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Mobile Banking Based on Stand-alone Mobile Application Clients -A Suggested Mobile Banking Solution for Banks in Jordan-

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Abstract: Mobile Banking is defined as online-banking enabled by wireless communication. Many banks are evaluating the use of mobile as a channel to expand their brand competitiveness to: attract new customers, improve customer service and reduce costs. Jordan with its special features as one of the developing countries will be a good environment to implement such system. Latest statistics showed that the percentage of mobile subscribers in Jordan was 76% of Jordanian people (who are ages 15 years or older) in May 2010-offered by its four major network operators according to a report by the IPSOS Jordan for studies and researches (www.IPSOS.com). Thus, this paper develops and presents a mobile business solution based on stand-alone mobile application clients (called MB-MAC) for banks in Jordan. MB-MAC extends the convenience of existing online services- such as account balance information, funds transfer, and mini-statements- by making them accessible from any mobile device. As such with mobile services, a bank will need to hire even less employees as customer will no longer need to visit bank branches apart from certain occasions. The MB-MAC -designed to accommodate banks and customers' interfaces- was developed, implemented and tested successfully.

Keywords: Mobile Banking, J2ME, push/pull services, and MVC Patterns

I. INTRODUCTION

Over the last several years, the mobile and wireless market has been one of the fastest growing and maturing markets in the world and it is still rising at a rapid pace [1, 29]. Mobile banking is still not widespread but has become much more interesting. Studies estimate that mobile banking still has a long way to go [26] and Mobile banking has been a mid-level IT priority for most banks [5]. In some countries like Japan, already seven out of 10 people have cell-phone accounts, and in other countries such as Australia, Italy, Norway, Sweden and the United Kingdom, the market penetration of mobile phones has already exceeded 100% [7, 9].

One of the first commercial applications in the field of mobile commerce was mobile banking (M-banking) [8]. M-banking is a further development upon earlier customer channel extensions such as phone banking and online banking. It can be defined as a channel whereby customers interact with a bank via mobile devices (e.g. cell phone or PDA) [25]. In one academic model [15] mobile banking is defined as: "Mobile Banking refers to provision and availment of banking- and financial services with the help of mobile telecommunication devices. The scope of offered services may include facilities to conduct bank and stock market transactions, to administer accounts and to access customized information."

M-Banking that covers the account management via mobile devices is changing the business of the commercial banks, significantly. It is supporting the banks in decreasing costs and increasing expediency for the customer, because the mobile phone is transforming the banking industry [*22*]. According to [20] Mobile devices reduce the cost to serve customers by 50 to 70 percent, making it possible to offer financial services to a vast population once considered unprofitable. The ever-increasing distribute of Internet that enables phones to make the transformation of banking applications to mobile devices a logical development of E-banking [16]. Financial transactions that are conducted using wireless handsets may soon prove to be as pervasive as Internet-based financial applications [18]. Mobile devices, especially smartphones and PDAs, are the most promising method to reach the masses and to create "stickiness" among current customers, due to their ability to provide services anytime, anywhere, high rate of penetration and potential to grow [28] [21]. This will open up wide range channels for financial organizations interested in offering value added services. With mobile technology, banks can offer many services to their customers such as doing funds transfer while traveling, receiving online updates of stock price or even performing stock trading while being stick around in traffic [13, 30]. According to many mobile operators, mobile banking will be the "killer application" for the next generation of mobile technology [17].

In the last several years, banks across the world have invested billions of dollars to build sophisticated internet and mobile banking functionalities. As the trend is shifting to mobile banking, there is a challenge for decision makers of these banks to decide on how to exploit their investment in internet banking

and offer mobile banking services, in the shortest possible time [10].

Many research institutions report many consumers surveyed said they were willing to try mobile banking services at least once. Moreover, many of the consumers have willingness to use mobile phones as a median for conducting a variety of types of banking transactions [4]. VeriSign allows banks and financial institutions to replicate the internet banking experience on the mobile phone providing customers with expedient options to access interactive services such as: balance inquiries, transaction history, bill payment, fund transfers and mobile alerts via the mobile phone [19].

The convenience of the mobile phone is to conserve retail-banking customers' time, enhance their transactions, and increase their loyalty to financial-service institutions [14].

Like other banking solutions, Mobile Banking can increase loyalty by giving the customer a wealthier, more personal and convenient user experience. The M-banking services enables anytime anywhere access to real-time information. Moreover, financial institutions can raise their level of service to customers while reducing the cost of customer-service calls and visits.

In the near future, mobile banking will encompass more services to enable more conveniences for customers. Mobile banking is not just added convenience; it is about giving millions of customers in developing countries (the 3rd world countries) access to banks services.

Today, most banks are deploying this technology to provide a high quality customer service and in turn minimize their own operational costs. Mobile banking technology helps the customer to do his account management, electronically, even while he is on move. After that, it could change the world.

Electronic banking is considered a way of delivering banking services through the internet to the consumer at a reduced cost to the banking industry and improved convenience to the customer. However there exists a low internet connectivity in Jordan given the costs of connection especially in rural areas and yet banking services need to be brought closer to the population to enhance development. Thus, a viable and proposed solution in this paper will be a mobile banking.

The high diffusion rate of mobile phones coupled with the stability of mobile communication technologies will have greatly contribution to the enhancement of mobile banking solutions in the provision of bank services in Jordan banks. In this paper, a new mobile bank system (MB-MAC) is proposed and developed. This paper is organized into seven sections. In section 2 we will explain the mobile banking services .In section 3, the technologies of mobile banking will be explained. In sections 4, 5 and 6 MB-MAC with its infrastructure and implementation will be presented respectively. The conclusions will be presented as well in the last section.

II. MOBILE BANKING SERVICES

Most of retail banks now have a Web site that gives customers the ability to perform most significant tasks such as checking account balances, transferring funds, and paying bills over the Internet. Recently more banks have started offering mobile banking services, giving customers the ability to conduct transactions with their bank using mobile devices, usually a mobile phone [12].

Gallup Consulting [12] conducted a survey in six countries, the survey found: Extremely satisfied mobile banking users are 15 times more likely to be engaged with their bank when compared to less satisfy mobile banking users, and approximately 1 in 10 uses a mobile device to conduct transactions with their bank. Based on the results of this study, Gallup believes it is extremely important for retail banks to keenly manage their digital touch-points by creating highly engaging Web sites and mobile banking offerings that service as a seamless part of the overall customer experience. Banks that thrive in this achieved effort will have a competitive advantage over those that fail. Banks offering mobile access are mostly supporting one or more of the following services [13]:

- ***a. Account Information,*** such as: Mini-statements, checking of account history, Access to loan statements, etc.
- ***b. Payments & Transfers***, such as: Domestic and international fund transfers, Micro-payment handling, Mobile recharging, Bill payment processing, etc.
- ***c. Investments***, such as: Portfolio management services, personalized alerts, etc.
- ***d. Support***, such as: Status of requests for credit, including mortgage approval, and insurance coverage, ATM Location, etc.
- ***e. Content Services***, such as: General information such as weather updates, news, etc.

Simplest way to categorize these services depending on the originator of a service session is the 'Push/Pull' nature. 'Push' is when the bank sends out information based upon an agreed set of rules, for example your banks sends out an alert when your account balance goes below a threshold level. 'Pull' is when the customer explicitly requests a service or information from the bank, so a request for your last five transactions statement is a Pull based offering [13].

Second way to categorize the mobile banking services, by the nature of the service, gives us two kind of services – Transaction based and Enquiry Based. So a request of your bank statement is an enquiry based service and a request of your fund's transfer to other account is a transaction-based service. Transaction based services are also differentiated from enquiry based services in the sense that they require additional security issues across the channel from the mobile phone to the banks data servers.

Based upon the above classifications, researcher in [13] arrived to the following taxonomy of the services listed before.

Table 1 Taxonomy of mobile banking system services

	Push Based	**Pull Based**
Transaction Based		* Fund Transfer * Bill Payment * Other financial services like share trading.
Enquiry Based	* Credit/ Debit Alerts. * Minimum Balance Alerts * Bill Payment Alerts	* Account Balance Enquiry * Account Statement Enquiry. * Cheque Status Enquiry. * Cheque Book Requests. * Recent Transaction History.

The figure below illustrates responses from a recent Forrester research survey to the question: "What mobile banking activities or services you would be most interested in?" [3].

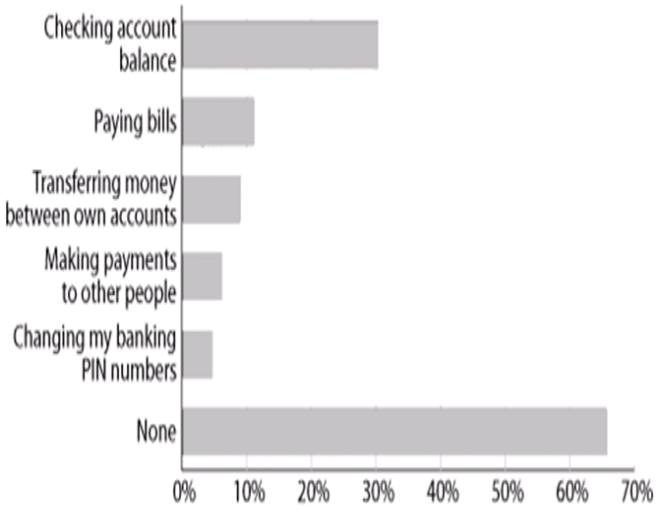

Figure 1 The mostly desired services of mobile banking, Source: ireach, www.ireach.ie

Based on a survey conducted by Forrester, mobile banking will be attractive mainly to the younger, more "tech-savvy" customer segment (about 70% of population in Jordan are 30 years old or younger). A third of mobile phone users say that they may consider performing some kind of financial transaction through their mobile phone. But most of the users are interested in performing basic transactions such as querying for account balance and making bill payment

III. MOBILE BANKINK TECHNOLOGIES

Previous generations of mobile banking only worked on a subset of high-end PDAs; now, virtually all mobile phones sold today can handle text-based mobile banking, and 40-50% of all mobile phones in the market are Web-enabled. Secondly, there is a large population of younger mobile users, and the immense majority of them use text messaging. Thirdly, there is a huge opportunity for financial institutions such as banks to reduce costs by diverting calls that would otherwise have been going to IVRs and call centers [6].

The bank typically has a multi-channel approach to conveying transactional services to its customer base. Its channels embrace the traditional bricks and mortar branch, ATMs, POS and the internet. These channels have gone a long way in servicing the retail banks in delivering financial transaction volumes and supporting in extending the banks reach to its customers. None of these channels have the ability to reach the consumer as comprehensively as the mobile phone. The mobile phone is in most consumers' hands and banks have recognized that the consumer does not need to travel to any bank facility in order to use banking services, once they have implemented mobile banking [11].

These Mobile Banking Technologies can be categorized into two environments; (1) Server-Side Technologies: are those applications built on a server, away from the consumer's SIM or Mobile handset. Examples of server-side technologies would be SMS, IVR, USSD2 and WAP. (2) Client-Side Technologies: are those applications, solutions and service offerings built or embedded on a consumer SIM or mobile handset. Examples of client-side applications are S@T and J2ME (Java 2 Micro Edition).

In server-side applications, consumer data that enables the processing of transactions (such as account/card details) are typically stored in a highly secured environment, on a server at a bank or at their allocated service provider. Whereas, in client-side applications, the consumer data is typically stored on the application, or entered by the consumer, and encrypted by the application in the SIM. Most of mobile banking services can be deployed using more than one technology or channel. Lately, Mobile Banking is being deployed using mobile applications developed on one of the following six technologies [2, 11, 13, and 17] (options or channels, we can use all of them mutually).

A. Interactive Voice Response (IVR):

IVR or Interactive Voice Response service operates through pre-specified numbers that banks advertise to their customers. Customer's make a call at the IVR number and are usually greeted by a stored electronic message followed by a menu of different options. Customers can choose options by pressing the corresponding number in their keypads, and are then read out the corresponding information, mostly using a text to speech program. Mobile banking based on IVR has some major limitations that they can be used only for Enquiry based services. Also, IVR is more expensive as compared to other channels as it involves making a voice call which is generally more expensive than sending an SMS or making data transfer (as in WAP or Standalone clients).

B. Short Messaging Service (SMS):

SMS uses the popular text-messaging standard to enable mobile application based banking. The way this works is that the customer requests for information by sending an SMS containing a service command to a pre-specified number. The bank responds with a reply SMS containing the specific information. Most of the services rolled out by major banks using SMS have been limited to the Enquiry based ones. However there have been few instances where even transaction-based services have been made available to

customer using SMS. One of the major reasons that transaction based services have not taken of on SMS is because of concerns about security and because SMS doesn't enable the banks to deliver a custom user interface to make it convenient for customers to access more complex services such as transactions. The main advantage of deploying mobile applications over SMS is that almost all mobile phones.

C. Wireless Application Protocol (WAP):

WAP is best described as the internet on a mobile phone. WAP is an open international standard for applications that use wireless communication. Its principal application is to enable access to the Internet from a mobile phone or PDA. A WAP browser provides all of the basic services of a computer based web browser but is simplified to operate within the restrictions of a mobile phone. WAP is now the protocol used for the majority of the world's mobile internet sites, known as WAP sites. Mobile internet sites, or WAP sites, are websites written in, or dynamically converted to, WML (Wireless Mark-up Language) and accessed via the WAP browser. WAP or mobile internet banking offers a consumer a similar experience to that of internet banking. The actual banking application resides at the bank and is secured and monitored in the same way as an internet banking website.

D. Standalone Mobile Application Client (MAC) or J2ME:

Standalone mobile applications are the ones that hold out the most promise, as they are most suitable to implement complex banking transactions like trading in securities. They can be easily customized according to the user interface complexity supported by the mobile. In addition, mobile applications enable the implementation of a very secure and reliable channel of communication. One requirement of mobile applications clients is that they require to be downloaded on the client device before they can be used, which further requires the mobile device to support one of the many development environments like J2ME or BREW. J2ME is fast becoming an industry standard to deploy mobile applications and requires the mobile phone to support Java.

The major disadvantage of mobile application clients is that the applications needs to be customized to each mobile phone on which it might finally run. J2ME ties together the API for mobile phones which have the similar functionality in what it calls 'profiles'. However, the rapid proliferation of mobile phones which support different functionality has resulted in a huge number of profiles, which are further significantly driving up development costs. This scale of this problem can be gauged by the fact that companies implementing mobile application clients might need to spend as much as 50% of their development time and resources on just customizing their applications to meet the needs of different mobile profiles.

E. Unstructured Supplementary Service Data (USSD):

In its simplest definition, USSD is a menu driven form of SMS where a customer would receive a text menu on their phone as opposed to a string of words. USSD is a data bearer channel in the GSM network. Like SMS, it transports small messages of up to 160 characters between the mobile handset and the network. Unlike SMS, which is 'store and forward', USSD is session based and can provide an interactive dialog between the user and a certain set of applications. In other words, both sides of the dialogue happen during a session whereas an SMS based interaction is broken into each segment of communication between the client and the service.

USSD1 only allows one way communication to the network, USSD2 allows two way communications between the user and the network. With USSD1, the interaction between the user and the service would be broken into each communication segment, much like SMS. With USSD2 it would be held in the same session and allow for a flowing conversation between the user and the service. This is similar to e-mail and instant messaging, e-mail waits for the recipient to read and respond while as instant messaging allows for immediate dialogue. USSD is as standard a feature as SMS and is available in an estimated 95% of handsets today.

USSD requires no pre-configuration on the consumers SIM or handset and is already built into most GSM networks. MNOs (Mobile Network Operators) do, however, need to commercialize the product by establishing the necessary bearer channel billing capability, and promoting the use of USSD for value added services in addition to internal network and customer care use.

F. SIM Based Applications (SAT):

The SIM Application Toolkit (SAT/S@T) allows for the service provider or bank to house the consumer's mobile banking menu within the SIM card. The SIM Application Toolkit (commonly referred to as STK) is a standard of the GSM system which enables the SIM to initiate actions which can be used for various value added services. The SIM Application Toolkit consists of a set of commands programmed into the SIM card which define how the SIM should interact directly with the outside world and initiates commands independently of the handset and the network. This enables the SIM to build up an interactive exchange between a network application and the end user, and access or control access to the network. The SIM also gives commands to the handset, such as 'display menu' and 'ask for user input'.

The challenge in SIM based applications is getting the application onto a SIM card that already exists in the market. The service provider has the option of sending the application Over the Air (OTA), which entails the delivery of several encrypted SMS messages that self-configure the application on the SIM, or, provisioning a new SIM card with the application already embedded within the SIM. The latter has an economic impact on the network operator and the existing consumer in that the consumer would have to obtain a new SIM card in order to use the application. Once the application is on the SIM, instructions from the consumer can be entered, encrypted, and transported by SMS to the service provider or bank. There may be difficulty in upgrading or making changes to the application on the SIM as the consumer would have to re-provision the application in a process similar to that described above; or the network operator would have to re-load the application over the air to each and every SIM card each time they make a change to the application.

Table 2. Impact of bearer technology on Bank transaction costs, Source: Krugel [11]

Technology	Transaction Cost
SMS	US$0.03 up to US$0.08 per SMS. Average transaction would require two SMS from the consumer and two returned from the bank. The bank would pay for their leg at a negotiated bulk rate. Total Consumer bearer cost per transaction would be US$0.14 and for the bank US$0.06.
IVR	As per consumer tariff. US$0.32c per minute.
USSD2	US$0.03 per 20 seconds, average transaction 40 seconds. Transaction cost to consumer US$0.06.
WAP	GPRS data rates. Transaction would use up around 1-2kb and would be priced between US$0.01 and US$0.03 per transaction.
J2ME	GPRS data rates. Transaction would use up around 1-2kb and would be priced between US$0.01 and US$0.03 per transaction.
STK	SMS bearer for the encrypted messages

The initial cost to the consumer is affected by the type of handset required, and whether or not the consumer has a capable SIM card to house the application. It seems that the higher the requirement for a more capable handset, the lower the cost of transacting and the better the consumer experience (colours and graphics). The J2ME market probably has access to internet and is also used to a higher graphic content. They would grasp the technology requirements more easily and thus are able to download an application or find the browser on their phone and browse to a mobile banking website. Each of MBanking technologies has its own strengths and appeals to different consumer segments. To appeal to the most customers and to increase customer adoption, financial institutions should incorporate all user interface types into their mobile banking solution.

Unlike other options, MAC applications have many advantages such as: *usability* (Ease of Use, which is the biggest benefit), *adding new services*, *security*, *ubiquity*, *certainty*, *versatility*, *non-repudiation*, *acceptable cost* (for customers and banks), and *telephone reach*. However, there are some challenges that deal with this option such as download and implementation issues. But according to an initial download of application across GPRS (General Packet Radio Service), GPRS rates would apply US$0.29c per mega [11] which is not very expensive in compare with the total cost of other options as shown in table 2.

IV. MOBILE BAKING SYSTEM (MB-MAC)

The initiation of mobile telephony has seen the widespread adoption of cell phone usage this makes mobile banking in Jordan a very attractive service for the banking industry mobile cellular subscribers will be increased to over 3.32 million (76% of Jordanian people) in May 2008 (IPSOS Jordan).

So, the objective of this project was to utilize technologies and applications that develop a mobile banking solution for commercial banks in Jordan. The author of this paper specifically looked at the MAC enabling technology because it is the most secure and cost effective service suitable. This Mobile Banking product has been created in 10 months time. It contains a set of basic transactions for banks who want to let their customers make use of the Java capability in their current mobile devices. The project and its results have created significant interest beyond national borders such Iraqi Banks.

The first step in building any mobile bank system is selecting the right technology for the market and understands the market's technology environment. The application must be able to get onto consumer's phone or handset without requiring the consumer to have an in-depth knowledge of the technology. Quite a few mobile software product companies have rolled out solutions, which enable J2ME mobile applications based banking. The mobile user downloads and installs the wireless application on their J2ME phone. The J2ME client connects to the wireless application server through the service providers GPRS network to enable users to access information about their accounts and perform transactions. One of the other big advantages of using a mobile application client is that it can implement a very secure channel with end-to-end encryption. Mobile application standalone clients bring along the burden of supporting multiple mobile device profiles.

According to the Gartner Group, mobile banking services will have to support a minimum of 50 different device profiles in the near future [13]. However, currently the best user experience, depending on the capabilities of a mobile phone, is possible only by using a standalone client. Many countries in the developing world face a serious obstacle in the proliferation of such clients as few users have mobiles, which support J2ME or BREW. There are some countries in the developing world like Jordan has a widespread adoption of the higher-end mobiles, which support application development.

J2ME is a feature that allows the device to run small, user-installable software applications written especially for mobile devices such as phones. J2ME requires a phone that can support the GPRS download of the initial application, assuming the phone is not pre-provisioned with the application. The phone would have to also have enough memory capability to support or house the application, and sufficient graphic ability to display the application. Once installed on the phone, the application would use GPRS, USSD or SMS to carry the consumer data or instruction from the device to the service provider. This can be in an encrypted format [11].

The J2ME environment can be mobile network operator (MNO) agnostic in that the application can be downloaded and used across any MNO that supports mobile internet. The user experience is similar to that of a web site and brings the same content and graphic rich benefits of the internet to the mobile phone. But the application can impact the consumer in the initial download process due to their phone not being provisioned properly by the handset manufacturer or their GPRS capability not being enabled at the network. These barriers affect all client-side applications. A consumer would browse through his phone menu until they find the J2ME application, select and launch the application, and follow the JAVA browser menus to complete a transaction. J2ME applications can be pushed to the mobile phone by a service provider or downloaded by a consumer by accessing the service provider's mobile internet site [11].

The most common mobile banking services available to customers include balance on demand (offered by 87 percent of banks with mobile banking services), transaction alerts (77 percent), money transfers (74 percent) and balance alerts (71 percent). Of those banks that offer such services, the top reasons for doing so are to improve the customer experience (87 percent), to extend internet banking (81 percent) and to achieve competitive advantage (71 percent) www.sybase.com/365. So, this project focuses to provide customers most these common services.

Modern mobile phones offer bigger screens, better usability and increasingly affordable high-speed data transfer. By 2011, more than 40% of new mobile phones will be equipped with a 3G broadband connection – according to projections by IDC, a technology consultancy. Better technology allows smooth and more enjoyable transactions and thus removes some of the obstacles which foiled the first attempts of mobile banking [27].

A. MB-MAC Benefits:

There are many benefits for the developed system for all partners (Banks and Customers) as follows:

For Customers:

a. Provides customers with access to information at their fingertips
b. Brings the information to the customer vs. bringing the customer to the information
c. Enables customers to access important personalized financial information - Any Time, Any Where
d. Personalized, tailored, and user-friendly customer interface
e. Menu driven, familiar, and user friendly customer interface
f. Ability for Value Added Services to be added or changed centrally
g. Opportunity for extended services such as ability to conduct financial transactions
h. Customer need not type the key word which saves his time as well as he avoids making any typographical error

For Banks:

a. Ability to retain most profitable clients
b. Enhanced channel in attracting new clients
c. New source of retail banking revenue from current customers through subscription and per transaction fees
d. Lower customer service costs
e. Differentiated product and service offerings
f. Improved information channel for customers
g. Improved competitive position as a technological leader
h. Extended client reach and improved customer loyalty

V. MB-MAC INFRASTRUCTURE

An Architecture of MB-MAC applied using MVC pattern [23] as in figure2. It is common to split an application into separate layers: presentation (UI), domain logic, and data access. In MVC the presentation layer is further separated into view and controller. MVC encompasses more of the architecture of an application than is typical for a design pattern.

a. Model: The domain-specific representation of the information on which the application operates. Domain logic adds meaning to raw data (e.g., calculating if today is the user's birthday, or the totals, taxes, and shipping charges for shopping cart items). Many applications use a persistent storage mechanism (such as a database) to store data. MVC does not specifically mention the data access layer because it is understood to be underneath or encapsulated by the Model.

b. View: Renders the model into a form suitable for interaction, typically a user interface element. Multiple views can exist for a single model for different purposes.

c. Controller: Processes and responds to events, typically user actions, and may invoke changes on the model.

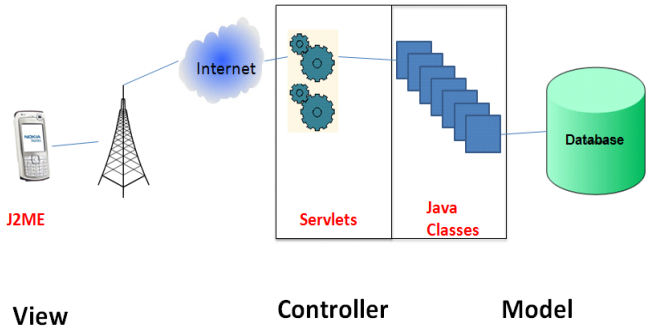

Figure 2 An Architecture of Mobile Banking based on standalone Mobile Bank Application MB-MAC

Clients are downloading and storing applications statically resident on their mobile phones, clients access a single menu based application, which connects them to the internet and then to the database as shown in figure 2. Using the menu based user interface, mobile users select the application, which they want to run on their cell phones.

Mobile Information Device Applications (MIDlets) are java programs loaded onto a mobile terminal for example a mobile phone. It consists of a JAD and a JAR file: *Java Application Descriptor* (JAD) is a single text file containing information about the MIDlet [2]. The information stored in this file depends on the version of Mobile Information Data Program (MIDP) in this project the version is 2.0. It comprises the path where the JAR file can be downloaded. The *Java Archive Files* (JAR files) [2] hold the Manifest file that contains some of the attributes of the JAD file and also contains all classes of the MIDlet and the resources it needs. The reason for storing the same information in the JAD and JAR files is for verification of the vender of the MIDlet application.

MB-MAC comprises a J2ME midlet downloaded to the handset and a J2EE servlet which resides in the bank's data centre. It can work securely on any Java handset with any mobile operator anywhere in the world – whether GPRS, EDGE, CDMA, 3G, or Wi-Fi. The user experience combines the best of online and offline communications, always ensuring fast response times and data integrity, with quick, 'atomic' synchronization.

The General Packet Radio Service (GPRS) is a packet-switching technology that can be used with the current GSM infrastructure to support packet-based transmission over GSM

networks. GPRS will enable mobile Internet functionality by allowing interworking between the existing Internet and the GPRS network. Any service that is used over the fixed Internet today – (e.g., www, e-mail, etc) will be also available over the mobile network. Third Generation (3G) cellular systems are being designed for a wide range of services (voice, data and multi-media), a wide range of propagation environments (indoor/outdoor) and a wide range of user densities, with a performance comparable to that of fixed networks. 3G systems will deliver bit rates up to 384 kbps for wide-area coverage and 2 Mbps for indoor or fixed [24].

The development environment used was the Netbeans Integrated Development Environment (IDE) that is written entirely in java using the Netbeans platform. Netbeans provides all the tools a software developer requires to create cross platform java desktop enterprise and web applications. It is an open source program and runs on various operating systems i.e. Windows, Linux as well as Solaris. The version of Netbeans used in this developed system was version 5.5 which introduced comprehensive support for developing IDE modules and rich client applications. All the applications in this system implementation were developed under this environment. The client User Interface MIDlet application was developed using the Netbeans mobility pack with an integrated mobile toolkit emulator. The database used in the project is the MySQL database and the connection is realized through the Java Database Connectivity (JDBC) using the My SQL *Java TM* library.

A new and innovative mobile service makes use of J2ME MIDP technology on the mobile device and J2EE technology on the server. A J2ME platform was used in MB-MAC as shown in Figure 3. Its goal is to ensure productive production of high-quality software that meets the needs of its stakeholders within a predictable schedule and budget.

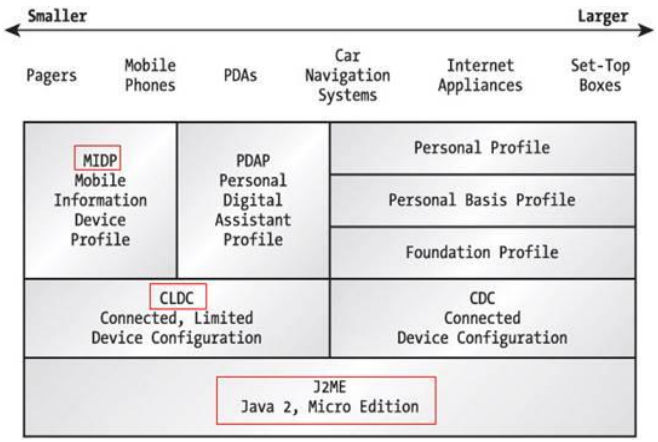

Figure 3 J2ME Platforms

VI. MB-MAC IMPLEMENTATION

MB-MAC was developed based on Standalone mobile application clients that are quite desirable for complex banking transactions. They are customized according to the user interface complexity that is supported by the mobile phone. Mobile applications clients are downloaded into the client's mobile device and thus require the device to support development environments like J2ME. The main short coming with standalone mobile application clients is that the application needs to be customized to each mobile phone on which it is to be run.

Author of this system have assumed that the mobile banking application is preinstalled on the clients' phone, in reality this may not be cost effective since the mobile phone manufacturers may have to be contracted and besides it's a cross platform application intended for various mobile phone operating systems. It is therefore important that ways of distributing this application without breach of security be explored.

According to survey conducted by financial consultancy Celent in 2007 [6]:

a. **73%** of consumers want to see account balance information on mobile phones.
b. **53%** of consumers want to see account transaction history on mobile phones.
c. **43%** of mobile phone users are likely to use alerts about their account information.

According to the result of this research, MB-MAC focused on the following features, services and functions that must be found and implemented as minimal requirements from any banking system:

a) ***Check Account Balance:*** Customer should be able to check their current balance for an indicated account.

b) ***Edits Personal Information:*** Customer should be able to edit personal information (phone number, address, e-mail address). This feature allows the customers to update personal information more easily anytime, anywhere.

c) ***Mobile - View Transaction History:*** Customer should be able to view transaction history from the last five transactions.

d) ***Mobile - Transfer funds Between Accounts****:* Customer should be able to transfer funds between multiple accounts

e) ***Mobile - Mobile Application Should be Made Available for Most Mobile devices:*** The downloadable application should be available for mobile devices of major mobile companies: Nokia, Motorola, Sony, Ericsson, Samsung, Palm OS, and Windows Mobile - for all phones/systems supporting GPRS and J2ME. To enable almost all users who have such a device to be able to use the service. Also by supporting most devices, it will be competitive advantage for any mobile bank system like the developed system.

f) ***Mobile - Response time for a Transaction Request Should be at most 5 Seconds:*** Response time for a request should be at most 5 seconds; that is the time from a request made from the mobile application till a response is received from the server. This is so to keep the mobile banking service useable; reasonably fast for the user, but slow enough to account for wireless communication constraints (e.g. delays).

g) ***Mobile - the Application Should show some Visual Feedback when a Transaction is Processing:*** There should be some sort of feedback shown on the mobile device screen that shows that a transaction is processing; it could be an animating icon, flashing text, etc.

h) Mobile - Language of Implementation: The mobile phone application will be developed in Java and will run on J2ME (Best for maximum compatibility).

i) Mobile - User Authentication: Customer should be provided access to Mobile Banking services based on valid bank account number. Customer should have the choice to put a constraint on the access to be only from a given handset. By default Mobile Banking is disabled, and must be explicitly enabled by customer to allow for its use.

j) Mobile- Error Handling: Make sure errors are handled (i.e. handle invalid input at any point) correctly and cause no problem to the entire system and customers.

When the client lunches the MB-MAC which must be downloaded into his mobile phones then he must login into the system using his authorized *Login ID* and *Password* in order to perform a remote banking transaction. Figure 4 illustrates the screenshots run with the wireless toolkit emulator taken from an example test of implementation of MB-MAC.

Figure 4. The login screen of MB-MAC

After the client logged-in, MB-MAC provides the following services which can be classified into either to retrieve information or to make transaction as follows (all of these services are shown in figures: 5, 6, and 7):

Figure 5 the Main Menu

a. Get Information, the choices applicable under this submenu are:
   i. Account Information
   ii. Last Five Transaction
   iii. Current Statement Summary
   iv. Branch and ATM Location
   v. Currency Rate

Figure 6 Get Information Functions

b. Do Transaction, whereas the choices applicable under this submenu are:
   i. Fund Transfer
   ii. Utility Bill Payments
   iii. Report Stolen or Lost Card
   iv. Change Password

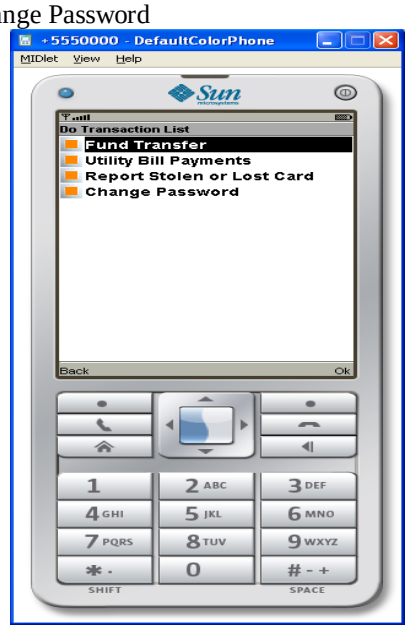

Figure 7 Do Transaction Functions

The client after selecting the transaction type proceeds and enters his banking details in the application interface and a secure request is created and sent by TCP socket connection to the server. The server decrypts the message, verifies request

integrity and carries out account authentication. When this is successfully achieved the server thereafter performs the requested banking transaction. A confirmation is thereafter sent to the client indicating success of the requested transaction. The last screen displays the received reply from the server depicting check balance test transaction as one of the provided.

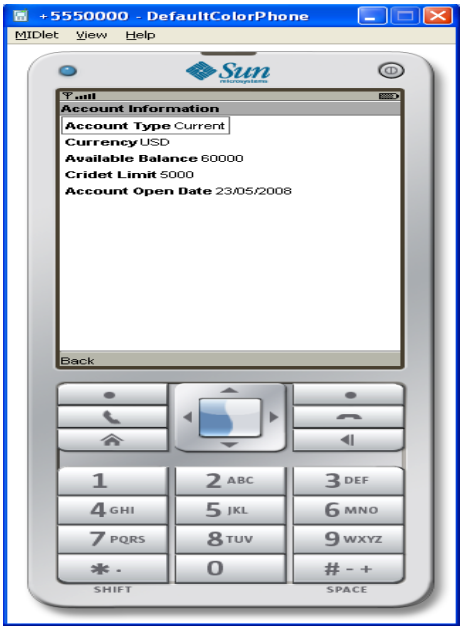

Figure 8 Account Information Result

VII. CONCLUSIONS

With MB-MAC, the customer may be sitting in any part of the world (a true anytime, anywhere banking) and hence banks need to ensure that the systems are up and running in a true 24 x 7 fashion. As customers will find mobile banking more and more useful, their expectations from the solution will increase. Banks unable to meet the performance and reliability expectations may lose customer confidence.

Mobile communications will provide new opportunities that are not feasible with PC Internet. Banks will be able to offer personalized services aligned to specific times and locations. The amount that users spend on mobile commerce services will rise; also demand for mobile banking will grow substantially. However, some challenges still face the mobile banking community (e.g., security, low-display capabilities, low-power devices, limited storage). The industry is working to provide solutions to these challenges.

Mobile banking is moving up on the adoption curve, which is evident in the number of implementations known in the world and the level of interest and discussion around the technology and its implementation. It is also evident in the number of technology providers emerging in the mobile banking space. There are several choices when considering how to implement mobile banking. These choices include whether or not to develop the technology within the bank, use a shared infrastructure, or purchase the enabling technology from one of many vendors.

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