Optimized Adaptive Back off Algorithm for Static and Mobile Wireless Ad hoc Networks

K. Kamali, K. Selvakumar

Abstract: ***In wireless ad hoc networks with stationary and portable nodules situation, planning a backoff procedure is decisive to evade impact and to increase the act of nodules. Majority of the Medium Access Control (MAC) etiquettes intended for ad hoc networks take up stationary nodules situation. In this paper, an Optimized Adaptive Backoff Algorithm (OABA) is proposed for static and mobile wireless ad hoc networks. In this algorithm, during the back off stage, the type of node is determined as static or mobile. For mobile nodes, their residence time is determined in addition to their priority. Then optimized adaptive backoff algorithm is applied, by checking the type of node. Simulation results have shown that OABA achieves higher delivery ratio with minimized delay, packet drop and energy consumption.***

Keywords: Wireless ad hoc networks; Backoff; Medium Access Control (MAC); Static; Mobility

I. INTRODUCTION

Wireless ad hoc network (WANET) is a cluster of dynamic, mechanical and radio invigorated nodules destitute of any arrangement. Ad hoc networks necessitate every single transitional nodule to execute as forwarders, receiving and progressing data to every additional nodule. This kind of network is normally located in abundant circumstances in which instant connectivity becomes the constant necessity, either in substitute conditions like a disastrous draining situation or in an unintended congregation for enactments [1]. IEEE 802.11 is the frequently utilised accustomed customary for wireless networks. In a common medium, any one of the positions can interconnect at any predefined period of time. If two or more positions attempt to direct data packages concurrently, collision will befall and the package is absent. IEEE 802.11 customary defines offers the Distributed Coordination Function (DCF) [2]. A MAC process must provide lively gadgets for collision avoidance (CA) and impartial quarrel resoluteness. The trouble of collision is inferior in multi-hop scenery than in a single-hop ambience [3]. Due to dissemination of wireless bandwidth among ad hoc nodules, MAC processes may rely on IEEE 802.11 DCF access contrivance [4].The disputation contrivance of the IEEE 802.11 is a frail variation contrivance of contention window (CW) and has numerous problems to be enhanced. There are humble and adaptive systems to augment the disputation contrivance of IEEE 802.11, but they do not revenue ideal presentation [5]. Because of the backoff phase contrivance, nodules in a network are frequent in diverse backoff phases, which persuade huge disparities in designated backoff counters and reasons little temporary justice [6].

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1.1 Problem Identification

Flexibility in wireless ad hoc networks reasons exclusive encounters to the strategy of MAC etiquette [7]. Wireless networks ought to offer more effectual and dependable communications amid the portable terminuses. If the procedure on the MAC layer is stationary and can't regulate itself to the varying network atmosphere, it will upshot in dilapidation of performance [8]. Hence, MAC etiquettes should offer a mechanism to afford an uninterrupted endwise communication bond regardless of the flexibility besides obliging the approaching and going of nodules [9].

Majority of the MAC etiquettes planned for ad hoc networks adopt stationary nodules situation. Deliberation of flexibility in adhoc wireless networks presents novel encounters for the strategy of MAC etiquettes. Henceforth the intention of our novel MAC etiquette is to offer impact evasion in both stationary as well as portable nodules situation.

II. RELATED WORKS

Changsen Zhang et al [8] have recommended a backoff technique based on self-adaptive contention window acquaint characteristic for IEEE 802.11 DCF. This recommended backoff technique can prominently enhance the yield by adjusting the optimal CW acquainting characteristic centred on the imaginary examination. When the quantity of active nodules varies, a clever system can adaptively control the CW apprising characteristic to achieve the greatest output at the time of course period. Accordingly, it proficiently diminishes the amount of collisions, advances the network utilization and grasps the welfares of the dualistic exponential back-off technique like lenience and zero price. In IEEE 802.11 disseminated coordination function (DCF) technique.

Hui-Hsin Chin et al [10] have proposed a meek, effective, importance aptitude, and fine attained skirmish resolution technique called augmented BEB (E-BEB) technique. They also provided a meek and accurate analytical exemplar to study the system backlog output of the strategic system.

Donghong Xu et al [11] have recommended an EA-MAC technique based on SMAC procedure. In EA-MAC, nodule link exploration technique and congestion adaptive obligation cycle device are encompassed. In the nodule link technique, the complete network nodules are fragmented into plentiful sectors by computing nodule link centred on the congregated data. In congestion based obligation cycle device, the obligation cycle is regulated forcefully to weakening lethargic observing by linking the edge group with the flow value acquired from the anticipated flow type. Moreover, nodules with more battery power have significance to access the network and have lesser back-off period that can preserve the steadiness of the complete system energy absorption and outspread system existence. The MT-MAC etiquette [12] utilises variation in RSSI and LQI values of the accepted SYNC packages to resolve great package fall proportion. But it didn't address the disputation problem of rival nodules.

1. Optimized Adaptive Backoff Algorithm (OABA)

3.1 Overview

In this paper, an Optimized Adaptive Backoff Algorithm (OABA) is proposed for static and mobile wireless ad hoc networks. In this algorithm, we consider a network which consists of significant amount of static nodes and few set of mobile nodes. During the back off stage, the type of node is determined (ie) static or mobile. Then for static nodes, priority of contending nodes is determined. For mobile nodes, their residence time is determined in addition to their priority. Then optimized adaptive backoff algorithm is applied, by checking the type of node.

3.2 Network Model

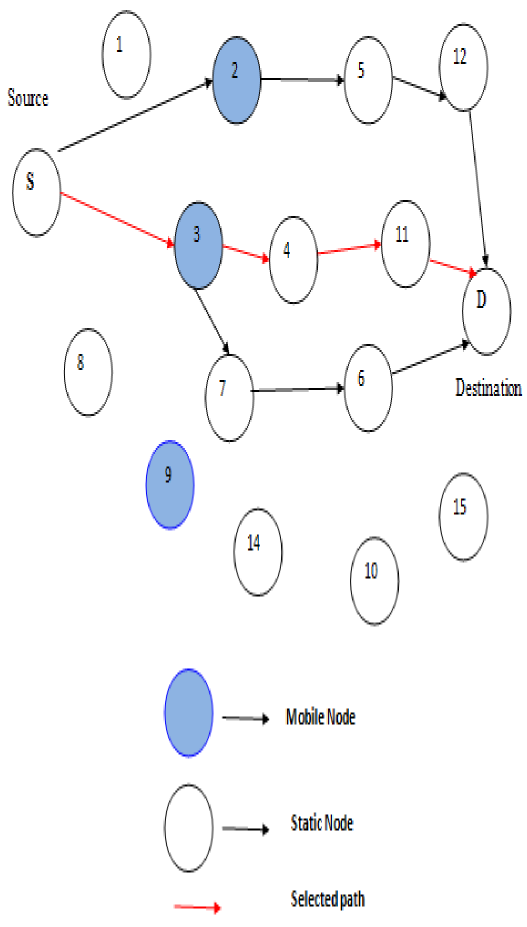

Figure 1 Network Architecture

Figure 1 presents the network architecture considered in this work. It consists of static and mobile nodes scenario. In Figure 1, N_2, N_3 and N_9 are mobile nodes whereas other nodes are static. S and D denote source and destination nodes. S transmits the data to D through the following established path:

$$S \xrightarrow{data\_packet} N_3 \text{->} N_4 \text{->} N_{11} \text{->} D$$

3.3 Priority of Contending nodes

Initially, each contending nodes are assigned priority depending on the residual energy of node, queue size of node and the service id of the requested traffic type.

The queue size of each intermediate node is estimated from its queue length. The residual energy of a node after transmitting data can be computed by subtracting the energy consumption from the initial assigned energy. The service id (S_{ri}) of real-time Video, VoIP and non real-time Best effort (BE) services are, namely 1, 2 and 3.

Let CN_1, CN_2,.....CN_m be the number of contenders for transmission, during the contention period.

Let S_j, E_{resj} and S_{rj} be the queue size, residual energy and service id of the node CN_j.

Then the priority P_j of CN_j is given by

$$P_j = (\alpha . Q_j + \beta . E_{resj}) / Sr_j \quad (1)$$

Where α and β are weighted constants.

The priority of node is assigned in such way that the nodes having higher load and residual energy with high service traffic gets higher priority and so on.

3.4 Determination of Residence time for Mobile Nodes

When a node N_1 enters into the neighborhood of another node N_j, it estimates the residence time of N_1.

The residence time of N_1 at a node N_j can be given by

$$T_D(N) = \begin{cases} \frac{R+r}{v}, | D = D+ \\ \frac{R-r}{v}, | D = D- \end{cases} \quad (2)$$

Where R is the transmission range of N_j

r is the distance between N_1 and N_j

v is the average velocity of N_1

D is the moving direction of N_1

D+ indicates the direction towards N_j

D- indicates the direction away from N_j

Depending on the value of residence time, the nodes with low and high residence time values are categorized into level 1 and 2, respectively. Let i is the level number of the node.

t is the backoff time

k is the backoff counter

bt be the backoff timer

bc be the back off counter

(k+r) be the retransmission limit of packet

CW_{min} and CW_{max} denote the minimum and maximum size of CW such that

$$(0 \leq CW_{min} \leq CW \leq CW_{max})$$

Then the CW of a mobile node with level i at backoff time t is defined as:

$$CW_i(bt) = \begin{cases} CW_{\min(i)}(bt); bt = 0 \\ 2^{bt}.CW_{\min(i)}(bt); 1 \leq bt \leq k \\ CW_{\max(i)}(bt); k \leq bt \leq (k+r) \end{cases} \quad (3)$$

3.5 Adaptive Backoff Algorithm

The enhanced adaptive backoff procedure is altered from the standard BEB procedure in which the rate of CW is adaptively allotted depending on the category of the nodule. The BEB algorithm in the MAC layer is modified as follows.

Let CW_i be the initial contention window of node N_i

Let S denotes a static node and M denotes a mobile node.

The adaptive back-off algorithm is given below:

Algorithm

If type(N_i) =M , then
  Estimate CW_i of node N_i using (3)
Else
  Estimate CW_i as per BEB algorithm
End if
Estimate the priority P_i of node N_i using (1)
If collision occurs, then
// Adaptive CW adjustment
  $CW_i = CW_i + P_j$, NCC
End if
// Modified BO
  If $CW_i > CW_{th}$
    $CW_i = Max(CW_i/2 , CW_{th})$
  Else
    $CW_i = Max(CW_i/2. CW_{min})$
  End if
Else
  $CW_i = Min(2 .Max(CW_i, CW_{th}),CW_{max})$
End if

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4. Experimental Results

4.1 Experimental Settings

The proposed OABA is simulated in NS2 and compared with the Mobility-aware timeout E-BEB protocol [10] in terms of the metrics end-to-end Delay (E2D), packet Delivery Ratio (PDR), packets dropped and energy consumption. The experimental settings are shown in Table 1.

Table 1 Experimental Settings

Number of Nodes	100
Size of the topology	1500 X 300m
Pause time of the node	5 to 25 seconds
MAC Protocol	IEEE 802.11
Traffic type	CBR
Data flows	2,4,6,8 and 10
Propagation Type	Two Ray Ground
Antenna Type	Omni Antenna
Initial Energy	10 Joules
Transmission Power	0.8 watts
Receiving Power	0.5 watts

A. Varying the Data Flows

In order to analyze the effect of contention, this section presents the results of varying the data flows from 2 to 10 for pause time 5 seconds.

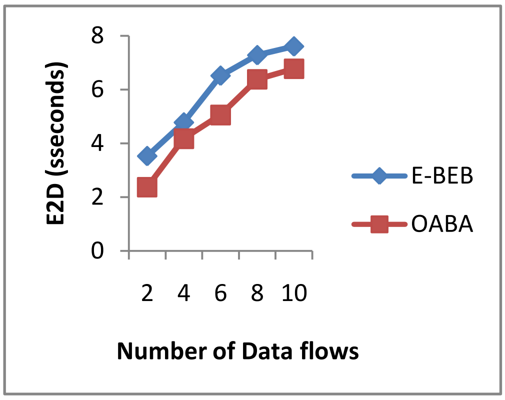

Figure 2 Delay Vs Data flows

Figure 2 shows the results of delay for increasing the data flows from 2 to 10. From the figure, it can be observed that OABA has delay from 2.3 to 6.7 seconds whereas E-BEB has delay from 3.5 to 7.6 seconds. Hence OABA achieves 18% lesser delay then E-BEB.

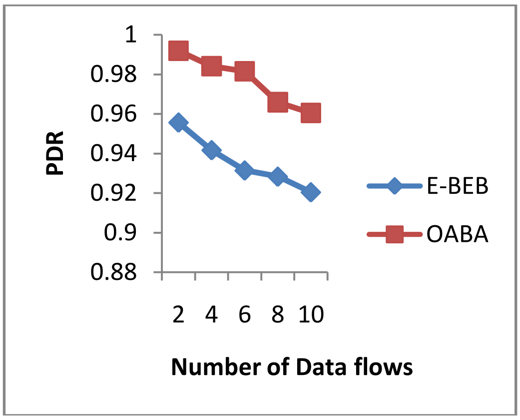

Figure 3 Delivery ratio Vs Data Flows

Figure 3 shows the results of packet delivery ratio for increasing the data flows from 2 to 10. From the figure, it can be observed that OABA has delivery ratio from 0.99 to 0.96 whereas E-BEB has delivery ratio from 0.95 to 0.92. Hence OABA achieves 4% higher delivery ratio then E-BEB.

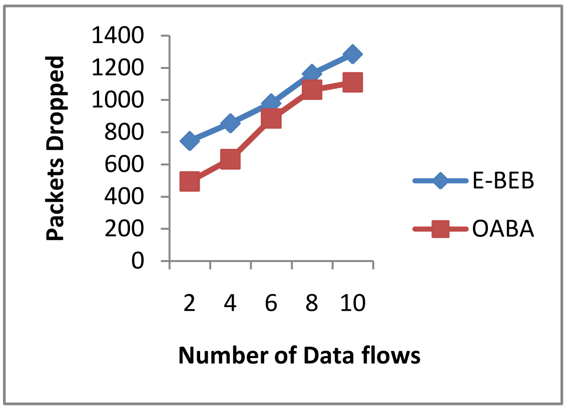

Figure 4 Packets drop Vs Data flows

Figure 4 shows the results of packet drop for increasing the data flows from 2 to 10. From the figure, it can be observed that OABA has packet drop from 493 to 1108 whereas E-BEB has packet drop from 745 to 1284. Hence OABA achieves 18% lesser drop then E-BEB.

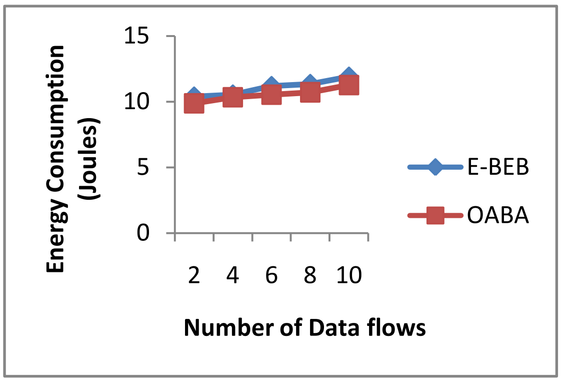

Figure 5 Energy consumption Vs Data flows

Figure 5 shows the results of energy consumption for increasing the data flows from 2 to 10. From the figure, it can be observed that OABA has consumed 9.8 to 11.2 joules whereas E-BEB has consumed from 10.3 to 11.8 joules. Hence OABA achieves 4.6% lesser enefy consumption then E-BEB.

B. Varying the Pause Time

In order to analyze the effect of node mobility, this section presents the results of varying the pause time from 5 to 25 seconds for 10 data flows.

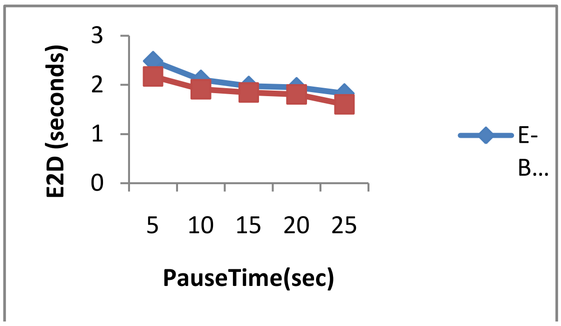

Figure 6 Delay Vs Pause time

Figure 6 shows the results of delay for increasing the pause time from 5 to 25 seconds. From the figure, it can be observed that OABA has reduced delay from 2.1 to 1.6 seconds whereas E-BEB has reduced delay from 2.4 to 1.8 seconds. Hence OABA achieves 9.6% lesser delay then E-BEB.

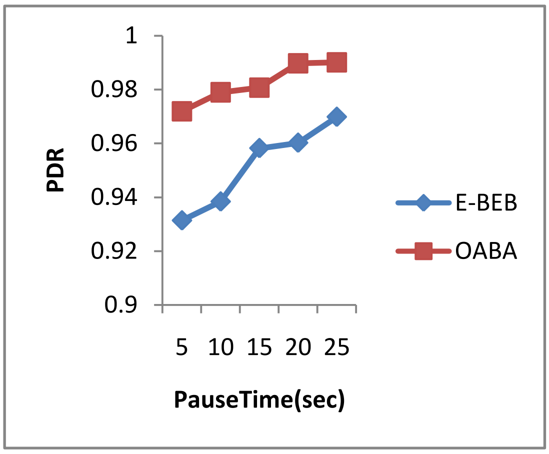

Figure 7 Delivery ratio Vs Pause time

Figure 7 shows the results of packet delivery ratio for increasing the pause time from 5 to 25 seconds. From the figure, it can be observed that OABA has delivery ratio from 0.97 to 0.99 whereas E-BEB has delivery ratio from 0.93 to 0.96. Hence OABA achieves 3% higher delivery ratio then E-BEB.

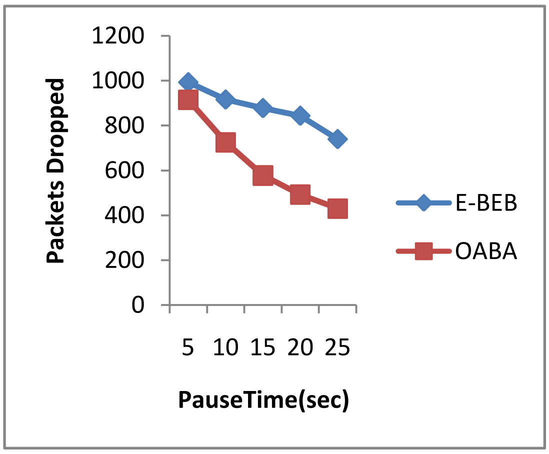

Figure 8 Packet drop Vs Pause time

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Figure 8 shows the results of packet drop for increasing the pause time from 5 to 25 seconds. From the figure, it can be observed that OABA has reduced packet drop from 914 to 430 whereas E-BEB has reduced packet drop from 992 to 739. Hence OABA achieves 29% lesser drop then E-BEB.

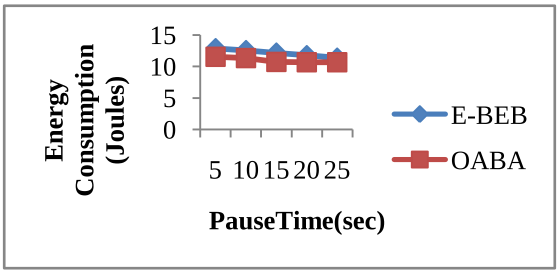

Figure 9 Energy consumption Vs Pause time

Figure 5 shows the results of energy consumption for increasing the pause time from 5 to 25 seconds. From the figure, it can be observed that OABA has consumed 11.5 to 10.6 joules whereas E-BEB has consumed 12.8 to 11.3 joules. Hence OABA achieves 9.6% lesser enefy consumption then E-BEB.

III. CONCLUSION

In this paper, an Optimized Adaptive Backoff Algorithm (OABA) is proposed for static and mobile WANET. In this algorithm, during the back off stage, the type of node is determined as static or mobile. For mobile nodes, their residence time is determined in addition to their priority. Then optimized adaptive backoff algorithm is applied, by checking the type of node. The proposed OABA is simulated in NS2 and compared with the E-BEB algorithm. Simulation results have shown that OABA achieves higher packet delivery ratio with minimized delay, packet drop and energy consumption.

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