# Proposal of Micropayment and Credit Card Model using NFC Technology in Mobile Environments

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## *Abstract*

*For many years, mobile communication networks were rapidly developed and many IT engineers studied the technology that the wallets are replaced by mobile phones. The technologies are RFID (Radio Frequency Identification) and NFC (Near Field Communication). In mobile environments, the mobile commerce (m-commerce) allows users to conduct business and service transactions over portable mobile phone. It is a NFC chip embedded phone and we called smartphones. Using NFC smartphone, m-commerce trials and researches have been studied all over the world. In this paper, we surveyed about the NFC technology, and electronic cash payments system. And we proposed a micropayment model based on NFC and credit card model.*

*Keywords: mobile communication networks, mobile environments, NFC, smartphone, micropayments system, credit card model*

## 1. Introduction

For many years, mobile communication networks were rapidly developed and many IT engineers studied the technology that the wallets are replaced by mobile phones. The technology is RFID (Radio Frequency Identification) [1] and NFC (Near Field Communication) [2]. In 2004, the NFC Forum was created to bring existing mobile RFID standards efforts together and create a short-range communication capability hat would enable a host of novel applications [3]. It has been a road for NFC with much market adoption since its inception. With advancement of mobile communication and information technology, mobile phone(Smart phone) is used to make phone calls, send text message, photos or movies, visit web sites, send emails, watch TV, buy products(mobile payments), mobile ticketing, access to a company's intranet, etc. The mobile commerce (m-commerce) allows users to conduct business and service transactions over portable mobile phone [4, 5]. This trend is

amplified by the NFC and electronic cash payments technology. The mobile phone is a NFC chip embedded phone and we called smartphones. Using NFC smartphone, m-commerce trials and researches have been studied all over the world [6-8].

The regional distribution industry is mostly medium and small but plays a pivotal role in connecting production with consumption between producers and consumers around city. However, with a recent spread of large-sized sales facilities, the sales of small retail trade and traditional markets are on a decreasing trend. In order to solve this problem, diversified efforts have been made. A new approach from IT angles is necessary to reinvigorate traditional markets. In this sense, this study suggests the micropayment model and credit card model based on android NFC of smart phone as a new approach from IT to contribute to accelerated reinvigoration of traditional markets.

In this paper, we surveyed about the NFC technology and micropayments system. And we proposed a micropayment and credit card model based on NFC.

## 2. NFC (Near-field Communication)

The concept of NFC [2, 9], which grafts existing non-contact card payment methods using a HF range of 13.56 MHz, enables authorization and payment to be made when a mobile phone is close to a payment system. Micropayments, Internet banking, and Internet shopping mall payments can be made via NFC rather than by SMS in automats or conveniences stores via the POS system. NFC is a low-power, low-cost communication solution focused on personalized communication, allowing various data to be exchanged in perfect safety.

### 2.1. Basics of Data Transmission

Like the RFID Standards 14443 and FeliCa NFC uses inductive coupling. Similar to the transformer principle, the magnetic near-field of two conductor coils is used to couple the polling device (initiator) and listening device (target) in Figure 1. The operating frequency is 13.56 MHz, and a bit rate of 106 kb/s is used (partly also 212 and 424 kb/s). The modulation schemes are amplitude on/off keying (OOK) with different modulation depths (100 % or 10 %) and BPSK.
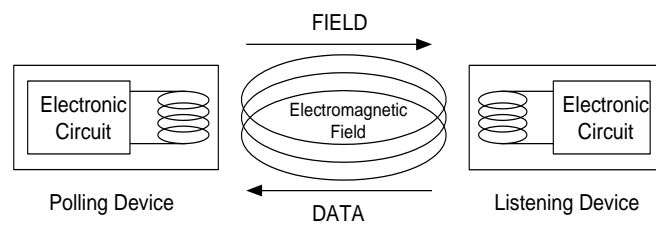


**Figure 1. Polling device (initiator) and listening device (target) configuration**

### 2.2. Infortainment field

The infotainment field is used to describe informative or entertainment data, and can apply to the on-line registration of purchased products, identification, micropayment functions such as transportation cards, and personal authorization or payment for home or Internet shopping. The NFC Forum defined and standardized the logical structures of NDEF (NFC Data Exchange Format), RTD (NFC Record Type Definition), NFC Text RTD, and NFC URI RTD technical specifications. The NDEF technical specification defines a common data format for

a device and a tag and NDEF message combination. Moreover, it presents a mechanism for defining an application data form that is included in the NDEF record. The RTD defines a standard record form for NDEF messages between devices or tags. The NFC Text RTD defines records that include plain text that the device can read, and describes the free-form text of different objectives in the tag. The Text RTD aims to add meta-data to URI. The NFC URI RTD defines records concerning NDEF elements that refer to Internet resources stored in NFC support devices.

## 2.3. Wireless communication mode and interface

NFC has three radio communication modes, as shown in Table 1.

### Table 1. Wireless communication techniques of NFC

| Mode<br>Details | ISO/IEC 18092 | ISO/IEC 14443 | IOC/IEC 15693 |
|---|---|---|---|
| Mode of Operation | Equipment to equipment communication (NFC mode) | Reader to Tag communication (PCD1 mode)[a] | Reader to Tag communication (VCD2 mode)[b] |
| Power supply | Active and Passive | Passive | Passive |
| Communication Distance | 10 cm | 10 cm | 1 m |
| Data Rate (kbps) | 106, 212, 424 | 106 | $\geq 26$ |

a: Proximity Coupling Device, b: Vicinity Coupling Device
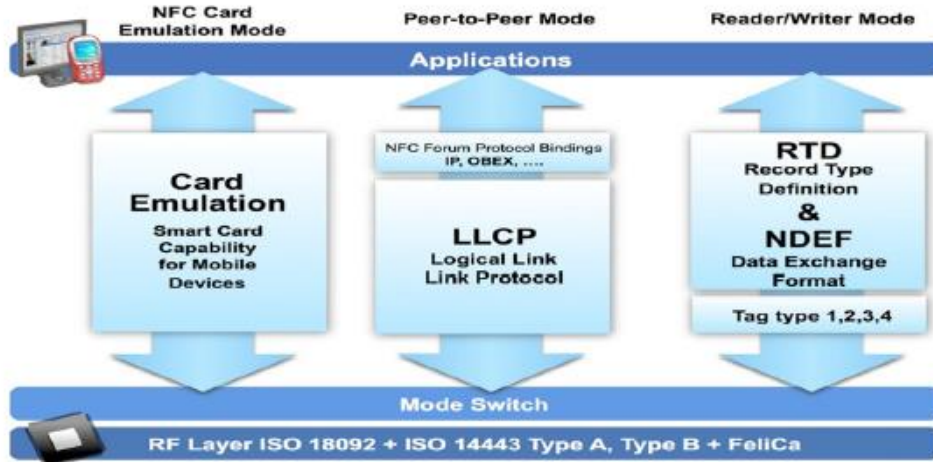


**Figure 2. NFC Technology**

NFC provides a mode switch function as shown in Figure 2, and applications in mobile phones, as shown in Figure 3, by selecting one of the NFC, PCD, and VOD modes defined in Table 1.

**Figure 3. NFC applications in mobile phones [10]**

## 3. Survey of Electronic Cash Payments

This section investigates the processing flows of electronic cash payments using ECash, CAFE, NetCash, and CyberCoin.

### 3.1. ECash (DigiCash)

ECash is a computer-generated, Internet-based system that allows the transfer of funds and purchase by credit card, check, or money order, providing secure on-line transaction processing. The structure of ECash is shown in Figure 4.
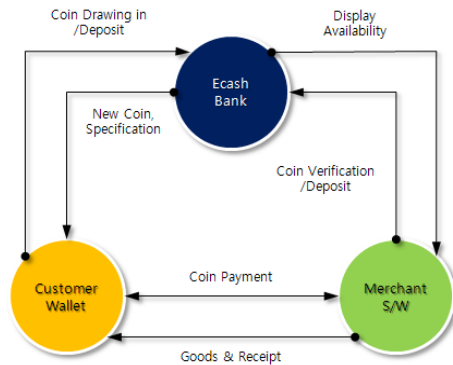


**Figure 4. Components and functions of ECash**

ECash was introduced by David Chaum as an anonymous electronic cash system. He used blind signatures to achieve unlink ability between receipt and spend transactions [11]. Depending on the properties of the payments distinction can be made between on-line and off-line electronic cash. The first off-line e-cash system was proposed by Chaum and Naor [12]. Like the first on-line method, this is based on RSA blind signatures.

### 3.2. CAFE

CAFE (Conditional Access For Europe) was a European Community ESPRIT project (Number 7023). This developed a secure electronic payment system that protects the privacy of the user, as shown in Figure 5. Thirteen partners from several countries were involved in the project, which aimed to form electronic wallets that could be used for payment, access to information services, and, if required, identification. CAFE was intended as an open, secure system.
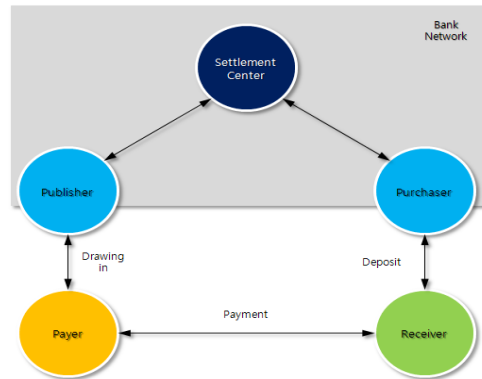
**Figure 5. Diagram of CAFÉ**

### 3.3. NetCash

The NetCash payment system is an electronic payment platform for the Internet. It was developed by Neuman and Medvinsky at the Information Sciences Institute of the University of Southern California [13]. A diagram of the NetCash system is shown in Figure 6. At present, the implementation is a research prototype, and is only available for licensing by companies implementing commercial payment services. It is not presently supported as a consumer product or service.
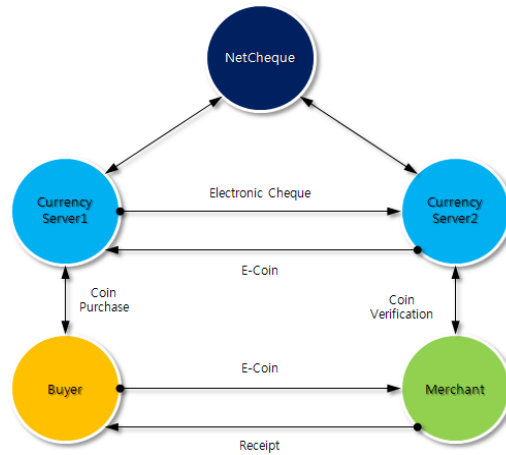


**Figure 6. Diagram of NetCash**

### 3.4. CyberCoin

CyberCash, Inc. was an internet payment service for electronic commerce, headquartered in Reston, Virginia. The company initially provided an electronic wallet to consumers, and provided the means for merchants to accept credit card payments. Later, they also offered "CyberCoin" as illustrated in Figure 7, a micropayment system modeled on the NetBill research project at Carnegie Mellon University, which they later licensed.
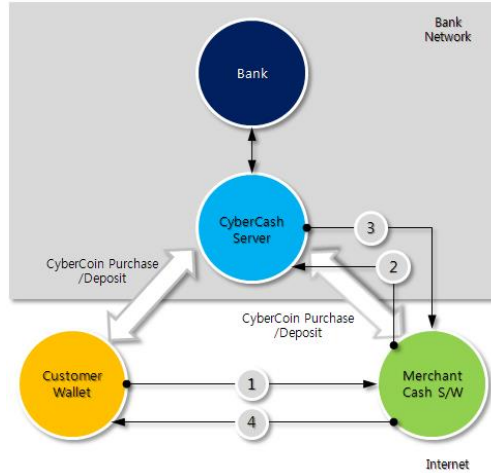
**Figure 7. Purchase processing by CyberCoin**

# 4. Design of Micropayment Model and Credit Card Model based on NFC

The procedure between small retailers and purchasers to reinvigorate traditional markets is divided into retailers, purchasers, and bank, as shown in Figure 8 [14].
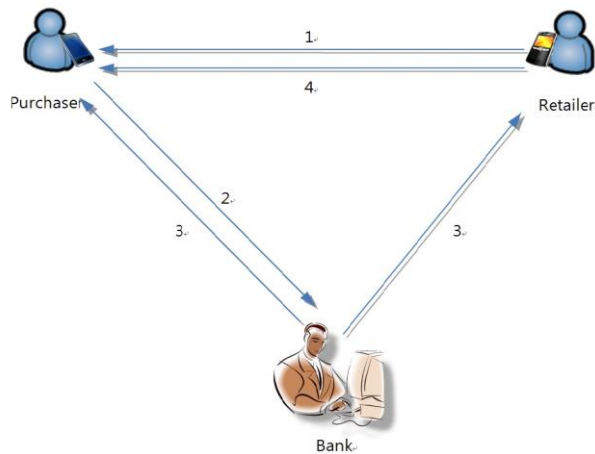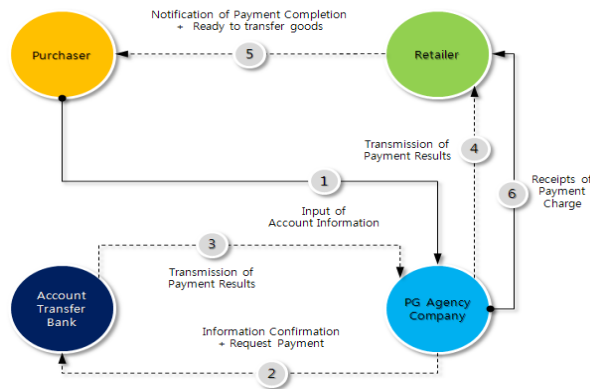


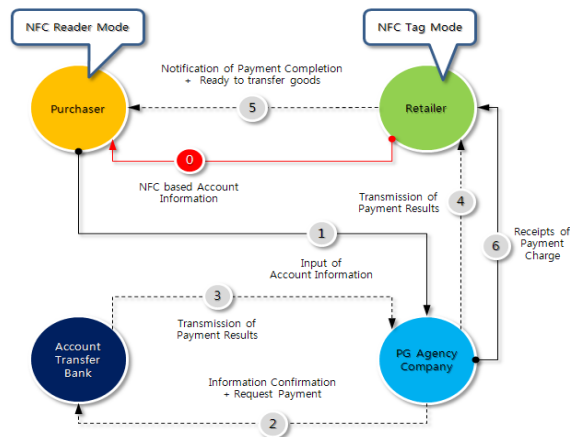**Figure 8. Android NFC based Micropayment Model in Traditional Markets**

A transaction begins at obtaining information on micropayment and retailers by purchasers via a NFC-based Android beam, as shown in line 1 of Figure 8. As a micropayment account number must be encoded for privacy, the retailer and the purchaser cannot know each other's account number. However, business information is unencrypted. In line 2 of Figure 8, the purchaser makes the micropayment for the purchased goods to the retailer's account number following authorization. The bank decodes the account number and executes the micropayment authorization. In line 3 of Figure 8, the bank authorizes the retailer and approves the transfer of the specified amount, and the purchaser receives transfer information. The retailer also receives transfer information upon completion of the transaction, and the cost of the goods sold is transferred to the retailer's account. Finally, in line 4 of Figure 8, the retailer delivers the goods to the purchaser according to the formation of a contract.

### 4.1. Proposed NFC-based Micropayment Model

The general payment system model is shown in Figure 9. We proposed the NFC-based micropayment system model in Figure 10. The general payment model is compared with the proposed micropayment system model. The only difference between the two models is step 0 of Figure 10, which concerns the NFC-based account information of the proposed micropayment system. Here, the 0 of Figure 10 in red color expressed the transaction of account information of Micro-payment using NFC P2P mode between NFC reader and NFC tag.



**Figure 9. General Payment System**



**Figure 10. Proposed NFC-Based Micropayment System Model**

NFC scenario: a basic concept of Bluetooth fairing provided in the Android development site is used. The proximity device operation of NFC is favorable to the personalization of a mobile phone. In particular, personalization requires a smaller area in the operation range of wireless network, compared with WPAN. While WPAN is within 10 meters, NFC becomes WBAN (Wireless Body Area Network). It is necessary to search and select surrounding Bluetooth/WI-FI devices to operate Bluetooth/WI-FI first as an initial setup. The setup of Bluetooth/WI-FI needs to exchange Bluetooth/WI-FI address information. Then fairing is made. In the course of fairing, retailer's business information and account number is scanned and stored.

**5.2. Design of NFC-based Credit Card Model**

The design of NFC-based credit card model is shown in Figure 11 which represents the flowchart of basic procedures for price payment. And the 0 of Figure 11 in red color expressed the transaction of account information of credit card using NFC P2P mode between NFC reader and NFC tag of mobile devices.
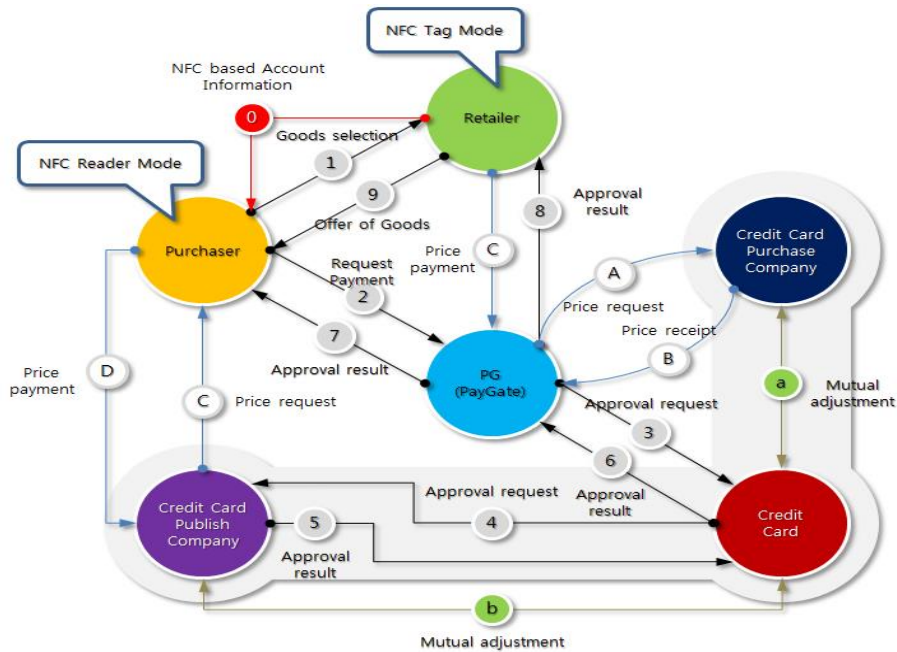


**Figure 11. Flowchart of the proposed NFC-Based Credit Card Model**

## 6. Conclusion

With advancement of mobile communication and information technology, mobile commerce allows users to conduct business and service transactions over portable mobile phone. This trend is amplified by the NFC and electronic cash payments technology. In this paper, we surveyed about the electronic cash payments. And we proposed a NFC-based micropayment model and NFC-based credit card model to revitalize markets. Further research should be conducted on the security of mobile e-payment. In particular, it is necessary to explore a variety of techniques to solve authorization and privacy problems.

## Acknowledgements

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