Open and Association MCTAs Access and Allocation Scheme by Staggering Algorithm in IEEE 802.15.3

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Abstract. The IEEE 802.15.3 medium access control (MAC) protocol is standard for high bit rate wireless personal area network (WPAN). The open or association management channel time allocations (MCTAs) are used by devices (DEVs) for sending command messages or association request command to piconet coordinator (PNC) by means of slotted aloha random access manner. Based on slotted aloha scheme the binary back-off algorithm has been considered as a primary contention resolution candidate due to its simple operation. However it is not appropriate for the future wireless networks because of low throughput and high delay and delay variance. Without loss of generality the goals of the random multiple access algorithm are to maximize the throughput and to minimize the average packet delay. In this paper, we propose a new multiple access protocol named staggering algorithm working on top of slotted aloha scheme. The performance results by NS-2 simulation show that the proposed algorithm achieves the maximum throughput up to 0.54 and guarantees the QoS in terms of delay and delay variance of realtime multimedia traffic.

1 Introduction

IEEE 802.15.3 working group [1] is working on technologies targeted at enabling high bit rate multimedia applications operating in WPAN. These technologies include both MAC and PHY protocols that enable WPAN to support up to 243 DEVs operating at least 20Mb/s [2]. IEEE 802.15.3 piconet is a wireless ad hoc data communications system which allows a number of independent data DEVs to communicate with each other. To provide multimedia QoS, a TDMA-based superframe structure is adopted. The superframe is composed of three major parts: the beacon, the optional contention access period (CAP) and the channel.
time allocation period (CTAP), as shown in Figure 1. Any DEV associated in the piconet may attempt to send a command frame to the PNC in an open MCTA. Any DEV not currently associated in the piconet also may attempt to send an association request command to the PNC in an association MCTA. It is the PNC’s responsibility to determine the number of MCTAs to use for each superframe. It is desirable that the number of MCTAs is dynamically adapted by the PNC depending on the current traffic conditions. As a random access scheme slotted aloha was proposed for an open MCTA or an association MCTA in [2]. However, this mechanism in line with the exponential back-off algorithm for a collision resolution has been challenged by some prior works in order to enhance realtime multimedia traffic access efficiently in terms of throughput, delay, and delay variance[4-6]. In this paper, we propose a new open and association MCTAs access and allocation scheme named staggering algorithm to deal with collision resolution which is inevitable in random access environment such as slotted aloha scheme. NS-2 simulation results show that the proposed scheme provides lower mean delay/delay variation and higher throughput than previous schemes. The throughput of the proposed scheme is remarkably increased up to 0.54.

This paper is organized as follows: Section 2 provides slotted aloha access scheme for open and association MCTAs followed by a description of previous proposed schemes. Section 3 describes the proposed scheme. We present simulation results in section 4. Section 5 concludes the paper.

<table>
<thead>
<tr>
<th>Beacon</th>
<th>Optional Contention Access Period</th>
<th>Channel Time Allocation Period (CTAP)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Management CTA</td>
<td>Guaranteed CTA</td>
</tr>
</tbody>
</table>

Fig. 1. Superframe structure

2 Related Works

2.1 Slotted Aloha Access for Open and Association MCTAs [2]

The access to an open or association MCTA shall be controlled by a contention window $CW_a$ maintained by each DEV. Each DEV decides $CW_a$ by the number $a$, where $a$ is the number of retransmission attempts made by the DEV. For the first access attempt, $a$ shall be set to zero. The size of the contention window, $CW_a$ is defined as follows,

$$CW_a = \begin{cases} 256 & 2^{a+1} \geq 256 \\ 2^{a+1} & 2^{a+1} < 256 \end{cases}$$

(1)