MEAL ELECTRONIC PAYMENT SYSTEM (MEPS)

KEAH DHENG SIEW

A theses submitted in fulfilment of the
requirements for the award of the degree of
Bachelor of Computer Science (Computer Systems & Networking)

FACULTY OF COMPUTER SYSTEMS & SOFTWARE ENGINEERING
UNIVERSITY MALAYSIA PAHANG

JUNE, 2012

ABSTRACT

This project is Meal Electronic Payment System (MEPS) purposed for helping the user in meal payment system at cafeteria. Previously, payment system in cafeteria is not efficiency and time consuming. It also wasted energy of user to do payment as it takes long time to queue up. The project's final output is wants to implement an efficient payment system with time consuming in each transaction will be as short as possible as within 1 minute. In this project, the contactless smart card is a tool to build the electronic payment system. The smartcard systems have been around for many years, used mainly to secure physical access to corporate facilities. The advantages of the card are its durability and reliability. With the advancement in radio frequency technologies, the contactless smartcard systems reduce the maintenance requirements for the smartcard readers. Their use is also very time efficient because the card needs not be taken out and placed in the card readers. Immediately, the transit systems saw the benefit for its time efficiency because the riders can go through the turnstile much quicker. Previously, payment system in cafeteria is not efficiency and time consuming. It also wasted energy of user to do payment as it takes long time to queue up.

ABSTRAK

Projek ini adalah Meal Electronic Payment System (MEPS) yang berazam untuk membantu pengguna dalam sistem pembayaran makan di kafeteria. Sebelum ini, sistem pembayaran di kafeteria tidak kecekapan dan memakan masa. Ia juga membuang tenaga pengguna untuk melakukan pembayaran kerana ia mengambil masa yang lama untuk beratur. Output akhir projek mahu untuk melaksanakan sistem pembayaran yang cekap dengan menggunakan masa dalam 1 minit untuk setiap pembayaran. Dalam projek ini, kad pintar tanpa sentuh adalah alat untuk membina sistem pembayaran elektronik. Sistem kad pintar telah wujud selama beberapa tahun, yang digunakan terutamanya untuk mendapatkan kemudahan fizikal kepada kemudahan korporat. Kelebihan kad ketahanan dan kebolehpercayaan. Dengan kemajuan dalam teknologi frekuensi radio, sistem kad pintar tanpa sentuh mengurangkan keperluan penyelenggaraan bagi pembaca kad pintar. Penggunaan mereka juga sangat cekap kerana keperluan kad tersebut tidak perlu dikeluarkan dari dompet dan terus boleh diletakkan pada pembaca kad. Serta-merta, sistem transit melihat manfaat untuk kecekapan masa kerana penunggang boleh pergi melalui pintu pagar yang lebih cepat. Sebelum ini, sistem pembayaran di kafeteria tidak kecekapan dan memakan masa. Ia juga tidak membuang-buang tenaga pengguna untuk melakukan pembayaran kerana ia mengambil masa yang lama untuk beratur.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, many people facing problem when make payment by cash. Since inefficiency of cash payment, it causes people wasting time and energy. For example, in Malaysia, the public buses using cash payments. Thus, all the people contend with each other to make payment because they are lacking in patience to wait to pay the money. This is same with what facing in school or university cafeteria which using cash payment. Students waste a lot of time in queue to make cash payment.

A contactless smart card is a pocket-sized card with embedded integrated circuits that can process and store data, and communicate with a terminal via radio waves. It have the capability to read up to 10 cm. Contactless smart cards operate at a frequency of 13.56 MHz, with higher memory capacity. The higher security capabilities and memory capacity of smart cards renders them suitable for applications such as e-passports, payment cards, and identification. It known as ‘wave and pay’ or ‘tap and go’ cashless and contactless cards are a method of paying for everyday items, such as coffee or newspapers, simply by swiping a credit or debit card across a reader. Its memory cards contain non-volatile memory storage components, and perhaps some specific security logic. Contactless smart cards contain a re-writeable smart card microchip that can be transcribed via radio waves

and can be used for identification, authentication, and data storage. They also provide a means of effecting business transactions in a flexible, secure, standard way with minimal human intervention.

Contactless smart card technology is not same as RFID technology. There is significant confusion in discussions of RF-enabled applications, with contactless smart card technology often incorrectly categorized as 'RFID.' There is a wide range of RF technologies used for a variety of applications -- each with different operational parameters, frequencies, read ranges and capabilities to support security and privacy features. For example, the RFID technologies that are used to add value in manufacturing, shipping and object-related tracking operate over long ranges (e.g., 25 feet), were designed for that purpose alone and have minimal built-in support for security and privacy. Contactless smart cards, on the other hand, use RF technology, but, by design, operate at a short range (less than 4 inches) and can support the equivalent security capabilities of a contact smart card chip.

Now, contactless smart card is widely used at different countries to make payment such as transport and meal payments. This kind of cashless payment benefits public by saving a lot of time and energy. For examples, Taiwan's EasyCard, Hong Kong's Octopus card, Shanghai's Public Transportation Card, South Korea's T-money (bus, subway, taxi), London's Oyster card, Beijing's Municipal Administration and Communications Card, Japan Rail's Suica Card, which predate the ISO/IEC 14443 standard.

The created needs for easy payment as contactless smart card in this project to solve the problem of UMP students who facing problem of long queue when make payment in cafeteria. Since contactless smart card need only hold the card in close proximity of the reader, and thus physical contact is not required. Once the reader read the card, the credit in the card will automatically reduce. This kind of payment is more efficiency than cash payment because it is a time saving payment’s method. Since it is cashless payment, it can top up to add the value of credit so that it can do transaction until the credit is empty.

1.2 Problem Statement

i. Inefficiency of cash payment.
ii. Waste time and energy.
iii. Difficulty of money changes by food stall's cashier.

1.3 Objectives

i. To build a prototype system for electronic payments using contactless smart card so that students can buy food by cashless payment.
ii. To proof the use of contactless smart card will deduct the credit by presenting on card reader.
iii. To validate the electronic payment system by top up the credit.

1.4 Scope

i. Administrator using the system to help students register and top up the credit of card.
ii. UMP students use the card to buy food by hold the card in close proximity of the reader.

1.5 Thesis Organization

This thesis contains six chapters. Chapter 1 gives an overview of the research conducted.

Chapter 2 explains about research that is done regarding to this project. This chapter divided into two major part namely, research on the existing system and about techniques and technologies that is related to this project. The research is based on the previous paper or research that had done by other scientist or any current systems that implements the techniques related to this projects. This chapter also explains about techniques or technologies relevant to this project.

In Chapter 3, the approach or overall framework about the development of project are discussed. This includes techniques, methods, or approaches that is used to develop and implemented throughout the project development.

Chapter 4 will document all the process that is involved in the development of the projects. It includes all the implementation and testing done for the project.

Chapter 5 will discuss about the findings or result that is obtained and analysis of the data. This chapter also includes the result analysis, project constraint and suggestion for improvement. Finally, this chapter also conclude overall projects that had developed. This includes the project summary, the summary of the data that is obtained and the effectiveness of data obtained with the objectives and problem statement.

CHAPTER 2

LITERATURE REVIEW

This chapter will outline the general overview of any domain studies that is related to this project. This is purposely to increase the knowledge and understanding about the background of this project. This chapter also explains any research made that related to contactless smart card regarding on the approach that will be used. Besides, the chapter also includes the study on the meaning of contactless smart card and also detection techniques or methods that is currently used. In addition, in this chapter also will have the brief information about the existing systems, the discussion of the programming languages and database generally used.

2.1 Contactless Smart Card

Smartcard systems used mainly to secure physical access to corporate facilities. The contactless smartcard systems reduce the maintenance requirements for the smartcard readers with the advancement in radio frequency technologies [1]. Smart cards can be used in transit payment applications and most of the time they are used together to provide increased convenience to end users. Contactless smart cards operate at a frequency of 13.56 MHz, with higher memory capacity. The higher security capabilities and memory capacity of smart cards renders them suitable for applications such as e-passports, payment cards, and identification. Such applications are also better positioned to absorb the higher cost of smartcards as compared to passive RFID tags. Contactless payment can be done at any retailer that displays the symbol as shown in Figure 2.1 [2].

Figure 2.1: International symbol for contactless payments

Contactless payment will save time at the checkout. Moreover, contactless smart card known as ‘wave and pay’ or ‘tap and go’ cashless and contactless cards are a method of paying for everyday items, such as coffee or newspapers, simply by swiping a credit or debit card across a reader. Contactless payments are expected to revolutionize the way low-value purchases are made. This particular method of payment is designed to save time for customers, reduce the risks of handling cash and mean less time dealing with purchases for retailers. It is expected to be used most often in transactions where speed is essential, such as at cinemas, fast food outlets, petrol stations, supermarkets and theatres [2].

2.1.1 Advantage of contactless smart card

Advantages of the contactless smart card are its durability and reliability. Their use is also very time efficient because the card needs not be taken out and placed in the card readers. Immediately, the transit systems saw the benefit for its time efficiency because the riders can go through the turnstile much quicker [1]. Mass transit authorities and fast ticket transaction oriented companies are looking for a robust, cost effective technology which will enable them to automate their fare collection systems, saving time, and thus making the system more cost effective [5].

2.1.2 Security capabilities

Contactless smart card issuers have insisted that the security risks are fairly low that is a retailer will not be able to accidentally take consumer payment twice from same account as the reader can only perform a single transaction at a time. In addition, they also claim that purchases cannot be made without consumer knowledge (for example, if consumer walk past the card reader it will not automatically activate) as the card must be within 10 centimetres of the reader and the retailer must have first entered the amount to approve. Significantly, there are no limits to the number of contactless transactions that consumer can make in a day (payments will be limited only by consumer maximum withdrawal limit). This has its advantages, but it also means that if the card falls into the wrong hands, it would be very easy for someone to make a lot of transactions very easily as they don't need to know owner PIN. Most credit cards are protected by a 100% fraud protection guarantee which should cover for any loss, theft and misuse [2].

Contactless smart cards and readers conform to international standards, ISO/IEC 14443 and ISO/IEC 7816, and can implement a variety of industry-standard cryptographic protocols (e.g., AES, 3DES, RSA, ECC). Contactless smart cards that implement security features are referred to as RF-enabled smart cards. They also describe that the contactless smart chip includes a smart card secure microcontroller and internal memory and has unique attributes such as the ability to securely manage, store and provide access to data on the card, perform complex functions (for example, encryption and mutual authentication) and interact intelligently via RF with a contactless reader [2].

Application using contactless smart cards supports many security features that ensure the integrity, confidentiality and privacy of information stored or transmitted, including the following [6]:

Table 2.1.2: Security features of contactless smart card

Feature	Explanation
Mutual authentication	For application requiring secure card access, the contactless smart card-based device can verify that the reader is authentic and can prove its own authenticity to the reader before starting a secure transaction.
Strong information security	For applications requiring complete data protection, information stored on cards or documents using contactless smart card technology can be encrypted and communication between the contactless smart card-based device and the reader can be encrypted to prevent eavesdropping. Additional security technologies may also be used to secure information integrity.
Strong contactless device security	Contactless smart card technology is extremely difficult to duplicate or forge and has built-in tamper-resistance. Smart card chips include a variety of hardware and software capabilities that detect and react to tampering attempts and help counter possible attacks.
Authenticated and authorized information access	Contactless smart card's ability to process information and react to its environment allows it to uniquely provide authenticated information access and protect the privacy of personal information. It can verify the authority of the information requestor and then allow access only to the information required.
Strong support for information privacy	Smart card technology strengthens the ability of a system to protect individual privacy. It can implement a personal firewall for an individual, releasing only the information required and only when it is required. The ability to support authenticated and authorized information access and the strong contactless device and data security make contactless smart cards guardians of personal information and individual privacy.

2.1.3 How do contactless smart cards work?

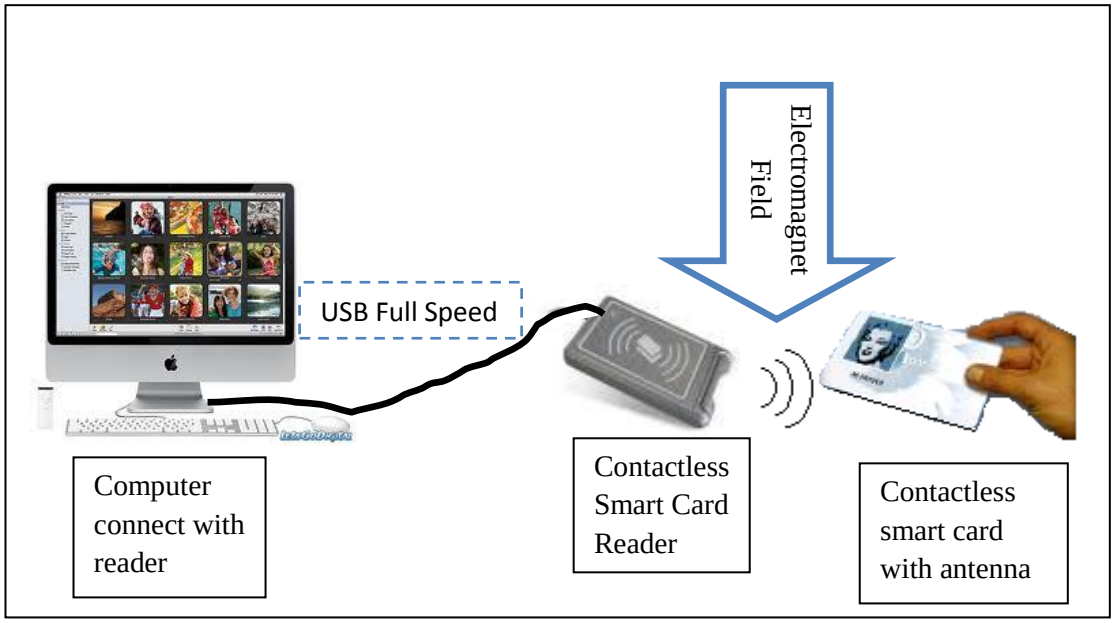

Figure 2.1.3: Work of contactless smart card

Contactless smart card systems are closely related to contact smart card systems. Like contact smart card a system, information is stored on a chip embedded within the contactless smart card. However, unlike the contact smart card, the power supplied to the card as well as the data exchanged between the card and the reader are achieved without the use of contacts, using magnetic or electromagnetic fields to both power the card as well as to exchange data with the reader [13].

The contactless smart card contains an antenna embedded within the plastic body of the card. When the card is brought into the electromagnetic field of the reader, the chip in the card is powered on. Once the chip is powered on, a wireless communication protocol is initiated and established between the card and the reader for data transfer [13].

The following four functions describe at a high level the sequence of events that happen when a contactless smart card is brought near a card reader [13]:

- Energy transfer to the card for powering the integrated circuit (chip)
- Clock signal transfer
- Data transfer to the contactless smart card
- Data transfer from the contactless smart card

Hence, once the card is brought within range of an electromagnetic field of the required frequency, the card will be powered up, ready to communicate with the reader. Since the contactless smart cards described in this FAQ are based on the ISO/IEC 14443 standard, this frequency is 13.56 MHz and a reader that complies with the standard would have an activation field (range) of about 4 inches (approximately 10 centimeters). In other words, the card needs to be within 10 centimeters of a reader for it to be effectively powered; however, the effective range for communications for the card to be read will depend on a number of factors like the power of the reader, the antenna of the reader and the antenna of the card [13].

2.1.4 Compare and contrast between Contactless Smart Card and RFID technologies

Both contactless smart card and RFID tag technologies are using radio frequency to communicate with its readers. When a contactless smart card or an RFID tag passes within range, a reader sends out radio frequency electromagnetic waves. The antenna, tuned to receive these waves and wakes up the chip in the smart card or tag. Moreover, the wireless communications channel is set up between the reader and the smart card or tag [7].

Since contactless smart card and RFID both using RF (radio frequency) in communication, thus confusion is especially strong between contactless smart cards and RFID. The key issue that has given rise to this debate is the contactless interface and that too an RF (radio frequency) one. Both contactless smart cards and RFID use radio frequencies for communicating between the card and reader. The applications for which RF is used can be different for RFID and smartcards. So, contactless payment technology is not the same as RFID (Radio Frequency IDentification). RFID technology is used to track objects, such as inventory or shipped goods. RFID can be read over a long range and is not very secure or private. Contactless payment cards on the other hand contain a smart chip that is a computer with strong security capabilities and can only read in short range and are mainly meant for payments/banking, mass transit, government and ID, and access control [2].

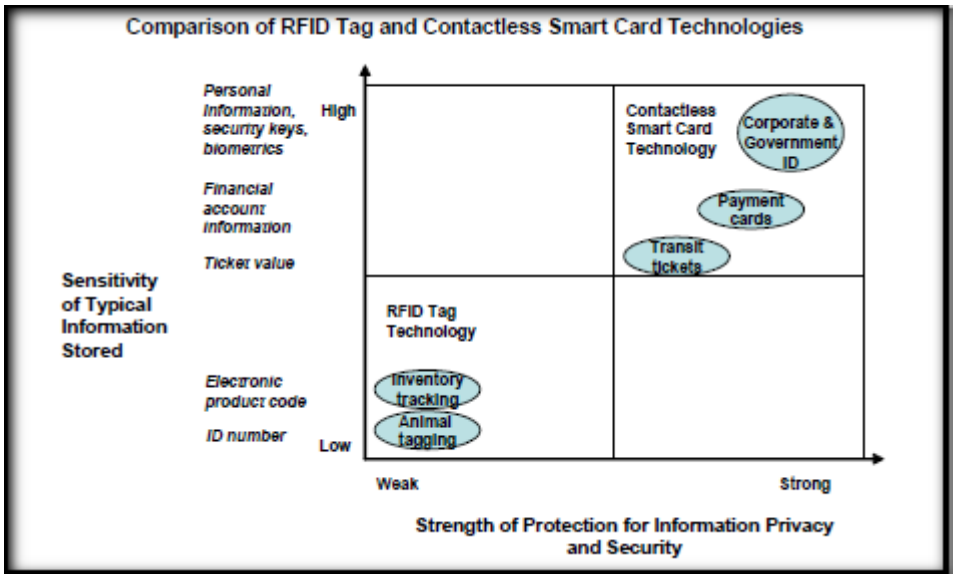

Figure 2.1.4: Comparison of Contactless Smart Card and FRID Tag Technologies

2.1.4.1 Contactless smart card and RFID tag

Contactless Smart Cards are cards that contain an ICC (integrated circuit chip) that complies with ISO 14443 (mostly type A) or better known as MiFare. It defined as any pocket-sized card with embedded integrated circuits which can process information. This implies that it can receive input which is processed - by way of the ICC applications - and delivered as an output. There are two broad categories of ICCs. Memory cards contain only non-volatile memory storage components, and perhaps some specific security logic. Microprocessor cards contain volatile memory and microprocessor components. The card is made of plastic, generally PVC, but sometimes ABS. The card may embed a hologram to avoid counterfeiting. ISO 14443 sets communication standards and transmission protocols between card and reader to create interoperability for contactless smart card products. Read/write range of devices is usually within 10 cm. Cards are intended to communicate with the reader antenna at a frequency of 13.56 MHz [2].

RFID is a wireless automatic identification and data capture (AIDC) technology, relying on storing and remotely retrieving data using devices called RFID tags or transponders. It includes tags, Antenna or coil Electronics programmed with unique information, reader and software. The Integrated circuits group comprises of IC designers, antenna and IC manufacturers. These ICs are used in the development of RFID hardware equipments which comprises of tags (that can be active or passive), in addition to readers and printers. An RFID tag is an object that can be applied to or incorporated into a product, animal, or person for the purpose of identification using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader [2].

Figure 2.1.4.1: Contactless smart card and RFID tag

Table 2.1.4.1: RF technology features

Frequency Range	Low frequency RF	High frequency RF ISO/IEC 15693	High frequency RF ISO/IEC 14443	Ultra High frequency RF
	125/135 KHz	13,56 MHz	13,56 MHz	902 – 928 MHz
Technology name	RFID	RF enabled contactless smart card	RF enabled contactless smart card	RFID
Standard (for communications link)	Proprietary for access control. ISO/IEC 11784 and ISO/IEC 11785	ISO/IEC 15693	ISO/IEC 14443 and ISO/IEC 7816, parts 4 & above for application/security standards	ISO 18000-6 for inventory control tags
Operational Range	Medium: < 20 - 60 cm	Medium: < 70 cm	Short: < 10 cm	Long: 3,5 - 10 m
Data transfer rates	< 10 Kbps	26 Kbps	106 – 848 Kbps	20 – 100 Kbps
Chip types supported	Memory only	Memory, Fixed Logic	Memory, Fixed Logic, Microcontroller, Crypto processors	Memory only
Memory capacity range	Hundreds to low kilobytes	256 bytes and 2K bytes	64 Kbytes and more	Hundreds of bits today
Read/write ability	Read/write	Read/write	Read/write	Read/write
Factory affecting security	Longer range, Fixed logic chip, Limited flexibility in communications protocols	Longer range, Fixed logic chip, Limited flexibility in communications protocols	Short range, Programmable microcontroller, Counterfeiting and tamper resistance features, More Flexibility in communications protocols	Longer range, Fixed logic chip, Limited flexibility in communications protocols
Available form factors	Tags, Plastic card, Key fob, Watch	Tags, Plastic card, Key fob, Watch	Plastic card, Key fob, Watch, Mobile phone	Tags, Plastic card
Applications	Security, Access control, Asset tracking, Animal tracking, Automobile immobilizer	Inventory tracking, Physical access control systems	Secure ID cards and documents (ePassport), Credit and debit card payment, Transit payment, Physical access control systems	Transportation vehicle Inventory tracking, Supply chain

2.1.4.2 Comparison between characteristic of a contactless smart card and RFID tag

Table 2.1.4.2: Characteristics of contactless smart card and RFID tag

Contactless Smart Card	RFID tag
Strong security capacities: i) Mutual authentication before providing access to information. ii) Access can be further protected via PIN or biometric encryption to protect data on card during exchange. iii) Hardware and software protection to combat attacks or counterfeiting [7].	Minimal security capacities: i) One-way authentication; card cannot protect itself. ii) Insufficient storage for biometrics. iii) No on-chip calculations of new information. iv) Relies on static keys [7].
Hundreds of security features mean an individual's personal ID, financial details, payment transactions, transit fares or physical access privileges can be safely stored, managed and exchanged [7].	Single function; used to help machines identify objects to increase efficiency. Example: inventory control [7].
Read and write memory capacity of 512 bytes and up, with very large memory storage possible [7].	Small memory (92 bytes); often read-only [7].
Short distance data exchange, typically two inches [7].	Larger distance data exchange, typically several yards [7]
More expensive [7]	Because of their more restricted capabilities, RFID tags are generally cheaper [7].