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Performance Analysis of ALOHA Framework under Limited Access of Data Transmission for Active RFID System

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Abstract

The data collision of multiple tags to access the channel is one of the most problems in active Radio Frequency Identification (RFID). The technique of random tag is based on William Feller equation by considering the successful probability (Psuc) may affect to increase the data collision if the tag is not limited the privilege. This paper proposes the modification of William Feller equation by dividing the privilege of tags into several groups. The results show that our scheme can provide the better performances as comparing with William Feller equation in term of successful probability. The maximum average of successful probability is more than 0.97.

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Keywords: active RFID, Slot, William Feller

1. Introduction

Radio Frequency Identification (RFID) [1] is the object identification system by using the radio frequency for the communication between the transmitter and receiver. In this system, the object surface is holded on the tag to communicate with the reader of RFID if the tag is in the radius of the radio frequency.Then, the data of tag will be record. Generally, There is one of the most problems of RFID if we have multiple tags access to a reader as the same time. The data collission can be occured. Therefore, several researchers have been proposed the protocol in order to avoid the data collisions. The ALOHA algorithm [2] is a basically method that prevents the collision of data based on Time Division Multiple Access (TDMA). There are three flavors of original ALOHA algorithm such as ALOHA, Slotted ALOHA [3] and Frame Slotted ALOHA [4]. Frame Slotted ALOHA (ISO/IEC1800-7)[5] is one protocol that developed from ALOHA. This method considers the concept of time division of sending tag for each frame called time slot and uses the random technique for accessing the slot of each frame. Usually, the random

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technique by the probability equation analysis of William Feller (Psuc) is a well-know technique which uses the tag to access the time slot of one frame only. In this concept, the collision of data may be increased due to the serveral tags may access the time slot as the same time, there are the chance of the collission.

In this paper, we present the concept of considering the frame slot into 2 sets and limiting the privilege to access the tag in the slot into **2**sets. The first set is the random for accessing overall slots and the second set is the random access for only half slot of frame. Both sets will consider the probability of sending success data based on William Feller and the both sets can random the tag with the different size freely by considering the performance analysis of each size of each frame and to find the appropriate of frame for transmitting the data of active RFID. This technique may improve the better performance of accessing the time slot of active RFID.

2. William Feller Equation Analysis

In order to analyze the probability of William Feller equation, we consider the successful probability. We suppose that *P* means the probability of sending data successfully in case of solving the collision in system and *C* that means the probability of event. *M* is the slot while sending the data successfully and *V* that means the slot of sending the request. The probability of transmitting success data can be expressed as

$$P_s(c|m,V) = \frac{(-1)^c V!m!}{V^m c!} \sum_{j=c}^{Min(m,V)} \frac{(-1)^j (V-j)^{m-j}}{(j-c)!(m-j)!(V-j)!} \tag{1}$$

where $0 \le c \le Min(m,V)$

We consider the probability of $P_{in}(m)$ from the slot *n* to *m* as sending the request to continue

$$P_m(m) = \binom{n}{m} p^m (1-p)^{n-m} \tag{2}$$

Where $S(n,m)$ is the request for accessing the slot in case of transmitting data

$$S(m,V) = J \cdot \sum_{c=1}^{Min(m,V)} c \cdot P_s(c \mid m,V) \tag{3}$$

group will access the slot more than the second group approximately 2 or it can access random slot between 1 slot to slot of $\frac{3}{2M}$

We can compute the probability by given

$$P\left\{a_1, a_2, ..., \frac{a_2 M}{3}\right\} = \frac{(N/2)!}{a_1!a_2!...a_{\frac{2M!}{3}}} \cdot \frac{(2M/3)!}{b_1!b_2!...b_{\frac{2M!}{3}}} p^{a_1} p^{a_2} ... p^{a_{\frac{2M}{3}}} \tag{4}$$

Where $p(a_i)$ of this group has the value equal $\frac{3}{2M}$. Thus, $p^{a_1} p^{a_2} ... p^{a_{\frac{2M}{3}}}$ can be obtained the value of $(\frac{3}{2M})^{N/2}$. The second group can random the slot of $\frac{2M}{3}+1$ until to *M* slot, the calculation of probability is given by

$$P\left\{a_{\frac{2M}{3}+1}, a_{\frac{2M}{3}+2}, ...a_M\right\} = \frac{(N/2)!}{a_{\frac{2M}{3}+1}!a_{\frac{2M}{3}+2}!...a_M!} \cdot \frac{(M-\frac{2M}{3})!}{b_{\frac{2M}{3}+1}!b_{\frac{2M}{3}+2}!...b_M!} p^{a_{\frac{2M}{3}+1}} p^{a_{\frac{2M}{3}+2}} ... p^{a_M} \tag{5}$$

Where $p(a_i)$ of this group has the value of $\frac{3}{M}$. Therefore, $p^{a_{\frac{2M}{3}+1}} p^{a_{\frac{2M}{3}+2}} ... p^{a_M}$ can be obtained by $(\frac{3}{M})^{N/2}$

3. Performance Analysis

The system analysis based on the equation of William Feller must use the overall events, the random slot of tag to calculate and it consists of the procedure of selecting the event in order to avoid the duplicate events as shown in Fig. 1. As we can get the value of accessing the slot of a and b, we should summarize all the values in one frame by defining the slot equal zero for calculation the probability of sending success data in one frame. The probability must not over one and it should repeat every frame for the comparison.