Barcode Payment System in Trusted Mobile Devices

Vibha Kaw Raina
Department of Computer Science,
Birla Institute of Technology,
Noida, India.

U.S Pandey
School of Open Learning,
Delhi University,
India.

Munish Makkad
Department of Management,
Birla Institute of Technology,
Noida, India

ABSTRACT

Mobile payment is an application of mobile commerce which facilitates mobile commerce transactions by providing the mobile customer with a convenient means to pay. Many mobile payment methods have been proposed and implemented like user friendly, customer centric, merchant centric where security concerns are highly addressed. This paper proposes a mobile payment model with barcodes for mobile users to improve mobile user experience in mobile payment. Unlike other existing mobile payment systems, the proposed payment solution provides distinct advantages to support buy-and-sale products and services based on 2D Barcodes. The aim of this work is to integrate a model of payment with the financial services, including payment and banking ones, based on two primary capabilities: the use of computational resources of a trusted mobile device and the establishment of a user controlled channel with the customer's bank. The proposed architecture is characterized bank-centric, since the bank acts consultatively, informatively and protectively for the end user and it offers flexibility, adaptability and continuous extendibility to open technologies.

Keywords:

Mobile Payment, POS, Payment Systems, m-commerce.

1. INTRODUCTION

Mobile payments are defined as the payments carried on the mobile devices. A mobile payment is the process of two parties exchanging financial value using mobile device in return for goods and services. It can also be defined as the transfer of money from one party to another through the exchange of information. Mobile devices may include mobile phones, PDA's, wireless tablets and any other device that can be connected to mobile telecommunications network for making payments. For any mobile payment to be widely accepted and adopted it is important to overcome the following challenges. Interoperability, Usability, Simplicity, Universality, Security, Privacy, Cost, Speed and Cross border Payments. [1] Different Payment systems have been developed and implemented with diverse features, from different perspectives like mobile payment market, business models, schemes and processes, as well as needs and challenges. Meanwhile, there are a number of mobile payment players, which provide mobile users with mobile payment systems, solutions and services. As more and more products are identified using 2D Barcodes, it is reasonable for merchants and business vendors to expect a mobile payment system to support the buy-and-sale products using standard 2D barcodes on mobile devices. With the development of mobile phones with touch screen feature and digital camera function, mobile users are looking for mobile solutions to provide rich mobile experience and simple operations for mobile transaction.

Mobile payment systems supporting 2D Barcodes are needed by mobile users and merchants for trust, security and flexible payments. This paper proposes a mobile payment system based on 2D barcodes for mobile users to improve mobile experience in conducting mobile payment transactions.

The paper is structured as follows. Section 2 provides the basic background about mobile payment and 2D barcodes, and reviews the related work on mobile payment systems and 2D barcode based mobile applications. Section 3 Mobile Payments, mobile payment processes for buying products with 2D barcodes and Mobile Enabled Security Solution in Mobile Payment. Section 4 discusses proposed payment model for products with identified 2D barcodes. Section 5 discusses the conclusion remarks and future research directions are discussed in Section 6.

2. RELATED WORK

Barcodes are printed horizontal strips of vertical bars used for identifying specific items. A "scanning device reads the barcode by moving a beam across the symbol". [2] Digital barcodes provide a great means to store information in a portable way. Barcodes represent machine-readable information that can be easily stored, transferred and processed. Barcodes have the capability to improve the productivity and reliability of nearly all applications as they are printed and processed by machines. They are processed faster than human data entry and have a higher degree of accuracy. Barcodes have many applications and are mainly used for product identification, inventory marking, payments, shipping container marking, and much more. Barcodes not only provide a simple and inexpensive method to present diverse commercial data, but also improve mobile user experience by reducing their manual inputs [3]. Since barcodes can be easily stored, transferred, processed and validated in a digital form, Barcode identification provides a simple and inexpensive way of encoding text information that is easily read using electronic readers. Hence, using barcodes provides a fast and accurate tool to enter data without keyboard data entry. Since the earlier forms of linear barcodes were not capable of encoding letters, 2-D barcodes were invented to meet the needs of encoding alphanumeric data, including letters, numbers, and punctuation marks. At the end of 1980s, two-dimensional (2D) barcodes appeared. With a much larger data capacity, 2D barcodes become popularly used in different areas. There are two types of 2D barcodes: a) stacked 2D barcodes, such as PDF417, and b) Matrix 2D barcodes, such as Data Matrix and QR Code. The barcode technology that has been further developed with the creation of 2D barcodes is to increase the data capacity of 1D barcodes. With the integration of cameras, mobile phones act as scanners, barcode readers and portable data storages and maintaining network connectivity. When used together with

such camera phones, 2D-barcodes work as a tag to connect the digital and physical world [4]. Today most of the mobile applications encode a URL or a website address inside a 2D barcode to visit a web page containing a video clip or a document that can be accessed from a mobile web browser. A 2D barcode can also represent a business card, an advertisement coupon, product information and it can be used in visual cryptography. Since it can encode a variety of text information, several mobile centric systems can be developed to manage information belonging to different domains including manufacturing industry, government organizations and public sector, for accurate asset tracking, healthcare, system logistics etc.

a)QR Code b) Data Matrix c) PDF 417

Figure 1 Type of Barcodes

3. MOBILE PAYMENTS

According to the Mobile Payment Forum the mobile payments are the transactions with a monetary value that is conducted through a mobile telecommunications network through diverse mobile users devices, such as cellular telephones, smart phones or PDA's and mobile terminals. Mobile payment is a transfer of funds in return for goods or services in which a mobile device is functionally involved in executing and confirming payment. The payer can be standing at a POS or be interacting with a merchant located somewhere else. Mobile Payment is a major component of m- commerce and is defined as a process of two parties exchanging financial value using a mobile device in return for goods or services. [5, 6] Mobile payment systems enables customers to purchase and pay for goods or services via mobile phones. Here, each mobile phone is used as the personal payment tool in connection with the remote sales. A phone card-based payment system has the advantage over the traditional card-based payment in that the mobile phone replaces both the physical card and the card terminal as well. Payments can take place anywhere far away from both the recipient and the bank. The basics and example of phone-based payment systems are described in [7, 8].Traditionally, in the real world, the most popular modes of payments are cash, cheques, debit cards and credit cards. With the possibilities created by the Internet, a new generation of payments appeared, such as electronic payments, digital payments and virtual payments.

3.1 Classification of mobile payments

Mobile payment methods currently in use or under trial may be classified according to the basis of payment. A payment transaction has been identified on the basis of multiple dimensions. A distinction between the different types of payments is on the basis of location, time, size and medium. Mobile payments are typically differentiated by technology, transaction size, location (remote or proximity), and funding mechanism.

On the basis of location payments are classified in two types: [9, 10, and 11]

- Remote mobile payments
- Proximity mobile payments

On the basis of Technology:

- SMS), a mobile browser, or a mobile application
- Bar codes or a contactless interface to chip-enabled payment technology, such as NFC-enabled mobile phones, contactless stickers, tags, or fobs.

On the basis of size the payments are classified into two types:

- Micro payments.
- Macro payments.

On the basis of funding mechanism the payments are categorised into following types: [12, 13]

- Account Based
- Real time
- Pre paid
- Post paid
- Smart card Based
- Credit card Based
- M POS
- Mobile wallets
- P2P Payments

The details of the classification are described in smart card alliance. [9, 10, 11, 14]

3.2 Payment Process with 2D barcodes

The 2D barcode-based systems allow mobile users to issue mobile payment transactions using their digital wallets based on mobile payment accounts in a mobile payment server. Comparing with the existing account-based mobile payment systems, this approach has five distinct advantages*:*

- It provides the buy-and-sale payment services for goods identified using 2D barcodes.
- Mobile users can easily retrieve all related product information from 2D barcodes.
- It easily supports product and customer verification for post-sale services, such as delivery and pick-up.
- It increases the mobile security for payment transactions.
- It improves mobile user experience by reducing user inputs.[15, 21, 22]

Following are the steps in the 2D barcode-based payment system:

- **Step 0:**

A registered mobile user uses his/her user account and PIN to login the mobile payment system by sending a login request to the mobile payment server. The mobile server processes mobile client authentication and sends a login response with the server certificate ID, and secured session ID, as well as a public key for the communications.

- **Step 1:**

The mobile client authenticates the mobile server with received public and server's certificate.

- **Step 2:**

The mobile client captures or receives a 2D barcode for an interested product from its advertisement. There are two scenarios in which a mobile user can get a 2D barcode. In the first case, a mobile user may use a mobile camera on the mobile device to capture the image of a 2D barcode from a posted product. In the second case, a mobile user may receive a mobile ad on a mobile device from a merchant. Meanwhile, the mobile client decodes the received 2D barcode, which includes product and maker's information, marketing data, merchant's mobile URL information.

- **Step3:**

The mobile use clicks the given 2D barcode to switch the target merchant's mobile site using the provided URL in the received 2D barcode.

- **Step 4:**

The mobile use prepares and submits a purchasing request with a digital signature as a 2D barcode to the merchant server.

- **Step 5:**

The merchant server authenticates the mobile client based on the provided the secured session ID from the mobile client, as well as the public key. Meanwhile, the received signed request is validated by the merchant using the private key.

- **Step 6:**

The merchant server generates and sends a signed purchase invoice with a transaction ID to the mobile client.

- **Step 7:**

The mobile client prepares and sends a payment request with the same transaction ID and a digital signature to initiate a payment request. The digital signature is made using the client private key. The entire message is encoded as a 2D barcode.

- **Step 8:**

A secure session is established between the payment server and the mobile client. In this step, the payment server validates the given security information, including the certificate from mobile client, session ID, public key, and received digital signature. The mobile payment server processes the payment transaction.

- **Step 9:**

The payment server prepares and sends a payment confirmation with a 2d barcode receipt to the mobile client. The mobile client displays the received confirmed message to the mobile user.

- **Step 10:**

The mobile server also sends a payment transaction completion notice with a 2D barcode to the merchant server. This barcode will be useful for the merchant to carry out the post-sale operations, such as pick-up validation or product delivery. [15, 21, 22]

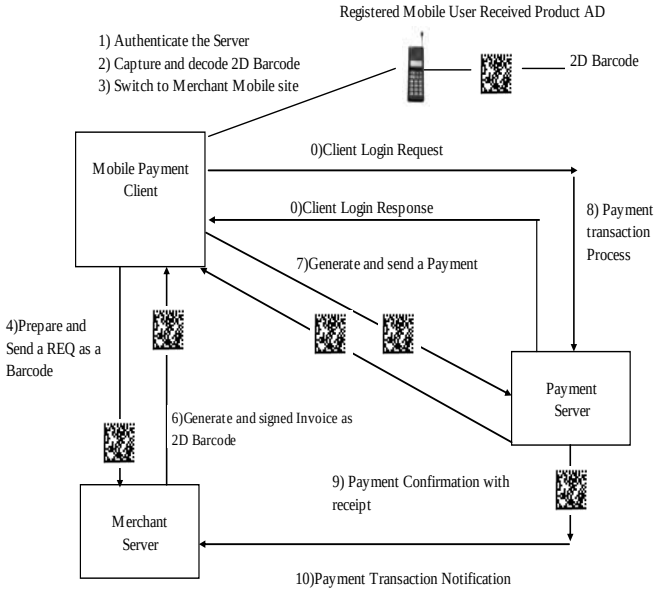


Figure 2: The 2D Barcode Payment System

3.3 Mobile Enabled Security Solution In Mobile Payment

To address these security issues in the 2D barcode payment system the following components are required.

- Authentication management:

This component is built to support the required authentication functions for each party, including mobile client, merchant, and the payment server. In this system each party must be authenticated before any payment transaction.

- Mobile session management:

This function component is designed to assure the security of a payment session between involved parties.

- Certification management:

This component is designed here to support the payment-oriented certification generation, validation, and management.

- Mobile key management

This component is built to generate, distribute, check public and private key based on the Elliptic Curve Cryptography (ECC) technique [16, 17, 18, 19].

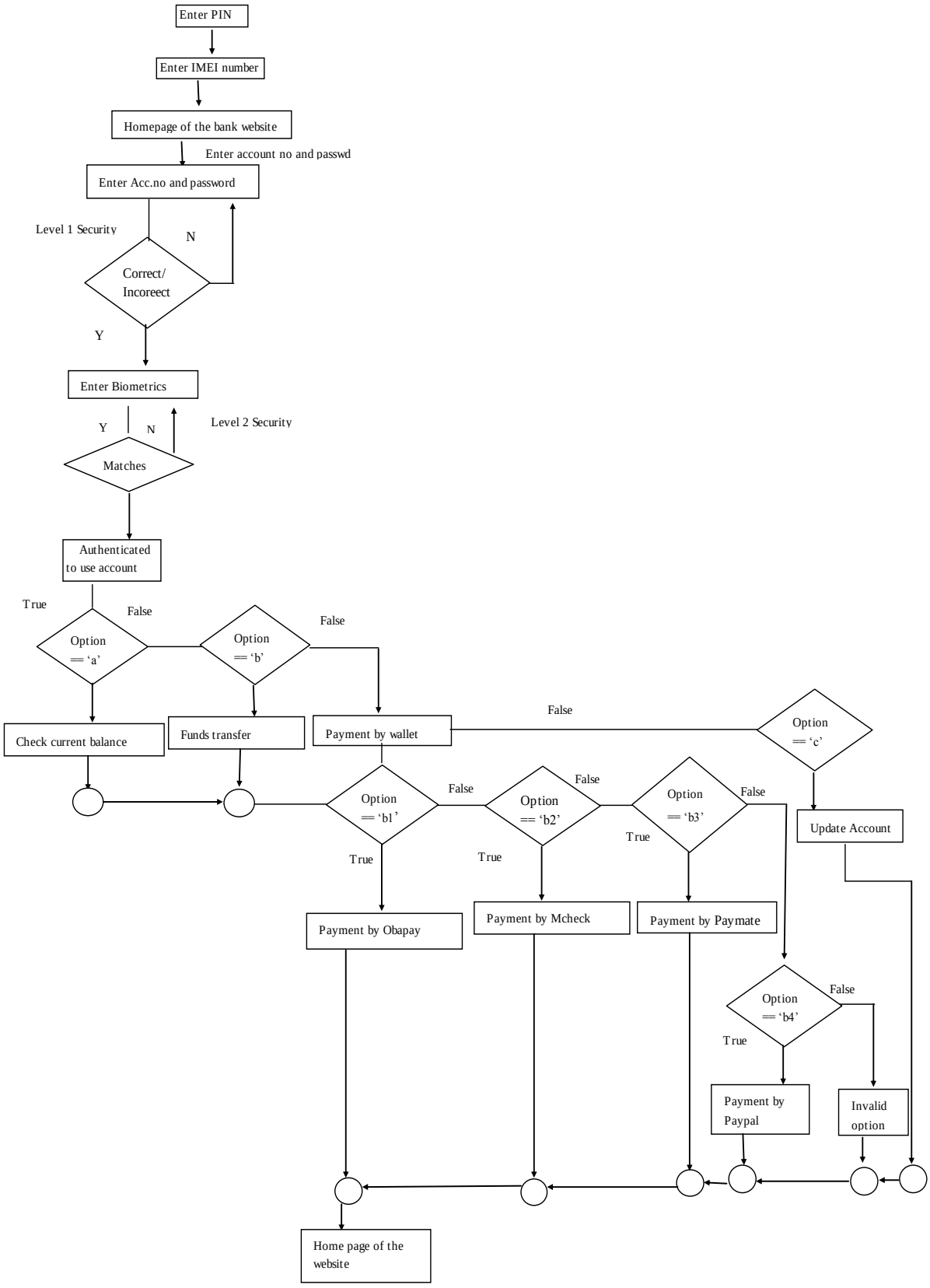
- Message and data integrity validation

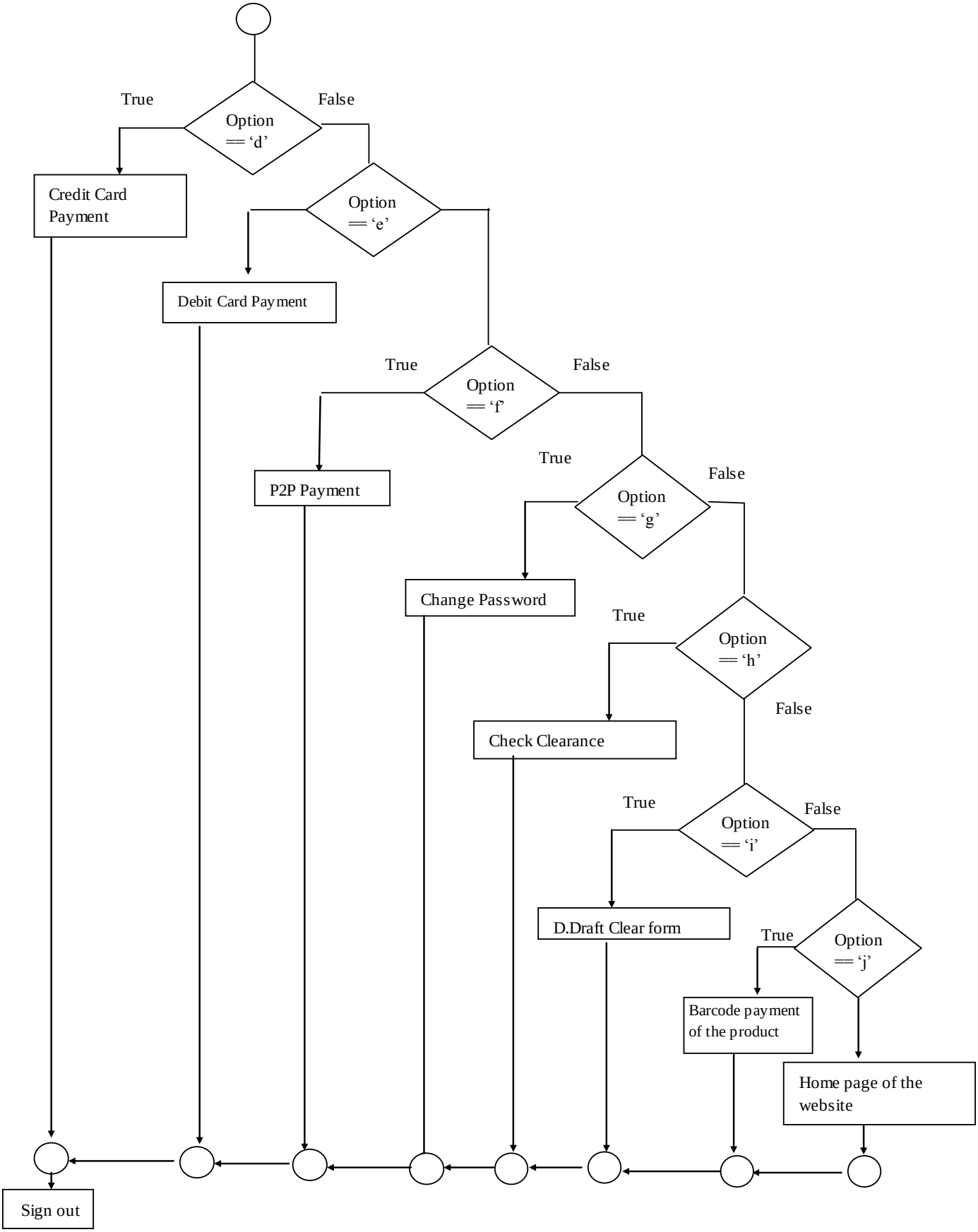
This component is useful to check the message and data integrity for the communications between mobile client and the payment server using encryption and decryption methods.

The mobile enabled security solution consists of three parts, which supports the security functions and needs in mobile client software, the mobile payment server, and the merchant server. Unlike other existing electronic payment systems, the major security solutions in the payment system used the Elliptic Curve Cryptography technique to deal with different security issues due its advantages in processing time, key

lengths and key generation, and energy consumption in mobile computing over other cryptography techniques [20].

4. FLOWCHART OF PROPOSED METHODOLOGY




True
Option == 'd'
False
Credit Card Payment
Option == 'e'
Debit Card Payment
True
Option == 'f'
False
P2P Payment
True
Option == 'g'
False
Change Password
True
Option == 'h'
False
Check Clearance
True
Option == 'i'
False
D.Draft Clear form
True
Option == 'j'
Barcode payment of the product
Home page of the website
Sign out

The proposed model gives the flexibility to perform any payment or transaction, where no external entity is involved other than bank. This model is based on customer centric and bank centric approach which is useful for both the bank as well as the user. The model has the two levels of security to authenticate the user. The first step in the proposed model is to check the first level of security i.e. in the form of account number and password. After entering the account number and password the system checks the validity of the user credentials. If the user enters the right account number and password the system enters into second level of security otherwise again asks for the account number and password. After authenticating the first level the system asks for the second level of security which is the biometric template of the user. The system verifies the biometric template of the user with the stored biometric template in the database. Then, the system proceeds and enters in to the mode of transactions/payments otherwise it will continue asking the valid set of credentials till the loop ends (three times). Since, this model is also used for P2P transactions and it uses mobile wallet it becomes necessary to ask for the security of mobile device. After entering the security credentials the model gets activated and the user can perform any kind of payment or transaction. For P2P transactions or POS transactions this model is to implement the NFC technology. In addition to P2P transactions, the model does payments with the help of barcodes. For barcodes extra hardware is required. In addition to the above mentioned processes one important check is present in the proposed model i.e. IMEI check. IMEI is a unique equipment identification number that is given to customer by service provider. The advantage of this number is that the payment model can be used with respective devices. If the IMEI number of the device matches the number stored in the device, then only user can proceed for further steps. There are two different modes proposed in this work. In the first one, the mobile user interacts with the bank of his choice and performs different transactions according to his requirements, where security measures have also been taken into consideration (i.e. Authentication can be done by biometrics and Password). By implementing the security measures the user can protect the mobile device as well as the transactions. After meeting the security requirements the user is able to do any type of transactions given in the choice. In the second mode, the transaction can be done by integrating with the different service providers (Airtel, Idea cellular, Vodafone, and BSNL).

5. CONCLUSION

The paper proposes a user friendly model of payment. This model provides the various modes of payments that are useful to the people in India especially the rural areas where the literacy rate is low. Technically the proposed work takes different challenges into consideration from implementation point of view. The scope of the proposed work is the combination of Android, Biometrics, NFC technology overcoming the technical limitations and the security considerations. The proposed work is beneficial from banking perspective as Reserve Bank of India has proposed a regulatory framework for mobile transactions.

6. FUTURE WORK

The future work can be diversified in the area of mobile payments and additional features can be added to it. (NFC, Biometrics).Based on the experiences drawn from researching risk and threat analysis on mobile payment systems, this is an area that needs to be further investigated. There are also a lack transaction protocols and databases used to compare the security of similar concepts which would be useful in order to evaluate different technologies. This might however depend on the difficulty of quantifying security which is highly subjective and can only be used as a pointer towards a correct value.

7. REFERENCES

[1] Praveen Chandrahas, Deepti Kumar, Ramya Karthik, Timothy Gonsalvis, Ashok Jhunjhunwala and Gaurav Raina " Mobile Payment Architectures for India", National Conference on Communications,2010.

[2] L. McCathie, "The advantages and disadvantages of barcodes and radio frequency identification in supply chain management". 2004 http://www.ro.uow.edu.au/thesesinfo/9/

[3] J. Gao, L. Prakash, and R. Jagatesan, "Understanding 2D-BarCode Technology and Applications in M-Commerce - Design and Implementation of A 2D Barcode Processing Solution," Computer Software and Applications Conference, 2007. COMPSAC 2007. 31st Annual International, 2007, pp. 49-56.

[4] H. Kato and K. Tan, "First read rate analysis of 2D-barcodes for camera phone applications as a ubiquitous computing tool." TENCON 2007 - 2007 IEEE Region 10 Conference, 2007, 1-4.

[5] Mobile Payment Forum www.mpf.org

[6] Innopay, Mobile Payments 2010, http://admin.nacha.org/userfiles/File/The_Internet_Council/Resources/Mobile%20payments%202010%20-%20Innopay.pdf

[7] Y. Lin, M. Chang, and H. Rao, "Mobile prepaid phone services", IEEE Personal Communications, 7(3): 6-14, June 2000.

[8] Z. Huang, and K. Chen, "Electronic Payment in Mobile Environment", In Proceedings of 13th International Workshop on Database and Expert Systems Applications (DEXA'02) September 02 - 06, 2002. Aix-en-Provence, France.

[9] Smart Card Alliance Payments Council, the Mobile Payments and NFC Landscape: A U.S. Perspective September 2011.

[10] Smart Card Alliance Payments Council Proximity Mobile Payments: Leveraging NFC and the Contactless Financial Payments Infrastructure.

[11] Jan Ondrus, "Mobile Payments: A Tool Kit for A Better Understanding Of The Market".

[12] Lecture note of Intensive seminar on m-commerce Mar, 1st to 5th, 2004.

[13] Stamatis Karnouskos, Fraunhofer Fokus, "Mobile Payment: A Journey through Existing Procedures and Standardization Initiatives". IEEE Communications. Volume 6, No. 4, 2004.

[14] Proximity Mobile Payments Business Scenarios: Research Report on Stakeholder Perspectives. A Smart Card Alliance Contactless Payments Council White Paper. July 2008.

[15] Jerry Gao, Vijay Kulkarni, Himanshu Ranavat, Lee Chang, Hsing Mei, "A 2D Barcode-Based Mobile Payment System". IEEE Third International Conference on Multimedia and Ubiquitous Engineering 2009.

[16] J. Krasner, Embedded Market Forecasters and American Technology International Inc, "Using Elliptic Curve Cryptography (ECC) for Enhanced Embedded Security Financial Advantages of ECC over RSA or Diffie-Hellman (DH)," White Paper Series, 2004.

[17] Certicom Research, "Standards for Efficient Cryptography -SEC 1: Elliptic Curve Cryptography", September 20, 2000.

[18] J. McCaffrey, "Encrypt It Keep Your Data Secure with the New Advanced Encryption Standard," Microsoft MSDN Magazine, November 2003.

[19] D. Hankerson, A. Menezes, and S. Vanstone, "Guide to Elliptic Curve Cryptography", New York: Springer, 2004, pp. 184 - 190.

[20] N. Jobanputra, V. Kullkarmi, D. Rao, and Jerry Gao, "Emerging Security Technologies for Mobile User Accesses", Accepted by The electronic Journal on E-Commerce Tools and Applications (eJETA), 2008.

[21] Jerry Zeyu Gao., Jacky,Cai,Min Li, and Sunitha Magadi Venkateshi, "Wireless Payment – Opportunities Challenges and Solutions". Published by High Technology Letters,Vol12 ISSN 1006-6748,2006.

[22] Antovski and MGusev, "M-Payments", Proceedings of 25th International Conference Information Technology Interfaces, 2003(ITI'03).