

# AN IMPROVED ACCELERATED FRAME SLOTTED ALOHA (AFSA) ALGORITHM FOR TAG COLLISION IN RFID

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## **ABSTRACT**

*The efficiency of tag identification in an RFID (radio identification system) can be low down due to the tag collision problems. The tag collision problem occurs when a reader try to read multiple tags in an interrogation zone. As a result, the reader doesn't identify the tag correctly. That causes a loss of information or data interference. To solve such kind of issues a series of ALOHA based algorithm and Binary search algorithm have been proposed. The most simple, popular and good giving performance algorithms are ALOHA based anti-collision algorithms. In this paper we present a new variation in Accelerated slotted Aloha (AFSA). Our proposed Algorithm by using the bitmaps and avoids wastages in bit times due to idleness and collided slots, reduce the tag reading time. The simulation result shows that AFSA can significantly reduce the average tag reading time with respect to the base protocols and achieve high tag reading rates under both static and mobile settings.*

## **KEYWORDS**

*Radio Frequency Identification (RFID), Anti-Collision, Tag Estimation, AFSA Algorithm.*

## **1. INTRODUCTION**

Traditional bar-coding technology is an economical solution for AIDC (Automatic Identification data Collection). By rapid usage we find some limitations on it. We need to scan each bar code item individually, that limiting the scanning speed and increase the cost of process by the use of manual labour. The manual process of scanning also increases the probability of human error. As a result engineers face a challenge to develop a new technology that ensures the efficiency and reliability of identification process. For the reason RFID technology has been making inroads in AIDC applications.

By the use of RF signal RFID technology make it possible to identify and collect the object data quickly and efficiently. The analysis process shows that RFID is much similar to bar-coding technology, but the biggest advantage of RFID is that it does not rely on the line of sight [1]. RFID is an emerging technology making ubiquitous identification possible. High speed moving objects and recognition of multiple tags simultaneously can be identified by RFID. Combined

with the internet, telecommunication and other technologies, RFID technology can achieve track and share object information world-widely.

The main advantages of RFID over barcodes are [3] [4]

- Don't require direct line of sight.
- Rugged then bar codes.
- Fastest reading speed
- Read/ write capacity as design allow.
- No need to attach outside the products.
- Greater flexibility.
- Higher data storage
- Increased data collection through put.
- Greater accuracy of data.
- Durability. (RFID tags still working if it become dusty)

Object identification dilemma requires the simultaneous recognition of multiple objects/ tags reliably and minimal user interaction. The key problem of RFID is its read rate and recognition speed. In RFID system there are two kinds of interference: 1. Tag interference and 2. Reader interference. At this stage our discussion is limited to tag interference

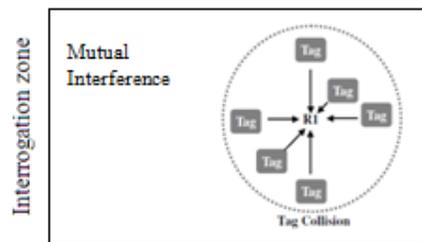


Figure. 1 Problems in transmission of data from many individual tags to reader.

In a dense RFID environment when multiple tags try to communicate with a reader simultaneously in its interrogation zone, the tags will collided and no more communication is possible. This is called tag collision or tag-to-tag interference. A reader cannot identify multiple tags because of signal collision. The tag in this state is in dead zone called as tag jamming state. Its results in surplus of energy, bandwidth as well as increase identification delay [2]. Figure 1 is a pictorial diagram of tag interference.

The rest part of this paper is prepared as follows: Section II describes the components and review of RFID technologies and their short comparison based on their operating principles. In Section III we present a short description of current Anti-collision protocols. Section IV describe our projected algorithm based on Accelerated frame slotted Aloha (AFSA). Section V concludes the paper.

## 2. BACKGROUND

Before moving to Anti-collision protocols discussion this section shows the components and the working/ operation of RFID technology.

## 2.1. Components of RFID System

A typical RFID system consist of three components as illustrated in figure 2 [3][4].

- One or more RFID tags, called as transponder, that affix to the object to be recognized. Tags may be active or passive. Active tags have its own battery source but passive tag don't require power source. It can be powered by the reader. Table 1 shows the common difference between passive and active tags.
- A reader or transceiver is a power full device with built in memory. RFID reader has two interfaces. The first one is RF interface that communicate with tags in their interrogation zone and the second one is a communication interface for interacting with server
- Finally an Application/ data processing sub-system, which may be an application/ data base that depend upon the application.

Table 1. Difference between Active and Passive Tags.

Factors	Tag Types	
	Active	Passive
<b>Power</b>	Internal	External
<b>Life</b>	Low	High
<b>Transmitter</b>	Yes	No
<b>Cost</b>	Expensive	Cheap
<b>Read Range</b>	(60-300) feet	Up to 30 feet
<b>Data Storage</b>	High	Less
<b>Size</b>	Slightly Bulky (Due to battery)	Small/ light weight
<b>Maganetic Field Strength</b>	Low	High

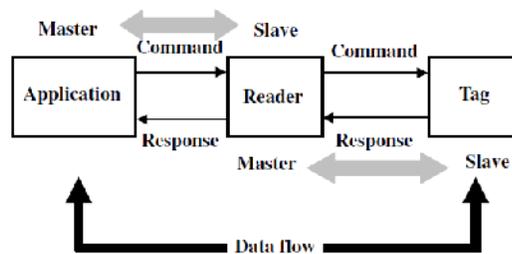


Figure. 2 Master-Slave principle between application, reader, and tag.

## 2.2. Communication Principal

Magnetic or electromagnetic coupling is used for RFID communication. The difference between these two system lies in their operating field i.e. near or far field [2][5][6][7]. Table II presents a comparison between magnetic and electromagnetic coupling system.

TABLE II. MAGNETIC AND ELECTROMAGNETIC COUPLING

Magnetic coupled system	Electromagnetic coupled system
Operate in LF or HF band	Operate in UHF and microwave band
Passively Operate	Active
Transformer type coupling	Backscatter Coupling
Using Amplitude modulation	Using RF power transmission
Low Range	High Range

### 3. EXISTING ANTI-COLLISION PROTOCOLS

There are several methods to handle the multi-tag interference. The most common algorithms to reduce collision are Probabilistic and deterministic. The deterministic schemes are ALOHA based anti collision protocols while deterministic refer to binary tree search. ALOHA based algorithms are very popular in industry. It schedules the response of tags at random time that leads to low probability of collision. As for this paper our discussion is not towards Anti-collision protocol discussion. So after a brief description we move towards our proposed algorithm. Figure 3 shows the Taxonomy of existing anti-collision protocols.

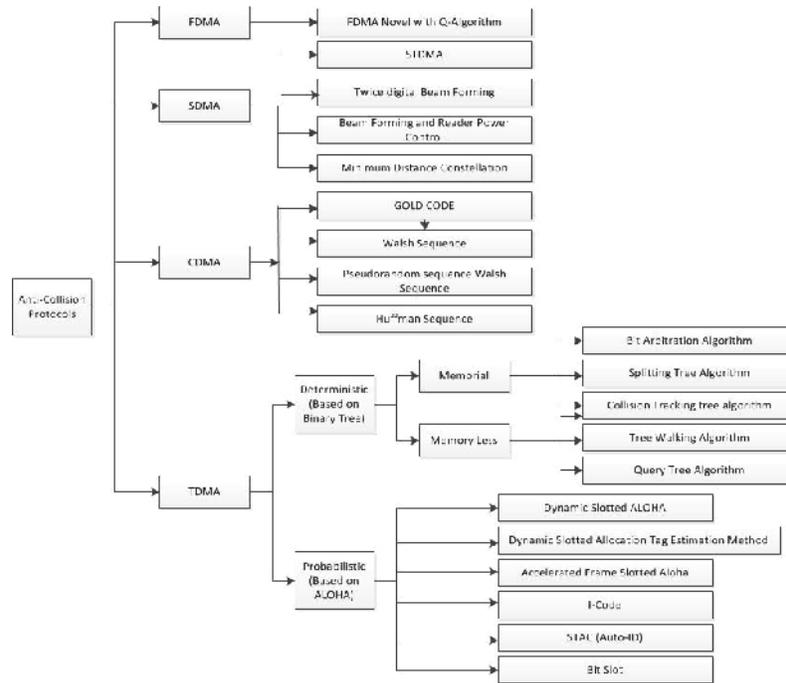


Figure. 3 Taxonomy of Anti-collision Methods in RFID system

### 4. DESCRIPTION OF THE PROPOSED ALGORITHM

We suppose the collision limit 900 MHz UHF RFID system. One tag transmits 64-bit identifier (EPC) and 16-bit CRC with 4μs time duration. A reader sends a query to tag by ‘0’, ‘1’, and Null. Reader time duration is 12μs [8] and it uses 900MHz continuous waves (CW) to power the tag. The proposed algorithm is a variation in AFSA, which has been implemented in MATLAB for getting simulation result. The operation will accomplish in five different phases.

1. In advertisement phase reader broadcast frame size (N) to all tags. Tag generates a random number, which allows the tag to participate in the current round if it gets remainder zero. In case of participation tag generate another random number from 0 to N to get the slot.
2. In Reservation phase n bit sequences are sending by tag in their chosen slot. For n there is  $2^n$  promising n bit sequence. A tag arbitrarily picks one of these  $2^n$  sequences to transmit these sequences to reader by chosen slot.
3. In third phase of reservation summary a tag send summary of reservation to tag. Suppose  $N=4$  the bitmap 1001 shows the tag chosen slot 1 & 4 as successfully reserved. In this case reader did not hear at slot 2 & 3 because of (i) collision I these slots or (ii) idle slots.
4. The next phase is data transmission phase in which the tag who find his slot successfully send the identifier and other associated data to reader.
5. Finally reader sends the acknowledgement to tag in the shape of bit. '1' represents successful transmission and vice versa. Figure 4.

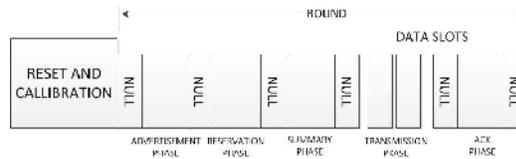


Figure. 4 Rounded Phases of AFSA

For the tag estimation we choose the approaches presented in [8] because of its simplicity. Let K tags are being estimated by the reader after completion of a round. As stated above each tag randomly transfers n-bit sequence in the selected slot. Let T be the total time of round  $T_{ad}$ ,  $T_R$ ,  $T_{su}$ ,  $T_D$ ,  $T_{ACK}$  Table III [8]. Then we can write T as.

$$T = T_{ad} + T_R + T_{su} + T_D + T_{ACK} \text{-----} \quad (1)$$

Thus the duration of reservation phase is  $12.5 * N n \mu s$ , while  $T_D$  is  $S * 320 \mu s$ . S indicates the no of successful slots reservation i.e.

$$S = E[R] + E[UC] \text{-----} \quad (2)$$

Where  $E[R]$  is average no of truly reserved slots, and  $E[UC]$  is the average no of collision slots. Since the tag choose one slot from N, so the values of average no of reserved slots can be written as [8].

$$E[R] = K (1-1/N)^{K-1} \text{-----} \quad (3)$$

If multiple tags choose one slot and all tags choose the identical bit sequence, then the calculation of average no of slot is

$$E[UC] = N \sum_{i=2}^{K-E[R]} (\text{Probability that } i \text{ tags in the same slot}) \frac{1}{2^{n-1}}$$

Let  $E[U]$  signify the total no of slots that more then on tag choose.

$$E[U] = N - E[I] - E[R] \text{ -----} \tag{5}$$

Where  $E[I]$  is total no of idle slots.

$$E[I] = N (1 - 1/N)^K \text{ -----} \tag{6}$$

TABLE III. MAGNETIC AND ELECTROMAGNETIC COUPLING

Symbol	Description
$T_{ad}$	Time of advertisement Phase
$T_R$	Time of Reservation Phase
$T_{su}$	Time of Reservation summary Phase
$T_D$	Time of Data transmission Phase
$T_{ACK}$	Time of Acknowledge Phase

If  $P_j$  the probability that two tags picks the identical  $n$  bits sequence in  $T_R$ . then from equation 4

$$E[UC] = E[U] \cdot P_j$$

As  $P_j = 1/2^n$  by combining all equation  $T$  becomes.

$$T = T_{ad} + 12.5Nn + T_{su} + 320(E[R] + E[U] \cdot P_j) + 12.5(E[R] + E[U] \cdot P_j)$$

By minimizing with esteem to  $n$  the optimal value of  $n$  is

$$n^* = 3.32 \log_{10} (19.13E[U] / N)$$

In optimal  $n^*$  calculation some of the collision go undetected during the reservation phase. Figure 5 shows the simulation result that getting after 25 experiments, is a plot of undetected collision for each tag with different  $n$  values. The proposed result show that if we have a large no of  $n$  bit sequences the undetected collision goes down.

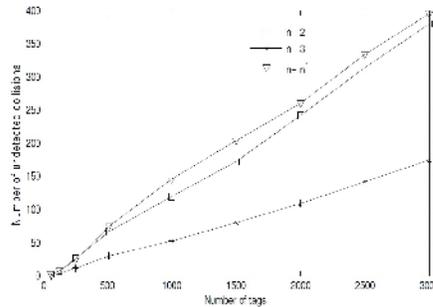


Figure. 5 Number of Undetected Collision vs. N

Figure 6 shows the simulation result of average tag identification time in m sec. by experiment when we use  $n=2$  we achieve better tag reading time as compare to  $n$  values for 3 and 4 respectively. The optimal values of  $n^*$  and  $n=2$  is same in average reading time. The reason is that  $n^*$  computed values always circulate around 2.

The comparison of AFSA with EDFSA and ASAP shows that AFSA tag identification time is less. Figure 7 gives the average for tag recognition period. The simulation shows that the average tag reading time for EDFSA is 1 ms where as ASAP average identification time is 0.59ms. Our proposed AFSA have steady performance with an average identification time of 0.49 ms.

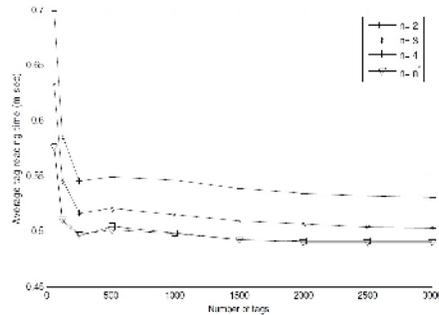


Figure. 6 Average tag identification times vs. N

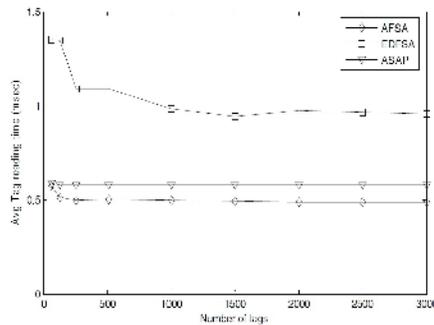


Figure. 7 optimal value  $n^*$  (AFSA) comparison with EDFSA and ASAP

## 6. Conclusion

The main issue in RFID system is a tag collision. There may be more than one tag in reader working range. When reader queried tags simultaneously it will create a tag collision paradigm. That causes the loss of information in a sophisticated identification system. This paper presents the AFSA protocol for resolving this interference. In this proposed algorithm we try to reduce the tag reading time with the passive use of bitmaps and avoid the surplus in bit selection time. Also the simulation result shows that the proposed algorithm has high efficiency and lower processing time.

## REFERENCES

- [1] Qingsong peng, ming Zhang, Weimin wu: variant Enhanced Dynamic frame slotted Aloha algorithm for object identification in RFID system, Proceeding of IEEE International workshop on anti-counterfeiting, security and identification 2007, pp. 88-91.
- [2] M. Kodialam and T. Nandagopal, "Fast and reliable estimation schemes in RFID system," in SIGMOBILE: ACM special interest group on Mobility of system, user, data and computing, pp. 322-333, 2006.
- [3] A. Juels, R. Pappu, Squealing euros: privacy protection in notes in computer science, vol. 2742, 2003, pp. 103-121.

- [4] K. Finkenzeller, RFID Handbook: Radio-Frequency identification fundamentals and Applications, John Wiley, New York, 2000, pp. 200-219
- [5] K. Finkenzeller, RFID Handbook, Fundamentals and Applications in Contactless Smart cards and identification. John Wiley and Sons Ltd.
- [6] S. Lahiri, RFID Source book. USA: IBM Press, 2006.
- [7] R. Want, "An Introduction to RFID technology" IEEE Pervasive Computing, vol 5, no. 1, pp. 25-33, 2006.
- [8] Draft protocol specification for a 900mhz class 0 radio frequency identification tag, Tech. Rep., Auto-ID Center, February 2003.
- [9] C. Law, K. Lee, K.Y. Siu, Efficient memory-less protocol for tag identification, in: Proceedings of the 4th International Workshop on Discrete Algorithms and Methods for Mobile Computing and Communications, Boston, Massachusetts, USA, August 11, 2000, pp. 75-84.
- [10] D.R. Hush, C. Wood, Analysis of tree algorithms for RFID arbitration, in: IEEE International Symposium on Information Theory, 16-21 August, 1998, p. 107.
- [11] Su-Ryun Lee, Sung-Don Joo, and Chae-Woo Lee, "An Enhanced Dynamic Framed Slotted ALOHA Algorithm for RFID Tag Identification," The Proceeding of the 2nd Annual International Conference on Mobile and Ubiquitous Systems, 2005.
- [12] Xu Huang, "An Improved ALOHA Algorithm for RFID Tag Identification," Lecture Notes in Computer Science. Springer Berlin/ Heideberg, Volume 4253/2006.
- [13] "Knowledge-Based Intelligent Information and Engineering System," KES06/ISBN 3-540-46535-9, B. Gabrys, R.J. Howlett and L.C. Jain (Eds), pp 1157-1162 2006 Springer-Verlag Berlin Heidelberg 2006 Global generation 2 Protocol. Page.
- [14] K. Finkenzeller and R. Waddington, RFID Handbook: Radio-Frequency Identification Fundamentals and Applications, John Wiley & Sons, January 2000. EPCglobal, EPC. Radio-frequency identity protocols class-1 generation- 2 UHF rfid protocol for communications at 860MHz-960MHz version technology. Version 1.2.0, 2008. <http://www.epcglobalinc.org/standards/>.
- [15] D Dongwook Lee, Okkyeong Bang, Sooyeol Im, and Hyuckjae Lee "Efficient Dual Bias Q-Algorithm and Optimum Weights for EPC Class1 Generation 2 Protocol", Wireless Conference, 2008. EW 2008. 14th European. 07/2008; DOI: 10.1109/EW.2008.4623846; 2008.
- [16] D Donghwan Lee, Kyungkyu Kim, Wonjun Lee, "Q+- Algorithm : An Enhanced RFID Tag Collision Arbitration Algorithm," Ubiquitous Intelligence and Computing: Lecture Notes in Computer Science, vol. 4611/2007, pp. 23-32, Aug. 2007.

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