the aggregate time T_T.

3.3 Smart Acknowledgement Distributed Channel Access

This segment gives the depiction of the proposed Smart Acknowledgment Distributed Channel Access (SADCA) strategy. The key thought of the proposed strategy is to boost the throughput without any delay in the network.

In this strategy, an extra fifth Access Category is characterized for data less TCP ACK. This new Access Category is given the highest preference. By putting data less TCP ACKs in top preference of the Access Category, the likelihood of transmitting them on time is amplified. Since TCP ACK transmission likelihood tends to 1, transmission likelihood of TCP traffic can be shown as equation (2). In the same form, TCP throughput can be achieved from equation (3) with the exemption that H_S increments by a value which is equal to the time required to transmit both TCP ACK and in addition MAC control packets that accompany it. By using this strategy, the likelihood that all TCP packets transmitted get recognized or acknowledged is gained. The hidden rule of this strategy makes utilization of Transport Layer to control the volume of TCP ACKs on the channel. The volume of TCP ACKs allowed on the channel equals to the volume of TCP data which is effectively transmitted and is not influenced by other traffic striving for the same medium. To evade any sort of congestion because of retransmission, COR is accepted inside the network, with the usage of equation (5) and in case the delay due to congestion is found, we use equation (6).

The execution of the SADCA takes after the accompanying steps:

Step 1: The Type of Service (ToS) is typically applied at the Application Layer. TCP ACKs begin to originate from the Transport Layer. Thus, Transport Layer is in charge of allotting a correct ToS to them.

Step 2: The Transport Layer consequently allocates the best effort ToS to TCP ACKs. A distinct ToS should be relegated to them to discriminate them from best effort traffic.

Step 3: To make the procedure basic, ToS value (224) is allotted to data less TCP ACK at the Transport Layer, when they are to be sent to the lower layer.

Step 4: The MAC Layer portrays 8 user preference levels which are utilized to organize the distinctive data packets into various Access Categories.

Step 5: By considering 224 as their Transport Layer ToS, TCP ACK will be assigned to the user 7.

Step 6: A fifth Access Category is characterized to MAC user preference value of 7 and subsequently accumulate the TCP ACKs.

The mapping of Client Priority (CP) to Access Category in SADCA is indicated in Table 1. Henceforth, an extra traffic queue is achieved in SADCA as indicated in Figure 1. The proposed goal is to permit TCP ACKs preference to the medium. After that, preference is allocated to the new Access Category having slight values of AIFS, CW_{min} and CW_{max} contrasted with the current higher preference voice activity as indicated in Table 2.

If TCP ACK is produced during the same time, when the voice traffic is produced, then station T_S achieves the
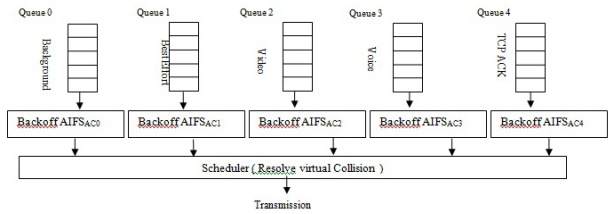
Table 1. Client Priority for Mapping in SADCA

Client Priority (CP)	Access Category (AC)	Designation
1	0	Background
2	0	Background
0	1	Best Effort
3	1	Best Effort
4	2	Video
5	2	Video
6	3	Voice
7	4	TCP ACK
8	1	COR

Figure 1. Node within Transmission Range with Multiple priority queues in SADCA Scheme.

Table 2. Medium Access Parameters for Different ACs in SADCA

AC	CW_{min}	CW_{max}	AIFSN	$TXOP_{limit}$
Voice	7	15	2	3264
Video	15	31	2	6016
Best Effort	31	1023	3	0
Background	31	1023	7	3264
TCP ACK	3	7	1	3264

medium contention since these TCP ACKs are in Access Category having higher preference than voice. Thus, it can be said that T_S will have more opportunity to transmit the TCP ACK before time - out and thus avoids re - transmission at the source. In the event that, TCP ACK is produced before time - out, then it keeps away from any sort of re - transmission at the source. Additionally, if TCP ACK originates after VoIP conversation began, then it will have a decent chance to contend the medium during the end of the next TXOP of the VoIP stations. Thus, it can be said that there is a high opportunity that ACK will be received within RTO limit and furthermore re - transmission can be evaded.

The representation of the proposed plan is given in Figure 2. The proposed network comprises of four nodes which are inside the transmission range. In this case, at time t_0, a TCP packet is effectively sent from TCP source T_S to the destination node T_P before the time - out, as the TCP ACKs are with higher priority Access Category.

4. Simulation Results

4.1 Simulation Setup

NS - 2 simulator is utilized to stimulate the proposed Smart Acknowledgment Distributed Channel Access plan for TCP (SADCA - TCP) convention. In
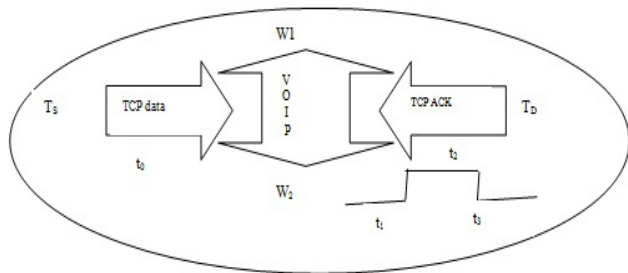
Figure 2. Illustration of SADCA Scheme.

the simulation, the channel limit of every single portable host is set to 2 Mbps. Distributed Coordination Function (DCF) of IEEE 802.11 for Wireless LANs is utilized as the MAC Layer protocol. It has the ability to inform Network Layer about connection breakages. The accompanying measurements are utilized to collate SADCA - TCP with standard basic TCP convention. Packet Delivery Ratio: It is the proportion of the aggregate number of packets received at the destination over the aggregate number of packets transmitted. Average end - to - end delay: The average end - to - end delay is the average over every surviving data packets from the source to the destination. Throughput: It is the aggregate bandwidth received at the destination and is measured in Mb/sec.

4.2 Static Line Topology

In Static Line Topology, 9 static hosts are organized as a line topology in a 1700 meter by 300 meter zone as indicated in Figure 3. Every one of the hosts has the same transmission range of 250 meters.

The simulation settings and parameters are given in Table 3. Figure 4 demonstrates the delay of SADCA - TCP and TCP strategies for various number of flow situations. Henceforth, it can be inferred that the delay of SADCA - TCP has diminished by 35% as that contrasted with standard TCP.

Figure 5 demonstrates the packet delivery ratio of SADCA - TCP and TCP strategies for various number of flow situations. Consequently, it can be inferred that the packet delivery ratio of SADCA - TCP has achieved 3% excess as that contrasted with standard TCP. Figure 6 demonstrates the throughput of SADCA - TCP and TCP strategies for various number of flow situations. Consequently, it can be inferred that the throughput of SADCA - TCP has expanded by 45% as that contrasted with standard TCP.
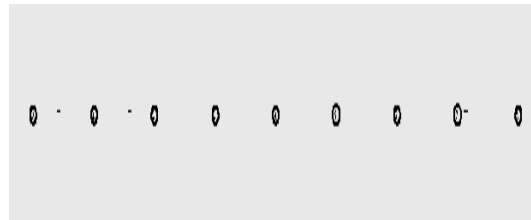

Figure 3. Static Line Topology.

Table 3. Simulation settings for Static Line Topology

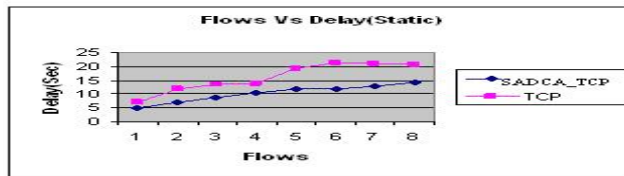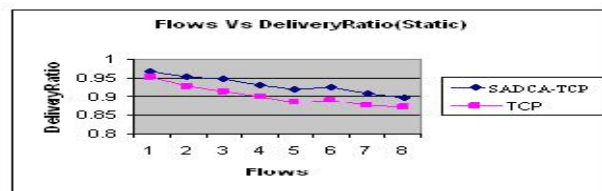| No. of Nodes	9
Area Size	1700 × 300
Mac	802.11
Radio Range	250m
Simulation Time	300msec
Traffic Source	FTP
Packet Size	1000 bytes
No. of Flows	1 to 8
Routing Protocol	AODV

Figure 4. Flows vs. Delay.

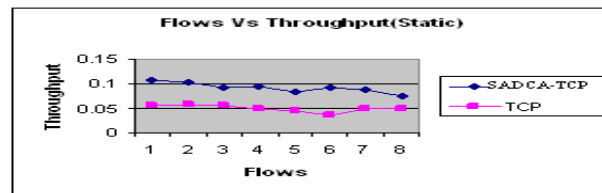**Figure 5.** Flows vs. Delivery Ratio.

Figure 6. Flows vs. Throughput.

4.3 Dynamic Random Topology

In Dynamic Random Topology, 50 portable hosts are conveyed arbitrarily in a 1500 meter by 300 meter zone as indicated in Figure 7. Every one of the hosts has the same transmission range of 250 meters. The random way point model of NS - 2 is utilized as the portability model where the pause time of the host is 5 seconds and the speed is 10 m/s. There are 10 traffic flows between various arrangements of source and destination pairs.

The simulation settings and parameters are given in Table 4. Figure 8 demonstrates the delay ratio of SADCA - TCP and TCP strategies for various numbers of flows. Thus, it can be inferred that the delay of SADCA - TCP has diminished by 28 % when contrasted with that of standard TCP.

Figure 9 shows the packet delivery ratio of SADCA - TCP and TCP strategies for various number of flow situations. Thus, it can be inferred that the packet delivery
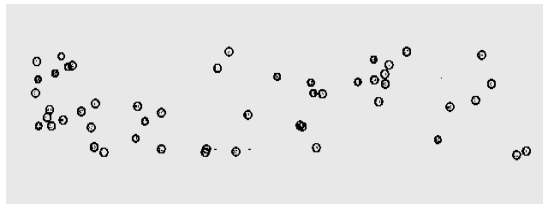

Figure 7. Dynamic Random Topology.

Table 4. Simulation settings for Dynamic Line Topology

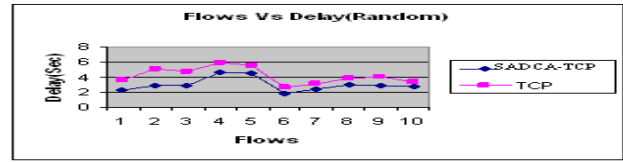| No. of Nodes	50
Area Size	1500 × 300
Mac	802.11
Radio Range	250 m
Simulation Time	300msec
Pause time	5 seconds
Speed	10 m / s
Traffic Source	FTP
Packet Size	512 bytes
No. of Flows	1 to 10
Routing Protocol	AODV

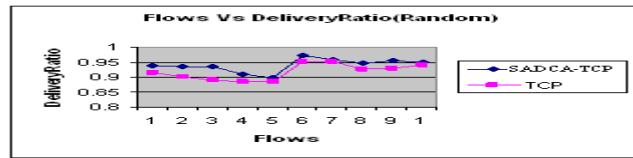**Figure 8.** Flows vs. Delay.

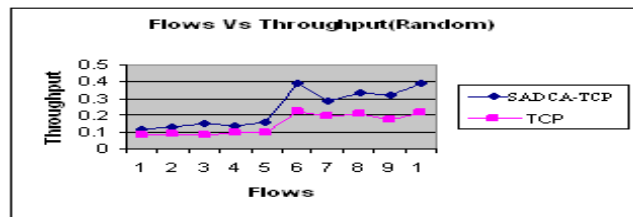

Figure 9. Flows vs. Delivery Ratio.

Figure 10. Flows vs. Throughput.

ratio of SADCA - TCP has gone up by 2 % when contrasted with that of standard TCP. Figure 10 shows the throughput of SADCA - TCP and TCP strategies for various number of flow situations. Thus, it can be reasoned that the throughput of SADCA - TCP has expanded by 37% when contrasted with that of standard TCP.

5. Conclusion

This paper proposes a Smart Acknowledgment Distributed Channel Access (SADCA) plan for enhancing the performance of TCP in MANETs. In the proposed plan, initially, a different Access Category for data less TCP acknowledgement packets is utilized and it is allocated the highest preference. As TCP ACK is allocated with another Access Category having highest preference, it has the highest likelihood of effective transmission by making proficient usage of contention window amid backoff stage. In this way, delay during the transmission of packet can be decreased. Furthermore, the packet can be recognized instantly. Further, to expand the performance, the delay window size can be balanced for improvement purpose by considering the parameters, for example,

transmission rate, number of jumps, and COR. Thus, the proposed scheme improves delay and overhead to send TCP acknowledgement.

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