A Performance Comparison of Different Backoff Algorithms under Different Rebroadcast Probabilities for MANET's

M. Bani Yassein , S. Manaseer, A. Al-Turani
Department of Computer Science, Jordan University of Science and Technology

E-mail: {masadeh@just.edu.jo, saher@dcs.gla.ac.uk, traini2001@yahoo.com }

Abstract

The backoff algorithm is a part of Media Access Control (MAC) protocol which used to avoid collision in the Mobile Ad hoc Network (MANET). When the nodes in the network try to access the channel, one of these nodes gains access the channel while the other nodes still contend for a time period. Many backoff algorithms have been proposed to improve network performance. One of these algorithms is Fibonacci increment backoff (FIB), FIB algorithm achieves higher throughput than the exponential backoff that is used by the standard IEEE 802.11 when it used in a mobile ad hoc network. The Pessimistic Linear-exponential Backoff (PLEB) is another proposed backoff algorithm which uses a combination of two increment behaviors; Exponential backoff and Linear backoff this scheme merges the advantages of the two increment behaviors. Exponential increments give enough backoff time to enhance the network throughput by reducing the number of transmission failures, and the linear increment reduces the average packet delay. Ad hoc On demand Distance Vector (AODV) routing protocol use a demand-driven route establishment procedure. AODV maintain the route table at each node. This paper uses different backoff algorithms at different values of rebroadcast probability.

Keywords: Fibonacci Increment Backoff, AODV, MAC, Throughput packet delay.

1 Introduction

A MANET is a set of wireless nodes which communicate with each other directly without relaying [1]. Rebroadcasting in the wireless network means transmitting packet by a node to all nodes in the transmission radius [2]. This model is called on-to–all model [2]. In this model since every node rebroadcasts the message received to all nodes this causes increasing in the collision in the network which generate a "broadcast storm problem" [2]. This problem seriously affects the network performance.
IEEE 802.11 MAC is a sub-layer of Data Link Control (DLC) layer determined in seven layer Open system Interconnection (OSI) model [2]. The main functions provided by MAC are channel access, multiple-access and addressing. The channel access method used is called Carrier Sense Multiple Access with collision Avoidance (CSMA/CA) [4]. A part of the MAC protocol is the backoff algorithm. Backoff is a mechanism used to avoid collisions in mobile ad hoc networks. Collision is avoided by requiring the node to wait for a time called Backoff time before trying to access the channel after a transmission failure [4].

Many backoff mechanisms has been suggested [4] such as linear backoff, exponential backoff, PLEB and FIB. Fibonacci increment backoff algorithm achieves higher throughput than the exponential backoff when it used in a mobile ad hoc network, FIB use a Fibonacci math series to the reduce the increment of contention window size. This algorithm increases the performance of MANET significantly when the network size is large [5]. PLEB algorithm increase the contention window size exponentially which gives a long waiting time before making a new attempt to access the channel, after a number of increments the waiting time starts to increase linearly instead of the exponential increment. PLEB introduces significant improvement of network performance when it used for a medium size (e.g. 50 nodes) and medium speed (e.g. 4 m/s) [5].

Mobile ad hoc network is a self-configuration network of wireless mobile nodes, the movement of nodes through the network results different topologies and changes the routes dynamically which require some mechanism to determine new routs. Several routing protocols have been proposed for mobile ad hoc network [2]. Dynamic Source Routing (DSR) protocol based on on-demand route discovery determines the proper rout only when a packet needs to be forwarded. The node floods the network with a route-request and builds the required route from the responses it receives. DSR allows the network to be completely self-configuring without the need for any existing network infrastructure or administration [1]. AODV routing protocol uses a demand-driven route establishment procedure. AODV maintain the route table at each node, the rout table contains the next hope node, hop count and a sequence number. Another routing protocol called TORA (Temporally-Ordered Routing Algorithm). TORA is designed to minimize reaction to topological changes by localizing routing-related messages to a small set of nodes near the change [2].

The rest of this paper is structured as follows. Section 2 discusses related work. Section 3 presents the simulation model and the parameters used in the experiments. Section 4 concludes the results.

2 Related work

M. Bani Yassein , Mould Khoua, L.M.Mackenzie and S Papanastasiou in [3] have suggested probabilistic flooding to reduce redundant rebroadcast messages then reduce the effect of broadcast storm problem. In this scheme when the node receives the message for the first time, the node rebroadcasts the message with a pre-determine probability P. the probability may be fixed or variable, every node in the network has the same probability. The probabilistic flooding has been affected by many factors such as network density, mobility speed and traffic load. This paper concentrates on the affects of network density on the probabilistic flooding which directly affects the network performance. The network density is determined by the number of nodes by the area of the network. In [4], Saher S Manaseer, Mohamed Ould-Khaoua and Lewis M Mackenzie proposed FIB. This algorithm achieves higher throughput compared to the standard IEEE MAC when it used in the ad hoc network.

In FIB, the differences between simultaneous contention window sizes are reduced by using a famous math series called Fibonacci series which defined by:

$$F_n = F_{n-1} + F_{n-2} \text{ where } F_0=0 \text{ and } F_1=1$$

The algorithm of Fibonacci Backoff shown in figure 1.

```
Step 0: Set BO to initial value
Step 1: While Bo≠0 do
            For each time slot
                  If channel is idle then BO=BO-1
            If channel is idle for more than IDFS then
                  Send
            Else
        BO i + 1 = fib (i) // where       in PLEB, CW= CW*2
                  GO to step 1
        Stop
```

Figure 1: Pseudo code of FIB Algorithm.

In [5] Manaseer and Masaadeh proposed PLEB to be use with the IEEE 802.11 Distribution Coordination Function (DCF). According to the PLEB mechanism uses a combination of exponential and linear increment backoffs, which merge the advantages of the two increment behavior.

3 Simulation

This paper uses NS 2.3 Network simulator. The standard MAC protocol has been changed to implement the modified backoff algorithms. The routing protocol used is AODV protocol by taking different values of probability of rebroadcast the messages P, every node in the network has the same probability of rebroadcast the messages. The values of rebroadcast probability are taken as P_{fixed} , P_2, P_3 and P_4.

This paper vary the network density by changing the number of nodes in the network by 50, 75 and 100 nodes in a fixed area, and take 10 scenarios and each scenario uses one of the probabilities with a significant number of nodes and repeat the experiment 10 times. In each experiment the performance of the MANET is measured in terms of throughput and average packet delay. Table 1 summarized the simulation parameters.

Parameter	**value**
Simulation time	900 seconds
Pause time	0 seconds
Packet size	512 byte
Area	500 ×500 m²
Number of node	50,75,100
Speed	2 m/s
Probability of rebroadcast (P_{fixed},P_2,P_3,P_4)	(0.7, 0.35, 0.25, 0.15)

Table 1: Simulation Parameters

Figure 2 depicts the average End-End delay level of FIB and PLEB algorithms at a network of Rebroadcast probability P_{fixed}, P_2, P_3 and P_4 for a number of node is 50 nodes. As seen in this figure for 50 nodes network the minimum packet delay can achieve by using PLEB algorithm at P_4 Rebroadcast probability, the worst case is using PLEB at P_{fixed} and there is no difference between PLEB and FIB at probabilities P_2 and P3. Figure 3 represents the packet delay for 75 nodes we get the best delay by using FIB at P_4 rebroadcast probability, by using PLEB algorithm with this number of nodes the packet delay decrease as the probability of rebroadcast decrease where $P_{fixed} > P_2 > P_3 > P_4$.

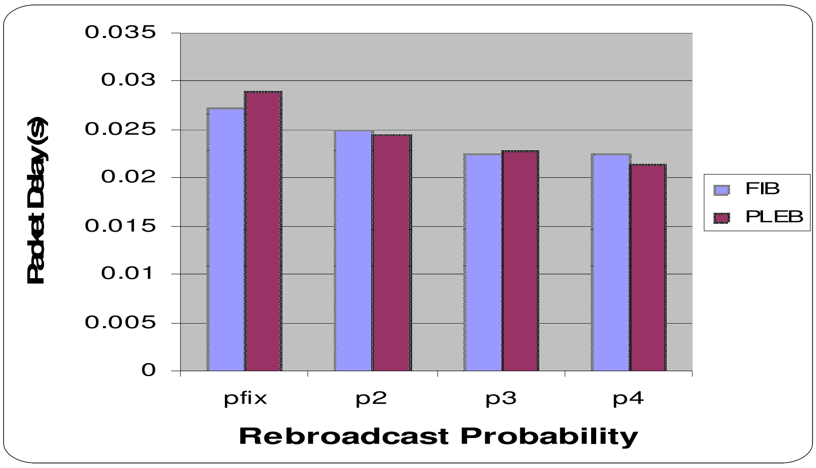

Figure 2: Rebroadcast probability vs. Network average End-End delay in FIB and PLEB for 50 nodes.

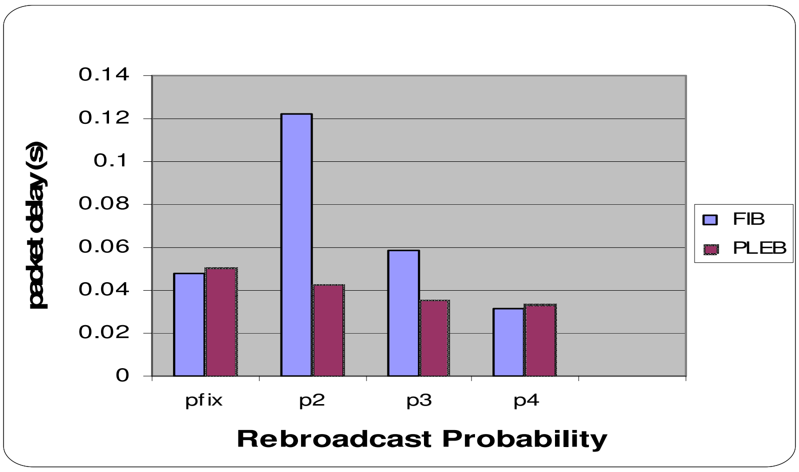

Figure 3: Rebroadcast probability vs. Network average End-End delay in FIB and PLEB for 75 nodes.

The same observations are made for networks with 100 nodes. These are presented in figure 4. in addition of a small gap between PLEB and FIB at all rebroadcast probability.

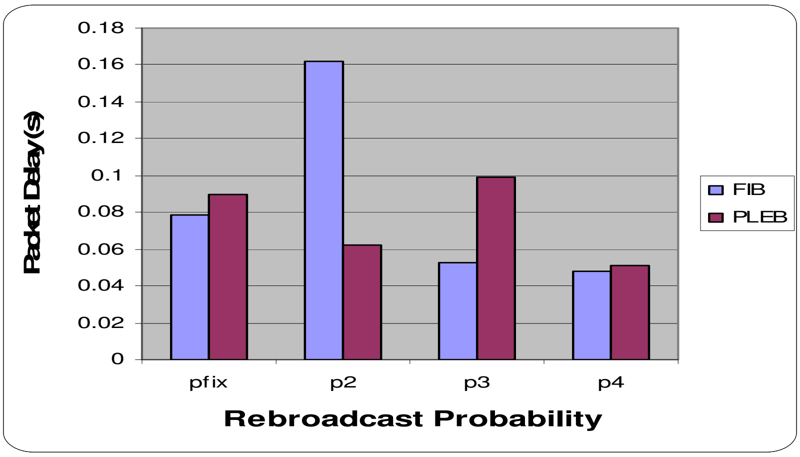

Figure 4: Rebroadcast probability vs. Network average End-End delay in FIB and PLEB for 100 nodes.

Figures 5, 6 and 7 represent the rebroadcast probability versus the routing packets in FIB and PLEB for number of nodes 50, 75 and 100 nodes simultaneously.

As shown in Figure 5, for 50 nodes, PLEB at P_{fixed} achieves higher routing packets level. However, as the rebroadcast probability decreases, PLEB and FIB routing packets decreases, because of increasing of the number of failure packets when the probability of rebroadcast packet decreasing.

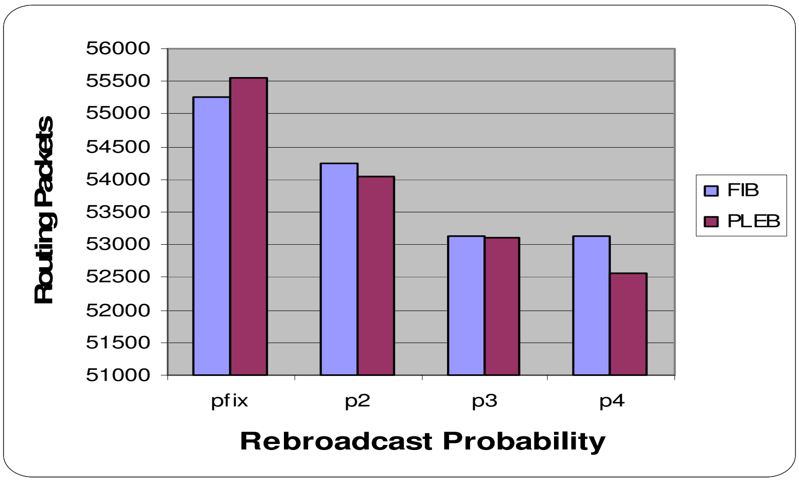

Figure 5: Rebroadcast probability vs. Network Routing packets in FIB and PLEB for 50 nodes.

Figure 6 represent the routing packet for 75 nodes FIB algorithm gives good values at P_2 , P_3 and P_4. but PLEB at P_{fixed} gives the better value of routing packet and the worst case is using PLEB at P_4 which gives minimum network routing packets. As shown in this figure the routing packet decreases as the rebroadcast probability decrease.

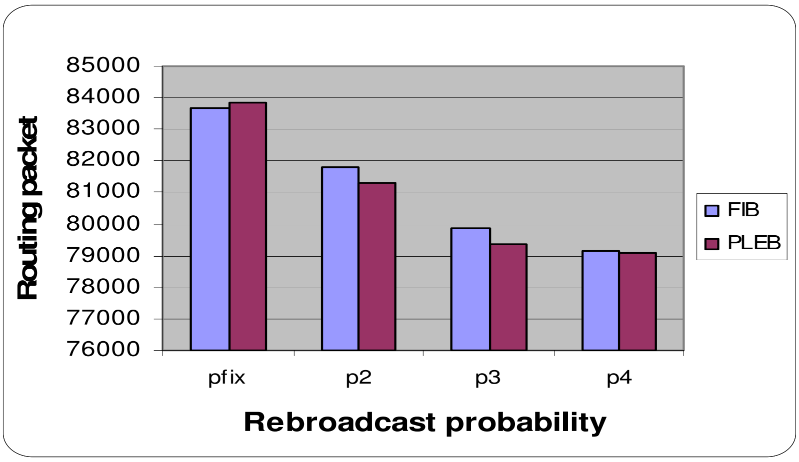

Figure 6: Rebroadcast probability vs. Network Routing packets in FIB and PLEB for 75 nodes.

The last figure for this network, figure 7. does not show any difference behavior for the previous figure.

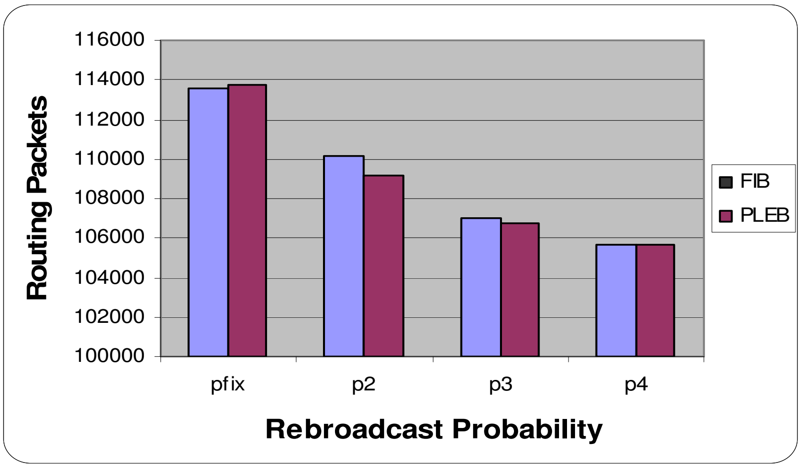

Figure 7: Rebroadcast probability vs. Network Routing packets in FIB and PLEB for 100 nodes.

4 Conclusions

In this paper, new scenarios have been suggested to compare the performance of Mobile Ad hoc Network (MANET) by using different backoff algorithms; Fibonacci Increment Backoff (FIB) and Pessimistic Linear-exponential Backoff (PLEB) at different values of rebroadcast probability. The network density has been changed by increasing the number of nodes in a fixed area.

After a deep study and analysis of the simulation results, it has been shown that using FIB algorithm at P_4 rebroadcast probability give the best network performance for number of nodes 75 and 100 nodes, where it produces shorter End-End packet delay and largest network routing packets. For the network of 50 nodes PLEB algorithm gives lower delay but lower routing delay in other cases, P_{fixed} gives maximum delay and routing packets. Therefore, by using FIB algorithm at rebroadcast probability P_3, the End-End packet delay and the network routing packets take a medium values. The best choice for 50 nodes network is using FIB algorithm at rebroadcast probability P_3.

References

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