

2011 3rd International Conference on Environmental  
Science and Information Application Technology (ESIAT 2011)

## Analyze on Mobile Payment Based on RFID

Wei Dai, Shuo Zhou, Guangjun Luo, Zongxing Chen, Ling Xie

*International School, Beijing University of Posts and Telecommunication, Beijing, China  
ee08b177@bupt.edu.cn*

---

### Abstract

This article introduces some technology about mobile payment, principle and development. By compared current solutions to mobile payment, we make analysis among them and put forward some suggestion.

© 2011 Published by Elsevier Ltd. Selection and/or peer-review under responsibility of Conference ESIAT2011 Organization Committee.

Keywords: RFID ; NFC ; SIMpass ; RF-SIM ; eNFC

---

### 1. Introduction

Mobile payment, just as the name implies, is a means of exchange via mobile phones. According to the different usage scenarios, mobile payment can be classified as remote payment and site charge payment. Remote payment refers to the distant transaction which is accessed through WEB, WAP, SMS, IVR and so forth, and site charge payment is when clients put their phones close to the POS (Point of Sale) machine and swipe them as site cards. Site charge payment provides a convenient and efficient way for transaction payment. Nowadays, technique of remote payment is relatively mature than that of site charge payment, and its business and market have been fairly flexible and of large scale. However, remote payment is restricted by the time and the place, which means that it is not qualified as a substitution of the traditional site charge payment. But we can integrate the remote payment with the traditional site charge payment in the traditional payment scenario, and this could be promising in the near future. Site charge payment has a potential market, and it has been the focus of the attention of the global. Currently, site charge payment can be supported by IRDA (Infrared Data Association), Bluetooth and RFID (Radio Frequency Identification Devices). Bluetooth requires manual launch of the device and IRDA requires a precise aiming at the object. The operation processes of these two techniques are complicated and not so convenient in practice. Fortunately, RFID is superior to the above two in many aspects like convenience, security and reliability and RFID has dominated the payment market at present. This article will focus on RFID and demonstrate the solutions to the site charge payment via RFID.

## 2. Current Situation of Site Charge Payment

### 2.1. Abroad

Nowadays, Japan plays a leading role in the field of phone card payment. Phones configured with the function of mobile payment can act as check-in staff at the airport, entrance guards, E-card at school and so on. In 2008, the number of subscribers of mobile payment occupies a percentage of 38.5% of the whole population and the gains from mobile payment reaches approximately 4,730 million Yuan.

Korea is the second to Japan in that field. In the year of 2003, the top three operators opened the mobile payment business based on IRDA. In 2006, those operators developed the business based on RFID through the cooperation with some banks. When it came to 2009, the revenue of mobile payment topped to 1,800,000 million Won.

O2, which is a company of U.K, promoted a business called Phone Wallet with a credit card company Barclaycard, Nokia and Visa Europe at the end of 2007. The Phone Wallet is mainly used in the small amount payment in some daily scenarios such as taking public transportation and buying a newspaper.

### 2.2. Domestic

At the beginning of 2008, China Mobile selected Hunan, Chongqing, Guangzhou as experimental cities of the mobile payment and in February of 2010, it promoted the business of Phone Wallet officially.

China Unicom and China Telecom also made some progress in this field and select pilot projects in cities like Shanghai in 2009. Besides, China Telecom opened Phone Wallet in some provinces like Fujian and Guangdong in March of 2010.

## 3. Working Principle

The RFID system consists of electronic tag, reader, and antenna. The detailed structure of RFID is shown in the following figure.

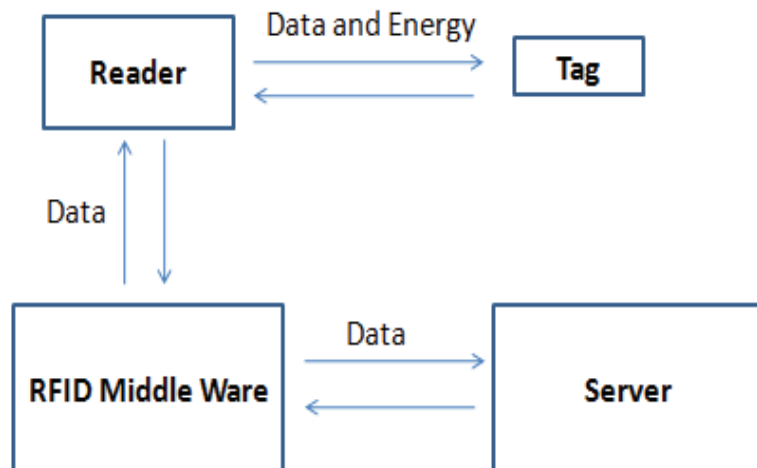


Figure 1 The Scheme of RFID System Working Principle

The electronic tag is composed of coupling device and chip which has a unique code. The tags can be divided into two modes, active and passive. Passive tag acquires energy from the electromagnetic generated by reader. When the tag saves enough energy, it will start working.

Reader is a kind of I/O instrument which exchange data with tag. It can communicate with electronic tag in noncontact way, and identify the tag which is in reaction area. Then the reader will address the data according to the instruction pre-programmed.

#### 4. Solution to Mobile Payment

So far, the mobile payment can be achieved in three noncontact ways: SIMpass, RF-SIM, and NFC.

##### 4.1. SIMpass

SIMpass is a dual-interface smart card technology, which combines the conventional SIM card and RFID card in only one standard card. Moreover, the contact interface satisfies the standard of ISO 7816, and noncontact interface meet the standard of ISO 14443.

SIMpass adopts 13.56MHz working frequency. As the frequency is not high, it is difficult to design minimize antenna. That is, the radio antenna must make use of an external antenna. There are two ways to make such antenna. One is a plane antenna which consists of coil and tip is added to the mobile phone. This solution is low cost, while it cannot be applied in the mobile phone which has monolithic battery and its cover. The other is to reform directly the hardware part of mobile phone. Compared with the previous solution, though it costs higher, it improves the stability and reliability of RFID function.

##### 4.2. NFC

NFC, proposed by Philips, Nokia and Sony, is technology which combines RFID and short-range communication. It is based on ISO/IEC 18092, ISO/IEC2148, and compatible with ISO14443A.

NFC has three main parts: NFC controller, antenna, and safety unit. According to different application requirements, safety unit can carried by different cards, such as SIM card, SD card.

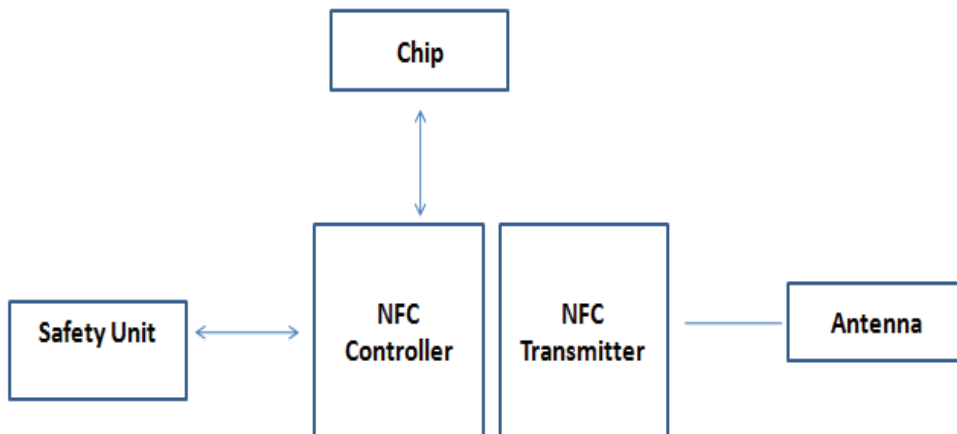


Figure 2 The Scheme of NFC Working Principle  
Solution by utilizing SD card as security chip

SD card is included in the category of memory cards. In this solution, it is necessary to embed security module (security chips such like a smart card) onto the SD card, so that management of the applications on SD card can be achieved. In a traditional SD memory card, SD control chip is linked only to flash memory and cannot have an external security module. This solution requires redesign of SD card, which allows the SD security controller can be link to both flash memory module and security module simultaneously, and thus realize synchronous read and write access.

Solution by utilizing SIM card as security chip

Although NFC implementations based on SIM card meet the telecommunication operators' requirement, the connection of SIM card and NFC controller via Pin C4 and Pin C8 of SIM card, however, may cause apprehensions just as the SIMpass technology did. So it is not conducive to further development.

Solution by utilizing enhanced NFC (eNFC) as security chip

The problem that the connection of SIM card and NFC controller will occupy Pin C4 and Pin C8 has been solved, since Gemalto Company comes up with a single-wire connectivity option (SWP) based on Pin C6 only. Non-volatile memory EEPROM used by SIM in the early stage needs high programming voltage (usually 12V~20V) when erasing and writing data. And this programming voltage is introduced via Pin C6. With the improvement of semiconductor process and chip design, modern SIM card has electric charge pump circuit in its own chip, where the programming voltage for EEPROM is pumped by VCC power source. So VPP voltage does not need to be introduced via Pin C6 from external part anymore.

#### 4.3. RF-SIM Program

RF-SIM card is the product of the penetration of dual interface (RFID card and SIM card) technology into the mobile phone industry. Combining mobile communication module and micro RF modules of normal SIM card, RF-SIM card is operated at 2.4GHz—a high frequency that has short wavelength. So the RF-SIM module can be very small in size, it communicate with external device at an automatic-adjusted distance of 10cm to 500cm through the build-in antenna.

RF-SIM card is one kind of active tags, when it works it needs to acquire power from a battery, and sends out information regularly. The tag could not work when it runs out of battery.

#### 4.4. Comparative Analysis

Significant indicators to evaluate the performance of RFID system include working range, reading and writing speed, stability and reliability, as well as cost and compatibility. These indicators have direct relation with factors such as communication protocol, RF select, antenna and electromagnetic properties, RF system design and physical realization. The implementation of Mobile payment by credit card should take all the factors into account. The diagram below will help to do comparative analysis by considering these factors.

Solutions indicators	SIMpass		NFC		eNFC	RF-SIM
	Simple antenna	Reformed Terminal	NFC-SD CARD	NFC-SIM CARD		
Working	13.56MHz		13.56MHz			2.4GHz

frequency						
Data rate	106kbps		424kbps			1Mbps
Sensing distance	Short(<10cm)		Short(<10cm)			Long(10cm-500cm)
Relevance with terminal	Non-related	related	related	related	related	Non-related
Stability	bad	good	good	good	good	good
Reliability	bad	good	good	good	good	Normal
Cost (formation)	SIM card, antenna	SIM card, mobile device, antenna	SD card, RF module	SIM card, RF module	SIM card, RF module, Mobile phone board	RF-SIM card
Compatibility	Occupy Pin C4 and C8 of SIM		good	Occupy Pin C4 and C8 of SIM	good	Not compatible with existing bank and bus POS system
Working mode	Passive induction	Passive induction	Passive induction	Passive induction	Passive induction	Sending information initiatively, need battery.
Support groups	Watchdata		Union -pay	-	NXP, INSIDE, GSMA	Directel

From the above table, we get:

SIMpass method occupied the C4 and C8 pins, which is reserved for the high speed interface of the large capacity SIM. Therefore, it makes a conflict of the SIM card future development. From long-term perspective, the SIMpass method is not fit for development. The speed of reading and writing influences the transaction processing time. The higher the speed is, the shorter time it takes, the higher security and reliability is. From this angle, SIMpass method performs a little worse.

SIMpass has a simple antenna, which costs minimum. Consequently, it is easiest for short-term promotion. However, the stability of simple antenna is little bad. If the user opens the back cover or changes the battery, the antenna would be broken. Hence, it will influence the normal usage. Considering the bad influences, it do not suggest to be used. Because SIMpass need to reform terminal device, the cost of it is near to eNFC method. Therefore, the SIMpass method is not recommended. RF-SIM, lowest cost, might not be the most proper solution. The reaction distance is the most significant factor in RFID system. For mobile payment, the shorter reaction distance, the more safe in transaction. To some extent, the distance depends on the working frequency. 2.4GHz, made use of RF-SIM, is not the safest obviously. 2.4GHz, a public frequency, support several technology, such as Bluetooth, Wi-Fi, Zigbee, UWB. Therefore, interference which RF-SIM suffers from is the most. RF-SIM performs poorly on compatibility, because the most common POS terminals adopt 13.56MHz instead on 2.4GHz. RF-SIM works in active

power mode. That is, mobile phone cannot implement RFID function when it is power-fail. Therefore, the RF-SIM method is not recommended.

NFC. Among NFC solutions, NFC-SIM has problem in pins of SIM card. And NFC-SD has more expansive cost than other solutions. Thus, eNFC is an optimum solution. Operators can cooperate with manufacture by customizing terminals. Because it is good for complementing each other's advantages. Besides, this cooperation contributes to control for operators.

## 5. Conclusion

Based on comparisons of several solutions to mobile payment, this article make a research on the current market and industry chain in China by suggesting that the technology of eNFC might be the most proper solution in mobile payment field. This promotion and maturation of this service needs the corporation between bank and operators. On one hand, they need to reform POS machines; on the other hand, they need to consider the change in SIM card. Only in this way should they complement each other's advantages and reach a win-win situation.

## References

- [1] Ci Xinxin, Wang Subin, and Wang Shuo, "The technology and application of RFID system," Posts&Telecom press, Beijing, pp65-70, July 2007.
- [2] Shan Chenggan, Shan Yufeng, and Yao Lei, "The principle and application of RFID," Publishing House of Electronics Industry, pp10-15, March 2008.
- [3] ISO/IEC 14443-1:2008, Identification cards-Contactless integrated circuit cards-Proximity cards-Part1: Physical characteristics[S]. 2008
- [4] ISO/IEC 18092:2004. Information technology-Telecommunications and information exchange between systems-Near Field Communication-Interface and Prorocol[S].2004