Optimization Of Multi-Queue Buffer Allocation For TCP Flow In Wlans Using Artificial Bee Colony Algorithm

Jafruddin Khan Baliyana, Dr. Anand Sharma

Abstract: Wireless Local area networks are used at a large scale in present world. A large number of devices communicate in a WLAN but the channels used for this purpose are limited which gives birth to congestion in the network. The main challenge in WLANs is the allocation of resources. Two types of TCP flows i.e., uplink and downlink exist WLAN, but with their existence at the same time the network service is somewhat biased towards uplink due which the downlink transmission flow suffers. In this research paper, we propose an optimization scheme based on the working of Artificial Bee Colony Optimization algorithm for dynamic allocation of multi-queue buffer for TCP flow in WLANs. The simulations are performed in MATLAB and the results are achieved in terms of throughput, drop packet and other parameters to prove the effectiveness the proposed technique.

Keywords: WLAN, TCP, congestion, optimization, Artificial Bee Colony, Multi-Queue

1. INTRODUCTION

Wireless LANs have experienced an explosive growth in the use of IEEE 802.11 to support various networking applications such as browsing the web, communication via emails, media downloads, etc. [1, 2]. Specifically for the on demand transmission of audio and video data, jitter is the main problem, which can be handled via buffering without affecting the reliability or bandwidth of the network. Buffering plays an important role in decreasing the network congestion [3,4].Buffering is used to slow start, congestion avoidance, fast retransmit, fast recovery with modifications and to accommodate short-term packet bursts so as to mitigate packet drops and to maintain high link efficiency of WLANs [5]. Transmissions are essentially broadcasted in WLANs, leading to variable mean service time, which directly affects the transmissions and resulting in buffering requirements. Secondly, wireless stations dynamically adjust the physical transmission rate/modulation for regulating non-congestive channel losses. This rate adaptation may induce large and rapid variations in required buffer sizes. Thirdly, the IEEE 802.11n standard improves throughput efficiency by the use of large frames formed by aggregation of multiple packets. This acts to couple throughput efficiency and buffer-sizing in a new way since the latter directly affects the availability of sufficient packets for aggregation into large frames in WLANs [5]. Buffer Size: Packet buffering is directly proportional to number of packet dropped and, especially with TCP traffic. Buffersize keeps on increasing with increase in the number of packets lost during the transmission. Under-utilization can be avoided in WLANs when TCP connections back off due to packet losses. Large buffer sizes can lead to high queuing delays, and to ensure low delays, the buffer should be as small as possible [5].

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There are some basic congestion control mechanisms such as TCP-Tahoe, TCP-Reno and TCP-SACK that work as TCP solutions are briefly introduced as:

TCP-Tahoe: Tahoe refers to the TCP congestion control algorithm. TCP is based on a principle of 'conservation of packets', i.e. if the connection is running at the available bandwidth capacity then a packet is not injected into the network unless a packet is taken out as well. TCP implements this principle by using the acknowledgements to clock outgoing packets because an acknowledgement means that a packet was taken off the wire by the receiver. It also maintains a congestion window CWD to reflect the network capacity [6].

TCP-Reno: This Reno retains the basic principle of Tahoe, such as slow starts and the coarse grain re-transmit timer. However it adds some intelligence over it so that lost packets are detected earlier and the pipeline is not emptied every time a packet is lost. Reno requires that we receive immediate acknowledgement whenever a segment is received. The logic behind this is that whenever we receive a duplicate acknowledgment, then his duplicate acknowledgment could have been received if the next segment in sequence expected, has been delayed in the network and the segments reached there out of order or else that the packet is lost [7].

TCP-SACK: TCP with 'Selective Acknowledgments' is an extension of TCP Reno and it works around the problems face by TCP RENO and TCP New-Reno, namely detection of multiple lost packets, and re-transmission of more than one lost packet per RTT. SACK retains the slow-start and fastretransmit parts of RENO. It also has the coarse grained timeout of Tahoe to fall back on, in case a packet loss is not detected by the modified algorithm. SACK TCP requires that segments not be acknowledged cumulatively but should be acknowledged selectively. Thus each ACK has a block which describes which segments are being acknowledged. Thus the sender has a picture of which segments have been acknowledged and which are still outstanding [8],[9]. In this research paper, a new technique base on Artificial Bee Colony Optimization Algorithm is proposed for multi-queue buffer allocation for TCP flow in WLANs.

2. LITERATURE REVIEW

Daigavhane Monika U. et al (2018) in [10] focused on an algorithm which used jitter ratio as a loss predictor. TCP was main transport layered communication protocol and worked very well with wired networks where bit error rate was very low and the main cause of loss was congestion only. It provided better results than XJTCP (cross layer jitter based transmission control protocol). Wei Bai et. al (2017) [11] buffer was introduced in Congestion control technique. A BCC is introduced at commodity switches. The operation of BCC depends on real-time shared buffer utilization. When the buffer is plentiful, then BCC shows high output and less packet loss. When the buffer is less, BCC triggered shared buffer to prevent packet loss with small degrade output. This technique maintains less packet loss continuously but there is some degradation in the output. M. Rajesh et. al (2017) [12] had proposed a congestion control scheme for heterogeneous wireless ad-hoc networks using self-adjust hybrid model. The bloom filter is used for the reduction of prediction errors. The Savitzky-Goaly filter is used for training a sequence of confidence window. This protocol is used for decreasing the congestion in the network by setting the accurate rates for free resources and the priority for data needed. This algorithm is applied on the nodes which are near to base station, which have more traffic. Flizikowski Adam et. al (2017) [13] introduced framework for designing and evaluation the video adaptation controllers i.e., the enablers for the growing market of user generated traffic. It proposed a systematic approach which combined real network traces, network modelling and emulation, video trans-coder as a service and the use of no-reference QoE metrics in order to assure effective means for video controllers design and tuning. It was described that the architecture as well as results of comprehensive sensitivity test of QoE in uplink for mobile WiMAX networks. The results showed that the proposed framework provided valuable potential for the development and evaluation answering the demand of emerging scenarios for mobile surveillanceS.Leandro et al (2016) in [14] analyzed real time and priority pre-emptive networks by presenting a novel analysis of the said networks by carefully modeling the buffering effects on indirect interference. The multiple interference problem caused by downstream interference was focused in the research. Realistic examples and large scale experiments with synthetically generated packet flow sets provided evidence of the strength of the proposed approach. Paliwal Girish et al [15] focused on review of TCP congestion control mechanism and comparative analysis of congestion control algorithms. There were a lot of modifications done in the field of TCP congestion control. In this paper, mainly focus was on TCP approaches and congestion window controlling like how TCP helped in preventing in congestion occurrence and if congestion occurred then what was the procedure worked with different TCP algorithms. It also reviewed the TCP for wired and wireless approaches. In future it can be extended for wireless or mixed network.

3. PROBLEM STATEMENT

Congestion has been considered as one of the basic important issue in packet switched network. Congestion control refers to the mechanisms and techniques to control the congestion and keep the load below the capacity. Many techniques exist for controlling the congestion in a network for efficient data transfer and communication but still congestion remains an emerging challenge for the researchers. The important parameters that define the quality of service of a network such as energy consumption, buffer size, throughput, delay etc.

4. METHODOLOGY:

In this research Artificial Bee Colony Optimization Algorithm is used for the optimization of Multi-queue buffer allocation for congestion control in WLANs. Artificial Bee Colony algorithm denoted by ‘ABC’ in our study, consists three “bee” groups in the “colony”: onlookers, scouts, and employed bees, where each bee represents a position in the search space; the ABC algorithm employs populations of bees to identify the optimal path. A bee waiting on the “dance” area to choose a food source is an onlooker, a bee randomly searching is a scout, and a bee going to a previously visited food source is an employed bee. The positions of food sources represent possible solutions to the optimization problem, and the amount of “nectar” of a food source corresponds to the quality (fitness) of the associated solution. The first half of the colony consists of employed bees and the second half consists of onlooker bees [16].
The working process of the proposed technique is given in form a flowchart shown in figure1 below:

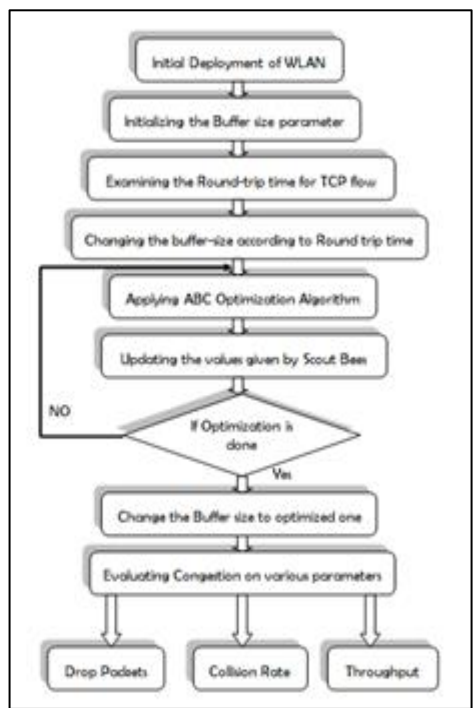

Figure 1: *Illustrating the working of ABC optimization Approach For multi-queue Buffer Allocation*

The flowchart represented in figure 1 is explained in form of steps below:

I. The first step is deploying the WLAN network in which the number of nodes communicating in the network along with the network area is also specified.

II. Buffer size parameter is initialized by giving a random value which will be optimized in the further steps.
III. TCP Round-Trip Time algorithm is initialized that changes the multi-queue buffer for TCP flow according to Round Trip Time.
IV. The Artificial Bee Colony optimization algorithm is initialized after examining the round-trip time of the buffer.
V. The values generated by Scout Bees of Artificial Bee Colony algorithm are updated in this step in order to get the optimized values.
VI. In this step, the optimization process will start and the updated values of scout bees will be examined whether they are optimized ones or not. If the optimized values are delivered in this step then the algorithm will resume for the next step otherwise the control will be returned to Step IV.
VII. The buffer-size set to the optimized value which is passed on to check the network performance.
VIII. The congestion is evaluated with the optimized buffer size on the basis of Throughput, Packet Drop, and Collision Rate to evaluate the network performance.

5. SIMULATIONS AND RESULTS

The simulations are performed in MATLAB with 700 network nodes and an area of 1000 mt^2. The simulation environment is as given in table 1 below:

PARAMETERS	*VALUES*
Address	*Auto Assigned*
WLAN bandwidth (bps)	*11Mbps*
PHY Characteristics	*Direct Sequence*
slot time	*5.0 E-05*
buffer size	*20 KB/queue*
Queues	*Apr-20*
Short Retry Limit (Attempts)	*12*
Long Retry Limit (Attempts)	*2*

The outputs obtained are compared with standard TCP-Buffer in terms of Drop packet, Throughput, and collision rate.

1. Drop Packets: It refers to the packets lost during travelling across a computer network i.e., the packets that fail to reach their destination and this loss of packets is called Packet loss.

Table 2: *Comparison of values of TCP-ABC with TCP-Buffer in term of Drop packets with increasing no. of nodes.*

Number of Nodes	*Drop Packet*	
	TCP Buffer	*TCP-ABC Buffer*
100	*34*	*20*
200	*31*	*30*
300	*40*	*35*
400	*29*	*20*
500	*32*	*20*
600	*27*	*17*
700	*18*	*13*

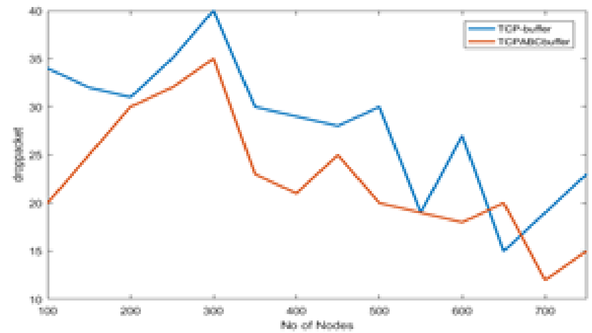

Figure 2: *Comparison of values of TCP-ABC with TCP-Buffer in term of Drop packets with increasing no. of nodes.*

Table 2 and Figure 2 show the comparison in terms of drop packets by buffer allocation in TCP represented by TCP-Buffer and proposed technique which predicts the priority by Bayesian approach represented by TCP-ABC. ABC is used to optimize the threshold of buffer by iteratively changing the buffer size and calculating the congestion and collision. Figure 1 shows the drop of packets w.r.t. number of nodes. Proposed TCP-ABC reduces the drop packet by 10-15% because of its adaptive and dependent relation with threshold & its impact on buffer size in queue as per its adaptive traffic.

2. Throughput: It is the amount of data moved successfully from one place to another over a certain interval of time.

Table 3: *Comparison of values of TCP-ABC with TCP-Buffer in term of throughput with increasing no. of nodes.*

Number of Nodes	*Throughput (Mbits/sec)*	
	TCP Buffer	*TCP-ABC Buffer*
100	*0.6*	*1.3*
200	*1.2*	*2*
300	*1.6*	*2.1*
400	*1.8*	*2.5*
500	*2.2*	*3.2*
600	*2.5*	*3.5*
700	*2.8*	*3.9*

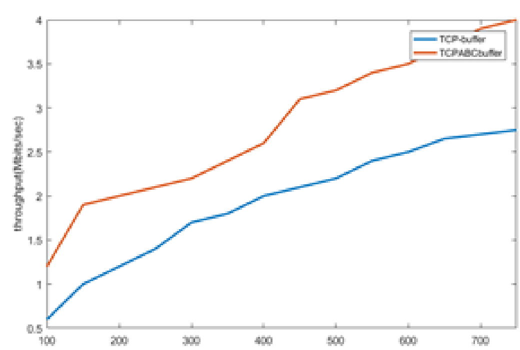

Figure 3: *Comparison of values of TCP-ABC with TCP-Buffer in term of throughput with increasing no. of nodes.*

Figure 3 and Table 3 show the comparison of throughput achieved by buffer allocation in TCP represented by TCP-Buffer and proposed TCP-ABC. In this analysis, the throughput achieved with increasing number of nodes is calculated during buffer allocation process. As seen in fig 3 and table 3, the proposed approach TCP-ABC shows effective throughput as compared to the TCP Buffer with the increase in number of nodes.

3. Collision Rate: A network collision occurs when more than one node attempts to send a packet on a network segment at the same time.

Table 4: *Comparison of values of TCP-ABC with TCP-Buffer in term of Drop packets with increasing no. of nodes.*

Number of Nodes	*Collision Rate*	
	TCP Buffer	*TCP-ABC Buffer*
100	*0.4*	*0.1*
200	*0.65*	*0.3*
300	*0.8*	*0.55*
400	*0.97*	*0.35*
500	*1*	*0.11*
600	*0.35*	*0.58*
700	*0.7*	*0.65*

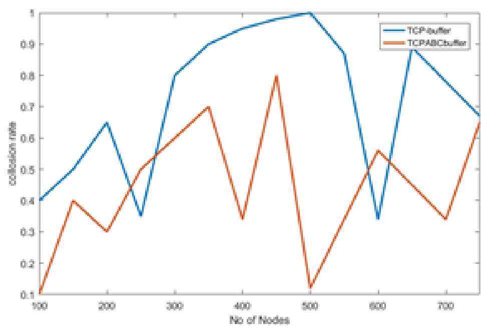

Figure 4: *Comparison of values of TCP-ABC with TCP-Buffer in term of Drop packets with increasing no. of nodes.*

Figure 4 and Table 4 represent the comparison of collision rate achieved by TCP-Buffer and proposed TCP-ABC. As shown in figure 4, the collision rate for both TCP-Buffer and TCP-ABC varies with the increase in number of nodes. As, collision depends on no. of users, channel capacity & buffer allocation, the simulation results show that the proposed TCP-ABC approach has optimized multi-queue buffer allocation for reducing the collision rate by 8% to 11%. Thus, we can say that the proposed Artificial Bee Colony Optimization based mechanism has significantly reduced the network congestion.

6. CONCLUSION

Congestion is a major research issue in WLANs. This paper presented Artificial Bee Colony Optimization Algorithm based buffer allocation control system for IEEE 802.11b WLANs. The performance evaluation was done by performing the simulation is MATLAB on the basis of dropped packets, throughput and collision rate in comparison to TCP-Buffer technique. The proposed algorithm regulated the amount of throughput and packet drop rate, resulting in reduced collisions, thus minimizing the congestion in the WLAN. Simulations show that the proposed model is more balanced and responds faster to different states of traffic. Thus, It may be concluded that Artificial bee colony queuing used in TCP improves the performance of the network by enhancing the throughput, decreasing packet loss and reducing the collision than TCP-buffer algorithm.

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