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Research on mobile payment based on connection of NFC and SIM card

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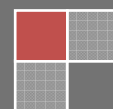
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ABSTRACT

As science advances, mobile communication technology is developing very fast, and smart phones have become more and more important in people's lives. Due to its large population, China has a huge number of mobile phone users which means one billion by 2011 with a penetration rate of more than 80%. Thus China is likely to become the mobile market leader in the future on the use of smart phones and mobile Internet services. With the development of smart phones, mobile applications are beginning to involve new areas such as mobile payment in addition to the traditional functions of calling, texting and surfing the Internet. With the above mentioned large group of mobile users, China has got a spontaneous market for mobile payment. Up to now, mobile payment has got much attention and applied by more and more mobile users. Among all the technologies of mobile payment, NFC has its own advantages over others and has a bright prospect in market and application. In the future, mobile payment will become the main payment method in China, and near-field mobile payments based on NFC technology will become more popular. Therefore, this paper, after combing the development of mobile payment at home and abroad, compares the present using mobile payment method with NFC-SIM based payment method, analyses the advantage of the latter one in safety and convenience, then explains the connection scheme of NFC and SIM card.

KEYWORDS

Smart phone; Mobile payment; NFC technology; SIM card.



INTRODUCTION

With economic development and improving people's living standards, the fast-food culture roots in our lives, arising growth in demand for personal financial services, thus fast payments become a trend. To meet needs of the people, People's Bank of China issued Notice on Improving the Individual Payment and Settlement Services, which read: Banks should continue to expand electronic payment functions, such as online payment, mobile payment, e-payment, so as to promote the development of self-help and home services, thereby reducing the pressure on the bank counter outlets^[1]. Due to the growing customer demand, mobile payment saw a rapid development. In 2012, total global mobile payment amounted to \$ 171.5 billion, an increase by 61.9% compared with 2011; by 2016 it is expected to reach \$ 617 billion. Mobile payment market will be growing as users' demand increases^[2]. This paper studies on NFC technology and the SIM card, introduces the development of mobile payment at home and abroad, and analyzes the connection scheme of NFC and SIM.

CONCEPTS

NFC Technology

NFC is the abbreviation of Near Field Communication, also called short-range wireless communication. NFC technology is a short-range high frequency wireless communication technology, transferring the data in the electronic device by non-contact point within 10cm range. It was developed together by Philips Semiconductors, Nokia and Sony on the basis of RFID (contactless radio frequency identification). Though having the same characters of non-contact short-range data transferring with Bluetooth and Infrared^[3], NFC is more reliable, more secure and quicker. The detail comparison of the three is shown in TABLE 1.

TABLE 1 : Comparison of short-range communications.

	NFC	Bluetooth	Infrared
Network Type	Point-to-Point	Point-to-Multipoint	Point-to-Point
Operational Range	≤0.1cm	≤10m	≤1m
Speed	106kbps, 212kbps, 424kbps; planned rate can be 868 kbps, 721 kbps, 115 kbps	2.1Mbps	1.0 Mbps
Setting Time	<0.1s	6s	0.5s
Security	Secure by hardware	Secure by software	Insecure with exception of IRFN
Communication Mode	Initiative-Initiative/Passive	Initiative-Initiative	Initiative-Initiative
Cost	Low	Low	Low

SIM card

SIM is the abbreviation of Subscriber Identity Module, also called smart card or user identity card. Only with a SIM card can a mobile telephony device realize its functions of calling and messaging. Through the user information and encryption keys stored in computers by a SIM card, GSM network identifies users' identity and carries out calling or messaging through SIM card, at the same time SIM card prevents messaging miscarry or wiretap. SIM card is designed according to the GSM international standards and regulations to protect users' rights and regular communication.

DEVELOPMENT STATUS OF MOBILE PAYMENT IN CHINA AND ABROAD

Current development of mobile payment abroad

Mobile payment services in foreign countries are mainly developed on the basis of Sony's Felica technology and Philips' NFC technology. Japan operator NTTDoCoMo uses Sony Felica successfully applied contactless technical mobile payment; Philips develops NFC technology based on its own Mifare technology and Sony's Felica technology. Figure 1 shows the chain structure of NFC technology. The emergence of NFC technology brought more rapid development to mobile payments. TABLE 2 shows early commercial trials of NFC technology. According to related research, mobile payment services in large-scale commercial testing has been carried out in developed electronic industry countries like the United States, Germany, Japan and Korea^[5]. More fast food restaurants, movie theaters, convenience stores and other businesses are looking forward to non-contact method of payment, hoping through these close contactless payment methods to expand the market.

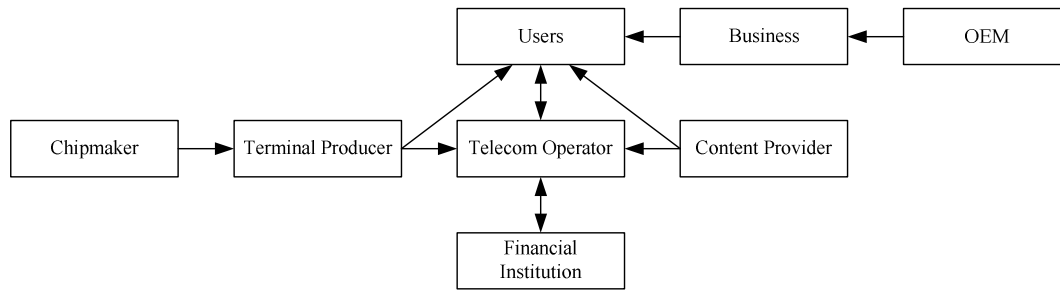


Figure 1 : NFC Chain structure

TABLE 2 : Early commercial trials of NFC technology

Time	Commercial Trials
October, 2005	Philips, France Telecom, Samsung and Orange as well as some other retail groups launched a multi-application NFC experiment in France Caen, with 200 trial users paying accounts by using Samsung D500 mobile phone at authorized retail stores or car parks.
November, 2005	RMV, Germany Hanau's public transport operator, with its manufactures, Philips, and Nokia launched the world's first NFC trial schedule.
November, 2005	The largest NFC project of North America was launched in Philips Arena in Atlanta, where users shopped and downloaded
Late in 2005	The largest mobile operator in America Cingular held a NFC mobile payment functionality testing.
June, 2006	Philips cooperated with SK of Korea for a 6-month trial in Korea, having a full-scale test on the development and deployment of NFC technology.

Current development of mobile payment in China

Back in 2001, China Unicom and China Telecom started to develop mobile payment applications^[5]. The development of mobile payment in China has experienced three stages: First, pay through SMS or voice, for example, the development of SMS banking, telephone banking, as well as via SMS validation Q coins recharge, download songs and other charges deducted from the telephone bill payment. Then, pay through the mobile phone WAP site login, but at this stage, slow connections, logins, and payments affected user experience. Last, users install an APP on smart phones for remote payments and near field payment. Remote payment is a paying method via mobile network or WIFI using installed phone trading platform, such as Alipay, mobile banking and so on; near-field payment is to pay directly through phone applications for contactless payment, typical example is the bus card. Up to now, near-field payment is still only applied limitedly in certain cities under the guide of government, generally in metro card, bus card and campus card.

INTRODUCTIONS OF NFC-SIM PAYMENT AND THE CURRENT MOBILE PAYMENT

NFC-SIM connection payment method

NFC-SIM connection payment method is convenient and safe, is prospected for scale application in the future. In this mode, SIM card plays the role of mobile user security identification, while the NFC plays the role of near field communication. This method is an operator-driven one, once it is put into use, operators will have more than 1 billion SIM card user resources. Thus it has a limitless profit prospect. This method enjoys a great advantage in the early promotion.

SIMpass mobile payment method

SIMpass combines technologies of DI card and SIM card, usually a CPU and a COS smart card are inserted in the system to ensure access to the chip by physical contact connection or non-contact connection. But this payment method requires for special phones or alteration of cell phones, bringing wide application and promoting a certain degree of restriction.

RF-SIM mobile payment method

RF-SIM is an abbreviation for Radio Frequency SIM, meaning RF recognition SIM card. By inserting a RFID radio chip in a SIM card, the SIM card can not only be able to complete the identification but also complete contactless near field communication. This method has been widely tested inside mobile company, which shows its strong competitiveness in identification and mobile payments^[6]. This method evolves into NFC technology.

INTRODUCTION OF NFC-SIM CONNECTION METHOD

Hardware frame of NFC

Figure 2 shows the hardware frame of NFC. According to the figure, NFC's hardware frame is made up by NFC controller, device processor and secure controller. NFC controller is to modulate contactless communication signals, has two switchable modes of manual type and automatic type. Device processor, as the base module of a standard phone, mainly receive-dispatch and process existing communication standards, also provides access interface, allowing NFC and mobile phone connections, which can communicate with the SIM card. Secure controller can be used as a standard SIM security module as well as implanting a special security smart chip, and its role is to provide identification and network monitoring. To realize the function of NFC, NFC analog front-end (composed of NFC controller and antenna) and secure modules are needed. Secure module can be divided into SIM, SD, SAM and other chips. Different chips are used for different needs.

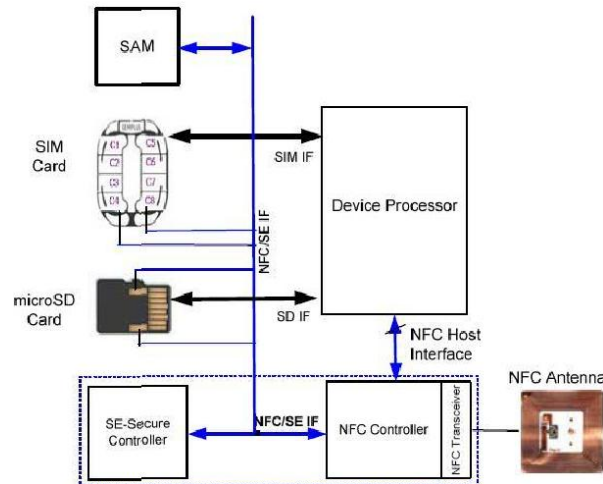


Figure 2 : Hardware frame of NFC

Analysis on SIM card interface

The pin definition of SIM card is consistent with the ISO7816 specification for integrated circuit cards with contacts. Figure 3 shows the above mentioned pin definition. Pin C1, C2, C3, C5, C7 are regular pin, C6 is high-voltage pin, while C4, C8 are high-speed interfaces of the new generation SIM card. The connection between NFC and SIM is to realize connection among the above mentioned 8 pins^[7].

Followings are definition of each pin of a SIM card:

- (1) C1 Power supply: C1 provides power supply interface for SIM to support its normal use.
- (2) C2 Reset: C2 is to realize the internal processor resetting as the reset signal.
- (3) C3 Time: C3 is specific clock for SIM card, is composed of two benchmarks.
- (4) C5 Negative terminal of power supply: C5 is the negative terminal used for SIM card power supply.
- (5) C6 Programmable power supply: C6, as the programming power interface, generally is an empty pin or is connected to the VSIM supply line.
- (6) C7 Interface: C7 plays a very important role in the SIM card, and prone to failure, it is primarily an interface for internal communication of SIM card and phone.
- (7) C4, C8 High-speed interfaces: C4, C8 are high-speed interfaces of the new generation SIM card.

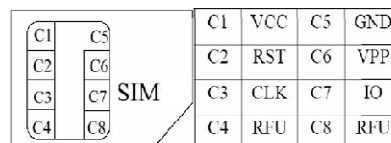


Figure 3 : Pin definition of SIM card

Possible solutions for NFC- SIM connection

C4, C8 interfaces connection

Earlier NFC methods generally are based on NXP solution, which is composed of SmartMX as secure chip and analog front-end chip. These two chips are connected by a S2C bus interface. Thus the function of SIM card is realized on the

basis of SmartMX. By connecting C4, C8 of SIM card with S2C, SIM is connected with NFC. There is another way to realize NFC-SIM connection through C4, C8 interfaces. That is to use dual SIM card interface directly to realize contactless transfer, but this will lack the functions of read and write and point-to-point communications which belong to NFC. C4, C8 interfaces connection is applicable, but due to pin C4 and C8 have been defined by the international standards organization as large capacity high speed interfaces, leaving a limited development prospect for SIM card, this solution is unable to be widely applied.

C6 interface connection

As above mentioned, though solution of C4, C8 interfaces NFC-SIM connection have long been proposed, due to its occupation of large capacity high speed interfaces for the future development, this solution has not yet received market approval. Then came C6 interface connection. The definition of C6 is the programming power interface to transfer non-volatile store device when read or written into high-pressure signal. However, as science and technology develop, semiconductor process and chip design technology progress highly, for the existing chip in IC card can directly supply high-pressure signal, so C6 interface has lost its original role. Centering on C6 interface, there are a lot of connection solutions, such as CLFI, MPI and SWP^[8]. So there is a big development prospect for NFC-SIM connection by C6 interface. However, due to the above mentioned solutions all need changes on SIM card, to realize NFC-SIM connection through C6 interface also has its limits.

C7, C8, C6, C1 interfaces connection

C4, C8 interfaces connection and C6 interface connection all have to change the structure of NFC chip or SIM card, thus have their limits. There comes a new solution to make up for limits. This is C7, C8, C6, and C1 interfaces connection. This solution has two characters: (1) It won't have to access to SIM card except for the start of connection for authentication and certification. So time for access to SIM is very short. (2) Time for NFC chip to access the SIM card is very short too, because it is a non-contact method of payment, usually one second will complete the process. In this solution, there are two 7816 interfaces pins in the NFC chip analog front end. In normal mode, baseband in NFC chip will connect with SIM card directly, and thus access to SIM; when NFC phones feel non-contact RF field, NFC chips will be converted to NFC connection mode, at the same time, there is still non-contact connection between SIM cards and NFC chips by 7861 interfaces. This solution does not change the structure of NFC chip and SIM card, while it needs less response time, so it is prospecting in the future.

CONCLUSION

In this study, concepts and current research in NFC technology, SIM cards and mobile payments are overviewed, the current development of mobile payment at home and abroad are analyzed, the current mobile payment methods of NFC-SIM and its advantages as well as its possible solutions of connection are all explained in detail. Up to now, there are so many payment institutions in the market, and payment solutions are emerging one after another. Due to the characters of safety and convenience, NFC-SIM mobile payment can do better in protecting the users' interests and saving their time. Besides, with the large number of SIM users which is over 1 billion, NFC-SIM mobile payment will have a great prospect in the mobile payment market. so in order to scheme after another, while the NFC-SIM has a safe, convenient features, can be very good to protect the interests of users, saving users time, and the user of the SIM card of more than 1 billion, so the NFC Mobile payment -SIM card combines in the field of mobile payment market has great prospects.

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