A New-Mac Protocol for Mobile Ad-Hoc Networks

Jyoti Shekhawat
Department of Computer Science & Engineering
World College of Technology & Management
Haryana, India
E-mail: jyotis136@gmail.com

Stuti Gupta
Department of Computer Science & Engineering
World College of Technology & Management
Haryana, India
E-mail: stuti.gupta09@gmail.com

Abstract: In Mobile Ad-hoc networks, the basic 802.11 Media Access Control (MAC) protocol uses the distributed coordination function (DCF) to share the medium between multiple devices. But uses of MAC protocol in Ad-hoc network affected by various issues such as limited power capacity, packet losses due to transmission errors, lot of control traffic and inability to avoid packet collision. To resolve these issues many protocols have been developed. But we have not found any efficient protocol which can solve the power management, packet collision and packet loss issues efficiently. In this paper, we propose a new protocol that adjusts the upper and lower bounds of the contention window to reduce the number of collisions. It also uses a power control scheme, triggered by the MAC layer to limit the packet loss, energy wastage and decrease the number of collisions. The proposed protocol “New-MAC” has implemented and its performance is compared with existing 802.11 MAC protocol. This paper shows calculated the packet delivery fraction, average (e-e) delay, and average throughput and packet losses in various situations. We found our proposed protocol is fairly better than the existing protocol.

Keywords: - Mobile Ad-hoc network, MAC protocol, power control scheme, contention window

I. INTRODUCTION

The Medium Access Control (MAC) Layer [12] is one among the two sublayers that form up the Data Link Layer of the Open Systems Interconnect (OSI) model. The MAC layer is answerable for moving information packets from one Network Interface Card (NIC) to a different NIC across shared channel. The MAC sublayer uses MAC protocols to confirm that signals sent from completely different stations across a similar channel do not collide.

The distributed coordination function (DCF) is an element of the IEEE 802.11 standard which relies on the CSMA/CA mechanism. Within the DCF mechanism a Contention Window (CW) is employed by a node so as to regulate the back-off window. Every node pick indiscriminately a contention slot from the [0, CW] interval. In every retransmission the CW is doubled by the Binary Exponential Back-off (BEB) algorithmic rule. As the amount of active neighbours increase, the amount of collisions also increases. When the CW is doubled, there is a continuous likelihood that competitive nodes selects an equivalent rivalry slots, as a result of the edge of the CW continuously tends to zero. The adjustment of the bound doesn’t take care about the network load or channel conditions. This offers rise to unessential collisions, in consequence with the retransmissions of a packet that results in loss of energy and a shorter lifespan of the network (only applicable when nodes are battery powered). On the opposite hand, once a transmission is booming or a packet is born, the bound of the CW is reset to the static minimum CW (CWmin and CWmax are fastened within the 802.11 DCF freelance of the environment). However, receiving a packet with success doesn’t say anything regarding the competition level while choosing a convenient CW worth. It’s not known in a better way whether the competition level is born or not. Just like in case of a born packet, this assumption also holds a lot of uncertainty. The optimum minimum worth of the CW depends closely on the amount of competitive nodes active within the network. As a result, DCF will neither consider the network load nor the remaining energy offer any chance for prioritizing, there are many approaches planned that do take consideration of the conditions and offer enough flexibility to be able to placed.

II. LITERATURE SURVEY

Primary fundamental task of the MAC protocol is to avoid collisions from interfering nodes. The MAC sublayer uses MAC protocol to ensure that signals sent from different stations across the same channel does not collide. There are many MAC protocols that have been developed for Mobile Voice and Data Communication networks. MAC protocols are of two types-

1. Scheduled based protocols (TDMA, FDMA, CDMA etc.)
2. Contention based protocols (IEEE 802.11, CSMA etc.)

Due to much packet loss and energy wastage, none of the above mentioned protocols are suitable for Ad-hoc network and WSN. Therefore it is very much clear that there is a need of different MAC protocols for Ad-hoc network and WSN. Before discussing about the MAC protocols for Ad-hoc network and WSN, put a glance at the most important source of energy wastage in the existing MAC protocols [10]. The first one is collision. Once a transmitted packet is corrupted, it has to be discarded and follow-on re-transmissions that increase energy consumption. Collision will increase latency as well. The secondary source is overhearing, which means that a node picks up packets that are destined to different nodes. The third source is control packet overhead (Sending and receiving control packets consume energy too). The last major source of inefficiency is idle listening, i.e., listening to receive possible traffic that has not been sent. This is often true in several sensor network applications. If nothing is sensed, nodes are in idle mode for most of the time. However, in several MAC protocols like IEEE 802.11 Ad-hoc mode or CDMA nodes have to listen to the channel to receive possible traffic. Measurements have shown that idle listening consumes 50–100% of the energy required for receiving. For example, Stecm and Katz measure that the idle: receive: send ratios are 1:1.05:1.4 [25], whereas the Digital Wireless LAN module (IEEE 802.11/2 Mb/s) Specification shows idle: receive: send ratios is 1:2.25 [26]. Most sensor networks are designed to control for long time and nodes are in idle state for a longer time. Thus, idle listening could be a dominant issue of energy wastage in such cases.

III. PROPOSED SOLUTION

The goal of the NEW-MAC protocol is to save energy (which leads to an extension of the period of time of nodes) and to reduce the amount of collisions. However, the NEW-MAC protocol doesn't degrade the throughput performance and fairness in terms of the throughput and sending rate, while fulfilling these goals.

We use an enhanced selection bounds (ESB) algorithm to flexible adjustment of the upper and lower bounds of contention window for minimizing the number of collisions. Also, we use the power control recovery and enhanced power control-dropped packet scheme to limit the waste of energy. The following algorithm used for improve the performance of MAC protocols:

1. Algorithm (ESB Algorithm)
(2) Algorithm (Power Control–Recovery Part)

(3) Algorithm (Enhanced Power Control-Dropped Packet Scheme)

IV. IMPLEMENTATION AND RESULTS

In this paper, we used NS-2 to simulate proposed protocol. The data rate of mobile hosts is set to a similar value: 2 Mbps. The active mobile nodes 30, 40, 50 and 60 are move in 1000 x 1000 meter rectangular region for a thousand seconds simulation time. Initial locations and movements of the nodes are obtained using the random way point model of NS-2. There is a common tendency to assume every node moves independently with a similar average speed. All nodes have an equivalent transmission range of 250 meters. The following factors are calculated according to the table 4.1:-

(a) Packet Delivery Fraction (PDF)
(b) Average (e-e) Delay
(c) Average Throughput
(d) Packet Loss

In Figure 4.1, the performance of MAC protocol has been compared based on the ratio of the number of delivered data packets to the destination. The result clearly shows that NEW-MAC is better than other MAC protocols.

**Average (e-e) Delay:-**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Number of Nodes</th>
<th>Protocol Name</th>
<th>NEW-MAC</th>
<th>802.11 MAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>79.72</td>
<td>84.67</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>97.39</td>
<td>105.79</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>615.81</td>
<td>610.19</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>60</td>
<td>608.26</td>
<td>653.87</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>70</td>
<td>671.29</td>
<td>703.32</td>
<td></td>
</tr>
</tbody>
</table>

**Table 4.3** Comparison on Average (e-e) Delay

Similarly, Figure 6.2 shows the performance of MAC protocols based on the Average (e-e) Delay. The X-Axis notes the number of nodes and Y-Axis shows the average (e-e) delay.

**Average Throughput:-**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Number of Nodes</th>
<th>Protocol Name</th>
<th>NEW-MAC</th>
<th>802.11 MAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>72.15</td>
<td>70.29</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>75.52</td>
<td>73.11</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>84.45</td>
<td>80.13</td>
<td></td>
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<tr>
<td>4</td>
<td>60</td>
<td>87.82</td>
<td>85.61</td>
<td></td>
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<tr>
<td>5</td>
<td>70</td>
<td>91.35</td>
<td>86.23</td>
<td></td>
</tr>
</tbody>
</table>

**Table 4.4** Comparison on Average Throughput

**Figure 4.2** Comparison of MAC Protocol based on Average (e-e) Delay

**Figure 4.3** Comparison of MAC protocol based on Average Throughput

Figure 4.3 shows the performance of MAC protocols that is depends on the Average Throughput.

**Packet Loss:-**
The above results show that the NEW-MAC protocol much better than the MAC 802.11 protocol.

V. CONCLUSIN AND FUTURE WORK

In this paper, we proposed and implemented an NEW-MAC protocol to handle the limited power and packet loss issues of existing MAC protocol. We implemented an enhanced selection bounds (ESB) algorithm to flexible adjustment of the upper and lower bounds of contention window for minimizing the number of collisions. Also, we used power control recovery and enhanced power control-dropped packet scheme to limit the waste of energy. To evaluate the performance of proposed protocol, we have measured the packet delivery fraction, average (-e) delay, average throughput and packet losses in various situations. We found our proposed protocol is fairly better than the existing protocol.

The proposed protocol works well for small size networks. We found that the increase in network size increases packet loss and average throughput decreases. For further work efforts are needed to minimize the packet loss for large size networks.

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