Research on Mobile Payment Technology and Business Models in China under e-Commerce Environment*

Gu Ruijun, Yao Juan, and Wang Jiacai

School of Information Science, Nanjing Audit University, Nanjing, China, 210029
grj79@hotmail.com

Abstract. Mobile payment is one rapidly-adopting alternative payment method especially in Asia such as Japan, Korea. As 3G service gets increasingly popularized in China, Mobile payment business has evolved into its growth period. Contactless mobile payment characterized by RFID will impact e-commerce market greatly. Payment technology and business model are certain to determine the success of mobile payment. In this paper, mobile payment key enabling technology in China is analyzed and the advantages and disadvantages of various techniques are compared. We also discuss four popular mobile business models and give some typical examples implemented in China. Finally current problems and development trends in Chinese mobile payment are pointed out.

Keywords: Mobile payment, business model, RFID.

1 Introduction

The emergence of mobile commerce is affected by the current mobile networks such as 2.5G, 3G and 4G. This provides an ideal environment for payment of digital and physical goods and services. Mobile devices can be used as payment device for all types of payment situations, either electronic commerce or standard commerce. Mobile Payment (mPayment) is nowadays gaining significant attraction and many users are already using mobile devices for mobile purchase.

mPayment [1] [2] can be defined as any payment transactions involving the purchase of goods or services completed with wireless device such as a mobile phone, personal computer (wireless), or PDA. A fundamental demand for the mobile device is that it must be able to connect to a network to initiate a payment. The network could be GSM or Internet and the clearing and settlement instance could be a bank or mobile operator. The most popular concept of mPayment is users are paying from mobile phones using either prepaid or post paid methods.

mPayment is one rapidly-adopting alternative payment method especially in Asia such as Japan, Korea and China. Instead of paying with cash, cheque or credit cards, a consumer can use a mobile phone to pay for music, videos, online game subscription or items and other digital goods. As 3G service gets increasingly popularized in

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China, mPayment business has evolved into its growth period. In 2009, the users of mPayment reached 108 million in China, and it is expected that the figure will be 147 million in 2010. mPayment is likely to become the first business mode integrating the Internet of Things [3] with mobile communication network.

The plan of the paper is the following: we present in Section 2 the introduction of RFID which is the enabling technology of mPayment, and we will discuss contactless mPayment technology based on RFID in Section 3. Then some popular business models of mPayment in China are compared in Section 4. At last Section 5, current problems and development trends in our mPayment are pointed out.

2 Radio-Frequency Identification

The Radio-Frequency Identification (RFID) technology [4] [5] is an automatic diagnosis technology which emerged in the 1990s. RFID is the use of an object (typically referred to as an RFID tag) applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader. RFID comprises interrogators (also known as readers), and tags (also known as labels). Most RFID tags contain at least two parts. One is an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency (RF) signal, and other specialized functions. The second is an antenna for receiving and transmitting the signal.

There are generally three types of RFID tags: active RFID tags, which contain a battery and can transmit signals autonomously, passive RFID tags, which have no battery and require an external source to provoke signal transmission, and battery, assisted passive RFID tags, which require an external source to wake up but have significant higher forward link capability providing greater range. The principle of RFID is shown in Fig. 1.

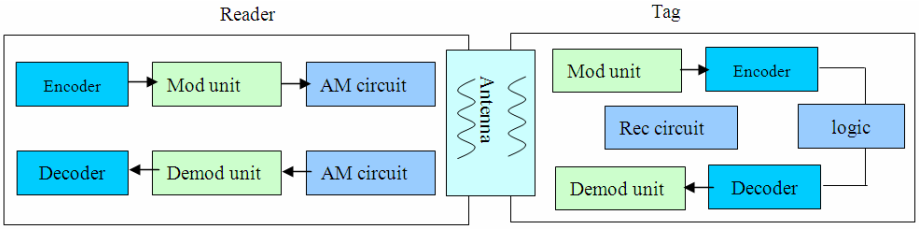

Fig. 1. Principle of RFID

As the basis of contactless mPayment application, RFID can be widely used for collecting and processing data in some areas such as logistics, transport, transportation, medical treatment, asset management, etc. In addition, RFID is the core technology of Internet of Things [3] which refers to the networked interconnection of everyday objects. It is generally viewed as a self-configuring wireless network of sensors whose purpose would be to interconnect all things. The Internet of Things will likely be a "non deterministic" and open network in which auto-organized or intelligent

entities virtual objects will be interoperable and able to act independently depending on the context, circumstances or environments.

3 Contactless Mobile Payment Technology Based on RFID

Contactless mPayment technology is usually the integration of RFID cards and other cards or devices. Mobile phones integrated RFID technology mainly includes the NFC, SIMpass and RF-SIM. These three technologies provide customers with more convenience and are the support technologies for China's three major mobile operators -- China Mobile, China Telecom, China Unicom. Therefore, NFC, SIMpass and RF-SIM are the emphasis of this paper.

3.1 Near Field Communication

Near Field Communication(NFC)[6][7], founded by Phillips and supported by Nokia and Sony, is a short-range high frequency wireless communication technology which enables the exchange of data between devices over about a 10 centimetre distance. The technology is a simple extension of the ISO/IEC 14443 proximity-card standard that combines the interface of a smartcard and a reader into a single device. An NFC device can communicate with both existing ISO/IEC 14443 smartcards and readers, as well as with other NFC devices. NFC has plenty of applications, such as mobile ticketing, mPayment, Bluetooth pairing, and so on. NFC has two modes: ①Passive Communication Mode: The Initiator device provides a carrier field and the target device answers by modulating existing field. In this mode, the Target device may draw its operating power from the Initiator-provided electromagnetic field, thus making the Target device a transponder.②Active Communication Mode: Both Initiator and Target device communicate by alternately generating their own field. A device deactivates its RF field while it is waiting for data. In this mode, both devices typically need to have a power supply.

Fig.2 shows the working principle of NFC.

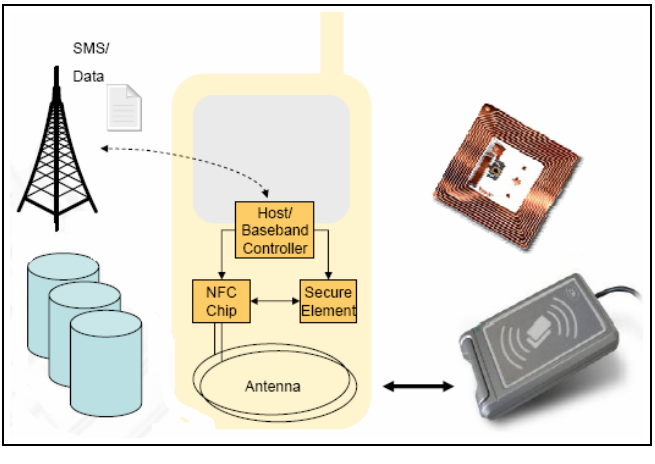

Fig. 2. Working principle of NFC

NFC technology is currently mainly aimed at being used with mobile phones. There are three main use cases for NFC: ①card emulation: the NFC device behaves like an existing contactless card. ②reader mode: the NFC device is active and read a passive RFID tag, for example for interactive advertising. ③P2P mode: two NFC devices are communicating together and exchanging information.

The NFC protocol has characteristic as follows.①secure communication and convenient establishment: The NFC protocol is one kind of short distance communication protocol, so it is safe. Just contacting both sides may establish the communication.② Supports the passive Communication model: This model is useful for the devices dependent on battery power, such as the mobile phone. ③ Compatibility: Compatible with other widely used contactless smart card protocols.

The disadvantage of using NFC mobile phone for mPayment is the high cost of hardware replacement. The user who wants to enjoy the convenience of mPayment must own a NFC mobile phone and the merchants must be equipped with appropriate payment terminals.

3.2 SIMpass

SIMpass [8] technology is founded by Watchdata who is a well-established and recognized pioneer of China in data security and smart card technology. SIMpass integrates the security module, payment module, telecom module and application module all in one SIM card. Through its contact interface, it acts as standard SIM card to execute subscriber identity authentication to your mobile phone. Via contactless interface it is ready to add contactless capabilities to your mobile phone that include transit, movie ticketing, mobile banking and payment, access control and many more applications. This allows mobile operators to stay at the centre of the mobile contactless service solution while giving their customers a highly cost effective value-added service that suit their lifestyles.

SIMpass is a Single Card Near Field Communication (SC-NFC) implementation and one of the most practical ways to implement widely accepted NFC technology. SIMpass complies with ISO/IEC 14443 Type A/B and ISO/IEC 7816 standards. The SIMpass Native card supports GSM, CDMA, China PBOC1.0, PBOC2.0 standards, Calypso European transportation standards and the Singapore CEPAS (Contactless e-Purse Application Specification) standards. Additionally, SIMpass Java card supports Java 2.2.2 and Global Platform 2.1. Both SIMpass cards also support M1 S50.

SIMpass supports telecom and non-telecom applications such as, contactless payment, e-wallet and debit and credit transactions. Compared to other NFC implementations, SIMpass has low introduction cost, as most mobile subscribers only have to change their SIM card to SIMpass card. The majority of mobile handsets currently out in the market today are compatible with SIMpass.

These are two forms of SIMpass available now: SIMpass with antenna and custom-made mobile phone. ①SIMpass with antenna: Cost effective and easily adopted by end-customers. No modifications to the mobile phones are needed. The antenna is connected to the SIMpass card and to be attached between the battery and back cover of the mobile phone.②Custom-made Mobile phones: More reliable with minimal modification needed. As an optimized SC-NFC solution, SIMpass is backed up by

mobile phone vendors. There are already three models of SC-NFC mobile phones available on the market. The SIMpass antenna is either integrated into the phone battery or the main board, which can be modified by mobile phone manufacturers without making major changes on the main board.

SIMpass mainly has two drawbacks.①the user must own one mobile terminal supporting SIMpass by either replacing one new phone or transforming current phone via adding an antenna. ②the SIMpass takes up C4 and C8 ports, which usually are used for high-speed data download.

3.3 RF-SIM

RF-SIM [9] card can realize the short distant communication which is embodied with new RF technology that the users only need a smart card and make the handset they are using into an NFC-based handset with normal SIM card function.

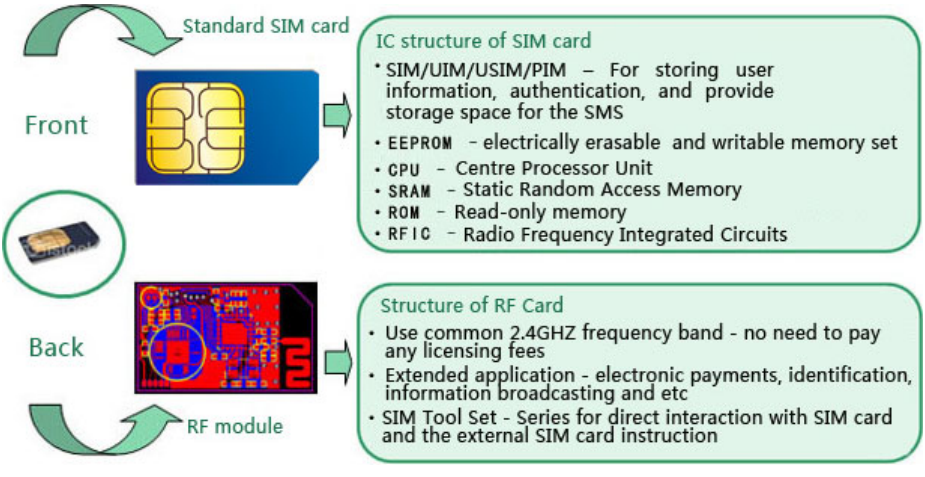

Fig. 3. Structure of RF-SIM

RF-SIM use miniature RF modules and built-in antenna to connect the external device communication. Some SIM cards is designed for mobile phones to normal communication, authentication, and only for the physical connection; Built-in software for managing is high safety of RF-ID and other logic-based VIP membership. The structure of RF- SIM is shown in Fig.3.

Its main communication features are as follows.①Using of 2.4G frequency band, automatic frequency selection, high reliability of connection and communication. ② Two communication methods: support auto-sensing and active to connect. ③Model of two-way communication from 10CM- 500CM, can be adjusted depending on the application.④One-way data broadcasting (radius 100M).□Air transport and auto TDES data encryption, anti-eavesdropping data, the mutual authentication conducts when card accessing.

One key advantage of RF-SIM is that it can be easily retrofitted to existing mobile phones. However, since it operates at 2.4GHz rather than NFC's 13.56MHz, RF-SIM terminals are incompatible with NFC terminals.

The above three kind of technologies are now most popular in China and the main features of them are shown in Table 1.

Table 1. Comparison of three technologies (solutions)

Technology	Support mode	Security	Terminal	Frequency	Compatibility	Cost	Example
NFC	all	security	replace phone	13. 56MH	yes	high	China Telecom, China UnionPay
SIMpass	card model		transform phone			medium	China Mobile
RF-SIM		security risk	change SIM card	2.4GH	no	low	China Mobile

4 Business Models of Mobile Payment

Due to different development level and diverse industry structure among different countries, four business models [10][11] for mPayment has emerged including Operator-Centric Model, Bank-Centric Model, Collaboration Model and Third Party Model.

4.1 Operator-Centric Model

The mobile operator acts independently to deploy mPayment service. The operator could provide an independent mobile wallet from the user mobile account. A large deployment of the Operator-Centric Model is severely challenged by the lack of connection to existing payment networks. Mobile network operator should handle the interfacing with the banking network to provide advanced mPayment service in banked and under banked environment. Pilots using this model have been launched in emerging countries but they did not cover most of the mPayment service use cases. Payments were limited to remittance and airtime top up. Now, China Telecom has adopted this mode to develop mPayment though there are many difficulties needed to be solved.

4.2 Bank-Centric Model

In this model, the financial institutions take the center stage and are similar to current credit card system. A bank deploys mPayment applications or devices to customers and ensures merchants have the required point-of-sale acceptance capability. Mobile network operator are used as a simple carrier, they bring their experience to provide QoS assurance. The merchant acquiring banks and issuer banks could be different and

the payment network could be managed by yet another financial institution like Visa or MasterCard. This model leverages the existing card payment system. China UnionPay is one practitioner of this model.

4.3 Collaboration Model

This model involves collaboration among banks, mobile operators and a trusted third party. Collaboration Model is seen as most feasible because it allows the stakeholders to focus on their own core competencies, opens the door for new revenue from incremental services, drives customer retention and loyalty, and responds to fundamental demand from customers. In a survey conducted by Smart Cards Alliance, 86% respondents supported this model as having the greatest potential for long term success. However, there are complicated relationships and hence complexity in negotiating deals amongst players. China Mobile China Mobile and SPD Bank have been in partnership to develop an online payment service that would be like having an Octopus card-like system in a mobile phone.

4.4 Third Party Model (Peer-to-Peer Model)

The mPayment service provider acts independently from financial institutions and mobile network operators to provide mPayment. The 3rd party company acts as a conduit between the customers, merchants and the bankers. The transaction is done

Table 2. Comparison of four business model for mPayment

Business model	Payment account	Main features	Description	Instance
Operator-Centric Model	Mobile fee account	The Operator contacts with users directly without the participation of banks, so the technology cost is low. But it is not suitable for large-value payments	Operators without payment license involved in financial transactions	China Telecom
Bank-Centric Model,	Bank account	Bank provides payment and transaction service and operator only provides information exchange. It is Suitable for large-value payments	Customized mobile phones and high initial cost	China UnionPay
Collaboration Model	Bank account	It combines Operator-Centric Model with Bank-Centric Model and is suitable for large-value payments	Operators obtain payment license indirectly through bank and is more competitive	China Mobile &SPD Bank
Third Party Model.	Bank account	The Third Party platform is a integration of merchants, banks and operators. Income is divided in accordance with their respective roles.	The third-party platform is demanding	Alibaba Pay Treasure

Peer-to-Peer between the customer and the merchant. This model is significantly different from the other three models and it threatens to eliminate the existing payment ecosystem as the role of the banks and the payment networks gets diminished. Moreover, the money can be transferred from one person to another in this way. Hence this model impacts the business of money transfer. Alibaba Pay Treasure for mobile phone is one good example of this model.

In China, there exist examples of each business model for mPayment as shown in Table 2.

5 Problems and Tendency

mPayment is typical technology-driven industry and has sufficient development space. Compared with Japan and Korea, China started later in mPayment but develop fast. At present, many problems have appeared in mobile technology and operation pattern. ①The payment security is the essential bottleneck of the mPayment. ② Different technical standards are difficult to come to an agreement. ③It is pool in mPayment service sources and is not attractive to users. ④Division of industry chain and profit distribution are urgent to be design and build.

Though there are some problems in mPayment development in China, mPayment business has evolved into its growth period [12], as 3G service gets increasingly popularized in China. mPayment is likely to become the first business mode integrating the Internet of Things with mobile communication network. Three major mobile operators together with financial institutions are actively promoting mPayment services. In May 2009, China Unicom launched its first payment service based on 3G network in Shanghai, the service was mPayment service on the basis of Near Field Communication (NFC) technology. In March 2010, China Mobile announced to acquire 20% stake of Shanghai Pudong Development Bank for the purpose of building a

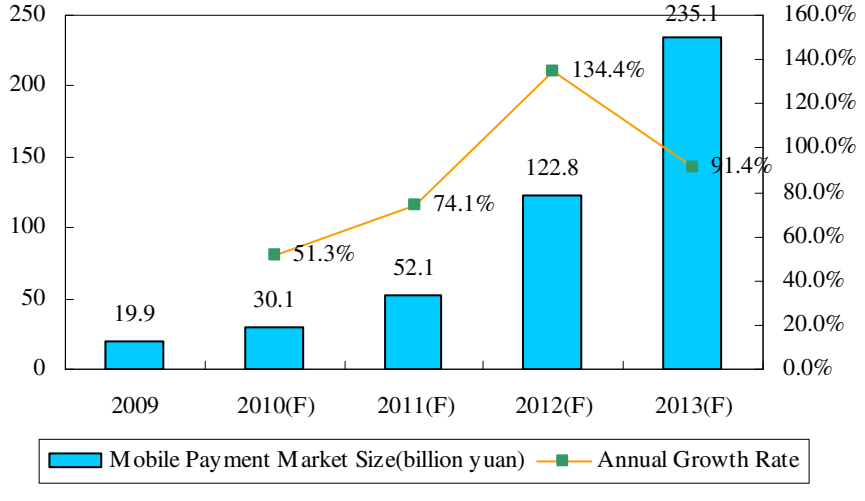

Fig. 4. Mobile market volume in China forecasting 2009-2013 [13]

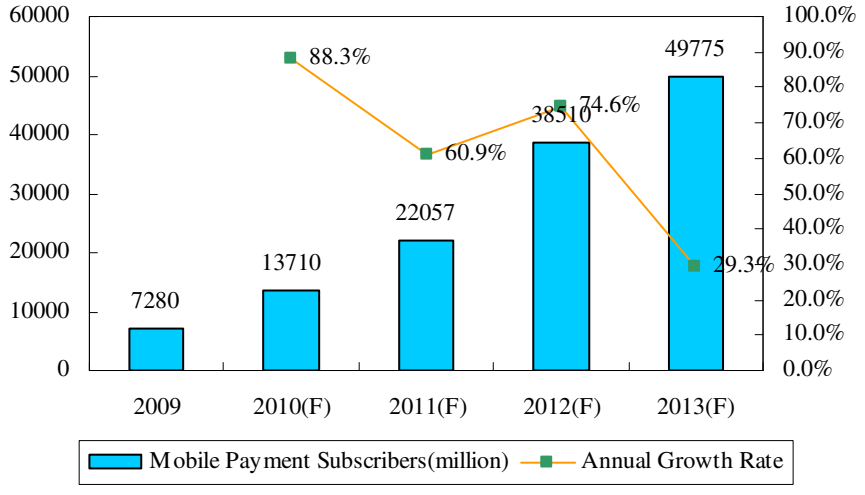

Fig. 5. Mobile payment subscribers volume in China forecasting 2009-2013 [13]

financial payment platform for developing mPayment services in the future. In addition, the huge potential market created by mPayment has attracted a large number of participants in addition to financial institutions and operators.

2010 is regarded as the beginning year of China's mPayment. Variety of innovative technologies is adopted in these trials. According to the recent research [13] as Fig.4-5 shows, the users of mPayment have reached 72.8 million at the end of 2009, and the number will be 220 million by 2011 which means triple in two years. It is predicted the market size will grow rapidly in the next few years, from 3 billion yuan in 2010 to 23.5 billion yuan in 2012. What is particularly worth mentioning is that the 3G subscribers will exceed 150 million by 2011 according to Chinese government's plan. The environment for the boost of mPayment is ripening. Mobile subscribers have exceeded 700 million in china. 3G subscribers will reach 150 million by 2011 in china. The market size will expand nearly 100% annually in average in the next three years.

6 Conclusions

In this paper, mobile payment key enabling technology in China was analyzed and compared, then four popular mobile business models were discussed. Driven by the demands of e-commerce, China's mPayment market is growing up fast. With the cultivation of user's habits and the improvement of security technology, its potential energy will be released and it also will speed up the development of huge e-commerce market of China. Mobile business, as one branch of e-commerce, is certain to develop fast with the suitable business mode reaches maturity.

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