

Dynamic Tree Based Anti-Collision Algorithm for RFID System

By

Tan Li Jig

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

In partial fulfillment of the requirement

for the degree of

BACHELOR OF INFORMATION AND COMMUNICATION TECHNOLOGY

(HONS) COMMUNICATION AND NETWORKING

Faculty of Information and Communication Technology

(Perak Campus)

JAN 2017

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DECLARATION OF ORIGINALITY

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First of all, I would like to express my sincere of thankful and appreciation to my final year project supervisor, Dr. Robithoh Annur that guidance me along throughout the entire project. She is patient and helpful by using her advance knowledge to guide me by giving useful comments and ideals that motivate me in RFID anti-collision algorithm area.

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ABSTRACT

Radio Frequency Identification (RFID) was the most famous technology that used in identification and tracking of a product or object. This object will attach with a RFID tag equipped with antenna that store the information of object. This RFID tag will then detect and identify by a RFID reader. However, in the real world environment there is multiple tags that need to pass its information to a RFID reader. Therefore, collision will be happening in the process of identification between multiple tags. In order to reduce the collision between RFID tag and improve the performance of tag identification process, RFID anti-collision algorithm have been introducing in this project which is tree based anti-collision algorithm. There are two type of tree based algorithm that are used in this project which is static based and dynamic based. In these algorithm, collision could be reducing by segment the slot using frame. The different between static based and tree based are definition of frame size. Moreover, a timing standard also going to introduce in this project which is Gen-2 RFID standard that able to define timing of success slot, idle slot and collision slot in the identification process and calculate the identification rate of the algorithm. Besides that, Manchester Coding tracking algorithm will be studied in this project in order to track error bit of the tags and solving the collision. At the end of this project, a new algorithm will be proposed by applying tree based algorithm logic, Manchester Coding theory and Gen-2 RFID standard timing method that improve the performance of existing tree based anti-collision algorithm in term of number of slot used, efficiency and identification rate.

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LISTS OF ABBREVIATIONS

ACK	Acknowledgement
ARAT	Active Reader Active Tag
ARPT	Active Reader Passive Tag
BAP	Battery-assisted Passive tag
BLF	Backscatter-link frequency
BSCTTA	Bi-slotted Collision Tracking Tree Algorithm
BSQTA	Bi-slotted Query Tree Algorithm
CDMA	Code Division Multiple Access
CTTA	Collision Tracking Tree Algorithm
CW	Continuous-wave
DSCTTA	Dynamic Slots Collision Tracking Tree Algorithm
EPC	Electronic Product Code
FDMA	Frequency Division Multiple Access
FPBS	Fast Parallel Binary Splitting
ID	Identity
NACK	Negative Acknowledgement
PRAT	Passive Reader Active Tag
QRep	Query Reply
QTA	Query Tree Algorithm
RFID	Radio Frequency Identification
RN16	16-bit Random Number
SDMA	Space Division Multiple Access
TDMA	Time Division Multiple Access

CHAPTER 1: INTRODUCTION

The main focus technology in this project was RFID. RFID stand for Radio Frequency Identification that having the similar functionality as bar code which provide a unique identity for an object or product. RFID system was based on wireless technology and communication that using radio-frequency electromagnetic fields in the process of transferring information between RFID reader and tag. The main purpose of RFID was automatically identified and track tags or transponder that attached on an object. RFID system mainly applies in business process automation industry such as retailer industry and warehouse industry. The similarities between these industries are they contain huge number of object or stock in their business process. Therefore, there is the need to introduce an identification technology that can automatically detect and identify the object or stock especially in large quantity. RFID system could help the industry to improve the performance of the business process and reduce the labor cost.

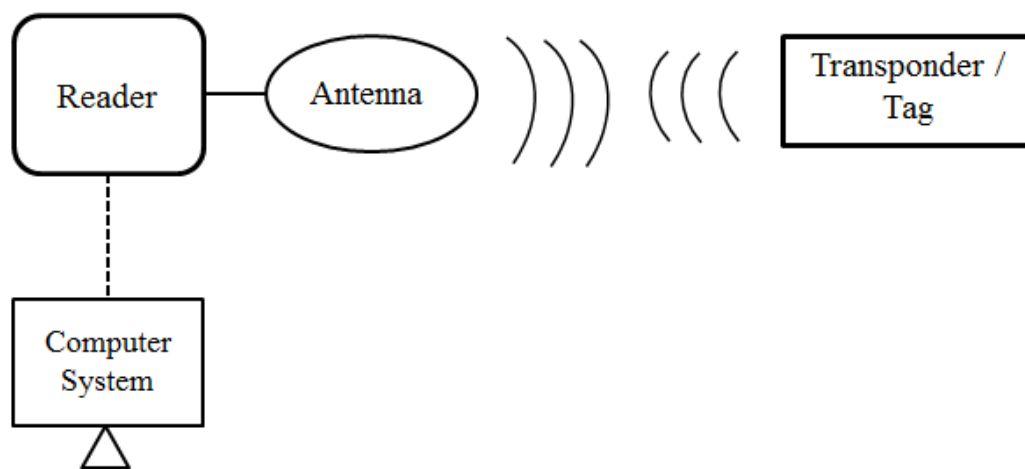


Figure 1.1: Components of RFID

The chip technologies that attached on an object that contain information of an object are known as tag or transponder. There are at least two parts that must be contains in a RFID tags which is an integrated circuit and antenna.

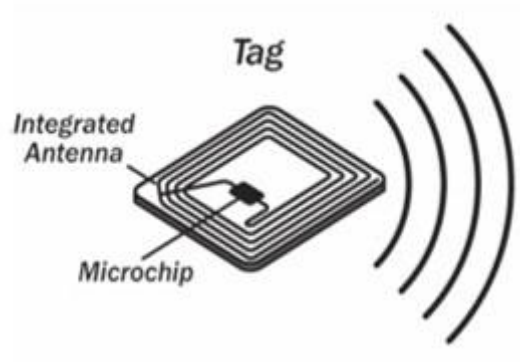


Figure 1.2: Components of Tag

The functionalities of integrated circuit are storing the information of an attached object and processing that information. The information is storing in a non-volatile memory. It also acts as modulator to modulate and demodulate a signal of radio frequency. Incident reader signal that generate DC power also will be collect by tag. On the other hand, the responsible for antenna of a tag are receiving and transmitting the signal from tag to antenna or antenna to tag.

Tag can be categorized into three types depending on the attached battery existence which is active tag, passive tag, and battery-assisted passive. Active tags incorporate an on-board battery to periodically transmit its ID signal to a reader antenna. With the existence of build-in batter, active tags could transmit through a greater distance and higher data rates. However, it also shortens the life time of active tag due to the short life time of a build-in battery. In the return, active tags have higher cost compare to passive tags.

On the other hand, passive tags define as a tag that does not contain any built in integrated power source and it will power up when RFID reader carry the signal. In order to activate a passive tag, they must be through an antenna located on the tag that receives with a power level around three magnitudes stronger than signal transmission. This make the passive tag have the issue on exposure to radiation. Besides, there are also battery-assisted passive tags that contain a tiny battery on board and could be activated with the existence of RFID reader. This type of tag has greater range compare to passive tag and have the ability to monitor sensor inputs that are not appear within radio frequency field.

Characteristics / Tag	Active Tag	Passive Tag	Battery-assisted Passive tag
Internal Power Source	Yes	No	Yes
Read Range	100m or above	Less than 10m	Less than 100m
Size	Big	Small	Medium
Lifetime	Shortest	Short	Longer
Cost	Most expensive	Cheap	Less expensive
Power of Reader	Lowest	High	Medium
Backscattering	No	Yes	Yes

Table 1.1: Comparisons between the Characteristic of Tags



Figure 1.3: Components of Reader

RFID reader can be defining as interrogator which is a device that connects between tag information and computer system. The communication between RFID reader and tag only could be success by the existence of attached antenna. The reader only can communicate with the tag that place within its field of antenna range or operation and performing several tasks for example filter and search for tags, write into the tag information, simple continuous inventorying etc.

There are several types of RFID reader. A Passive Reader Active Tag (PRAT) receives signal from active tags by using a passive reader. The communication range is about 30cm to 610m. However, an Active Reader Passive Tag (ARPT) have the functionality of receive response of authentication from passive tags and transmit interrogator signals through active reader. There is also having an Active Reader Active Tag (ARAT) which will use an interrogator signal that receive from active reader in order to awake active tags. Normally ARAT is use by BAP. The last type of RFID reader was fixed readers that are specially use to create a specific interrogation

zone that let user control closely. Fixed reader allows reading areas that are highly defined when tags exist and exit the interrogation zone.

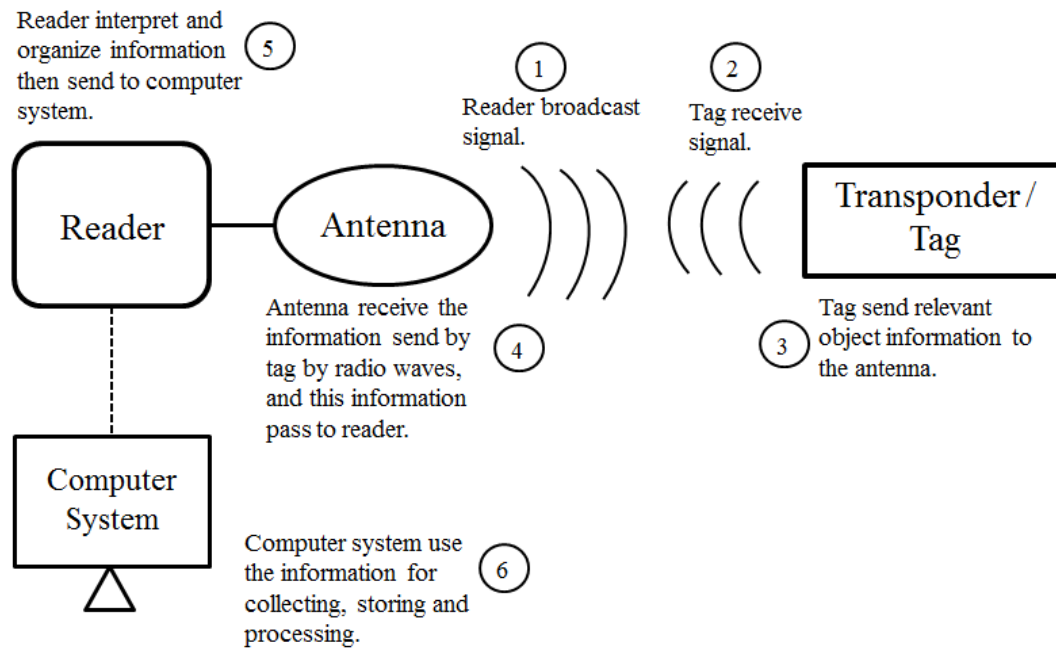


Figure 1.4: Process of RFID System

1.1 Problem Statement

a) Problem of multiple tags

One of the great selling points of RFID system is able to identify and track multiple objects simultaneously that bar code could not achieve. However, it also could increase the number of collision if the RFID reader can't afford to identify and read the information of the object due to receive overload of RFID tag's request within RFID reader range in the same time. Moreover, RFID reader also have the limitation on processing power therefore it could not handle too much of tag's data query in the same time within reader range. Therefore, RFID tags have to compete with each other within the frame sizes that introduce by RFID reader in order the send their information to RFID successfully.

b) Problem of determine frame size

In order to increase the performance in Dynamic tree algorithm, there is the need to reduce the collision and idle slot and increase the probability of successful slot within the process of identification. The main thing that should concern in this case is frame size. The determination of frame size could affect the identification rate and the performance of the process. If the frame size is less, it would increase the probability of collision occur within the frame size while if the frame size is bigger, it would increase the probability of detecting the idle slot in the process of identification and this will result in resources wasted.

c) Problem of checking tag identification in binary form

There is a unique tag ID that represented in binary form will be assigned to each of the tag that discovered within reader range. This tag ID will be used for checking and verification purpose. If there is any bit of tag ID are different from other tags in same position, it will consider as error bit. This error bit will then use to resolve the collision problem in the process of sending information to reader. Therefore, there is important on choosing a method that can identify the error bit efficiently.

1.2 Background and Motivation

One of the characteristic of RFID was allow more than one objects to be identified in one time. This thing can be done either one reader read multiple tags in the same time or one tag read by multiple readers in the same time. Therefore, it creates a problem which is collision because RFID work in single channel. In this project, the focus will be on one reader read multiple tags in the same time which is RFID tag collision.

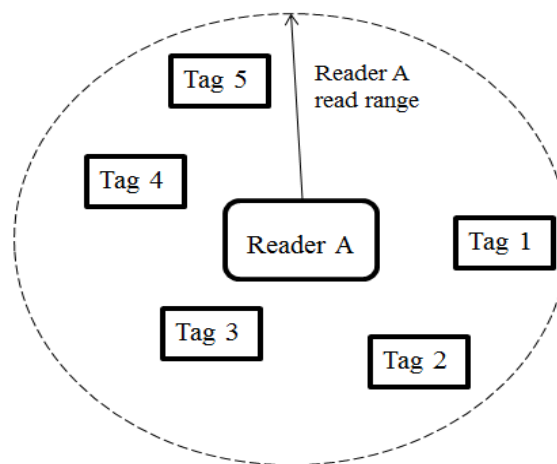


Figure 1.2: RFID tag collision

RFID tag collision happen when there are more than one tags are present in a RFID reader range. Therefore, RFID reader have to handle more than one tags request in the same time and it will occur collision.

In RFID system, anti-collision is a big issue that will affect system efficiency. There are two categories of RFID anti-collision which are Aloha based algorithm and Tree based algorithm. Aloha based algorithm eliminates collision by distributing tags into different frames. Meanwhile tree based algorithm utilizes prefix matching technique while achieving reliability of identification throughput.

RFID tag collision issues create the purpose of conducting this project. In this project, the characteristic of tree based anti-collision algorithm will be study and differentiate existing tree based anti-collision algorithm and new improvement anti-collision algorithm in term of slot used in multiple tags, efficiency and identification rate. Slot used in multiple tags is calculated by how many slot will be used when there was a

number of tags occur. So as to maintain the accuracy of the stimulation result, the program has to be executed multiple times to get the average of the slot used. Besides, the efficiency has to be calculated in order to identify which of the algorithms will have high efficiency. Efficiency is calculated by using the number of tags divided by the average of slot used. Moreover, timing is also very important in this project because it will affect the identification time of tag collision. Therefore, a standard of RFID timing will be applied which is Radio Frequency Identify Protocols Generation-2 (Gen-2). The understanding of Gen2 standard will be applied in the application in order to calculate the timing for each success slot, idle slot and collision slot. Identification rate can be calculated by using these timings.

The motivation of conducting this project is to make improvement on current anti-collision algorithms by reducing tag collisions and minimizing the time used for identification on collisions. Therefore, the efficiency of communication between tag and reader could be improved. The improvement in efficiency can enhance the processing time for the business process that uses an RFID system to track and identify their products or objects. The user could use a little amount of time to process more information on the object or product by applying the minimum of labor. It does not only improve efficiency in terms of time, it also reduces management and labor costs because it only consists of a little work load of human to control the process of identification.

1.3 Project Objectives

- a) To study the difference type of tree based anti-collision algorithm in terms of static based and dynamic based

In order to understand the process of tree based anti-collision algorithm, there are two main types of the algorithm to study which are static based and dynamic based. The difference between these tree algorithms is the adapting of frame size. The frame size of static based is defined and fixed at the beginning of the program while the frame size of dynamic based adapts according to the number of tag collisions. In this project, the comparison of tree algorithms in static based and dynamic based in terms of number of slots used, efficiency and

identification rate will be determining in order to identify which of the tree algorithm is better in use.

- b) To understand Gen-2 RFID standard with timing and slot duration

The timing of the identification process of tree algorithm will be identifying in this project by applying Gen-2 standard. Therefore, there is a need to understand the timing detail for each type of slot which is success slot, idle slot and collision slot. Each of the slot define by different timing process according to Gen-2 RFID standard. These timing involve in both tag and reader side including the command use in tag and reader and also the interval time between the command. Identification rate of the algorithm will be defining after applying the Gen-2 RFID standard.

- c) To utilizing Manchester coding in order to help resolving the collision during the identification process

Manchester coding able to detect each individual bit of tag ID in the process of identification to determine where is the collision happen. Manchester code also can determine the location and number of collision bit happen in the identification process accurately. This Manchester code will utilize in new anti-collision algorithm to resolve and reduce the time slot of collision bit by applying the concept of tree algorithm.

- d) Proposing new concept anti-collision algorithm that improve the performance of existing tree anti-collision algorithm

In the end of this project, a new concept of anti-collision algorithm will be proposed. This concept will decrease the number of slot used in multiple tag and increase the efficiency compare to existing tree anti-collision algorithm. Meanwhile, the new concept of anti-collision algorithm also will shorten the identification time of tag success, tag idle and tag collision in order to improve the identification rate after applying Gen-2 RFID standard concept.

1.4 Proposed Approach/Study

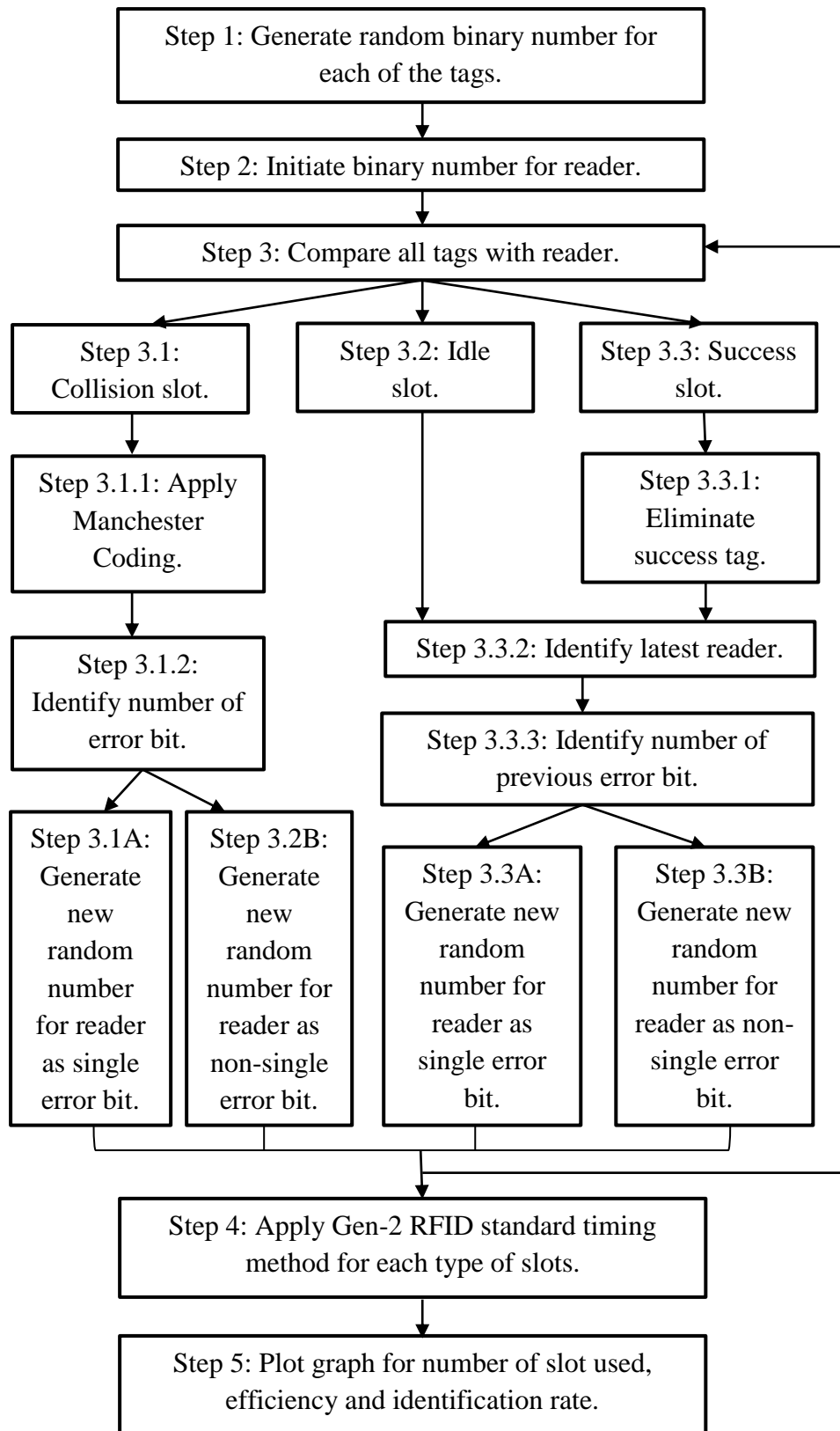


Figure 1.4: System Flow for Two-Bit Error Anti-collision Algorithm

CHAPTER 1: INTRODUCTION

In the beginning of application, all the tags are requiring to have a unique identification code to act as their identity to send information to reader. Therefore, a unique random binary number have to been generate for each of the tags and make sure all the tags is using same bit of binary random.

While generate a unique random binary number to all the tags, there is also a need to initiate a binary number for reader that using same bit with tags in order to use as comparison with tag's identification code. In the initial stage of application, this reader will be assign as highest binary number within the number of bit. The reader binary number will be adapting after going through the rest of the process. It means that the reader binary number will always different in every turn.

After the binary number is generate for reader and tags, the tags are competing with each other the send their information to reader. Therefore, there is a need to have some process to solve the competition and let the tags successfully send their information to reader one by one. One of the process is having a comparison between reader and tags. When the tag's identification code meets the condition that is less than or equal to reader binary number, this tag is giving the priority in slot to send their information to reader. Else the tags are not allowing to send their information to reader.

However, it also will occur the case that there are more than one tags that having identification code is less than or equal to reader binary number which occur collision that is collision slot mean that there are multiple tags meet the condition in one slot. They are also having another type of slot which is there is only one tags that meet the condition and it allow to send it information to reader within that particular slot, it is success slot. The last type of slot is idle slot. Idle slot occurs when there is no tag's identification code meet the condition of less than or equal to reader binary number.

In order to solve the collision inside collision slot, there are a few step need to follow by apply Manchester coding collision tracking method to generate a new reader's binary number for next slot for comparison used. The detail of the step will be explaining in chapter 4. Meanwhile, there are also a few step need to follow when there are success slot and idle slot occur in order to generate new reader's binary number for next slot as comparison used so that all the tags could successfully send their information to reader. The detail of the step will be discussing in chapter 4.

After all tags successfully send their information to reader, a timing method which is Gen-2 RFID standard is applied in the application in order to identify the time used for each type of slot for identification rate calculation. Lastly, a few graph will be plot such as the number of slot used, efficiency and identification rate on multiple tags for performance analysis.

1.5 Achievement

The achievement in this project was successfully proposed a method that could have better performance in term of number of slot used, efficiency and identification rate compare to existing algorithm. This proposed method is two-bit error anti-collision algorithm. This algorithm could help in industry that having multiple object or product that need to be trace in their production line. Especially when the industry is requiring to process large amount of object or product, this algorithm could reduce the processing time by reduce the collision occur and lesser the number of slot used. Moreover, this algorithm has the behavior that when the amount of object or product is larger, the efficiency will keep on increasing compare to existing algorithm that only could maintain it efficiency until a certain amount of tags.

1.6 Report Organization

The following are the organization of the rest of the chapter in this report.

Chapter 2: Literature Review

In this chapter, there are a few number of research paper have been studied in term of RFID system, Gen-2 RFID standard timing method, Manchester coding collision tracking method. Moreover, there are a few existing tree based algorithms will be discussing in this chapter.

Chapter 3: Algorithm and Method Description

In this chapter, the algorithm that used in this project will be discuss in detail. Besides that, the methods that applied in proposed method also will be discuss in detail in this chapter.

CHAPTER 1: INTRODUCTION

Chapter 4:

This chapter include all the system flow of algorithms that used in this project and the step of conducting algorithm will be discuss in detail.

Chapter 5:

This chapter will be explaining the method that used in this project to optimize the performance of different algorithms that used in this project. Moreover, the performance analysis will also discuss in this project.

Chapter 6:

This chapter include the summarization of this project, the achievement of the project and also objective achieved.

CHAPTER 2: LITERATURE REVIEW

2.1 Definition of RFID System

RFID is one of the type of wireless communication technology that automatic identify, store and retrieving data remotely with the component of RFID tag and reader through a radio wave (Jia and Feng, 2013). Networked electromagnetic RFID reader and tags are the component on RFID systems where tags are identifying by readers as fast as possible via a wireless communication channels (MOHAMMED and SALAH, 2011). With the advancement of RFID technology, reorganization of multiple object has been achieving and become one of the important direction area of identify and tracking application (Bai, He, and Wang, 2014).

The useful application that created using RFID technology is involve in many areas such as environmental area which is waste collection, traffic area which is traffic monitoring application, business area which is supply chain management and also commerce area which is identify product using wireless identification through RFID technology (Yeo et al., 2007). These applications require the use of multiple tags simultaneously. However, RFID tags is a self-attached that do not have the knowledge or neighbor tags, therefore, they always applying their own schedule to send information to the reader. Unfortunately, since the reader only have communication of single channel, therefore transmission simultaneously in RFID occur collisions between reader and tags that communicate using a single channel (Jia and Feng, 2013). Moreover, retransmission is needed if the collision occurs in the process of communication, however this also will lead to collision again and the system will experience to the high latency of tag identification and performance degradation on RFID system (Gao and Yoo, 2012).

There are four multiple access techniques in anti-collision algorithms which include frequency division multiple access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA) and space division multiple access (SDMA). Recently, the most popular anti-collision algorithms are Aloha-based algorithms and tree-based algorithms and both of them are belong to TDMA anti-collision algorithms (Shao, Jin, and Jin, 2014). In Aloha-based algorithms, they are using the tag collision's probability of occurrence. The transmission timeslot will be randomly

chosen by tags. Meanwhile, predication technique applies in tree-based algorithm in process of identification. The identification of all the tags will be by drawing a binary tree with tag ID and travel between tree and root nodes (Yeo et al., 2007).

2.2 Radio Frequency Identify Protocol Generation-2 (Gen2)

Gen2 protocol defining the requirements of logical and physical for a passive tag in RFID system that operating in the range of frequency between 860 MHz to 960 MHz. By applying Gen-2 standard, the tags have the ability to read the distance up to 10 meters from reader and do not require battery build in. Tags that come with Gen-2 technology usually powered by using radio waves that transmit by reader antenna. However, since Gen-2 tags do not require battery build in, therefore they do not afford to have high process operation. Energy-efficient technique for communication between multiple tags and reader have been employed such as Medium Access Control (MAC) mechanism. According to (Solic, Stella, and Saric, 2013), there is necessary to reduce the number of idle and collision slot in order to increase the identification rate of the system. Therefore, the concern will be put on frame size since there is this the only thing that can be adapt. According to the researcher, the probability of detecting collision slot will be increase providing by less frame size. Meanwhile, the larger the frame size, the larger the number of idle slot. Moreover, the value of frequency also important in identification process. If the frequency parameter that apply in Gen-2 RFID standard is high, it will generate faster rate of data transfer and long distance of read ranges but have interference when apply on liquid and metals surface. Whereas for lower frequency it has short read range and slow read rate compare to high frequency but it able to read on metal or liquid surface. However, it does mean that high frequency is better than low frequency but it has to depend on what application that use in RFID system. The application that suitable for high frequency such as book tracking, transit ticketing system and patient flow tracking. Whereas the low frequency is ideal for food tagging, animal tagging and access control.

2.3 Manchester Coding in RFID

Manchester coding mostly use in collision tracking purpose which is detect how many collisions bit happen in the process and detect the location of collision bit. Electrical level transition applying in Manchester coding to determine the situation whether is up or down. In up situation, the value of electrical will be 0 whereas for down situation, the value of the electrical will become 1. The receiver can use this transition for signal synchronization since this transition is occurs in between each symbol. There was an error happen if the transition didn't appear for a long time in the process. When more than one tags return their EPC command to the reader in the same time after the reader synchronizing the signals that have been received, the translation of inverse for collision bits will be offset between each other and this will bring to a no state of no transition. By this way, the location and number of collision bits can be defining (Shao, Jin, and Jin, 2014).

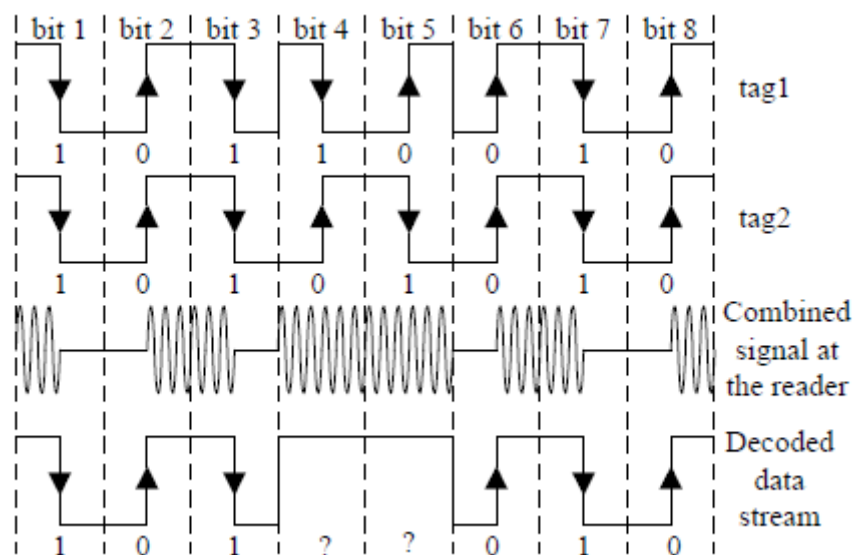


Figure 2.4.1: Tracking Individual Bits by Using Manchester Coding (Yeo et al., 2007a)

Two tags have been shown in Figure 3.1. Tag 1 ID is 10110010 whereas tag 2 ID is 10101010. Both of the tags will response to the reader when receive a Request command send out by reader. The positive and negative transition for bits received of bit 4 and bit 5 will be offset with each other in order to receive subcarrier for the duration of bit 4 and bit 5. The state of bit 4 and bit 5 will be define as error and make it possible to detect the number and location of collision bit in Manchester Code (Yeo et al., 2007a).

2.4 Existing Tree Based Algorithm

2.4.1 Query Algorithm (Q-algorithm)

A reading slot number will be choosing dynamically according to Q values that contain integers between 0 to 15 by tags in Q-algorithm. First, a *query* command that contain session number and Q values will be sending out by reader. Whereas tags that appear in identification process will randomly choose a value between 0 to $2^Q - 1$, this value will be store in slot counter. When value 0 as slot counter are chosen by tag randomly, the tag will switch to *Reply* state. Another tags that choose other value than 0 as slot counter will change to *Arbitrate* state. If there is any collision occur, a *QueryAdjust* command will be announce to modify Q value. Q value will not be change if there is success tag occur and an *ACK* command will be transmitted if tag is successfully responses to reader. All of the tags will decrease their slot counter by 1 after receiving *QueryRep* command (Charoenpanyasak et al., 2016).

2.4.2 Query Tree Algorithm (QTA)

Binary splitting strategy had been used by QTA in order to identify tag. K-length prefix will be transmitted by reader to tags. The tag will send out the bit from $(k+1)th$ to the end bit of it ID if it found out that tag IDs contain the first k that are same as the reader's transmit prefix. If the received tag IDs is in collision situation, the extended prefix will attach with '0' or '1' to retransmit. If there are no collision occurs, one of the tag will be identify by reader (Liang and Lin, 2007). QTA have an advantages which is memoryless because the tags in QTA does not need to have any additional memory other than ID, it only need little functionality and provide less expensive tags. However, QTA performance is affected by distribution of tag ID that a reader need to be identify (Bonuccelli, Lonetti and Martelli, 2009).

2.4.3 Fast Query Tree Algorithm (FQT)

FQT is an anti-collision algorithm that focus on improving the speed. It also introduces to reduce the identification time of data transmitted (Charoenpanyasak et al., 2016). FQT was applied Manchester code in the process of tracking collision bits between tags. The query prefix is maintained by stack. Reader are responsible to gets the last bit of current prefix in order to use for interrogate all the tags. A feedback will be transmitting once the reader received tag's response. A state counter (SC) and a

pointer was maintained by tags where SC is used for tags grouping and the pointer is used for pointing at the bit that are used to comparing the reader's query bit. When the SC is equal to 0, tags will response to reader. When the pointer comparing result is true, the tags will also respond to readers (Gang Wang, Yong Peng and Zhaomin Zhu, 2011).

2.5 Comparative Analysis of Existing Tree Based Algorithm

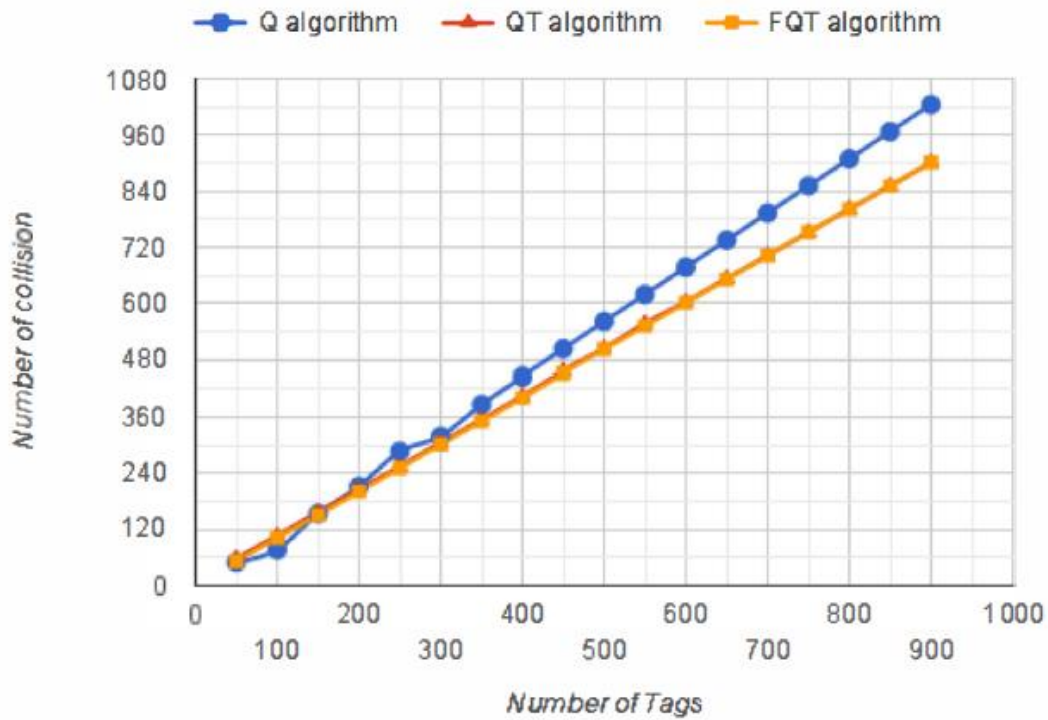


Figure 2.5.1: Simulation Results of Number of Collision Among Existing Tree Based Algorithm (Charoenpanyasak et al., 2016)

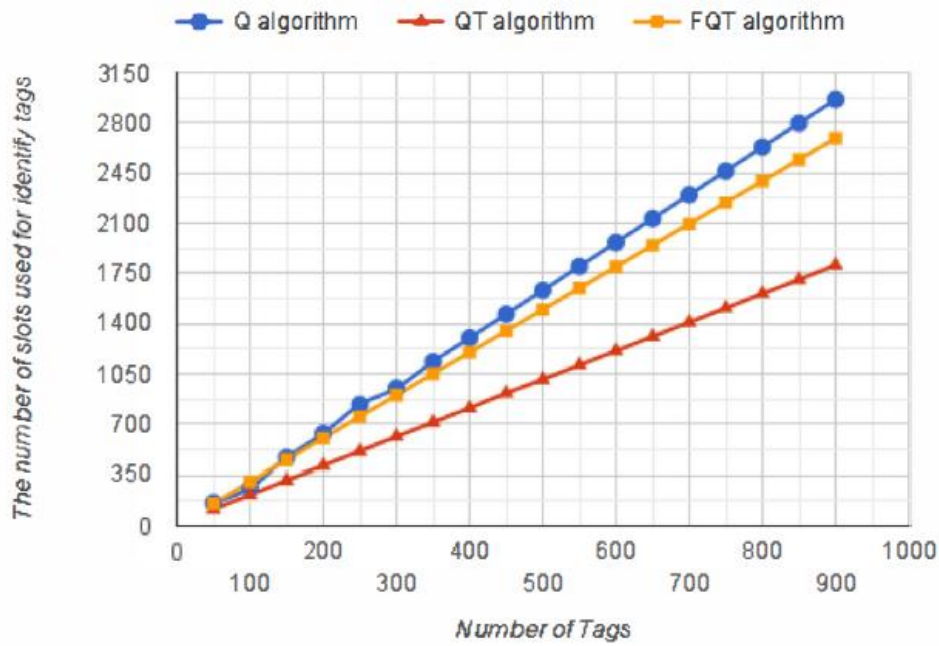


Figure 2.5.2: Simulation Result of Number of Slots Used for Identify Tags Among Existing Tree Based Algorithm (Charoenpanyasak et al., 2016)

The simulation results in Figure 2.5.1 shown Q algorithm have more number of collision compare to QTA algorithm and FQT algorithm. Moreover, Q algorithm also used the most slots to identify tags among three algorithm based on Figure 2.5.1. Besides, QTA algorithm and FQT algorithm produce almost similar results in number of collision simulation. However, QTA is using less number of slots compare to FQT algorithm in Figure 2.5.2 and it provide better performance.

CHAPTER 3: ALGORITHM AND METHOD DESCRIPTION

There are four algorithms that involved in this project which two of them are existing algorithms while the rest of them are new proposed concept of algorithms. The existing algorithms include static tree based anti-collision algorithm, dynamic tree based anti-collision algorithm. Whereas, the new proposed concept algorithms that are single bit error anti-collision algorithm and two-bit error anti-collision algorithm. There are two methods involved in this project including collision tracking method which is Manchester Coding and timing method which is Gen-2 RFID Standard.

3.1 Static Tree Based Anti-collision Algorithm

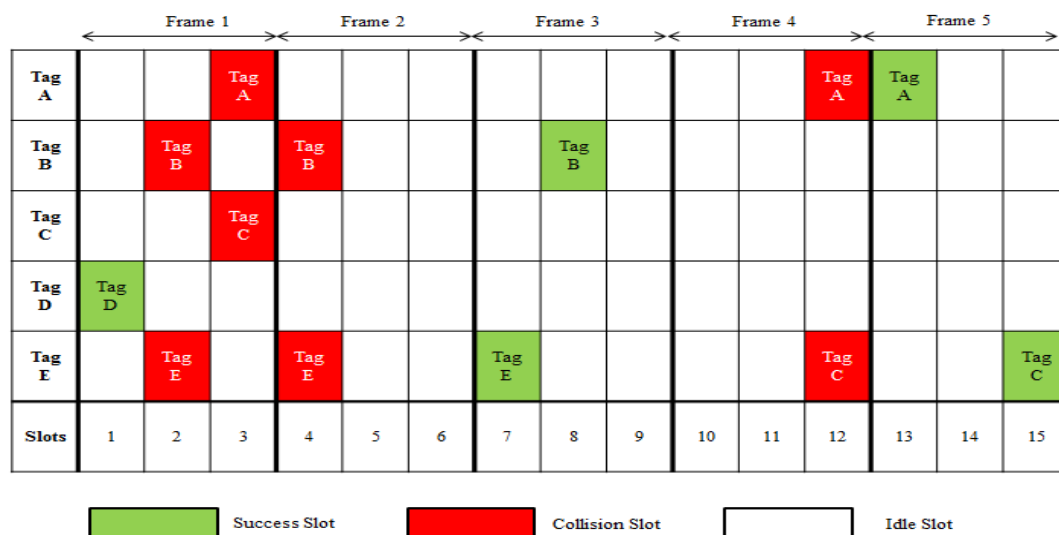


Figure 3.1.1: Static Tree Based Anti-collision Algorithm Process by 3 Frame Sizes

In static tree based algorithm, reader will announce the frame size according to the segmentation of slot number. These frame size is fixed in entire of process. The tags that wish to send the information to the reader will only send their information within a frame. If there was collision occur in the frame, this collision will be solved in the next frame. After this collision solve, the rest of the tag will give same opportunity to send the information again to the reader. This process will be repeating until all the tag information had successful send to reader.

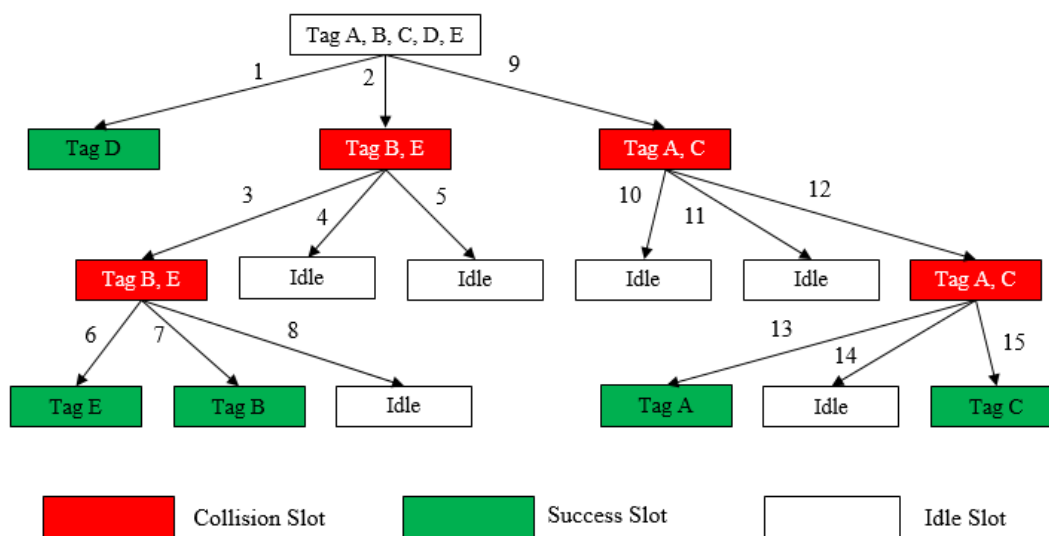


Figure 3.1.2: Tree Diagram for Static Tree Based Anti-collision Algorithm

3.2 Dynamic Tree Based Anti-collision Algorithm

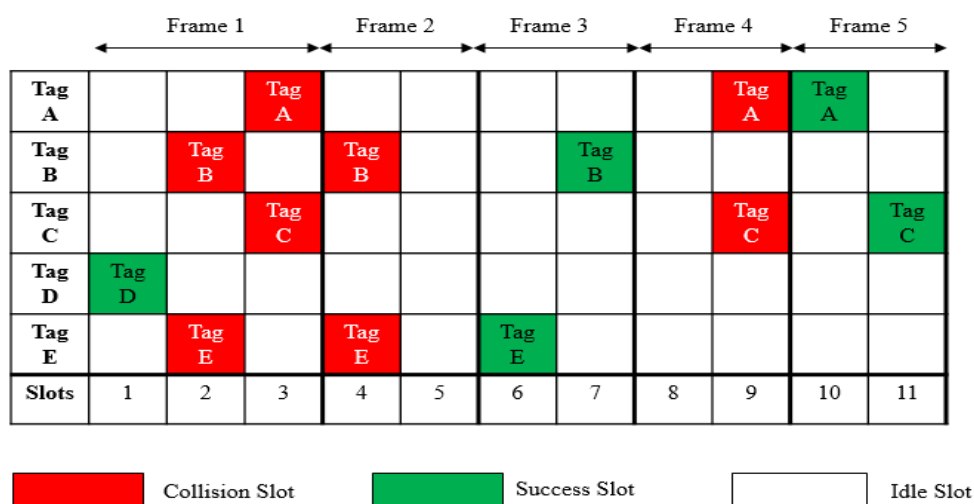


Figure 3.2.1: Dynamic Tree Based Anti-Collision Algorithm Process

The difference between static based and dynamic based is the definition of the frame size. In dynamic tree based algorithm, reader will only announce the frame size according to the segmentation of slot number in the first place. However, the next frame size will be deciding by the number of the collision tags. The frame size is same as the number of tags collision in that particular tags. It given the meaning that the frame size is always dynamic according to the number of tags collision occur. The rest of the process will be same as static based tree algorithm.

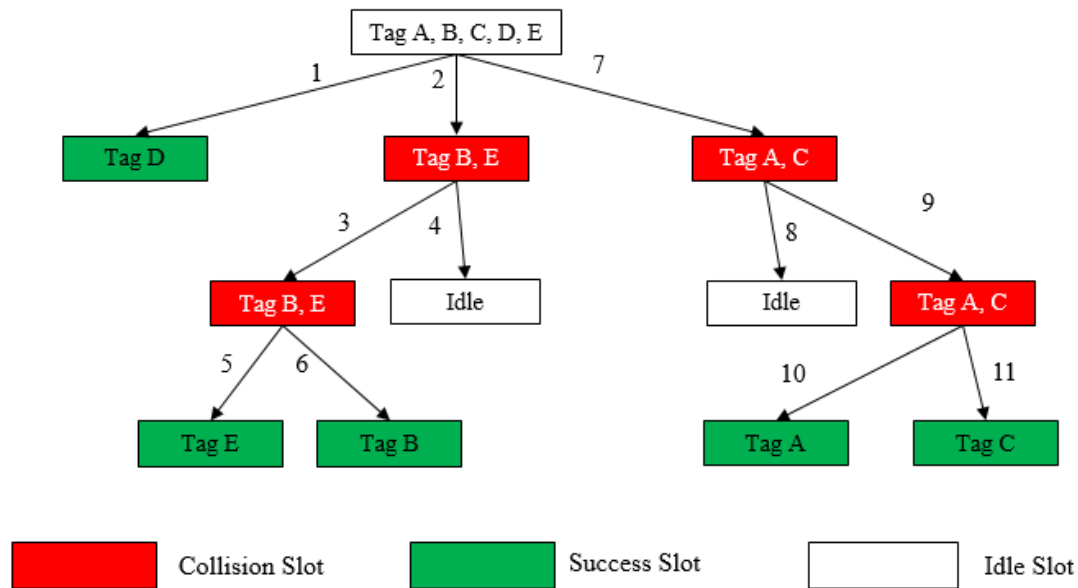


Figure 3.2.2: Dynamic Tree Diagram for Tree Based Anti-Collision Algorithm

3.3 Collision Tracking Method – Manchester Coding

The new proposed concept algorithms are applied with collision tracking method which is Manchester Coding. Therefore, the Manchester Coding theory will be explained before the new proposed concept algorithm for better understanding.

	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
Tag A:	1	0	1	1	0	1	0	1
Tag B:	1	1	0	0	0	1	1	1
Tag C:	1	1	0	1	0	0	1	1
	1	X	X	X	0	X	X	1

Figure 3.3.1: Example of Manchester Coding Theory for Three Tags

According to Manchester Coding theory, suppose each of tags will have a unique identification code that are represent in binary form (Zhiwen and Min, 2016). It will track each bit by each bit to search for collided bit and success bit. The bit that offset with each other is consider as error bit which is collided bit. From Figure 3.3.1, bit 2,

bit 3, bit 4, bit 6 and bit 7 are offset between three tags, therefore it considers as collided bits. Whereas bit 1, bit 5 and bit 8 are same among three tags therefore it considers as success bits and will return back the same value in the sending process. The reader will receive 1XXX0XX1 as identification code.

3.4 Single Bit Error Anti-collision Algorithm

Tag A: 1010 0001		Tag B: 1011 1101		Tag C: 1010 0010	
Tag D: 1011 1110		Tag E: 1010 1010			

Slot no: 0	Slot no: 1	Slot no: 2	Slot no: 3	Slot no: 4
Reader: 1111 1111	Reader: 1010 1111	Reader:1010 0011	Reader:1010 0010	Reader:1010 0011
Collision: A,B,C,D,E	Collision: A,C,E	Collision: A,C	Success: C	Success: A
1010 0001	1010 0011	1010 0011		
1011 1101	1010 0010	1010 0010		
1010 0010	1010 1010	1010 001X		
1011 1110	1010 X01X			
1010 1010				
101X XXXX				

Slot no: 5	Slot no: 6	Slot no: 7	Slot no: 8	Slot no: 9
Reader: 1010 0111	Reader: 1010 1111	Reader:1011 1111	Reader:1011 1101	Reader:1011 1111
Idle Slot	Success: E	Collision:B,D	Success: B	Success: D
		1011 1101		
		1011 1110		
		1011 11XX		

Figure 3.4.1: Example of Single Bit Error Anti-collision Algorithm Process for Five Tags

In single bit error anti-collision algorithm process, each of the tags that occur within reader range will be assigned with a unique identification code in binary form. From figure 3.4.1, there are five tags that assigned with eight bits identification code. At the beginning of the process, reader will broadcast a request which is the highest value of particular bits. In the example, the reader will broadcast highest value of eight bits which is 1111 1111 to all the tags within the reader range. After that, all the tags will compare their identification code with the value that send by reader, if the tag's identification code is less than or equal to the reader's value, the tags will send it identification code to reader. From figure 3.4.1, all of the tags are less than reader value, it creates collision situation which all the tags will send it identification code to reader. Hence, Manchester coding theory is applied when the collision occurs in order to track error bit occur and make adjustment of bit according to error bits.

After applied with Manchester coding theory, the result received is 101X XXXX. In this single bit error anti-collision algorithm, the first collided bit will be set to 0 while

the remaining collided bit will be set to 1. The new setting value will become the next value that broadcast by reader. The next value broadcast by reader will be 1010 1111 according to figure 3.4.1. Again, all the tags will compare their identification code with reader's value, now there are 3 tags are less than or equal to reader's value which is tag A, tag C and tag E. Then it will use Manchester Coding to track error bits and change the error bits value become the next value broadcast by reader. These process will be repeat until there is success tag or idle tag occur. Success tag occur when there is only one tag identification code is less than or equal to reader's value. Idle tag occurs when there is no tag identification code is less than or equal to reader's value. When success tag or idle tag is occurring, the last bit of 0 will set to 1 such as the process in slot no 3 and 4 in figure 3.4.1. The new setting value will become next value that broadcast by reader and continue comparison and Manchester Coding process. The solving collision step will be repeat until all tags are successfully send their information to reader.

Although this algorithm performs better than existing algorithm which is static tree algorithm and dynamic tree algorithm. However, this new proposed concept having disadvantages which is when the more bits used as tag's identification code, the more number of slot used will be occurs. Therefore, another new concept which is two-error bits anti-collision algorithm is proposed to reduce the number of idle slot and increase efficiency.

3.5 Two-Bit Error Anti-collision Algorithm

Tag A: 10 0000 1110		Tag B: 01 1000 0110		Tag C: 01 1100 0011	
Tag D: 00 1101 0011		Tag E: 11 1111 0100			

Slot no: 0	Slot no: 1 [00]	Slot no: 2 [01]	Slot no: 3 [00]	Slot no: 4 [01]
Reader: 11 1111 1111	Reader: 00 1111 1111	Reader: 01 1111 1111	Reader: 01 1000 0011	Reader: 01 1000 0111
Collision: A,B,C,D,E	Success: Tag D	Collision: B, C	Idle Slot	Success: Tag B
10 0000 1110 01 1000 0110 01 1100 0011 00 1101 0011 11 1111 0100 XX XXXX XXXX		01 1000 0110 01 1100 0011 01 1X00 0X1X		

Slot no: 5 [10]	Slot no: 6 [11]	Slot no: 7	Slot no: 8
Reader: 01 1100 0011	Reader: 01 1100 0111	Reader: 11 1100 0111	Reader: 111 1100 0111
Success: Tag C	Idle Slot	Success: Tag A	Success: Tag E

Figure 3.5.1: Example of Two-Bit Error Anti-collision Algorithm Process for Five Tags

In order to have better explanation for algorithm, the example of two-bit error anti-collision algorithm will be represented in ten bits. This is because two-bit error anti-collision algorithm is suitable used for long bits of tag's identification code. At the beginning of the process, reader will broadcast a request which is the highest value of particular bits which is ten bits for example. In the example, the reader will broadcast 11 1111 1111 to all the tags within the reader range. After that, all the tags will compare their identification code with the value that send by reader, if the tag's identification code is less than or equal to the reader's value, the tags will send it identification code to reader. If there are more than one tags send their identification code to reader, there is collision occur, therefore Manchester coding was applied.

There are two condition will occur in this algorithm after applied with Manchester Coding which is there is only one error bit being track and there are more than one error bits being track. If there is only one error bit being track, the process will be same as single bit error anti-collision algorithm until there is success tag or idle slot occur. Once success tag or idle slot is found, the previous error bits will be identified and adjust according to the condition.

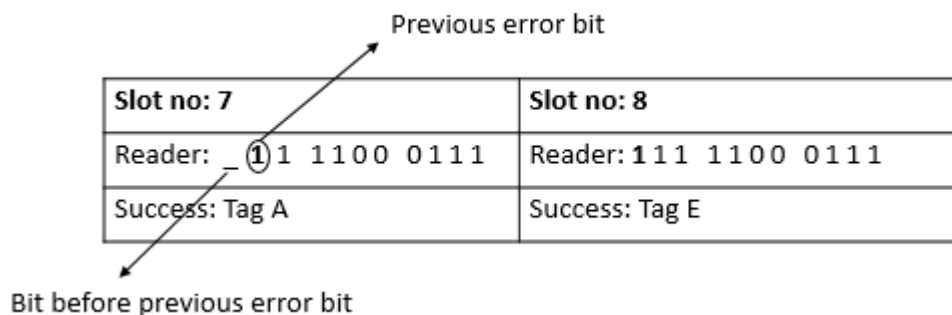


Figure 3.5.2: Detail of Example for Slot Condition for One Bit Error

If the previous error bit is 0, this particular error bit will set to 1 and become next reader value. Else if the previous error bit is 1, the position of bits that are place before the previous first error bit will be check. The last bit that is 0 will be set to 1 and become next reader value. This condition occurs in Slot no 7 and Slot no 8 as shown in Figure 3.5.2.

However, if there are more than one bits being track, thus there are four possibilities will be found with the first two collided bits which is 00, 01, 10, 11. In the case that there is collision occur will set the first two collided bits to 00, the rest of the collided bits will set to 1. Once success tag or idle slot is occurring, the previous error bits will be identified and adjust according to the condition. There are four conditions will happen which is:

- If previous error bits are 00, these particular error bits will set to 01 as next reader value.
- If previous error bits are 01, these particular error bits will set to 10 as next reader value.
- If previous error bits are 10, these particular error bits will set to 11 as next reader value.
- If previous error bits are 11, the bits before first error bit's position will be identified, the last bit that is 0 will set to 1 and become next reader value.

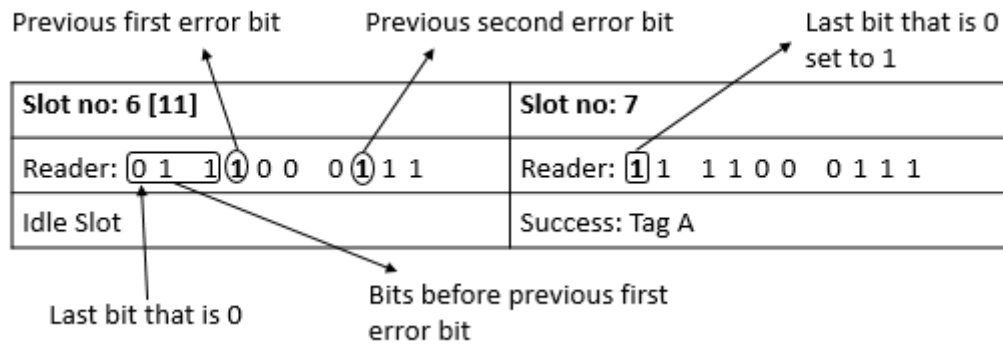


Figure 3.5.3: Detail of Example for Slot Condition for Two Bit Error

The process will repeat until all tags successfully send their identification code to reader.

3.6 Timing Method – Gen-2 RFID Standard

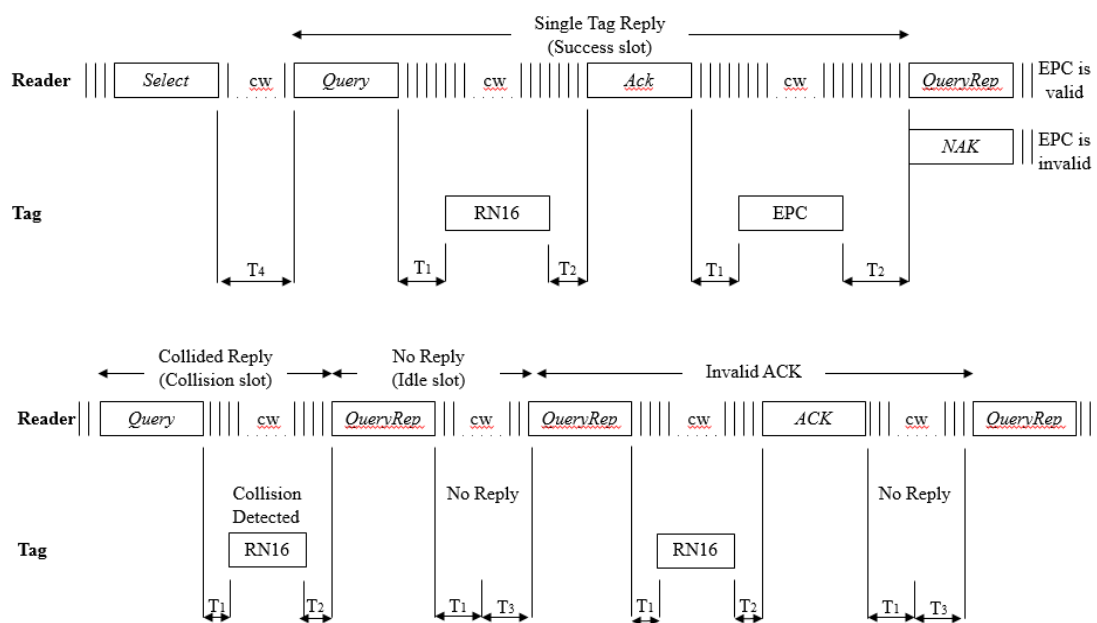


Figure 3.6.1: Detail of timing for each success, collision and idle slot in Gen-2 Standard (Solic, Stella, and Saric, 2013)

A reader transmits a continuous-wave (CW) RF signal to tag in order to receive information from that particular of tag. Reader will announce the frame size to tag by broadcasting through a *Query* command. Tag will then choose random spot by using build-in slot counters in the frame. This slot counter is randomly choosing from number. After finish this process, reader will start interrogation to tags. Tag will then set their slot counter to 0 and immediately respond their 16-bit random number (*RN16*)

back to the reader. If this *RN16* command successfully decode by the reader, the acknowledgement (*ACK*) should be sending out by the reader. After receive the *ACK*, tag will send their Electronic Product Code (*EPC*) to the reader. This *EPC* define as a tag identifier which is used for item identification. Once reader read *EPC* successfully, this slot can define as success slot. However, if the decoding process does not successfully, the reader will send a negative acknowledgement (*NACK*).

In the case that collision is detected when multiple *RN16* that generate by tags are sending to the reader, these collisions have to be resolve until it become successful slot. For empty slots cases, reader does not read *RN16* from the tags if the tags do not respond to the reader in the time range of Query Reply (*QRep*).

Symbol/Term	Description
BLF	Backscatter-link frequency define as tag-reader response frequency
DR	Divide ratio, use to define tag-reader symbol rate.
M	Number of Miller subcarrier cycles.
Rbl	Reader bit length.
RTcal	Reader-to-tag calibration symbol.
T ₁	Transmission time from reader to tag response for an reply from immediate tag.
T ₂	Response time from tag to reader.
T ₃	Waiting time for reader before issues another command and after T ₁ .
T ₄	Minimum of time between each of reader commands.
TFS	Time Frame Sync
TRcal	Tag to reader calibration symbol.

Table 3.6.1: Description of Term for Gen-2 Standard

Symbol/Term	Formula
BLF	$40kHz \leq BLF \leq 640kHz$
DR	64 / 3 or 8
M	1, 2, 4 or 8
Rbl	$(2Tari + 0.5Tari) / 2 \leq Rbl \leq 3Tari / 2$
RTcal	$1.5Tari \leq RTcal \leq 2Tari$
Tari	$6.25\mu s \leq Tari \leq 25\mu s$
TRcal	$DR \times Tpri$
Tpri	$1 / BLF$
TRext	Value 0 (TRext ₀ = 4) or value 1 (TRext ₁ = 16)
TFS	$(12 \times 10^{-6}) + Tari + 2.5Tari \leq TFS \leq (12 \times 10^{-6}) + Tari + 3Tari$
PRT	$2.5 \times 10^{-6} + Tari + 2.5Tari + 1.1TRcal$

Table 3.6.2: Formula Detail for Term using in Gen-2 Standard

Time	Equation
T_1	$\max(RT_{cal}, 10T_{pri}) \times (1 - 0.1) - (2 \times 10^{-6}) \leq T_i \leq$ $\max(RT_{cal}, 10T_{pri}) \times (1 + 0.1) + (2 \times 10^{-6})$
T_2	$3T_{pri} \leq T_2 \leq 20T_{pri}$
T_3	$\min(0.1T_{pri})$

Table 3.6.3: Equation Detail for Timing in Gen-2 Standard

Command Time	Equation
T_{Query}	$PRT + 22Rbl$
T_{ACK}	$TFS + 18Rbl$
T_{Qrep}	$TFS + 4Rbl$
T_{RN16}	$\lceil (TR_{ext_i} \times M) / BLF \rceil + (6M / BLF) + (17M / BLF)$
T_{EPC}	$\lceil (TR_{ext_i} \times M) / BLF \rceil + (6M / BLF) + \lceil (M \times (16 + 97 + 17)) / BLF \rceil$

Table 3.6.4: Equation Detail for Command Timing in Gen-2 Standard

$$\text{Duration of Idle slot } (T_E) = T_{query} + T_1 + T_3$$

$$\text{Duration of Collision slot } (T_C) = T_{query} + T_1 + T_{RN16} + T_2$$

$$\text{Duration of Successful slot } (T_S) = T_{query} + T_1 + T_{RN16} + T_2 + T_{ACK} + T_1 + T_{EPC} + T_2$$

CHAPTER 4: SYSTEM DESIGN

4.1 System Flow for Static Tree Based Anti-collision Algorithm

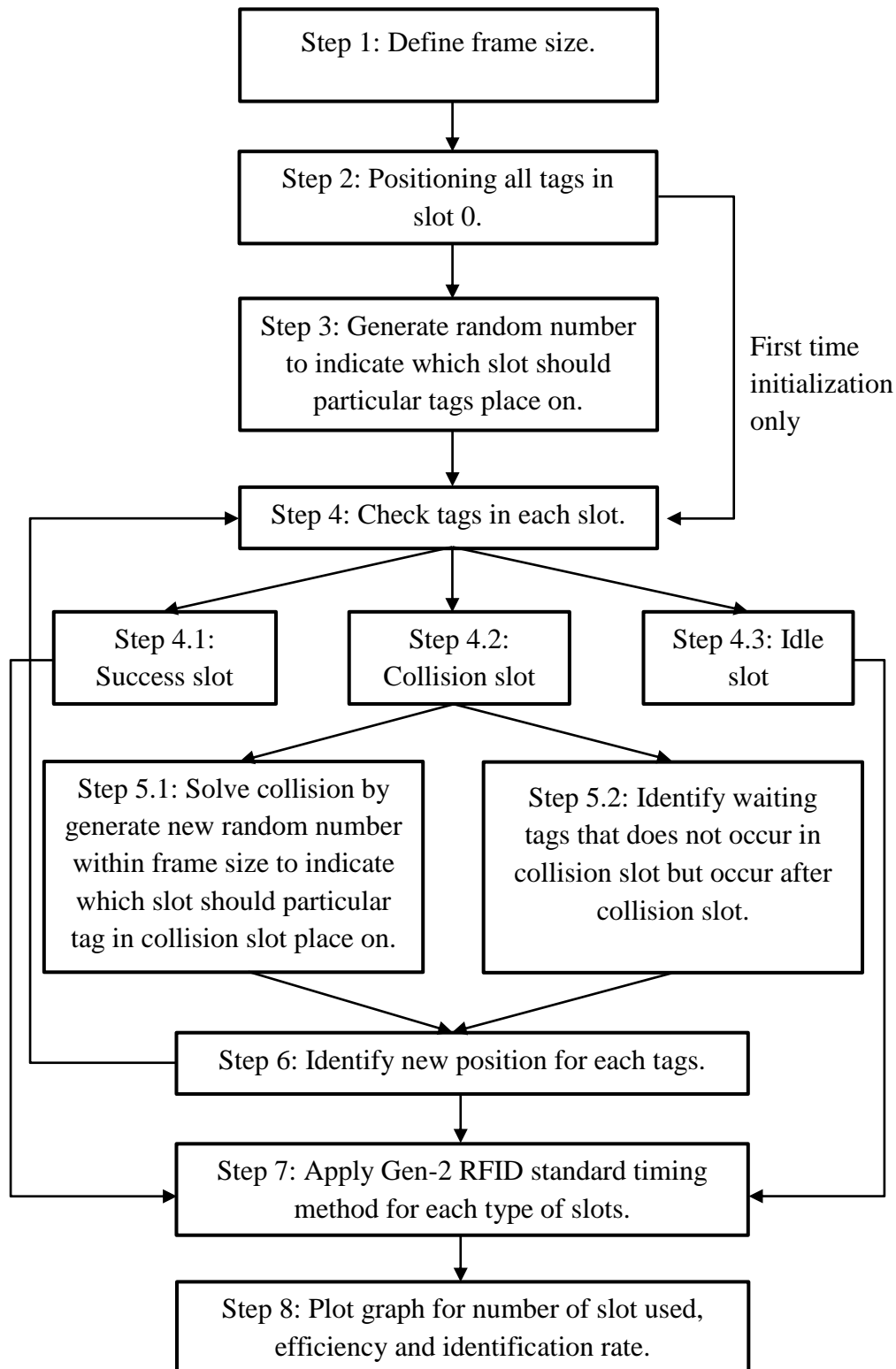


Figure 4.1.1: System Flow for Static Tree Based Anti-collision Algorithm

Step 1: Define frame size

Frame size will define in the initial of the application. This frame size is fixed and will be used for entire application.

Step 2: Positioning all tags in slot 0

All tags are set to slot 0 in the beginning of the application for ease of calculation purpose. For first time initialization, it will skip step 3.

Step 3: Generate random number to indicate which slot should particular tags place on

A matrix will be creating in order to generate a random number according to the frame size that define in the beginning of the application. This random number generated will indicate the particular tags should place at which slot within a frame size. Therefore, the random number is defining as slot number for each of the tag.

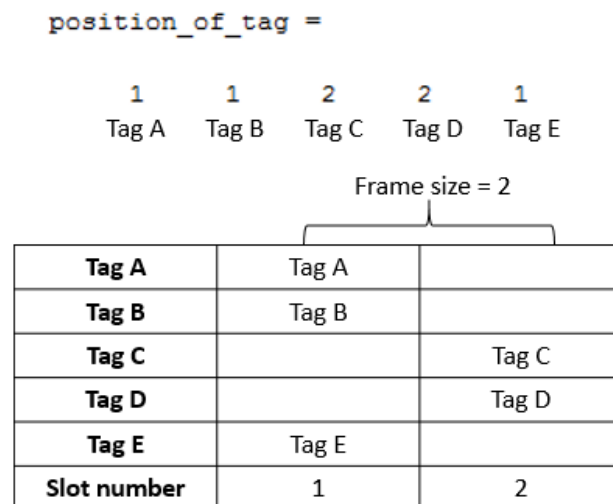


Figure 4.1.2: Example of Random Number Generation for 2 Frame Sizes

Step 4: Check tags in each slot

In this process, each of the slot will be check in order to find out which tags inside that particular of slot. There will be categorize into three categories after checking which is success slot, collision slot and idle slot.

Step 4.1: Success slot

Success slot mean there are only one tag happen in that particular slot. If there is success slot occur, the next process will be on step 7.

Step 4.2: Collision slot

Collision slot mean that there is more than one tag happen in that particular slot. Therefore, they are requiring to solve this particular collision slot first before proceed to next slot.

Step 4.3: Idle slot

Idle slot is the slot that do not have any tag inside. If there is idle slot occur, the next process will be on step 7.

Step 5.1: Solve collision by generate new random number within frame size to indicate which slot should particular tag in collision slot place on.

In order to solve the collision of tags happen in particular slot, a new random number have to generate. This new random number having the range according to the frame size that define in Step 1. For example, if the frame size defines as 2, then this new random number have to generate between 1 and 2.

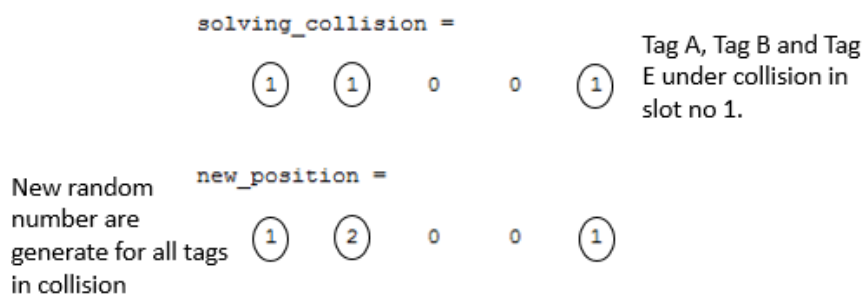


Figure 4.1.3: Example of Solving Collision by Generate New Random Number in Static Based

Step 5.2: Identify waiting tags that does not occur in collision slot but occur after collision slot.

The tags that does not occur in collision slot and not a success tag that occur before collision happen is define as waiting tags. This tags need to identify in order to process in the frame after the initial collision have been solve.

waiting tag = 1's complement of success x 1's complement of tag checking

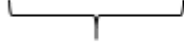
	Original		1's complement		
	success = [0 0 0 0 0]		~success = [1 1 1 1 1]		
	tag_checking = [1 1 0 0 1]		~tag_checking = [0 0 1 1 0]		
	Tag A	Tag B	Tag C	Tag D	Tag E
	1	1	1	1	1
x	0	0	1	1	0
<hr/>					
	0	0	1	1	0
<hr/>					
					
			Tag C and Tag D are waiting tags		

Figure 4.1.4: Example of Identifying of Waiting Tags

Step 6: Identify new position for each tags

The new position of collision tags has to identify in order to process the tags in next frame. Whereas the new position of waiting tags need to be identify in order to process the tags after the collision have been solve. Therefore, the new position of waiting tags should be after collision tags. After new position of each tags have been identified, the process will be repeat again from step 3 until the success tag is equal to number of tags.

new position of collision tags = position of tag + random number


	Tag A	Tag B	Tag C	Tag D	Tag E
Position of Tags	1	1	2	2	1
+ Random Number	1	2	0	0	1
<hr/>					
New position of Collision Tags	2	3	2	2	2
<hr/>					
					
			Tag C and Tag D are waiting tags, their new position should be after collision tags		

Figure 4.1.5: Example of Identify New Position of Collision Tags

new position for waiting tags = position of waiting tag + frame size

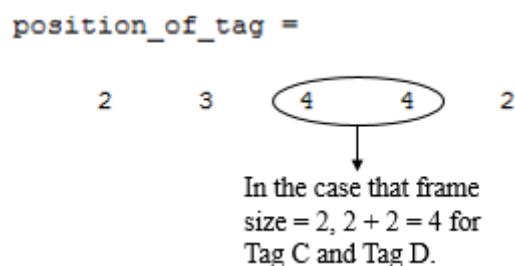


Figure 4.1.6: Example of Identify New Position of Waiting Tags

Step 7: Apply Gen-2 RFID standard timing method for each type of slots

Gen-2 RFID standard timing method will be applied and calculated for success slots, collision slots and idle slots in order to define the time used for each type of slots. This timing method is important to figure out the identification rate of the algorithm. The description of Gen-2 RFID standard has been discussed in previous chapter.

Step 8: Plot graph for number of slot used, efficiency and identification rate

The graph is plot according to the total number of slot used, efficiency and identification rate for multiple tags. Total number of slot used is the number of slot need to be used in order to achieve the condition that all tags successfully send out their information.

Calculation of Efficiency:

$$\text{Efficiency} = \frac{\text{Number of tags}}{\text{Number of slot used}}$$

Calculation of identification rate:

$$\text{Timing for success slot} = \text{Number of success slot} \times T_s$$

$$\text{Timing for collision slot} = \text{Number of collision slot} \times T_c$$

$$\text{Timing for idle slot} = \text{Number of idle slot} \times T_e$$

$$\text{Throughput} = \frac{\text{Number of slot used}}{\text{Timing for success slot} + \text{Timing for collision slot} + \text{Timing for idle slot} + T_{\text{query}}}$$

Step 1: Define frame size

Frame size will define in the initial of the application. However, this frame size will not be fixed and will be re-write that will be explain the process in Step 6.

Step 2 to Step 4

The process and description is exactly same as static tree based anti-collision algorithm.

Step 5.1: Identify number of tags in collision slot

In dynamic tree based algorithm, the frame size will be adjusting according to number of tags that happen in collision slot. Therefore, there is important to identify the number of tags occur in collision slot.

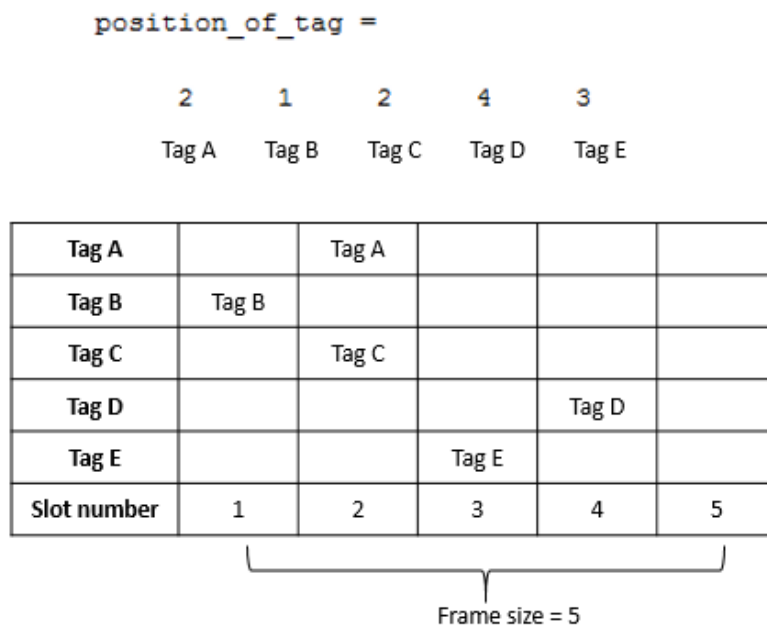


Figure 4.2.2: Example of Random Number Generation of 5 Frame Sizes

The collision occurs in slot number 2 will be solve first which is Tag A and Tag C. Since there are two tags occur in collision slot, therefore the next frame size will become 2 and this frame size will be use to generate new random number for collision tags.

Step 5.2: Identify waiting tags

The process is same as static tree based anti-collision algorithm.

Step 6: Solving collision by generate random number according number of tags occur in collision slot

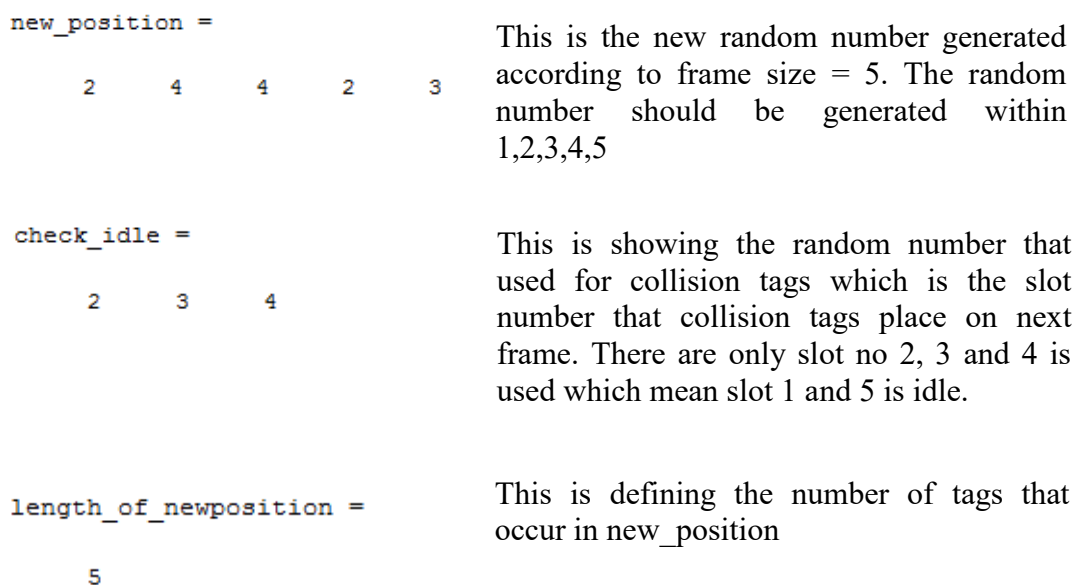
In order to solve the collision of tags happen in particular slot, a new random number have to generate. This new random number generate according to how many tags collision haven in this particular slots. It means that the frame size is generate according to the size of tag collision.



Figure 4.2.3: Example of Solving Collision by Generate New Random Number in Dynamic Based

Step 6.1: Identify hidden idle slot

There are hidden idle slot case happen when new random number is generating according to the number of collision tags.



```
length_of_checkidle =  
3
```

This is defining the length of check_idle which is the number of slot that have tags place.

Number of hidden idle slot = length of new position - length of check idle
 $= 5 - 3 = 2$

Step 7 to Step 9

The process and description is exactly same as static tree based anti-collision algorithm in step 7 to step 8.

4.3 System Flow for Single Bit Error Anti-collision Algorithm (Proposed Method)

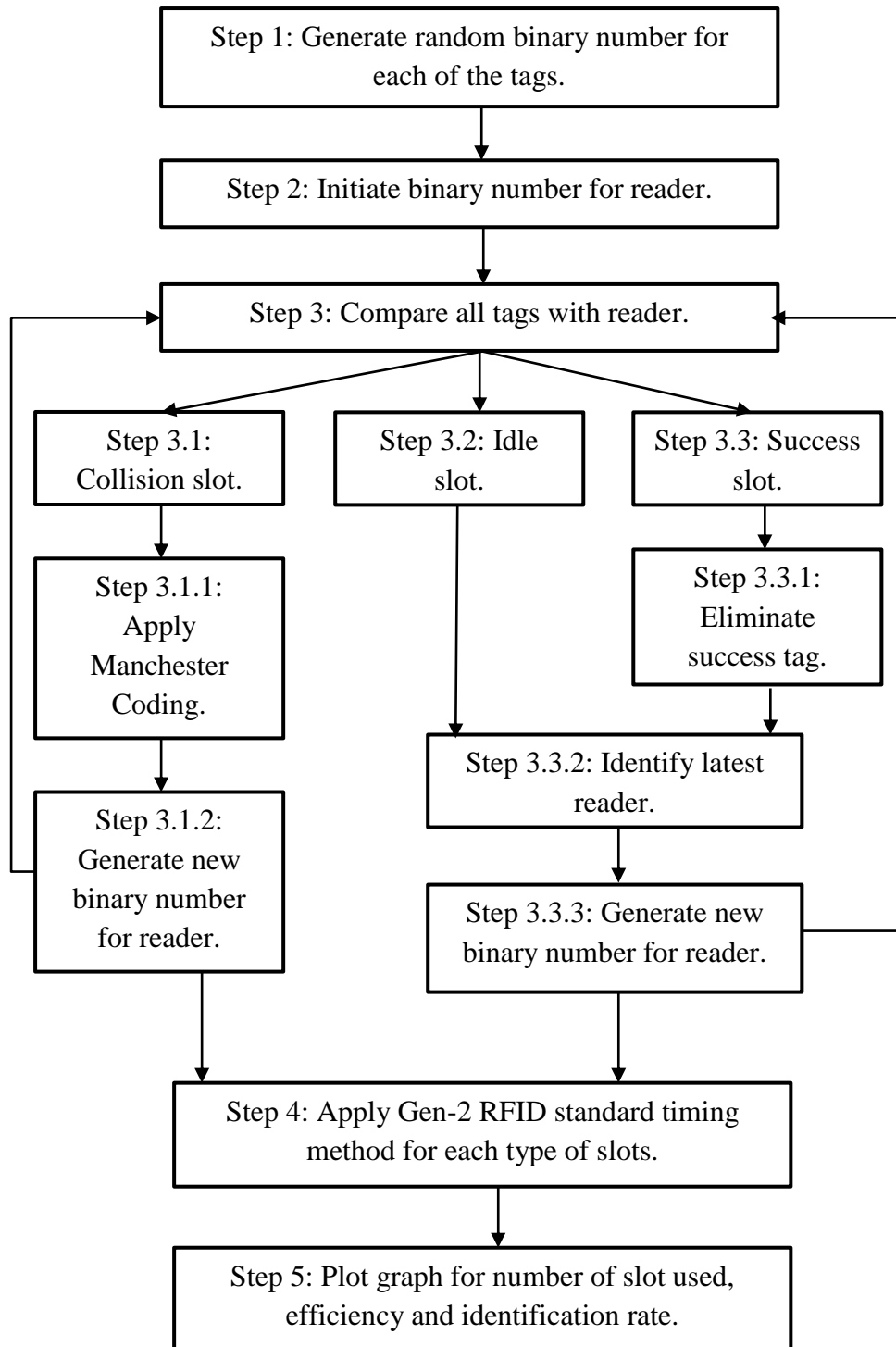


Figure 4.3.1: System Flow for Single Bit Error Anti-collision Algorithm

Step 1: Generate random binary number for each of the tags

A unique random binary number will be generating for each of the tags.

```

rand_tag =
    0   1   0   0   0   0   1   0   1   1
    0   1   1   1   1   0   0   1   1   1
    0   1   0   0   0   0   0   1   0   0
    0   0   1   0   0   1   0   1   1   1
    1   0   1   0   0   0   0   1   0   1
    
```

Figure 4.3.2: Example of Random 10 Bits Binary Number of 5 Tags

Step 2: Initiate binary number for reader

A binary number will be initiate by reader in order to perform comparison process with tag's identification code. In first time initialization, the binary number that assign for reader is the highest value of particular bits. If 10 bits have been assign to tags, then the reader will be initiate as highest value of 10 bits which is 11 1111 1111.

Step 3: Compare all tags with reader

All the tags binary number will perform comparison process with reader initialized binary number. If the tag's binary number value is less or equal to reader initialized binary number, this tag has priority to send their information to the reader. However, there were occur three case after comparison process which is success slot, idle slot and collision slot.

Step 3.1: Collision slot

Collision slot mean that there are more than one tag's binary numbers value are less than or equal to reader initialized binary number. In this case, these tags are not able to send their information to reader and have to compete again with each other. In order to solve the collision, there are a two steps need to perform.

Step 3.1.1: Apply Manchester Coding

Manchester Coding theory have been explained in chapter 3. Basically Manchester Coding is the method of collision tracking which can figure out which bit of tag's binary number are error.

m =	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10
Tag A	0	1	0	0	0	0	1	0	1	1
Tag B	0	1	1	1	1	0	0	1	1	1
Tag C	0	1	0	0	0	0	0	1	0	0
Tag D	0	0	1	0	0	1	0	1	1	1

different =	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10
	1	0	0	0	0	0	0	0	0	0

Error bits because there are not same bits with each other.

Figure 4.3.3: Example of Applied Manchester Coding Theory

Step 3.1.2: Generate new binary number for reader

The new binary number for reader is generating according to error bit after applied Manchester Coding. In single bit error anti-collision algorithm, the first error bit will be set to 0 while the remaining error bit will be set to 1. The bit that does not error will remain the same. This new reader's binary number will use to perform comparison process in step 3.

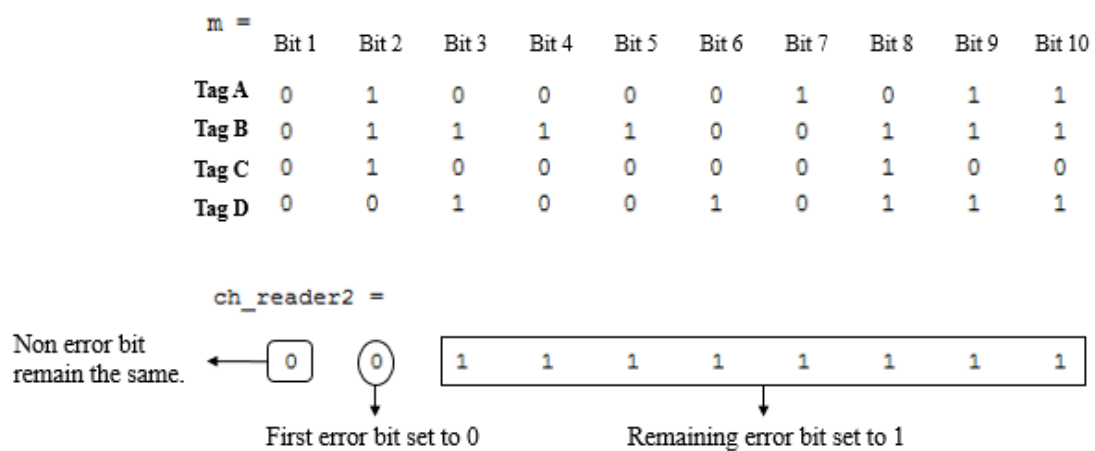


Figure 4.3.4: Example of New Binary Number Generation for Reader in Single Bit Error Anti-collision Algorithm

Step 3.2: Idle slot

Idle slot means that there is no tag's binary number value is less than or equal to reader initialized binary number. There are a few steps need to perform after identify idle slot which is step 3.3.2 and step 3.3.3 which is same as success slot that will explain later.

Step 3.3: Success slot

Success slot mean that there is only one tag's binary number value is less than or equal to reader initialized binary number after comparison process.

Step 3.3.1: Eliminate success tag

The success tag that happen in success slot will be eliminate for the following process because this tag already successfully sends its information to reader.

Step 3.3.2: Identify latest reader

The identification of latest reader process mean that the previous reader binary number need to figure out in order to understand which bit is error in previous process. This is because the reader binary number will be adapting in every slot.

Step 3.3.3: Generate new binary number for reader

The way of generating new binary number for reader in success slot and idle slot is different with collision slot. In success slot and idle slot, the last bit of 0 in previous reader binary number will change to 1. The new reader's binary number will use to perform comparison process with the rest of the tags in step 3.

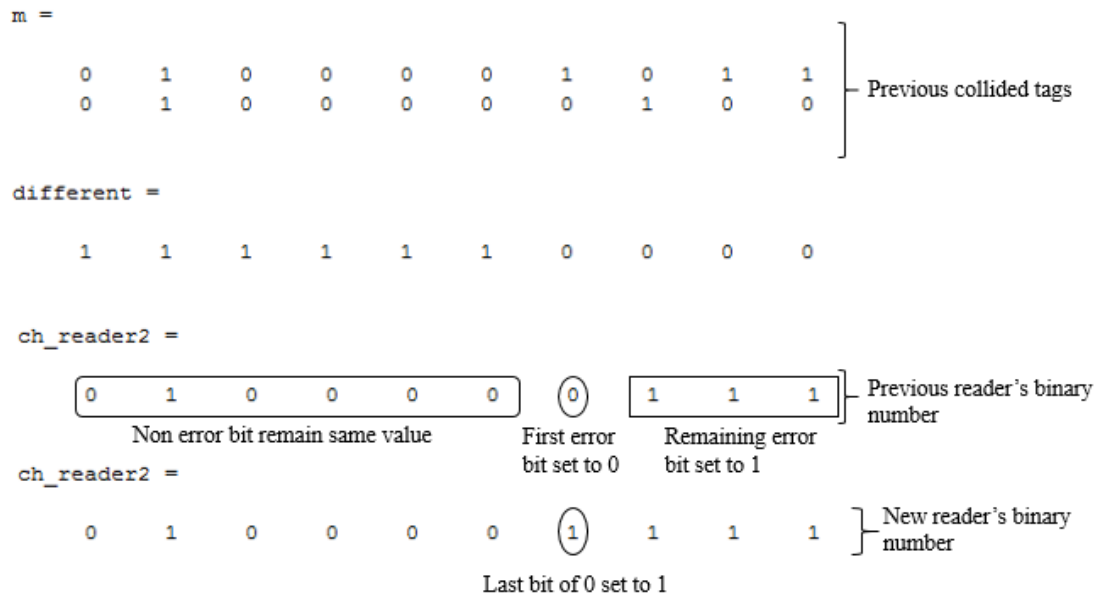


Figure 4.3.5: Example of New Binary Number Generation of Success and Idle Slot
Step 4 to Step 5

After all tags is successfully send out their information, these two steps need to perform. The process and description is exactly same as static tree based anti-collision algorithm in step 7 to step 8.

4.4 System Flow for Two-Bit Error Anti-collision Algorithm (Final Proposed Method)

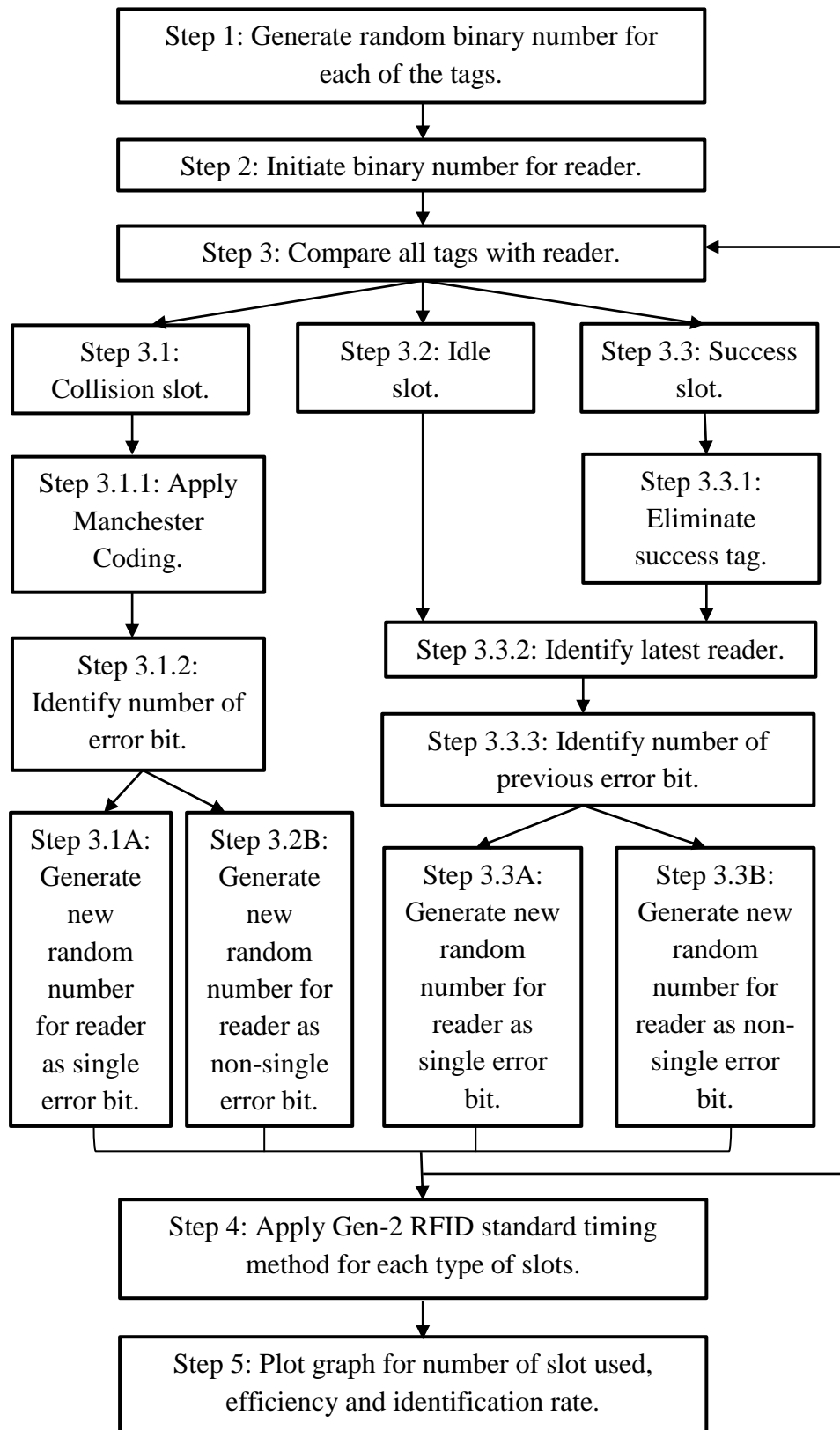


Figure 4.4.1: System Flow for Two-Bit Error Anti-collision Algorithm

Step 1 to Step 3

The process and description is exactly same as single bit error anti-collision algorithm.

Step 3.1.2: Identify number of error bit

Since the algorithm is seeking for two error bit, therefore there is important to detect how many error bit occur in the collision slot. There are two possibilities which is error bit is single error bit and more than one error bit which is non single error bit. Both of the solution of generate new reader's random number is different.

Step 3.1A: Generate new random number for reader as single error bit

If there are only one error bit occur in collision slot, the process of generation of new random number for reader is exactly same as single bit error anti-collision algorithm in step 4.1.2.

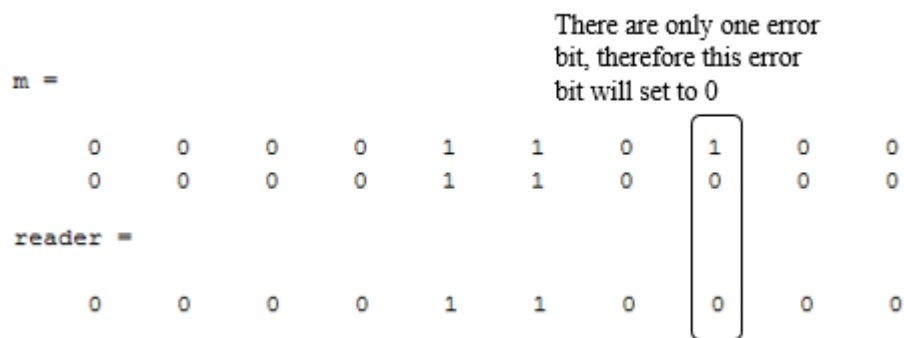


Figure 4.4.2: Example of Generating New Random Number for Reader as Single Error Bit for Two-bit Error Anti-collision Algorithm

Step 3.2B: Generate new random number for reader as non-single error bit

If there are more than one error bit occur in collision slot, the first two error bits set to 00, the rest of the error bits set to 1, and non-error bits will remain

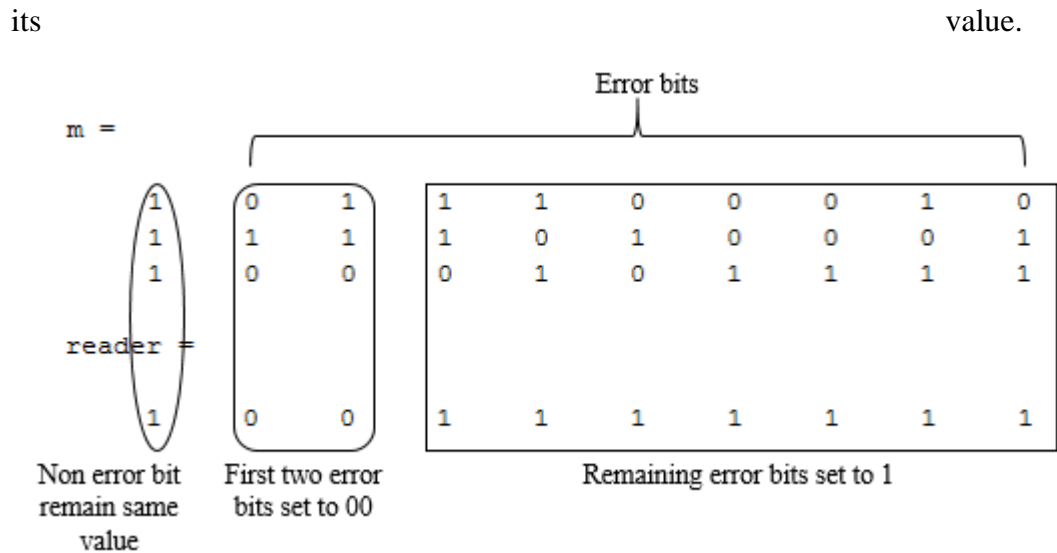


Figure 4.4.3: Example of Generating New Random Number for Reader as Non-single Error Bit for Two-bit Error Anti-collision Algorithm

Step 3.2 to step 3.3.2

The process and description is exactly same as single bit error anti-collision algorithm.

Step 3.3.3: Identify previous error bit

There is important to identify number of previous error bit because there are two possibilities of error bit which is single error bit and non-single error bit. The content of error bit also need to identify in order to have different way of binary number generation for reader.

Step 3.3A: Generate new random number for reader as single error bit

There are two possibilities case of getting previous error bit which is either 0 or 1. If the previous error bit is 0, then this error bit will change to 1 for next reader value.

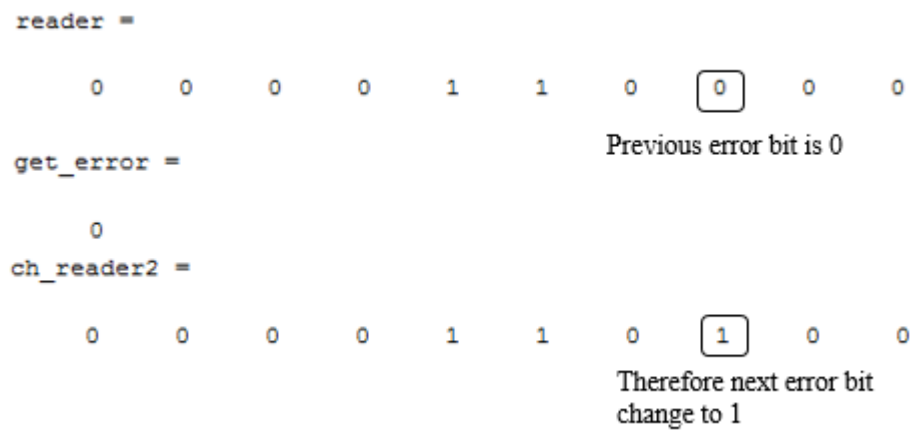


Figure 4.4.4: Example of New Generation of Reader Value when Previous Error Bit is 0

Whereas if the previous error bit is 1, then the last bit of 0 before the error bit will change to 1.

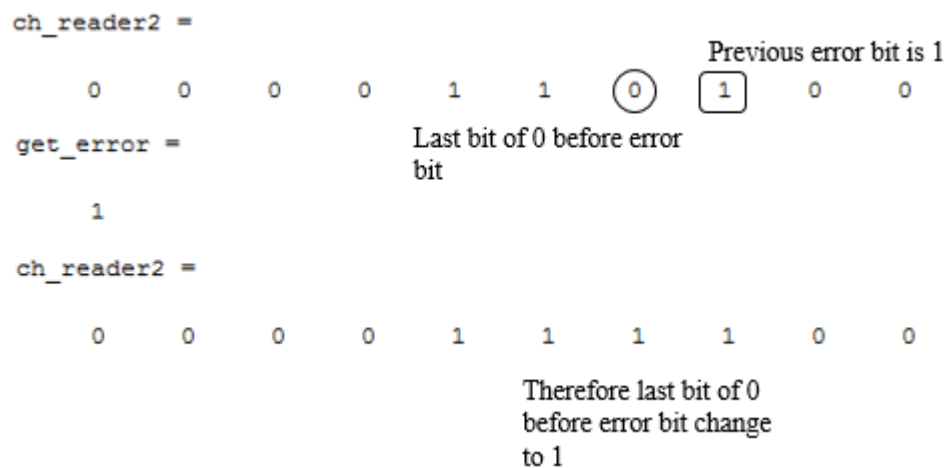


Figure 4.4.5: Example of New Generation of Reader Value when Previous Error Bit is 1

Step 3.3B: Generate new random number for reader as non-single error bit

There are four possibilities case of getting previous error bit which is 00, 01, 10 and 11. If previous error bit is 00, then this error bit will change to 01 for next reader value.

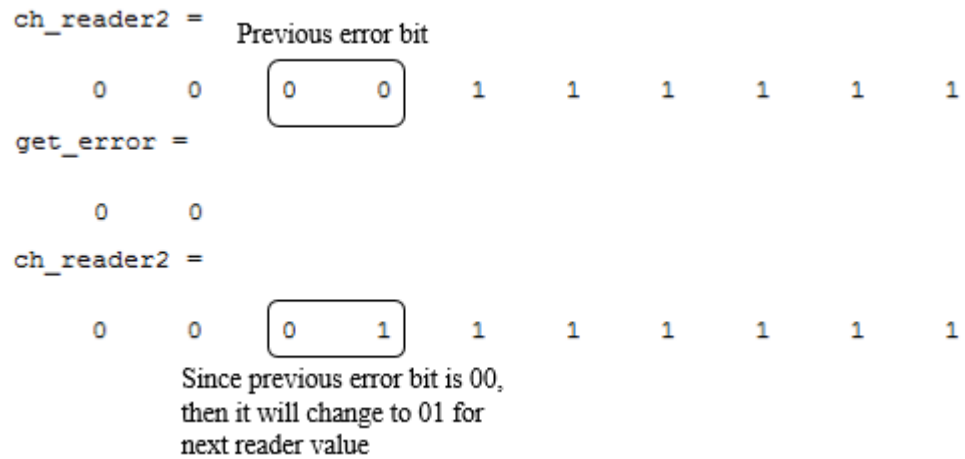


Figure 4.4.6: Example of New Generation of Reader Value when Previous Error Bit is 00

If previous error bit is 01, then this error bit will change to 10 for next reader value.

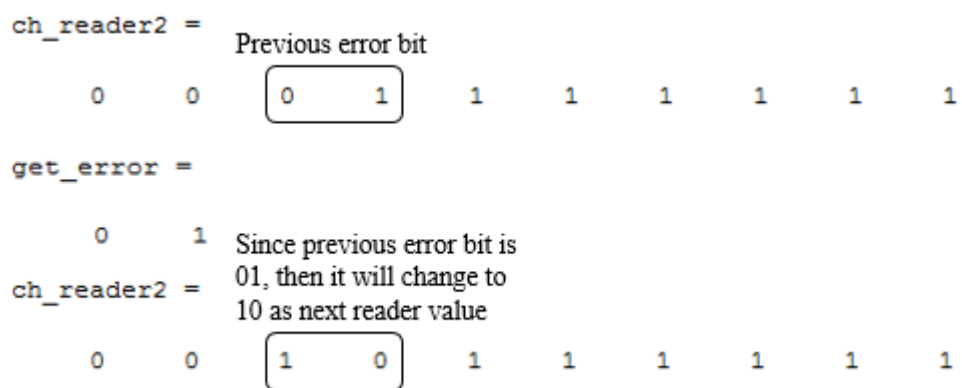


Figure 4.4.7: Example of New Generation of Reader Value when Previous Error Bit is 01

If previous error bit is 10, then this error bit will change to 11 for next reader value.

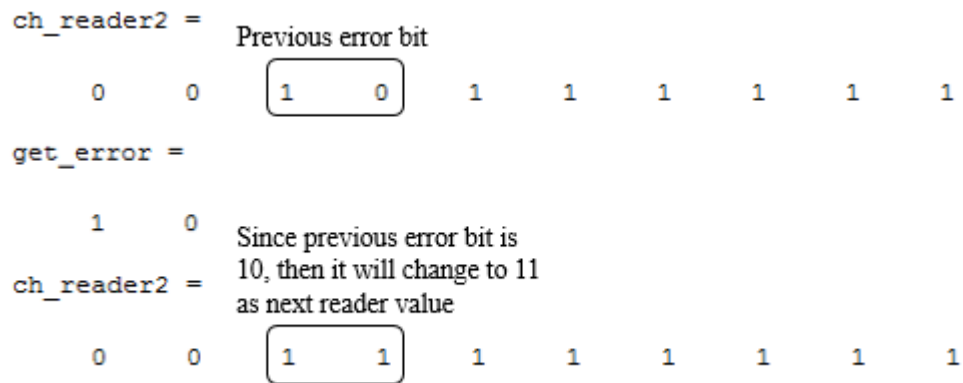


Figure 4.4.8: Example of New Generation of Reader Value when Previous Error Bit is 10

If previous error bit is 11, then the last bit of 0 before the error bit will change to 1.

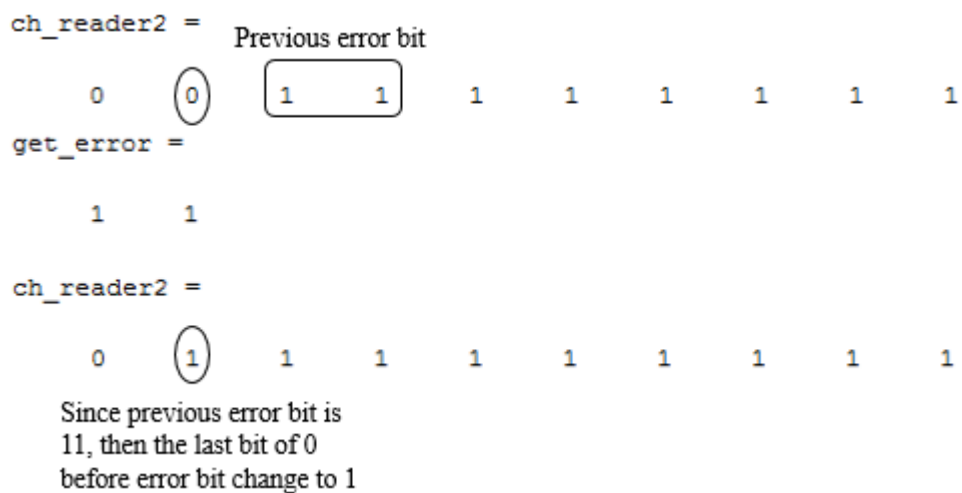


Figure 4.4.9: Example of New Generation of Reader Value when Previous Error Bit is 11

Step 4 to Step 5

After all tags are successfully sent out their information, these two steps need to perform. The process and description is exactly same as static tree based anti-collision algorithm in step 7 to step 8.

CHAPTER 5: METHODOLOGY AND PERFORMANCE ANALYSIS

5.1 Methodology

Appropriate methodologies take an important role to accomplish this project in a well structure to achieve the project objective. The delivery of this project is focus on simulation on performance of all four algorithms including static tree, dynamic tree, single bit error and two-bit error anti-collision algorithm for RFID system, therefore the methodologies that choose should support on these areas. A well know program that chosen to accomplish this program is Matlab.



Figure 5.1.1: Logo of MATLAB application (Kenn, 2015)

MATLAB also known as matrix laboratory serve as a high level programming language that developed by MathWorks. It has capabilities in, data analysis and visualization, numeric computation, development of programming and algorithm and also development and deployment of application (*Products & Services*, 2015).

The application for four algorithms will be executed by Matlab and plot different graph to examine their number of tags according to tags number, efficiency and identification rate after applying timing from Gen-2 standard. The performance of algorithms is shown in simulation result that created through Matlab application.

5.2 Performance Analysis

5.2.1 Slot Used Performance Analysis

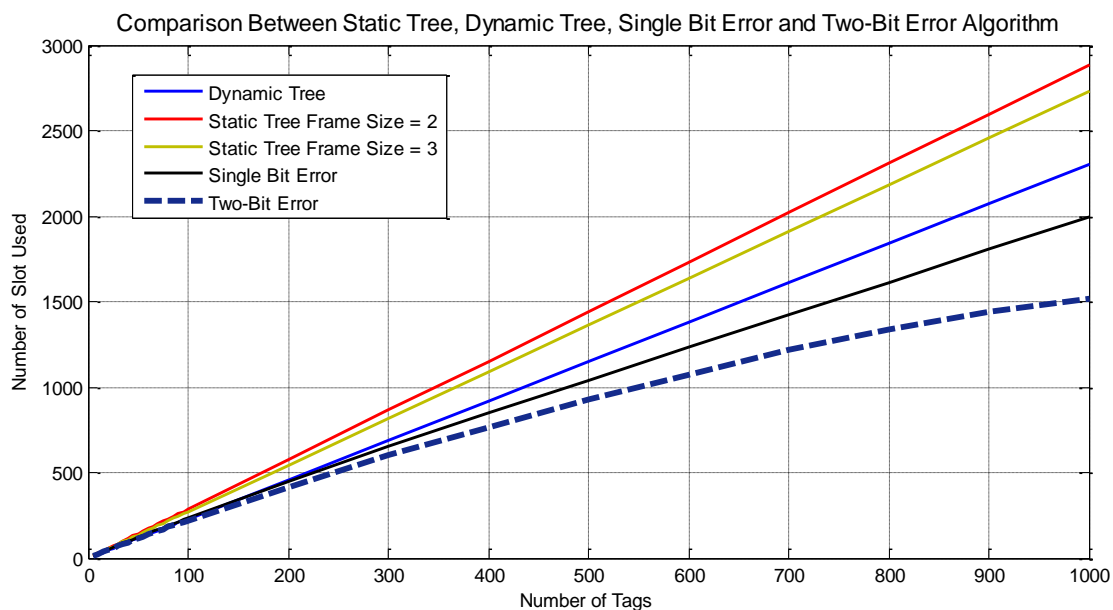


Figure 5.2.1: Slot Used Performance Result Between Four Algorithms

The benchmark on evaluate the number of slot used performance is according to how many slots will be used when there are 1000 tags in process. The lesser the number of slot used, the better the performance. According to the simulation result shown in Figure 5.2.1, two-bit error anti-collision algorithm have the best performance of number of slot used among all algorithms which is approximately to 1500 slots used when there are 1000 tags in the process. Whereas the second best performance of number of slot used among all algorithm was single bit error anti-collision algorithm that used approximately 2000 slots in order to solve 1000 tags in process.

This result show that the proposed method of two-bit error and single bit error anti-collision algorithm is improve the performance of existing algorithm which is static tree and dynamic tree anti-collision algorithm. Static tree algorithm need approximately 2700 slots in order to solve 1000 tags in process whereas dynamic tree algorithm need approximately 2250 slots to solve 1000 tags in process.

5.2.2 Efficiency Performance Analysis

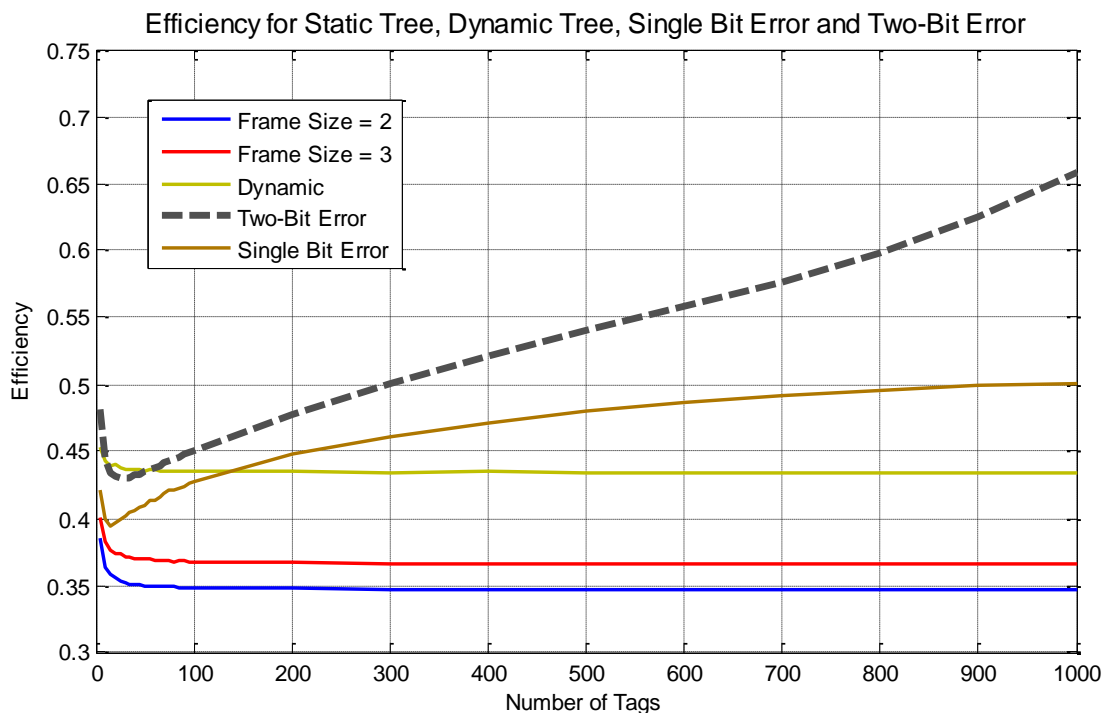


Figure 5.2.2: Efficiency Performance Result Between Four Algorithms

The benchmark on evaluate the efficiency performance is based on the number of tags divide by the number of slot used. The higher the efficiency, the better the performance. Based on Figure 5.2.2, the highest efficiency among four algorithms was two-bit error anti-collision algorithm that have the result of approximately to 0.66 which is 66%. Whereas the performance efficiency for single-bit error anti-collision algorithm is approximately to 0.5 which is 50% that better than existing algorithm but worse than two-bit error anti-collision algorithm.

The efficiency on Static tree on frame size = 2 is approximately to 0.346 which is 34.6% and for frame size =3, the efficiency is approximately to 0.366 which is 36.6%. Besides, the efficiency on Dynamic tree also achieve up to 0.433 which is 43.3%.

The simulation result show that the proposed method of two-bit error anti-collision algorithm have best performance among four algorithms that increase almost 20% of efficiency compare to existing algorithm. This is because proposed method could solve the collision by least amount of slot while reducing the number of idle slot. From the behavior of simulation results, the efficiency of proposed method is increasing while the number of tags is increase. This show that when the number of

tags is increasing, the number of slot used to solve the collision is decreasing means that the proposed method could use less number of slot to solve collision when they have large amount of tags.

5.2.3 Identification Rate Performance Analysis

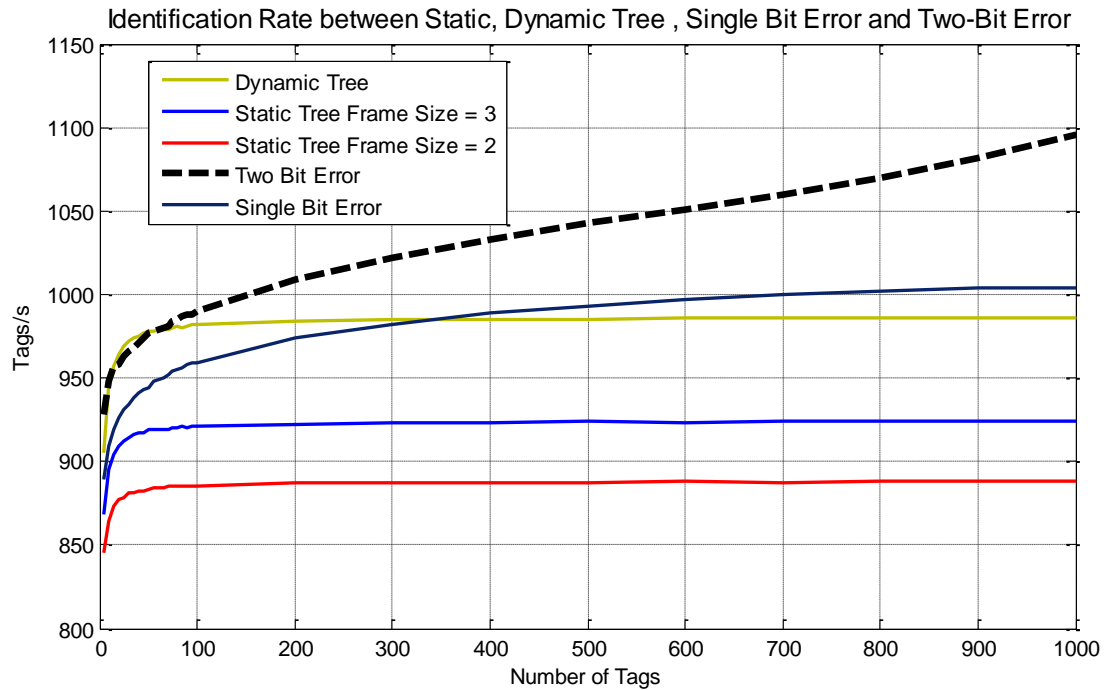


Figure 5.2.3: Identification Rate Performance Result Between Four Algorithms

	Scenario 1
Tari	6.25μs
RTC _{cal}	1.5Tari
BLF	640kHz
R _{bl}	22μs
DR	8
M	1
T _{Rext}	4

Table 5.2.1: Gen-2 RFID Standard Reader-tag Interrogation Parameter

The parameter used in simulation result shown in Table 5.2.1. The benchmark of identification rate performance is based on the number of tags can be detecting within a particular range of time which in this project is using second. Therefore, the higher the number of tags can be detecting in one second, the better the performance.

According to Figure 5.2.3, two-bit error anti-collision algorithm have the best identification rate performance that it could process approximately 1100 tags within a second when they are 1000 tags in process which also as the highest probability that response of tags will be detected successfully. The gap between two-bit error anti-collision algorithm and existing algorithm are approximately to 120 tags/s.

However, the performance of single bit error anti-collision algorithm does not seem to be ideal because it has a lower identification rate when they are 350 tags and below in the process compared to existing algorithm. Although the identification rate of single bit error anti-collision algorithm could achieve up to approximately 1000 tags/s when they are 1000 tags in process, but it is just slightly higher than existing algorithm with the gap of 20 tag/s because dynamic tree anti-collision algorithm can identify 980 tags in a second when there are 1000 tags in process. This is one of the reasons that a better method which is two-bit anti-collision algorithm is proposed when figure out the first proposed method which is single bit error anti-collision algorithm does not show ideal performance in identification rate simulation result.

5.2.4 Collision Performance Analysis

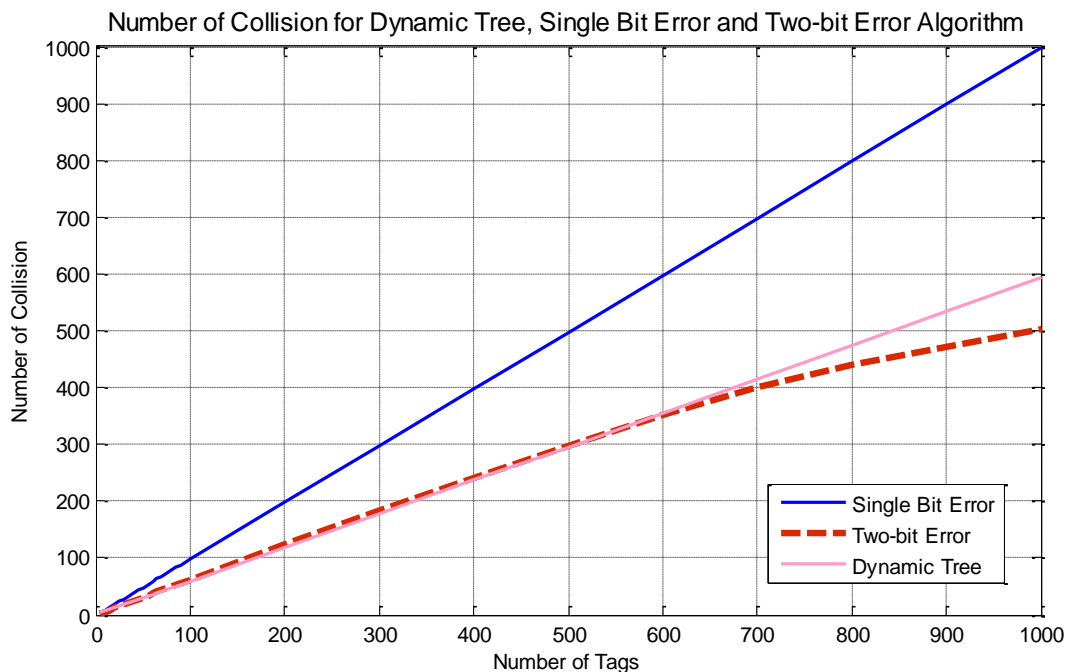


Figure 5.2.4: Collision Performance Between Dynamic Tree, Single Bit Error and Two-Bit Error Anti-collision Algorithm

The benchmark on evaluate the collision performance is the lesser the number of collision occurs, the better the performance. According to Figure 5.2.4, the performance of collision occurs when there 1000 tags in process for two-bit error anti-collision is the best among three algorithms which approximately 500 collision occurs. Whereas single bit error anti-collision having worst performance in number of collision which is approximately 1000 collision occur when there are 1000 tags in process. The performance of existing algorithm which is dynamic tree anti-collision algorithm have better performance compare to single bit error which is approximately 600 collisions occur when there are 1000 tags in process.

The worst performance in number of collision of single bit error anti-collision algorithm is one of the reason that another new method which is two-bit anti-collision algorithm is proposed.

CHAPTER 6: CONCLUSIONS

With the advancement of wireless technology in RFID system, there are many industries involve in using RFID system in their business process including transportation, rescue team, object identification and tracking, inventory management and asset control (Liang and Lin, 2007). Most of the industries involve RFID system in large scale. Therefore, the challenge of collision occur in tag is critical in order to improve system performance and efficiency. The type of tree based algorithms had been study which is static based and dynamic based anti-collision tree algorithm. Dynamic based is the enhancement of static based algorithm by adapting the frame size in the process of identification while the frame size of static based is fixed and define in the early stage of the process.

There are two new algorithms have been proposed in this project which is single bit error anti-collision algorithm and two-bit error anti-collision algorithm. Two-bit error anti-collision algorithm is an improvement of single bit error anti-collision algorithm which could produce better performance. The reason of proposed another new method instead of using single bit error anti-collision algorithm as final proposed algorithm is that it does not show ideal performance in number of idle slot, number of collision slot and also identification rate performance. Although it has good performance in number of slot used and efficiency, however it does not match with the purpose of conducting this project which is reduce the collision occur and processing time when there is large amount of tags occur. Therefore, a new algorithm has been proposed based on single-bit error anti-collision algorithm which is two-bit error anti-collision algorithm that could reduce collision occur meanwhile lessen the processing time.

There are a lot of concepts and methods have been applied in the new proposed method which is tree based concept algorithm, Gen-2 RFID standard timing method and Manchester Coding collision tracking method which allow the new proposed method give better performance compare to existing algorithm. Therefore, the objectives of this project which is to utilizing Manchester coding in order to help resolving the collision during the identification process and proposing new concept anti-collision algorithm that improve the performance of existing tree anti-collision algorithm have been achieved throughout this project.

CHAPTER 6: CONCLUSIONS

This proposed method could help in industry that having large amount of object or product that need to be trace in their production line. This is because the new proposed method which is two-bit error anti-collision algorithm could help industry to identify and track the object or product efficiently by reducing the collision occur and decrease the processing time.

BIBLIOGRAPHY

BIBLIOGRAPHY

Annur, R., Nakpeerayuth, S., Takada, J. and Wuttisittikulij, L. (2014) 'Heuristic Approach of Dynamic Framed Slotted Aloha for RFID Systems', *Australian Journal of Basic and Applied Sciences*

Bai, Z., He, Y. and Wang, S. (2014) 'Research of RFID tag anti-collision algorithm based on binary tree', *Journal of Networks*

Bonuccelli, M., Lonetti, F. and Martelli, F. (2009). Exploiting signal strength detection and collision cancellation for tag identification in RFID systems. *2009 IEEE Symposium on Computers and Communications*.

Charoenpanyasak, S., Sasiwat, Y., Suntiamorntut, W. and Tontisirin, S. (2016). Comparative analysis of RFID anti-collision algorithms in IoT applications. *2016 International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS)*.

Choi, J., Lee, D. and Lee, H. (2006) 'Bi-slotted tree based anti-collision protocols for fast tag identification in RFID systems', *IEEE Communications Letters*

EPC™ radio-frequency identity protocols generation-2 UHF RFID specification for RFID air interface protocol for communications at 860 MHz – 960 MHz version 2.0.0 ratified (2013) Available at: http://www.gs1.org/sites/default/files/docs/epc/uhf1g2_2_0_0_standard_20131101.pdf (Accessed: 31 July 2016).

Gang Wang, Yong Peng, and Zhaomin Zhu, (2011). Anti-collision algorithm for RFID tag identification using fast query tree. *2011 IEEE International Symposium on IT in Medicine and Education*.

Gao, H.S. and Yoo, Y.H. (2012) 'Bit Collision Detection Based Query Tree Protocol For Anti-Collision In RFID System', *International Journal of Innovative Computing, Information and Control*

Jia, X. and Feng, Q. (2013) 'An improved anti-collision protocol for radio frequency identification tag', *International Journal of Communication Systems*

BIBLIOGRAPHY

Liang, C.-K. and Lin, H.-M. (2007) 'Using dynamic slots collision tracking tree technique towards an efficient tag anti-collision algorithm in RFID systems

MOHAMMED, U.S. and SALAH, M. (2011) 'Tag Anti-collision Algorithm for RFID Systems with Minimum Overhead Information in the Identification Process', *RADIOENGINEERING*

Shao, M., Jin, X. and Jin, L. (2014) 'An improved dynamic adaptive multi-tree search anti-collision algorithm based on RFID', *2014 International Conference on Data Science and Advanced Analytics (DSAA)*

Solic, P., Saric, M. and Stella, M. (2013) 'Tags/s -RFID reader-tag communication throughput using gen2 Q-algorithm frame adaptation scheme', *Recent Advances in Information Science*

Yeo, H.J., Kim, Y.H., Lim, H.Y., Park, Y.S. and Ahn, K.S. (2007) 'ID Prediction Algorithm for Tag Collision Arbitration in RFID System', *13th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications*

Zhiwen, L. and Min, S. (2016). Adaptive N-tree Anti-collision Algorithm Based on Collided Bit Collided Bit. *2016 3rd International Conference on Information Science and Control Engineering (ICISCE)*.

APPENDIX A-WEEKLY REPORT**FINAL YEAR PROJECT WEEKLY REPORT**

Trimester, Year: Y4S1	Study week no.:1
Student Name & ID: Tan Li Jig 14ACD00346	
Supervisor: Dr. Robithoh Annur	
Project Title: DYNAMIC TREE BASED ANTI-COLLISION ALGORITHM FOR RFID SYSTEM	

1. WORK DONE

- Research on Manchester Coding Theory
- Searching journal article for existing tree based algorithm

2. WORK TO BE DONE

- Understand the Manchester Coding Theory
- Apply Manchester Coding Theory into algorithm
- Studied existing algorithm

3. PROBLEMS ENCOUNTERED

- Difficulty in study existing algorithm that apply Manchester coding due it is a new technique.

4. SELF EVALUATION OF THE PROGRESS

- Able to search a lot of reference on Manchester coding.
- References of existing tree algorithm in progress.

 Supervisor's signature

 Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

Trimester, Year: Y4S1	Study week no.:3
Student Name & ID: Tan Li Jig 14ACD00346	
Supervisor: Dr. Robithoh Annur	
Project Title: DYNAMIC TREE BASED ANTI-COLLISION ALGORITHM FOR RFID SYSTEM	

1. WORK DONE

- Understand the Manchester Coding process applied in tree algorithm.
- Proposed a new method based on reference in theoretically.

2. WORK TO BE DONE

- Identify the feasibility of new proposed method

3. PROBLEMS ENCOUNTERED

- Difficulty in proposed a new method that could solve all collision.

4. SELF EVALUATION OF THE PROGRESS

- Behavior of Manchester coding has been figure out.
- Initial structure of a new method have been proposed

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

Trimester, Year: Y4S1	Study week no.:5
Student Name & ID: Tan Li Jig 14ACD00346	
Supervisor: Dr. Robithoh Annur	
Project Title: DYNAMIC TREE BASED ANTI-COLLISION ALGORITHM FOR RFID SYSTEM	

1. WORK DONE

- Testing all possibilities of new proposed method in Matlab.
- Finalized new proposed method

2. WORK TO BE DONE

- Program with new proposed method
- Stimulation result of new proposed method

3. PROBLEMS ENCOUNTERED

- Difficulty in using Matlab in binary number mathematic.

4. SELF EVALUATION OF THE PROGRESS

- Progress slow due to program new proposed method in binary form.

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

Trimester, Year: Y4S1	Study week no.:7
Student Name & ID: Tan Li Jig 14ACD00346	
Supervisor: Dr. Robithoh Annur	
Project Title: DYNAMIC TREE BASED ANTI-COLLISION ALGORITHM FOR RFID SYSTEM	

1. WORK DONE

- Analysis stimulation result of new proposed method

2. WORK TO BE DONE

- Proposed another new method is needed because previous proposed method stimulation result doesn't seem to be satisfy

3. PROBLEMS ENCOUNTERED

- Stimulation result not satisfy

4. SELF EVALUATION OF THE PROGRESS

- Progress slow due to the stimulation result analysis doesn't satisfy

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

Trimester, Year: Y4S1	Study week no.:9
Student Name & ID: Tan Li Jig 14ACD00346	
Supervisor: Dr. Robithoh Annur	
Project Title: DYNAMIC TREE BASED ANTI-COLLISION ALGORITHM FOR RFID SYSTEM	

<p>1. WORK DONE</p> <p>- Proposed second method</p>
<p>2. WORK TO BE DONE</p> <p>- Analysis second proposed method stimulation result</p>
<p>3. PROBLEMS ENCOUNTERED</p> <p>- Difficulty in figure out another new idea on second proposed method</p>
<p>4. SELF EVALUATION OF THE PROGRESS</p> <p>- Progress slow due to the lack of idea</p>

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

Trimester, Year: Y4S1	Study week no.:11
Student Name & ID: Tan Li Jig 14ACD00346	
Supervisor: Dr. Robithoh Annur	
Project Title: DYNAMIC TREE BASED ANTI-COLLISION ALGORITHM FOR RFID SYSTEM	

<p>1. WORK DONE</p> <ul style="list-style-type: none"> - Finalized second proposed method - Analysis stimulation result
<p>2. WORK TO BE DONE</p> <ul style="list-style-type: none"> - Create report for this project
<p>3. PROBLEMS ENCOUNTERED</p> <ul style="list-style-type: none"> - Program have to run up to 1000 times to ensure accuracy
<p>4. SELF EVALUATION OF THE PROGRESS</p> <ul style="list-style-type: none"> - Progress slow due the time used to run the program is very slow. It took almost up to 4 hours to simulated a result on a program.

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

Trimester, Year: Y4S1	Study week no.:12
Student Name & ID: Tan Li Jig 14ACD00346	
Supervisor: Dr. Robithoh Annur	
Project Title: DYNAMIC TREE BASED ANTI-COLLISION ALGORITHM FOR RFID SYSTEM	

1. WORK DONE - Create report for this project
2. WORK TO BE DONE - Review on report and check plagiarism in Turnitin software
3. PROBLEMS ENCOUNTERED - Formatting on report.
4. SELF EVALUATION OF THE PROGRESS - Progress fast in creating report due to good understanding on what have been done so far.

Supervisor's signature

Student's signature

APPENDIX B-POSTER

DYNAMIC TREE BASED ANTI-COLLISION ALGORITHM FOR RFID SYSTEM

INTRODUCTION

RFID stand for Radio Frequency Identification used in object identification and tracking. In RFID system environment, it normally will contain multiple tag with one reader which will occur tag collision problem. Therefore, there is a need for anti-collision algorithm to resolve the collision. The algorithm that will focus in this project is Dynamic Tree Anti-collision algorithm which will improve the efficiency and throughput of the system

PROJECT OBJECTIVES

- To study the difference type of tree algorithm in term of static based and dynamic based
- To understand Gen-2 RFID standard with timing and slot duration
- To utilizing Manchester coding in order to help resolving the collision during the identification process
- Proposing new concept anti-collision algorithm that improve the performance of existing tree anti-collision algorithm

ALGORITHM DESCRIPTION

Tag A: 10 0000 1110		Tag B: 01 1000 0110		Tag C: 01 1100 0011	
Tag D: 00 1101 0011		Tag E: 11 1111 0100			
Slot no: 0	Slot no: 1 [00]	Slot no: 2 [01]	Slot no: 3 [00]	Slot no: 4 [01]	
Reader: 11 1111 1111	Reader: 00 1111 1111	Reader: 01 1111 1111	Reader: 01 1000 0011	Reader: 01 1000 0111	
Collision: A,B,C,D,E	Success: Tag D	Collision: B, C	Idle Slot	Success: Tag B	
10 0000 1110		01 1000 0110			
01 1000 0110		01 1100 0011			
01 1100 0011		01 1X00 0X1X			
00 1101 0011					
11 1111 0100					
XX XXXX XXXX					

Slot no: 5 [10]	Slot no: 6 [11]	Slot no: 7	Slot no: 8
Reader: 01 1100 0011	Reader: 01 1100 0111	Reader: 11 1100 0111	Reader: 111 1100 0111
Success: Tag C	Idle Slot	Success: Tag A	Success: Tag E

SYSTEM DESIGN

PERFORMANCE ANALYSIS

	Number of Slot Used	Efficiency	Identification Rate
STATIC BASED	2700	36.6%	880
DYNAMIC BASED	2250	43.3%	980
Single Bit Error	2000	50%	1000
Two Bit Error	1500	66%	1100

CONCLUSION

In this project, a new method have been proposed which is Two-bit Error Anti-collision Algorithm that applied with Manchester Coding theory and Gen-2 RFID standard in the process of solving collision. There are three performance have been analyze between existing algorithm and new proposed method which is number of slot used, efficiency and identification rate. Proposed method produce the best performance in all performance analysis and it has successfully achieve the objective of this project.

APPENDIX C-PLAGIARISM CHECK RESULT

check_2			
ORIGINALITY REPORT			
% 6	% 2	% 3	% 2
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS
PRIMARY SOURCES			
1	Submitted to National University of Singapore Student Paper		% 1
2	www.naun.org Internet Source		% 1
3	Der-Jiunn Deng. "Optimal Dynamic Framed Slotted ALOHA Based Anti-collision Algorithm for RFID Systems", Wireless Personal Communications, 12/25/2010 Publication		<% 1
4	Submitted to University of Sheffield Student Paper		<% 1
5	Gang Wang. "Anti-collision algorithm for RFID tag identification using fast query tree", 2011 IEEE International Symposium on IT in Medicine and Education, 12/2011 Publication		<% 1
6	www.v-c-s.org Internet Source		<% 1
7	Lecture Notes in Computer Science, 2006. Publication		<% 1

APPENDICES

8	www.star2star.com Internet Source	<%1	14	Zhang, Hang, and Jing Sha He. "An Anti-Collision Algorithm for Applications with Massive RFID Tags", Advanced Materials Research, 2013. Publication	<%1
9	Weidong Wang. "Analysis of anti-collision algorithms in RFID system", 2009 IEEE International Conference on Communications Technology and Applications, 10/2009 Publication	<%1	15	ru.scribd.com Internet Source	<%1
10	Jeong Geun Kim. "Performance Analysis of EPC Class-1 Generation-2 RFID Anti-collision Protocol", Lecture Notes in Computer Science, 2007 Publication	<%1	16	Jihoon Myung. "Adaptive Binary Splitting: A RFID Tag Collision Arbitration Protocol for Tag Identification", Mobile Networks and Applications, 10/2006 Publication	<%1
11	Submitted to University Tun Hussein Onn Malaysia Student Paper	<%1	17	Submitted to Universiti Tunku Abdul Rahman Student Paper	<%1
12	Jae-Hyun Kim. "Dynamic framed slotted ALOHA algorithms using fast tag estimation method for RFID system", CCNC 2006 2006 3rd IEEE Consumer Communications and Networking Conference 2006, 2006 Publication	<%1	18	Submitted to The Hong Kong Polytechnic University Student Paper	<%1
13	Kwang Seon Ahn. "ID Prediction Algorithm for Tag Collision Arbitration in RFID System", 13th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA 2007), 08/2007 Publication	<%1	19	Submitted to University of Liverpool Student Paper	<%1
			20	www.tdksemiconductor.com Internet Source	<%1
			21	www.prestigecasino.com Internet Source	<%1
			22	Wu, Haifeng, and Yu Zeng. "Bayesian Tag Estimate and Optimal Frame Length for Anti-Collision Aloha RFID System", IEEE Transactions on Automation Science and Engineering, 2010. Publication	<%1
23	Dan Liu. "ALOHA algorithm considering the slot duration difference in RFID system", 2009 IEEE International Conference on RFID, 04/2009 Publication	<%1			
24	Najafi, V.. "A dual mode UHF EPC Gen 2 RFID tag in 0.18@mm CMOS", Microelectronics Journal, 201008 Publication	<%1			
25	Satellite Communication Systems, 1999. Publication	<%1			
26	Qing, Yang, Li Jian-cheng, Wang Hong-yi, and Shen Rong-jun. "An Anti-collision Algorithm Using Tag Random-Dispersing for RFID Systems", 2013 IEEE International Conference on Green Computing and Communications and IEEE Internet of Things and IEEE Cyber Physical and Social Computing, 2013. Publication	<%1			
27	Kitazume, . "Case Histories", The Sand Compaction Pile Method, 2005. Publication	<%1			
28	Cheng Jin and Sung Ho Cho. "An Efficient Collision Detection Scheme for Generation-2 RFID Systems", International Journal of Computer Science Issues (IJCSI), 2012.	<%1			

APPENDICES

29	Publication Waleed Alsalih. "Optimal distance-based clustering for tag anti-collision in RFID systems", 2008 33rd IEEE Conference on Local Computer Networks (LCN), 10/2008 Publication	<%1
30	Publication Cheng-Hao Quan. "Performance Analysis of Tag Anti-collision Algorithms for RFID Systems", Lecture Notes in Computer Science, 2006 Publication	<%1
31	Publication Min Shao, , Xiaofang Jin, and Libiao Jin. "An improved dynamic adaptive multi-tree search anti-collision algorithm based on RFID", 2014 International Conference on Data Science and Advanced Analytics (DSAA), 2014. Publication	<%1
32	Internet Source espace.curtin.edu.au	<%1
33	Internet Source researchonline.jcu.edu.au	<%1
34	Publication YongHwan Kim. "An anti-collision algorithm without idle cycle using 4-ary tree in RFID system", Proceedings of the 3rd International Conference on Ubiquitous Information Management and Communication - ICUIMC 09 ICUIMC 09, 2009 Publication	<%1
35	Internet Source aaa.nevada.edu	<%1
36	Internet Source documents.mx	<%1

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(ii) Matching of individual sources listed must be less than 3% each, and	
(iii) Matching texts in continuous block must not exceed 8 words	
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Name: _____	Name: _____
Date: _____	Date: _____

APPENDICES

APPENDIX D-CD