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An Improved Framed slotted ALOHA-Based Anti-collision Algorithm with Skipping Idle Slots for RFID Systems

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Abstract: Recently a new framed slotted ALOHA based anti-collision protocol has been proposed that yields better tag identification efficiency than all existing conventional identification algorithms. The protocol employs idle slot skipping method where the reader creates the subsequent frames by omitting the non- selected slots, and uses the variable frame size of two or four. In this paper we investigate the effects of exploiting different frame sizes on the identification efficiency of the protocol. The simulation results shows that the performance of the original protocol can be enhance by fixing frame size to a larger number. The identification efficiency is significantly increased by 20% .

Keywords—**ALOHA**

1. Introduction

Radio frequency identification (RFID) is a wireless technology to track particular objects using radio frequency signals. A typical RFID system including an application, a reader and several tags relies on exchanging command between the reader and tags [1]. If multiple tags present in readers interrogation zone, the reader may not be able to identify the signals from the tags uniquely. This is called a collision, and anti-collision algorithms are invented to solve it. Anti-collision algorithms are categorized into ALOHA based and tree based algorithms. The main idea of the tree-based algorithms is to splitting the collided tags into subsets and recursively execute until the collided tags are identified. Such algorithms are computationally complex and required more time to execute large number of tags. Meanwhile, in ALOHA based algorithms the time is divided into time slots, and tags can send data at the beginning of each slot, when collision occurred the collided tags will resend data after random period. Variations of ALOHA based algorithm were introduced such as Frame slotted ALOHA (FSA), which groups time slots into fixed-size frames, while Dynamic framed slotted ALOHA (DFSA) used variable frame sizes. In [2] He et al have recommended an improved anti collision algorithm based on Dynamic framed slotted ALOHA (DFSA) algorithm and enhanced the efficiency of identifying the collided tags. DFSA is the method of adjusting the next frame size by estimating the collided tags in the current frame. DFSA is more popular in the research field since, it can achieve higher throughput than ordinary slotted ALOHA [3]. However, The main drawbacks of the existing DFSA algorithms is the lack of concern for the time wasted in idle and collision slots and a delay that the collided tag needed to wait before retransmissions. Therefore, in [2] the authors overcome these limitations by identifying the selected time slots information in advance and taking necessary action immediately when the collision occur. Their algorithm successfully prevented the occurrence of idle slots and mitigate the effect of collision by allocating collided slot to different subset based on the ratio of number of selected time slots to frame size. In this article, we evaluate the work in [2] and confirm that the proposed method is equivalent to variation of tree algorithm with initial frame size of 64 time slots, when the idle slots are completely skipped. Furthermore, we simulate the splitting tree concept with larger frame size when all the idle slots are completely skipped. The remainder of the article is structured as follows: Section 2 describes the related work, Section 3 describes He's algorithm and the Section 4 provides simulation results and the discussion. We conclude our work in Section 5.

2. Related work

Tree Algorithm :
The tree algorithm is superior than the frame slotted ALOHA in terms of mean collision resolution interval (CRI) length and throughput. Collided tags are resolved based on the divide and conquer model. The collided tags in the frame are divided into subsets and execute recursively until they are identified while the other subsequent tags are waiting. Although this requires more computational complexity, it resolves tags collision faster than ALOHA base algorithms.
Dynamic Frame slotted ALOHA:
Similar to ALOHA concept, the tags randomly select a time slot in the given frame. The collided tags are resolved by assigning the frame size equal to the number of collided tags [3]. Therefore, the frame size is not a fixed size as in frame slotted ALOHA.

3. Proposed Algorithm in [2] (He's algorithm)

As described earlier idle slots and collision slots are crucial points in DFSA anti-collision method. The He's algorithm has significantly enhanced the tag identification efficiency by forming a frame where the idle slots can be skipped based on the information of the selected slots of each tags transmitted to the reader in advance. Then the collided tags are process immediately by splitting each collided slot into new frame sizes of 2 or 4 time slots depend on the ratio of number of

selected slots to the previous frame size. The process of the He's algorithm is as follow,
Step 1: Reader broadcast the "Query (Q)" command by indicating the frame size as Q.
Step 2: After receiving Query command, each of the tags in readers interrogation zone send the selected slot information back to the reader as one sequence.
Step 3: Upon receiving the sequence of information, the reader forms a frame and calculates the ratio of number of selected slots to frame size.
Step 4: If the created frame contains collided slots, resolve them immediately by splitting the collide tags into subset base on their selected slot. Then create a new frame where its size is calculated using the ratio of number of selected slot to the previous frame size.
Step 5: If the ratio is less than 0.5 append a new frame with four slots to resolve the collision else append a new frame with two slots to resolve it.
Step 6: repeat step 4 and step 5 until all the tags are identified

4. Simulation Results and Discussion

This section illustrates the simulation outcomes of He's algorithm compare to our analyzing method. The authors in [2] divided the colliding tag in to subset of two or four time slots based on the ratio of number of selected slot to frame size to resolve the collision. In our analyzing method we split the collided tags in to fixed frame sizes of 2,3,4,5,6 and compare the results with He's algorithm.
In our work we use the **tag identification efficiency**, which is the ratio of the number of tags to total number of time slots and **total time taken to identify all the tags**, which is equal to total time slots require to identify all the tags as performance evaluation parameters. For the simulation purpose we varied the number of tags from 2 to 1000 and each point simulated on average of 1000.
In our analysis method we used binary, ternary, quaternary, quinary and senary concepts to represent the behavior of the original He's algorithm when the collided tags are divided in to fixed frame sizes of collision recursively. Figure 1 illustrates the efficiency of the algorithms when the number of tags increases from 2 to 100 with the initial frame size of 64 time slots. When the number of tags increases, the tag identification efficiency decreases due to extensive number of collisions. As shown in Figure 1, for low number of tags (less than 35 number of tags) He's algorithm performs similar to quaternary (4-ary) splitting tree. When the number of tags is greater its performance is similar to binary (2-ary) splitting tree concepts. Because the colliding tags are resolved by appending four slots when the ratio of selected slots to frame size is less than 0.5,i.e., the number of tags are less than 35. When there are more than 35 tags it appends only two slots which follows the binary concept. This process is clearly clarified in Figure 2, which represents the occurrence frequency of frame sizes 2 and 4, when the number of tags increases up to 100. Figure 3 illustrates the tag identification efficiency for higher amount of tags with the initial frame size of 64 time slots. When the

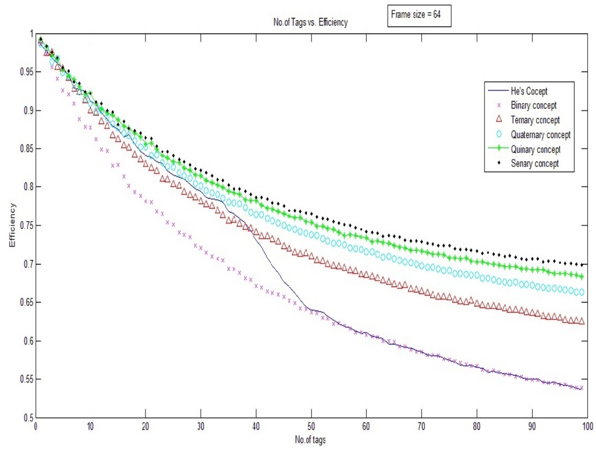

Figure 1. No. of tags vs. Tags identification efficiency

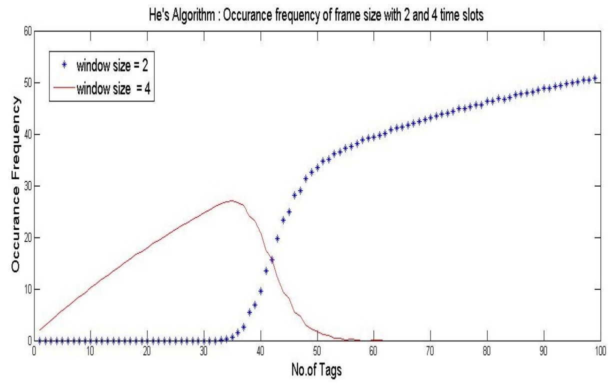

Figure 2. No. of tags vs. Occurrence of frame size 2 and 4

number of tags is more than 40 the He's algorithm follow the binary splitting tree concept where the idle slots are not considered. Moreover, both Figure 2 and Figure 3 show better performance when appends higher number of slots to resolve the colliding tags by skipping the idle tags. Figure 4 shows the required number of slots to identify the all the tags in the system when number of tags vary from 2 to 100 for the initial frame size of 64 time slots. More number of tags creates more number of collisions, therefore when number of tags increase, the required time slots also increase. Furthermore, it follows similar binary and quaternary splitting tree concepts as described above. Figure 5 highlight the required number of slots to identify all the tags in the system when the number of tags varies from 100 to 1000 for the initial frame size of 64 time slots.
For large number of tags the efficiency of ternary, quaternary, quinary and senary concepts are higher than 50 percent while the He's algorithm and binary concepts provide only 45 percent. Furthermore, for small number of tags ternary, quaternary, quinary and senary concepts provide superior performance than He's algorithm and binary concepts. Figure 6 shows the performance for the initial frame size of 256.

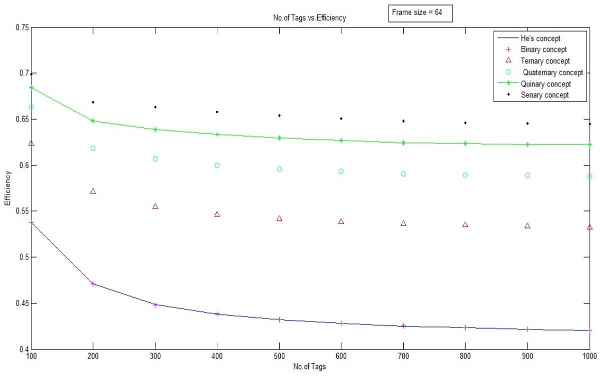

Figure 3. No. of tags vs. Tags identification efficiency

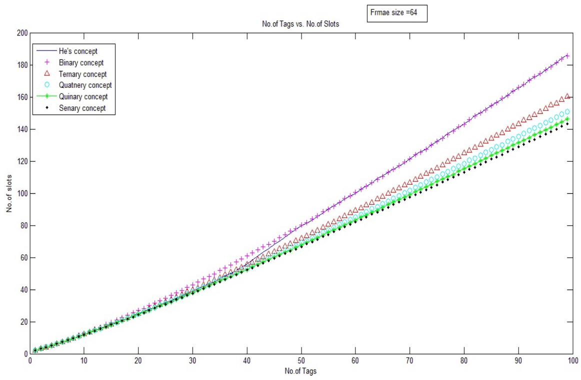

Figure 4. No. of tags vs. No. of slots

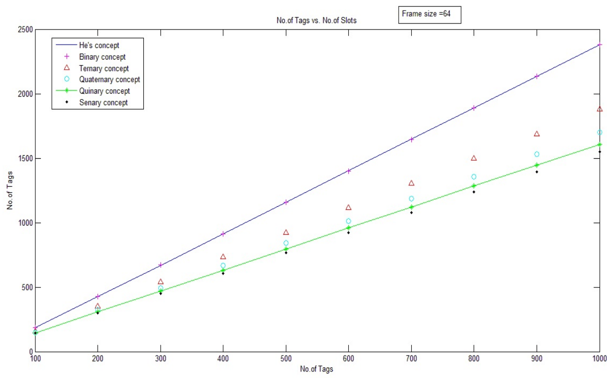

Figure 5. No. of tags vs. No. of slots

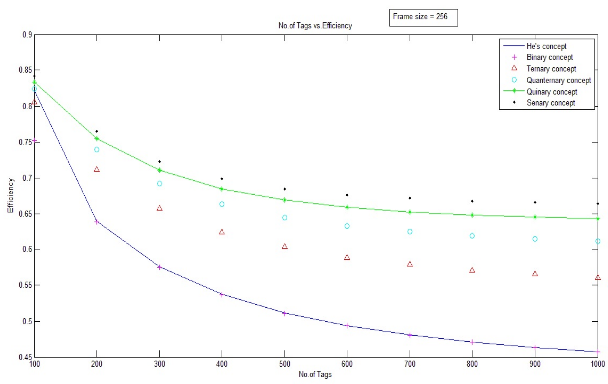

Figure 6. No. of tags vs. Tags identification efficiency

5. Conclusion

This article investigates the work in paper [2] which introduced a novel concept of omitting idle slots and forming an efficient algorithm called He's algorithm in dynamic framed slotted ALOHA. In addition the said algorithm resolved the collided tags by splitting it in to frames with 2 or 4 time slots. This method significantly enhances the tag identification efficiency when compare to several currently accepted and more accurate algorithms according to the work in [2]. In our work we have shown that the He's algorithm is using a similar technique to binary and quaternary splitting tree where the idle slots are omitted with the initial frame size of 64 time slots for small number of tags and 256 for large number of tags. Furthermore, the simulation results proof that setting large and fixed consequent frame sizes yield better performance than varying the frame size between two and four.

6. References

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