

Design and Development of NFC Enabled Loyalty System

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Abstract – NFC (Near Field Communication) technology facilitates mobile phone usage of billions of people throughout the world that offers diverse services ranging from payment and loyalty applications to access keys for offices and houses. NFC technology is one emerging and promising technology that have adopted smart card as secure element (SE) to provide a secure area for the execution of multiple applications as well as storing sensitive data. In this study, the design of new way of NFC enabled loyalty system on smart cards of NFC mobiles and development details are presented. With this model, loyalty and payment applications share and exchange valuable information through NFC Loyal Database system on smart card.

Key words – NFC, Near Field Communication, loyalty, system model, components

I. Introduction

NFC technology is a short-range, high frequency, and low bandwidth wireless technology which occurs between two devices within few centimetres, using 13.56 MHz frequency, with a bandwidth not more than 424 Kbit/s [1,2]. NFC technology provides card emulation, reader/writer, and peer-to-peer operating modes where communication occurs between an NFC mobile on one side, and an NFC reader, an NFC tag (passive RFID tag) or an NFC mobile on the other side [2]. Reader/writer mode provides NFC mobiles to read and modify data stored in NFC compliant passive RFID tags. Card emulation mode enables embedding information of some traditional physical components, such as payment or door key cards, onto the smart card. Peer-to-peer mode enables two NFC mobiles to establish a device-to-device link-level communication to exchange any kind of data.

NFC technology is one emerging and promising technology that have adopted smart card as secure element (SE) to provide a secure area for the execution of multiple applications as well as storing sensitive data [3].

It is currently a demanding area for researchers and practitioners to enable secure concurrent execution of multiple applications on the same smart card. Lots of cards such as credit cards, debit cards, membership cards, and loyalty cards can be stored in one single card [4]. With the help of the payment (credit and debit card) applications the availability, mobility, and simplicity of using loyalty services can be increased to obtain more customer satisfaction and customer loyalty. So, advantages of loyalty cards can be enriched which act as an effective marketing tool.

Currently, loyalty smart cards have a positive impact on the repeat purchase behaviour of loyal customers through stimulating product or service usage as well as increasing switching costs [5]. Customers receive a number of loyalty or membership cards from different companies and get benefits from each of them such as free miles, points, or coupons for each transaction, which can be defined as structured marketing efforts [6]. Hence, companies started to perform

efficient analysis on complex customer databases using new advances in the technology such as Customer Relationship Management (CRM) software tools. However, big number of loyalty cards in the user's wallet also create unmanageable and problematic situation such as misuse of customer data.

At this point we believe that more attention on loyalty programs in terms of NFC technology is required since NFC technology aims to integrate people's daily usage needs into their mobile phones securely and to eliminate the need for physical objects (i.e., identification, loyalty, debit and credit cards, keys as well as wallets) to be carried by the customer.

In this study, a new way of operating NFC enabled loyalty services on smart card of NFC mobile is designed and developed which is called NFC Loyal system. NFC Loyal extends conventional understanding of loyalty card to a more efficient and secure usage by storing loyalty data on the smart card which is embedded to a mobile phone, and by enabling secure data exchange between applications afterwards.

According to our new application, loyalty and payment applications share and exchange valuable information to obtain mutual financial outcomes, to increase the repetition of purchase behavior of existing customers, and to start new purchase behaviour (Fig. 1).

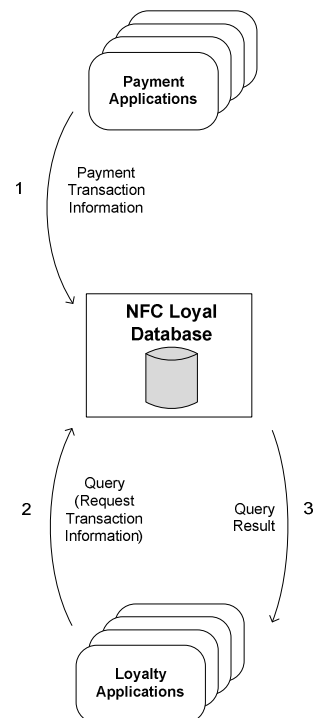


Fig.1 NFC Loyal Model

NFC Loyal consists of a method which tends to change the behaviour of the marketing techniques of the companies dramatically. NFC Loyal is indeed a win-win model which improved customer satisfaction. As the loyalty applications are installed on the smart card of NFC mobile by the user, an improved loyalty service is already available.

The users gain some profits as they allow transfer of partial purchase information to the loyalty applications. The loyalty services might for example propose a sale just near to the market that the purchase is made in. In traditional models the proposal can be made only by the banks, since they exclusively own and use the purchase data, which normally can be made off-line; but NFC Loyal enables a more expert usage of the on-line data.

In the next section, we briefly describe the developed NFC Loyal system and its components within NFC Mobile. Each component's responsibility and features, data exchange mechanism are explained with screenshots from developed NFC Loyal program. In the last section, we provide useful guidelines, and conclusions of our new application for the reader.

II. NFC Loyal System and Components

NFC Loyal system is compromised from six main components; NFC Loyal User Interface, NFC Loyal Background Application, NFC Loyal Applet, NFC Loyal database, Test Loyal Application and Applet (Fig. 2). The application is developed on Java Card and Android OS platform.

The developed NFC Loyal system includes two main Java Card application; NFC Loyal Database and NFC Loyal Applet. NFC Loyal Applet enables NFC Loyal system to reach to the NFC Loyal database.

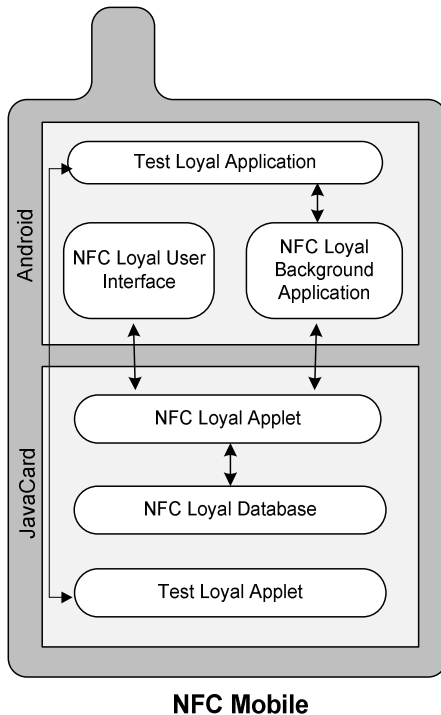


Fig.2 NFC Loyal System Components

NFC Loyal Applet serves for two other applications in the system (Fig. 2); NFC Loyal User Interface for the users of the system and NFC mobile, and NFC Loyal Background Application which acts like a bridge between loyalty applications and NFC Loyal Applet (Fig. 3).

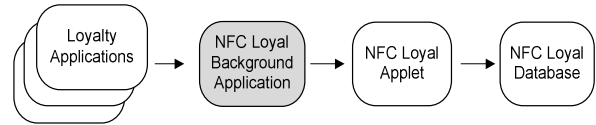


Fig.3 NFC Loyal Background Application

1. NFC Loyal Applet: This Java Card application performs the necessary processes on the NFC Loyal database by APDU communication format.

In order to provide data exchange between loyalty applications and NFC Loyal Database, an interface to access the smart card at the application layer is necessary [4]. Thus, the Java Community Process Program has already standardized an Application Programming Interface (API) for using the features of a smart card. or SE One of the optional packages of API specifications is the data exchange format to exchange data between a reader and smart card chips, allowing communication with SE through APDU (Application Protocol Data Unit) commands. Currently, SE communicates with phone using APDU. Indeed, the ISO 7816 standards define only a set of low level APDU commands, which perform writing orders, reading orders, or cryptographic functions invocation.

As mentioned, there are two important components at this level; NFC Loyal User Interface and NFC Loyal Background Application. NFC Loyal User Interface allows users to view the information on database (Fig. 4). This component transmits the APDU commands (requests) from loyalty applications to NFC Loyal database and similarly transmits the APDU commands (responses) from NFC Loyal Database to the loyalty applications.

Table 1: APDU Command Format - Request

Field	Length (Byte)	Description
CLA	1	Instruction Class
INS	1	Instruction Code
P1-P2	2	Instruction parameters for the command
L _c	0, 1 or 3	Encodes the number (N _c) of bytes of command data to follow
Command Data	N _c	N _c bytes of data
L _c	0, 1, 2 or 3	Encodes the maximum number

		(N _e) of response bytes expected
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Table 2: APDU Command - Response

Field	Length (Byte)	Description
Response Data	N _r (at most N _e)	Response data
SW1-SW2	2	Command processing status

2. NFC Loyal User Interface: NFC Loyal User Interface as an Android application can reach to the loyalty applications on the smart card of the NFC mobile. These loyalty applications can be downloaded easily by users of NFC mobile. Users can use all her loyalty applications and perform several operations through this interface. Users can display the earned points, gifts, promotions and other offers provided by the loyalty applications; can view last month's shopping details, companies and details, shopping category details, transaction amounts etc. on her NFC mobile with this new loyalty system (Fig. 4, 5 and 6).

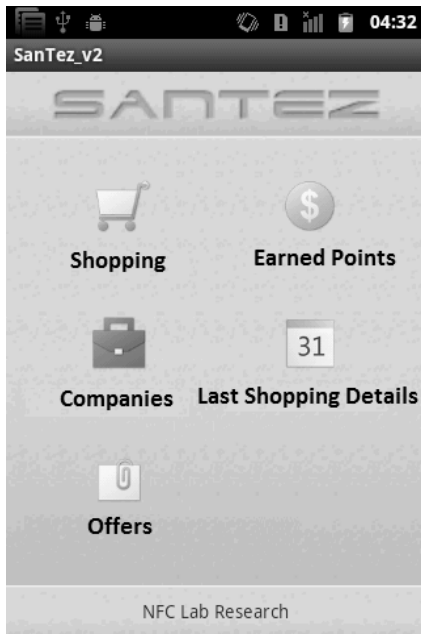


Fig.4 NFC Loyal User Interface-1

3. NFC Loyal Background Application: As mentioned, NFC Loyal Background Application acts like a bridge between NFC Loyal Applet and loyalty applications and operates on the background of the NFC Loyal system. So, loyalty applications cannot reach directly to the NFC Loyal Applet; an authorization mechanism is developed which increases the security of NFC Loyal Applet. Only authorized loyalty applications on the smart card of NFC mobile can reach NFC Loyal applet.

In NFC Loyal system, the payment and loyalty applications can share either partial or all information with loyalty applications. To share partial information, a setting mechanism and business model should be developed among payment, loyalty service providers and users. Such a mechanism is beneficial for users and service providers who

prefer more privacy to more profit [4]. For example the amount of the shared information can be low or high, depending on the user's sharing preferences. A user who prefers more privacy may configure the system accordingly, but will gain less than the user who prefers high profit and configures the system to exchange more data among the payment and loyalty applications.

This components transmits the APDU requests such as adding, reading, updating to database, from loyalty applications, and then transmits the responses to the loyalty application.

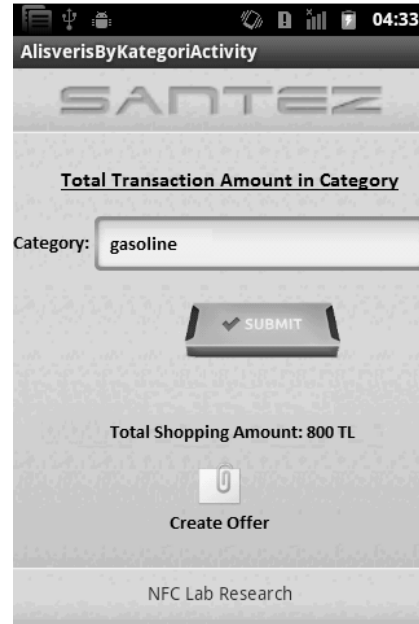


Fig.5 NFC Loyal User Interface-2

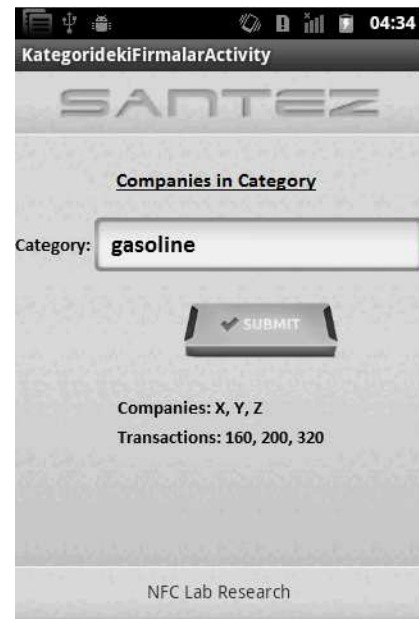


Fig.6 NFC Loyal User Interface-3

4. Test Loyal Application: This test loyalty application is developed for operating and testing the

NFC Loyal system. This loyalty application requests valuable information from NFC Loyal Applet with pre-defined parameters. After getting valuable information, it processes and provides loyalty offers such as bonus, earned points, promotions, discounts etc. The usage status information of these offers are also stored on NFC Loyal Database to share with other loyalty applications as well (Fig. 7).

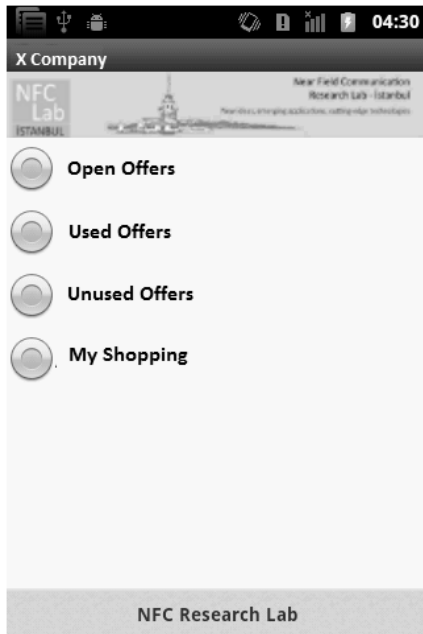


Fig.7 Test Loyal Application Interface - X Company

III. Conclusion

The developed NFC Loyal system maintains storage, retrieval, and sharing data among payment and loyalty applications on the smart card of a NFC mobiles through our proposed structure. NFC Loyal is a beneficial model to share the purchase / transaction data among payment and loyalty applications. Usage of NFC Loyal provides different benefits to each actor in the NFC ecosystem.

The NFC Loyal users benefits from all service providers of the payment and loyalty services on the smart card as SE. As the user becomes happy, she tends to increase her usage of the payment applications, which is for the benefit of the payment applications as well.

NFC Loyal, being the first comprehensive loyalty application that makes use of NFC has the following R&D properties:

- It is the first model that allows secure data exchange between the applications installed on the same SE which also provides the essential security structure as required,
- As the valuable payment transaction data is stored on NFC Loyal Database system, it allows on-line data transfer to the services,
- Third party firms cannot reach to unwanted transaction and loyalty information since the data is stored only in smart card and type of the information to be shared is configured by the user.

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