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Baggage Claim in Airports using near Field Communication

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Abstract

The popularity of public transportation has increased as infrastructures have been repaired and other supporting facilities have been added. One of the facilities which can be added in the transportation system is the implementation of Near Field Communication in order to accelerate each transaction in the transportation system. In airports, transaction activities need to be done efficiently, like claiming baggage at the baggage carousel. The speed of transaction to claim the baggage depends on the number of officers, passengers, and the amount of baggage brought by the passengers. In the conventional system, the most effective way of getting the maximum speed of transaction is to have officers as many as the number of passengers, but this is not efficient regarding the use of human resources. The use of Near Field Communication can solve the problem related to the efficiency of resources, safety, and the increasing speed of transaction.

Keywords*: Near Field Communication, Baggage Claimming, Contactless Transaction, Airport*

1. Introduction

Public transportation has been popular recently. The users are increasing as the infrastructures supporting the transportation are being repaired. The use of public transportation is chosen since it can save energy and time needed to travel (due to traffic jam, etc.). However, as the people who use the public transportation are increasing in number, the service of it should also be enhanced. One of the services that needs to be improved is that the efficiency of time in ticket reservation, check-in service, material fees (for tickets, labels, etc.). Because of that, it needs a feature which can ease the transaction and shorten the time of transaction. One of the means which can be used to achieve these purposes is by implementing Near Field Communication (NFC) [1].

Transportation such as buses, trains, ships, planes still run conventionally nowadays. Ticket reservation is still done by coming directly to the locket and even the ticket is still from paper. Additionally, the cash payment increases the transaction time. One of the implementations of NFC related to transportation is e-ticketing by using NFC. E-ticketing is very possible to be applied in airports. The biggest obstacle at the moment is the availability of infrastructures supporting NFC. The use of NFC in airports can give positive impacts to shorten the time needed to check-in, for instance.

Another reason to use NFC in airports is to make the process of check-in, security check, and baggage claim area simpler. Therefore, passengers are not always required to show the ticket and identity card or baggage checks. The use of NFC for E-Ticketing can also be applied for taking the baggage. In order to do so, passengers usually need to show the identity written on the paper and it will be matched with the baggage. In addition, one of the benefits in using NFC is that we do not use paper (paperless) for tickets, baggage checks, etc.

The study which had been conducted was about the characterizations and advantages of using NFC in public transportation. The result of this study revealed that with international standardization, NFC could be used to support contactless transaction and data exchange [2]. Another research was done in relation to the use of e-ticketing on ferry boats. The result of this research was that the use of e-ticketing could positively impact passengers and operators on the ferry. One of the obstacles which appeared was that the system could be different

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(common) towards velocity, distance, weather conditions for all types of ferry boats which are operating [3].

This present study will discuss about the simulation of implementation of NFC protocol for data exchange and read/write features. The reason is because data exchange and read/write features are widely used altogether in the implementation. This research is only conducted for domestic flights, and the stimulated process is the common process done when we use planes. This study is a development from the available system and implemented in public transportation.

2. Research Method

2.1. Related Research

Tickets are important aspects in a transportation system. They can be bought in counters or online. The problem which often occurs is that there are some things that require time and need extra payment starting from the check-in process until we are on the plane. By using NFC, transaction, validation, and information exchange can be done quickly. In addition, the use of NFC can save space since we do not need to bring many cards, tickets, and many more.

NFC is an open platform, so that the standardization in using NFC in airports is needed. Thus, the data from a certain airport can be processed by other airports. The standardization which is necessary to be implemented is the one towards the speed transfer, protocol systems, types of data, data string, authentication method, and validation method. The NFC has several operation modes including Peer-to-Peer (P2P), Reader/Writer (R/W), dan NFC Card Emulation (NCE). These modes can be used for Mobile Transaction (Contactless Payment) [4] [5] [6] [7], Data Exchange, and Read and Write.

The problem faced in implementing NFC towards electronic ticketing is that how we can prevent the ticket from being used more than once [8]. The ticket which can be used more than once will cause errors in the system. This problem may be solved by implementing pre-validation ticket cloning and post-validation ticket cloning. The implementation of two (2) methods can possibly prevent the ticket from being used more than once (1) with different persons.

2.2. The Scheme of Taking the Baggage in a Conventional Way

The passenger's baggage which has arrived at the destination will be brought into the baggage claim area. The baggage is put on the conveyor belt which is moving towards the baggage claim area. The passenger will take the baggage and head for the exit door. Then, the baggage will be checked by the security. The problem that may happen is that no one knows who owns the baggage except the owner. As a result, there is a possibility that the baggage can get mixed up or be taken by other passengers. This problem can be prevented if the officer checks the baggage at the exit. The security will match the number stated on the ticket with the number on the baggage.

The implementation of baggage checking at the exit door still causes some problems in terms of time. The limited human resources for the checking process and the time needed to do the checking may cause a great number of passengers to wait in line. Furthermore, the implementation of the checking still has the security vulnerability which can occur due to the long wait (passengers not wanting to wait break through the queue) or the intentional violation towards the system done by a passenger (passengers take other people's baggage and take advantage of the situation) or the bad manner of the security (the officer does not do the checking properly). NFC is used to shorten the waiting time and to overcome the problem related to the limited human resources, and to close the security vulnerability, for instance, a passenger taking another person's baggage and other problems associated with the waiting time or intentional bad behaviors.

3. Results and Analysis

Tickets are used as a legal proof of payment and as the passenger's identity and all the things that are related to the trip such as departure schedules, place of origin, and destination. In addition to the passenger's identity, schedules, and destination, there are other information on the ticket (particularly in air transportation), specifically baggage checks. A label will be attached on the baggage, and it will be used to match with the numbers owned by the passenger. When the passenger takes his/her baggage, the security matches the label attached on the baggage with the numbers owned by the passenger. This surely needs a long time if the security has to match the numbers and the passenger brings more than one (1) baggage.

3.1. Conventional System vs System using NFC

Given the time needed by the security to check a passenger (having communication in order to ask and give the baggage check back) is 15 seconds, to search the position of the label on the ticket is 10 seconds, to check each baggage (matching the numbers of the baggage) is 15 seconds, and to let the passengers take turn to do the checking is 10 seconds. The time required to check more than one baggage is the accumulation of time from the multiple of the total number of baggage. The process of checking for one passenger with one baggage can be written as follows:

$$T = T_{passenger} + T_{search} + T_{baggage} \quad (1)$$

The process of checking for N passengers and M baggage can be written as follows:

$$T = \frac{\sum_{i}^{N}[Tpassenger\ i + (Mi\,.(Tbaggage + Tsearch))] + (Tshift\ .Nshift)}{No} \quad (2)$$

T = total amount of time
$T_{passenger}$ = time required to communicate with passengers
T_{search} = time required to search for the position of the baggage tag or NFC Tag
T_{shift} = time required to let passengers to take turn in order to do the checking
$T_{baggage}$ = time required to check one baggage
Mi = the total amount of baggage brought by one one passenger
N = the total number of passengers who bring the baggage
N_{shift} = the total number of shifts required to check all passengers.
N_o = the total number of the securities

In the conventional system, N_{shift} is the total number of passengers (N) - N_o. That is because the first passenger Tshift = 0 thus for one security N_{shift} = N – 1. The use of NFC changes the conventional system a little bit since the contribution of the securities is reduced. As a result, the time required to communicate with the passenger can be used to search for the position of NFC Tag, and it can be done more briefly. Therefore, the second (2^{nd}) equation will be $T_{Passenger}$ = 0, T_{shift} = 0, and N_{shift} = 0. Given the use of NFC, $T_{baggage}$ is 2 seconds. The difference of time in the conventional system and the system using NFC can be seen in Table 1.

Tabel 1. The comparison of time between the conventional system and the system using NFC

	Conventional	Using NFC
$T_{passenger}$	15	0
T_{search}	5	10
$T_{baggage}$	15	2
T_{shift}	10	0
T for M =1 and N = 1	35	12
T for M = 1 and N = 10	440	120

3.2. The Basic Concept of System

By using NFC, all data can be stored digitally. The passenger’s baggage will be attached by the NFC Tag and the information related to the passenger’s identity will be stored in the NFC tag with other information in a series of data (Figure 1). The data of the passenger’s identity and the baggage’s identity will be saved in the passenger’s NFC and the NFC tag. The data stored in the NFC tag contains the encrypted information to activate or deactivate the alarm. The passenger’s NFC has a password to deactivate the alarm. Its use will be combined with RFID [9-12].

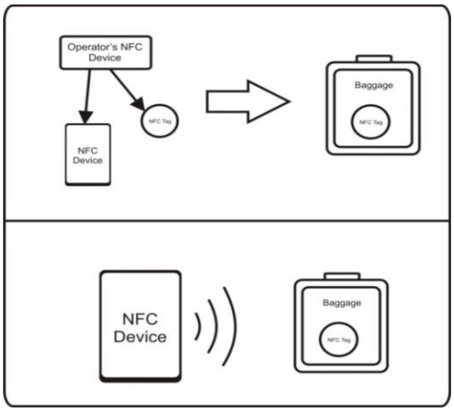

Figure 1. System Design

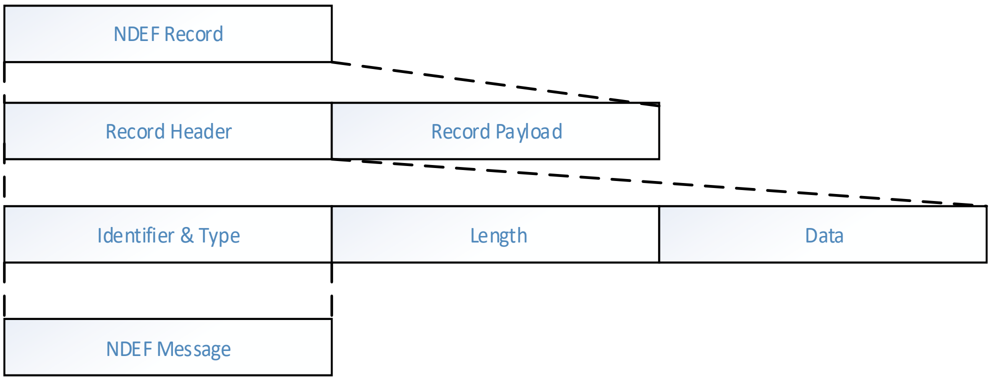

Figure 2. NDEF Breakdown Structures

3.3. Reader/Writer NFC Protocols

Reader/Writer mode needs two (2) devices to communicate, including NFC R/W in the format of NFC data-exchange format (NDEF) (Figure 2) and NFC Record-Type Definition (RTD) and the other one is NFC Tag. The devices which have NFC are able to access data from RFID-enabled object. NFC Tag is a passive device which can be used to communicate with an active NFC device. NFC data-exchange format (NDEF) is a very essential component for the process of data exchange in the NFC which contains various data including URI, URL, vCards, and many more. NFC data-exchange format (NDEF) Record consists of:

1. Type Name Format (TNF), is used to identify the characteristics of Record Type Definition (Table 2).
2. Record Type Definition (RTD), explains the format record used.

Table 2. TNF Structures

Record Type				
urn:nfc:wkt:T (text)	T	0x54		
urn:nfc:wkt:U (uri)	U	0x55		
urn:nfc:wkt:Sp (smart poster)	Sp	0x53	0x70	
urn:nfc:wkt:Sig (signature)	Sig	0x53	0x69	0x67

According to the studies used as references in this research, there are ways of working of NFC that can be implemented to assist passengers claiming baggage and belongings. This study uses Read/Write feature in the NFC.

3.4. File System

In the design of file system, there are two (2) types of targets which will become the media to save information when passengers store and take their baggage. The first target is NFC device and then NFC tag. The data stored in the NFC device (Figure 4) and NFC tags (Figure 3) are the same, but in the NFC tag, there will be data related to alarm.

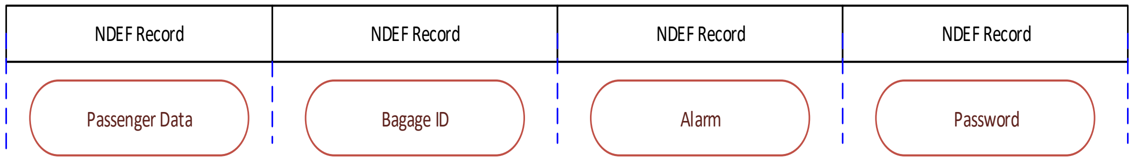

Figure 3. NDEF stored in NFC Tag

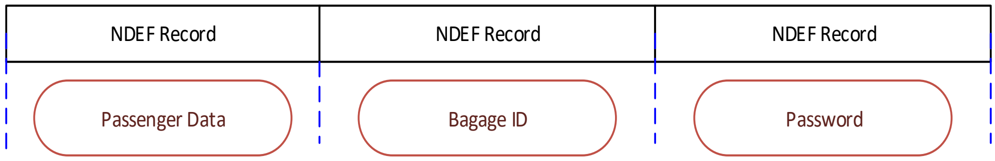

Figure 4. NDEF stored in NFC Device

3.5. Simulation

The purpose of this simulation is to prove that the concept of the system can be implemented. The system which will be designed is simulated using Java programming language. The simulation which is conducted uses two (2) NFC Devices and two (2) NFC Tags. Users or teller at the airport input passengers' data, baggage's data, and password. NFC Device asks for PassengerId, BaggageId, dan Password from NFC Tag. NFC Tag gives the data which are asked by NFC Device. NFC Device will do matching and validating. Then, if the data are not matched, the alarm's data stored in the NFC Tag will be turned off. A clearer process can be seen in Figure 5.

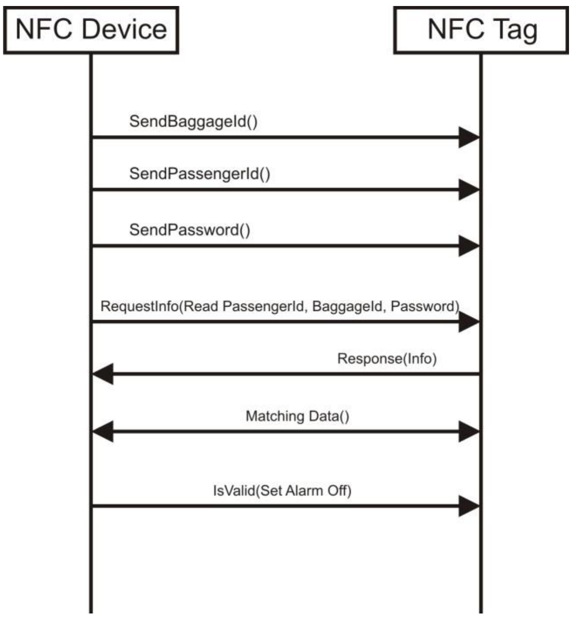

Figure 5. Matching & Validation Process

The implementation of NFC in the process of taking the baggage in the baggage claim area can shorten time and overcome security vulnerability. The case of 100 passengers, tested in a condition in which there are 1 baggage and 2 baggage and in a condition in which there are 1 security and 2 securities using the second (2^{nd}) equation can be seen Figure 6. The influence of the addition of the number of securities and the addition of the number of baggage is significant towards time. The maximum speed may be achieved by having officers as many as the number of passengers and the baggage brought by each passenger is only one.

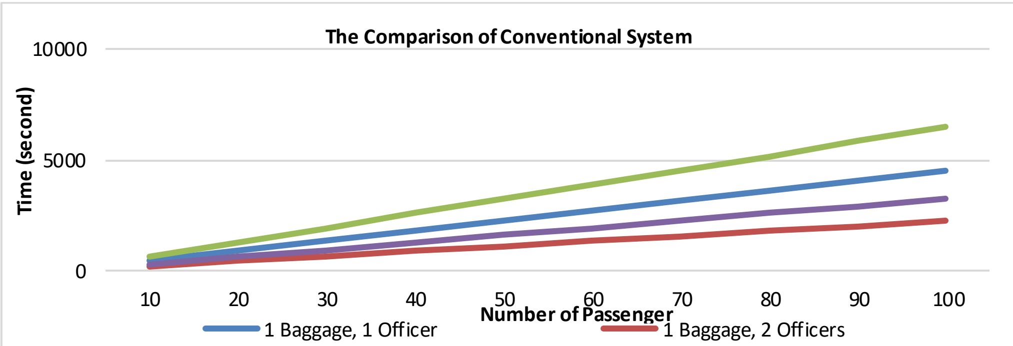

Figure 6. The comparison of time of conventional system towards the changing of the number of securities and baggage

The technology implementation of NFC is possible in use the maximum actors (the total numbers of actors/securities equal to the number of passengers) since the passengers themselves are the actors, thus $N_o = N$. The time required to use NFC in taking the baggage is the amount of time needed by the actors to search for the position of NFC Tag and added by the time needed to turn off the NFC Tag, then multiplied by the total amount of baggage brought by a passenger. The second (2^{nd}) equation can be made simple as follows:

$$T = (T_{search} + T_{baggage}) \times M \quad (3)$$

4. Conclusion

In this study, it can be concluded that the design system can be implemented and can shorten the transaction time of taking the baggage in airports. The use of NFC makes the transaction be done in a shorter time compared to the use of conventional system. NFC Tag should be kept, so that it will not be separated from the baggage. Besides, there is a mechanism which should be made, so that the data in the NFC tag cannot be changed with other data from an unauthorized person before the alarm is shut down. Hence, a security needs to be created, so that the data can be kept.

The suggestion which can be given to further studies is that a study related to data security. In addition to that, there should be a way/ system to be able to handle the passenger who brings more than two (2) baggage.

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