

# Design and Implementation of Wireless Payment System using GVM and MobileC<sup>\*</sup>

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## ABSTRACT

With the remarkable development of wireless Internet, there are rapidly growing mobile telecommunication services for its terminal. In particular, wireless e-commerce market offering information service as well as on-line or off-line sales and has been growing at a rapid pace, requiring wireless payment system for the success for it. The existing methods for the payment system are divided into hardware one and software one. However, the shortcoming of the former one is that user is required to attach smart card to mobile terminal and it cannot prevent the misuse of the third party. On the other hand, software one is to link real-time approval and payment system through mobile telecommunication wireless network.

In this paper, we would like to suggest MobileC-based wireless payment system to execute on GVM (General Virtual Machine) based application program download solution. The wireless payment system is composed of initialization process and transaction process. Initialization process is to download program of payment system, formal authentication certificate and personal credit information to mobile device, to save them into non-volatile memory, while another one is executed every time of transaction through mutual exchange between connection server and mobile device. Mobile device is input through users' interface and encrypts input data, to transfer to server.

**Keywords:** MobileC, GVM, Wireless Payment System, download solution, authentication, Mobile device

## 1. Introduction

Splendid development of wireless internet makes possible for mobile communication service for mobile devices to be now rapidly increasing. Particularly, since the wireless e-commerce market to sell products both on and off lines and to provide with information services is growing rapidly, it requires wireless payment system in order to successively perform the wireless electronic commerce. The wireless

payment system refers to a payment system to pay the charges through mobile devices when we purchase service and product on and off lines. The wireless payment system started from a cellular phone small sum payment market that had kept some of mutually complementary relationship between early wired internet and wireless internet, and recently it changes even into a model for a terminal to substitute for previous financial system such as credit card. However the wireless payment system like this has weaknesses that it is complicated to necessarily equip the mobile device with IC chip of smart card type and that it cannot prevent from misuse or overuse of a third party incurred by the loss of the terminal.

In this paper, we suggest a wireless payment system based on MobileC[8] to be performed on GVM grounded on application download solution. A MobileC-based wireless payment system even without smart card equipped can manage payment service with downloading wireless payment system, and since it requires the input of the credit data of the person, it can prevent from misuse or overuse of a third party. The suggested wireless payment system comprises of server and client. The server of the wireless payment system is divided into connection server and authentication server, which perform authentication for private authentication number and payment information received from a client and transfer it to the server of financial agency. The client performs management of private information and user interactive role and saves private authentication number and payment information required for wireless payment. The wireless payment system suggested in this paper can resolve the weaknesses of previous wireless payment system, that is, the complicity to equip IC chip of smart card type and misuse or overuse of a third party due to the loss of the mobile device.

## 2. Study of Background

### 2.1 GVM and MobileC

#### 2.1.1 GVM

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GVM is a virtual machine platform that can execute applications dynamically in the mobile device. As a wireless internet middleware solution, GVM downloads application programs through a wireless network to perform on a terminal at required time. GVM system comprises of GVM

SDK, GVM server and mobile device with built-in GVM module.

GVM SDK is a general term for program development tool to produce GVM application, comprising of MobileC compiler, Media Tool Kit and GVM emulator. [Figure 1] shows application development procedure using GVM SDK.

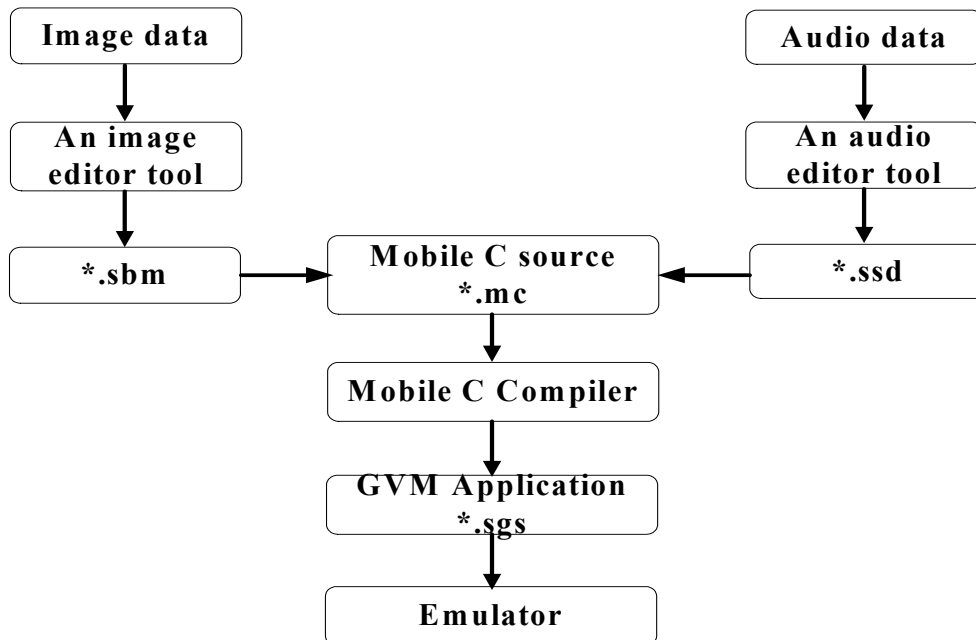


Figure 1: Composition of GVM SDK

### 2.1.2 Composition of GVM service

It converts produced images and sounds into GVM standard through the production tools of GVM SDK for images and sounds, including it in the MobileC source file (\*.mc) and generating \*.sgs by compilation. The mobile

application created like this takes tests on emulator and actual mobile device before uploaded on the server. The user downloads to run mobile application through a mobile device with built-in GVM. This process shows in [Figure 2].

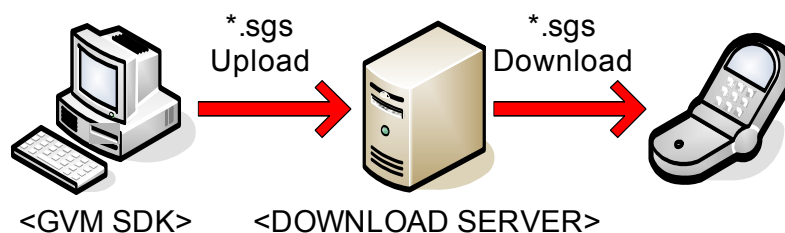


Figure 2: Execution model of GVM

### 2.1.3 MobileC

MobileC is a language based on ANSI C to develop a application program according with the limited mobile platform. It has the almost same syntax with that of ANSI C and has 192 production rules. It generates optimized code to be a language fit to bad condition of mobile computing. MobileC program is converted into a code (\*.sgs) executable on GVM, the virtual machine, through the MobileC compiler. MobileC has the characteristics of a language reflected of hardware limitations of a mobile device, thus it does not support floating point. But it support multimedia data such as images or sounds, with appropriate design for multimedia programming on a mobile device.

## 2.2 Payment System

### 2.2.1 Payment System

Payment system refers to a service to pay the charges using credit card, debit card or mileage when we purchase service and product on and off lines. The processing procedure of the payment system is generally divided into customer security, payment at POS, imposition and request of payment and liquidation between payment service provider and consumer. Most of the payment systems take similar procedure regardless of its technical method. The small sum payment system, an early model of payment system, can be said to be the method to purchase products using wired internet and mobile device. In the small sum payment system, we choose a product on wired internet and the payment method as the small sum payment, and input user information like the number of the device and residence registration number, then it transfers after confirmation the authentication number to the mobile device, which is input again on wired internet to finish the authentication procedure. [Figure 3] shows this procedure.

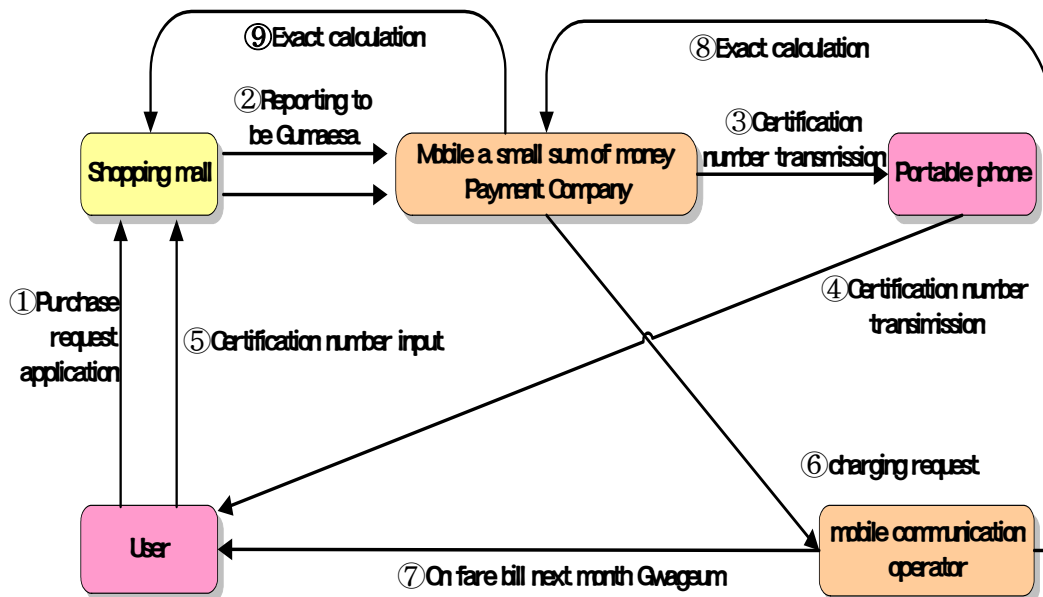


Figure 3: Procedure of Payment System

### 2.2.2 Wireless payment system

The wireless payment system has two methods for payment, which is based on card (hardware type) or not on card (software type). The method based on card is equipped with a smart card having various financial

applications saved in, such as credit card, debit card or mileage, for processing authentication and payment, and it can be classified according to the number of the equipped cards within the mobile device. The types are dual-slot type, dual-chip type and one-chip type. The dual-slot type is equipped with a separate smart card reader slot inside of the mobile device in order to

process the payment with own smart card inserted. The dual-chip type is to have IC chip saving the payment application inside of the mobile device separately from SIM card. The one-chip type combines the member authentication function of SIM card with the financial application of IC chip in order to save in one SIM card. The method based not on card is to associate real-time authentication with payment system through the mobile communication wireless network without separate smart card to save inside the personal financial information, which is classified as cellular phone integrated charge method and mobile wallet method. The cellular phone integrated charge method is a method to pay the charges later with integrated payment bill for mobile communication at the next month. The mobile wallet method is to input user

information in the server of a bank or a credit card firm, to which the user logs on through the mobile device.

### 3. Design of Wireless Payment System

#### 3.1 Configuration of System

The wireless payment system proposed in this paper is based on MobileC that is practicable on GVM based on the application download solution. The overall system is divided into a client as the mobile device and a server. The client plays a role to save user interface and fundamental user information, and the server takes the intermediary role between the client and the card firm and authentication organization and the save role of the certificates of each user.

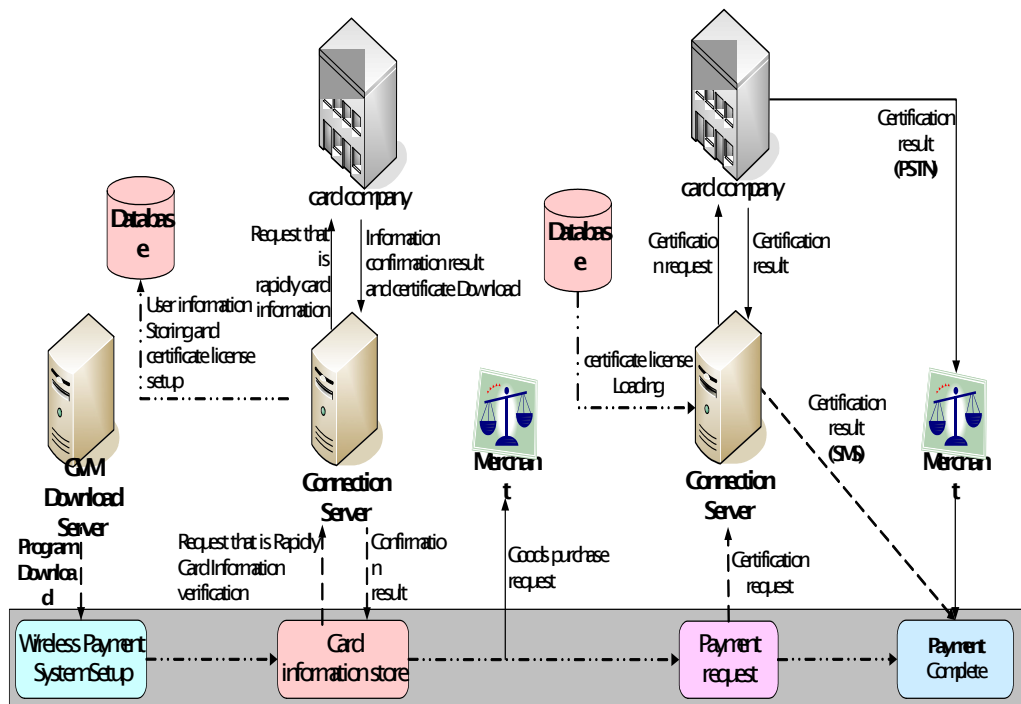


Figure 4: Configuration of Wireless Payment System

The process of this system comprises of initialization process and transaction process, and the details of these will be mentioned in the section 3.2 and 3.3. [Figure 4] shows the overall configuration and process of the wireless payment system proposed in this paper.

#### 3.2 Initialization Process

The initialization process is a preparation process for operating the wireless payment system on a mobile device. Basically the mobile device does not have the wireless payment system equipped inside. Thus it requires a procedure to download and install from the

server, the wireless payment system necessary for the mobile device, and requires initial configuration procedure to operate the wireless payment system installed in the device. This initialization has the following order for process.

- Connecting GVM download server using the mobile device.
- Downloading the wireless payment system from the GVM download server.
- Inputting user's personal password for operating the wireless payment system.
- Inputting card information to be used in the wireless payment system.

- Transmitting the personal identification number and card information to the connection server in order to confirm the input information of card.
- The connection server transmits the information from the mobile device to the server of card company or authentication organization and requests the certificate.
- As the authentication process is normally over, it downloads the certificate of the card company or authentication organization to save in the connection server and transmits the authentication result to the mobile device.
- The mobile device taking the authentication result saves the personal card information in the non-volatile memory of the mobile device.

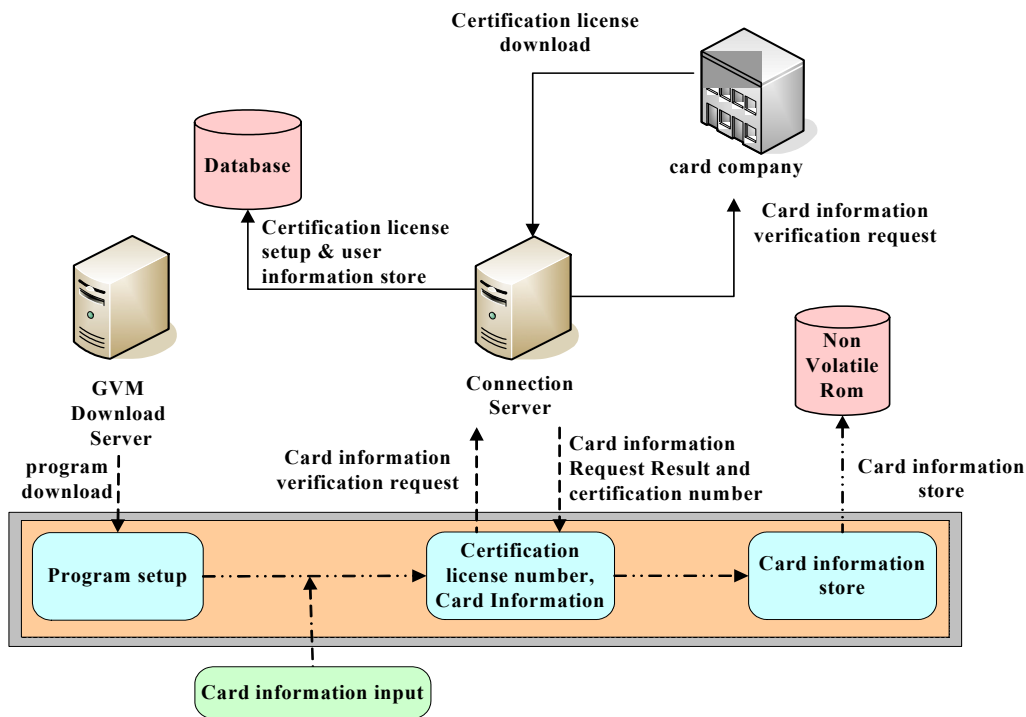


Figure 5: Initialization process

This is the initialization procedure of the wireless payment system that requires only one performance. However, if it requires user's card replacement when the wireless payment system is used, the initialization is processed by stepping up from the 4<sup>th</sup> stage of the overall procedure. [Figure 5] shows the initialization process of the wireless payment system.

### 3.3 Transaction Process

The transaction process is a procedure of payment for the purchases of products through user's mobile device on and off lines. The mobile device transmits card information, mobile device identification number (e.g. telephone number), unique identification number of the store where the product is purchased (e.g. store

ID given in advance) and the amount to the connection server, which confirms the payment information transmitted from the mobile device to load the certificate corresponding to the card information and the mobile device identification number. And, using the encryption key of the loaded certificate, it enciphers the overall payment information before transmitting it to the authentication server. The authentication server verifies the overall payment information transmitted from the connection server. If the card information equals to that of the user, it

transmits the admission number about the payment in question to the connection server and the store. The connection server transmits the admission number sent from the authentication server to the mobile device to finish the all the transaction procedure. The admission number transmitted to the store from the authentication server is receivable through the previously constructed card reader of the store. [Figure 6] indicates the transaction process of the wireless payment system.

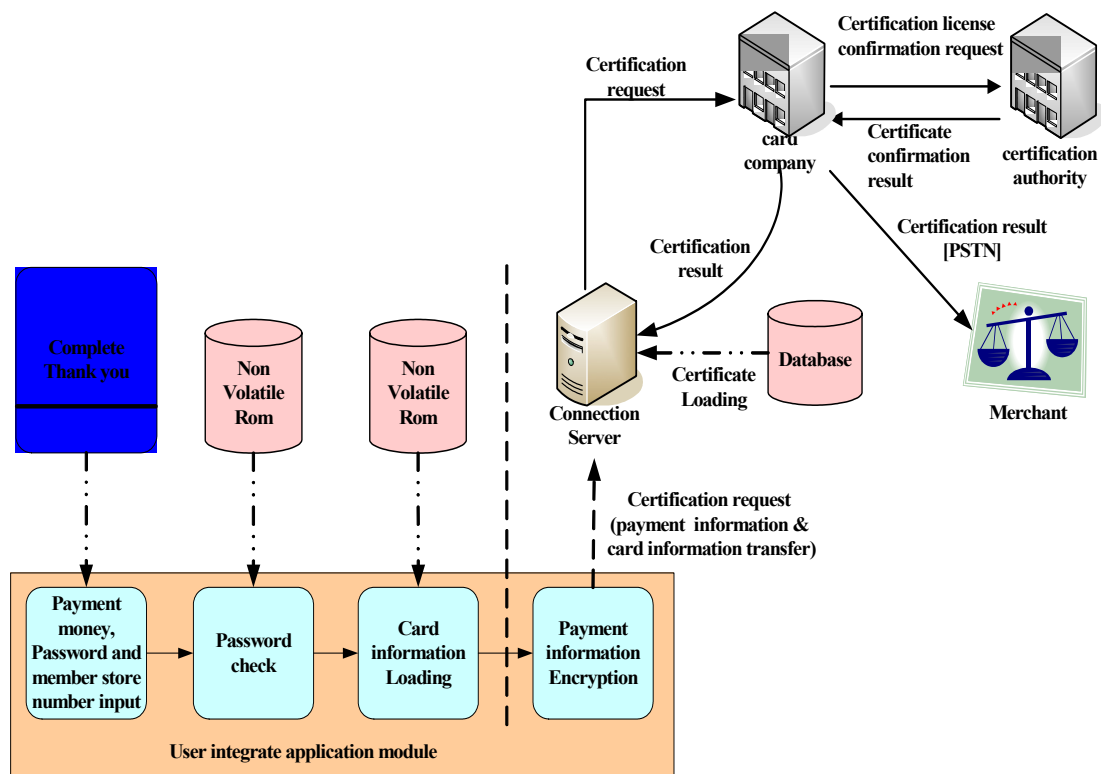


Figure 6: Transaction Process

## 4. Implementation of Wireless Payment System

### 4.1 Environment of Implementation

The development environment and experimental tools for implementation of the wireless payment

system are composed as seen in [Table 1]. It uses GVM SDK emulator to provide with the same environment with that of the actual mobile device and experiments with imaginary stores and store IDs given arbitrarily.

Table 1: Experimental Tools for Implementation

Classification		Details	Remarks
Server (Connection server & authentication server)	CPU	Pentium 4 2.0 GHz	
	OS	Windows XP	
	Program. language	C#	
	Database	MS-SQL	
Client	VM	GVM	v2.0
	Program. language	MobileC	
Store Identification Number (ID)	Store A	00000001	Given arbitrarily
	Store B	00000002	Given arbitrarily
	Store C	00000003	Given arbitrarily

## 4.2 Server

As we've seen in the introduction, the server of the wireless payment system comprises of connection server and authentication server, and we implemented both servers for the experiment. However the detailed design and implementation of the authentication server will have to consult with the card companies or authentication agencies later. Thus here we'll see the implementation of the connection server between those required in the system of this paper.

The connection server comprises of the communication module to communicate between the mobile device and the authentication server, the encryption module that enciphers payment information

and the module manager that manages all the modules and processes data. Additionally a database is included for saving each user's information and certificate.

### 4.2.1 Communication Module

The communication module of connection server is the first module to process the payment information transmitted from the mobile device and extracts only actual data from the all the information to transmit to the module manager. The protocol type between the connection server and the mobile device is similar to the usual type as seen in [Table 2].

Table 2. Protocol Type between Connection Server and Mobile Device

Byte Index	0	1	2	3	4	5	6~Len-1	Len+5
Field	'S'	'G'	Section	Op Code	Len-H	Len-L	Data(variable) [D <sub>0</sub> ][D <sub>1</sub> ]...[D <sub>len-1</sub> ]	SUM

[Table 3] describes each field within the protocol type between connection server and mobile device.

Table 3: Description of Each Field within the Protocol Type between Connection Server and Mobile Device

Field	Length	Description
['S']['G']	1 byte ea.	Verifier of Sinjisoft Game Companion message, necessarily to be indicated as 'S' and 'G'
[Section]	1 byte	Distinction of transmission position of packet, indicated as 'G'
[Op Code]	1 byte	Message OP Code, communication between mobile device and connection server to be indicated as 'D'
[Len-H][Len-L]	1 byte ea.	Total length of data

[D0][D1]...[Dlen-1]	1 byte ea.	Reserved information for data or Op Code
[SUM]	1 byte	Check sum parity to check error in transmission Addition of all the bytes without carry

#### 4.2.2 Encryption Module

mobile device and of the user information saved in the database

The encryption module uses encryption key included in the each user's certificate to perform the encryption function of payment information transmitted from

Table 4: Table Definition

No.	Items	Item ID	Type	Length	Remarks
1	Mobile device ID No.	Phone_num	varchar	14	
2	Payment Password	personal_pass	varchar	20	
3	Certificate Path	authen_path	varchar	50	
4	Date to issue	authen_date	date		

#### 4.2.3 Database

The information of each user for wireless payment system is saved in the database. The information of user includes payment password, mobile device identification number and certificate. <Table 4> shows the simplified table definition about information saved in the database.

#### 4.2.4 Module Manager

The module manager works for the data flow and process between each module and the database. The user's information and payment information extracted

from the communication module are transmitted as enciphered module through the module manager, and the enciphered information get back to the

communication module to be transmitted to the authentication server. Processes for authentication and payment are done by this procedure.

#### 4.3 Client

The client of wireless payment system means the actual mobile device. It is implemented by MobileC practicable on GVM, and it uses emulator provided by GVM SDK for the experiment. The functions of client like those of server are divided into initialization process and transaction process. It provides with user interface for each process, and the user's information requiring archival is saved in the non-volatile memory of the mobile device.

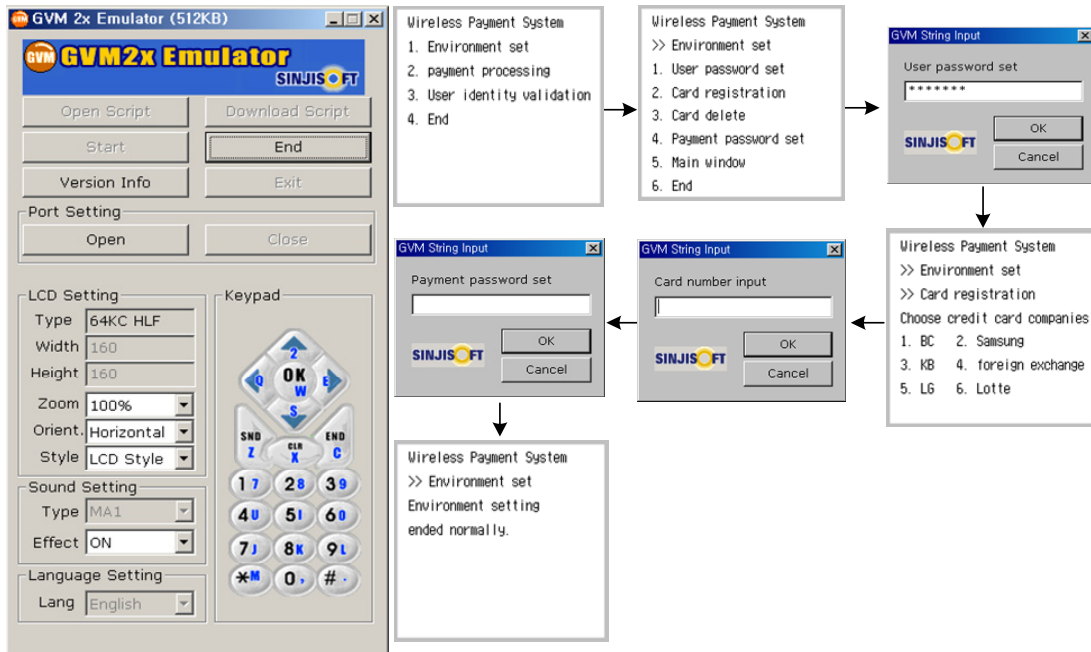


Figure 7: Initialization Process of Client

[Figure 7] shows the user interface screen for the initialization, and [Figure 8] shows that for the transaction process.

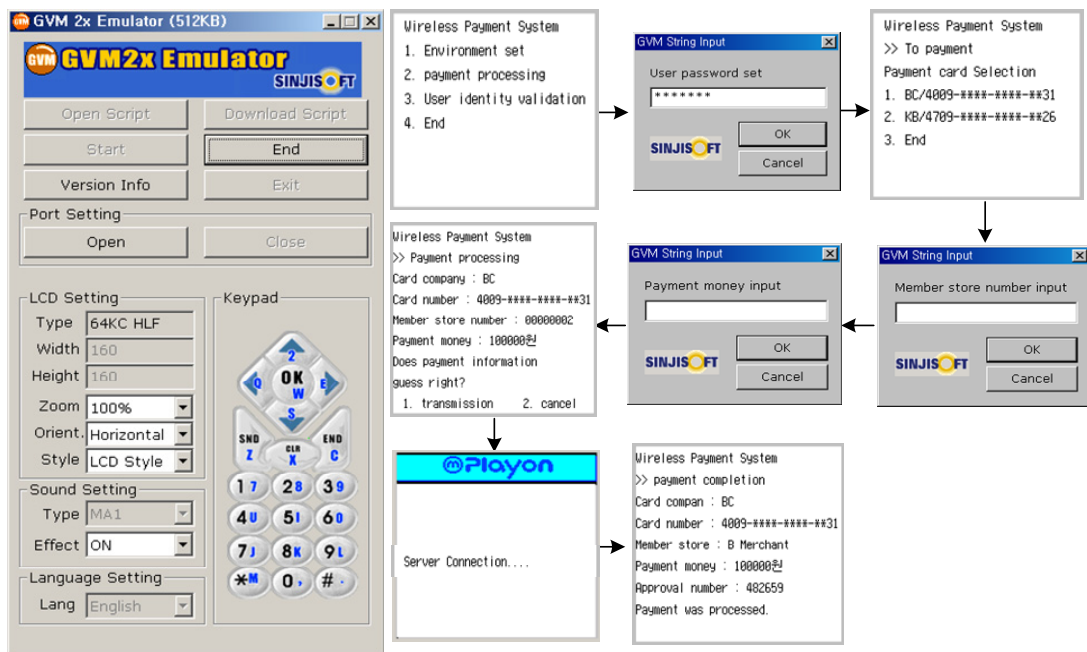


Figure 8: Transaction Process of Client

## 5. Conclusion and desirable studies

The wireless payment system implemented in this paper is designed based on GVM and MobileC, comprising of initialization process and transaction process. This system uses the application download techniques based on GVM and is usable in a mobile device equipped with GVM.

Far from the wireless payment system based on smart card saving personal information inside, it is not dependent upon one specific card, and since it applies official certificate of an official authentication agency for personal payment information and security of credit information, it can prevent from misuse or overuse of a third party which is caused by the loss of the device. Moreover, since the official certificate and personal payment information saved in the mobile device can be used continuously unless those are deleted directly by the user only with one download, it takes advantage of using perpetually. The paid amount and personal payment information are input through the convenient user interface of the wireless payment system. It takes advantage for anyone to easily utilize it because the keypad of the mobile device is used as the user interface of the wireless payment system. It is applicable for various types of mobile device.

The proposed wireless payment system is implemented with dividing the functions into connection server and client, and the structure of the client and the servers and related modules were explained in details. The connection server is implemented by C# language, and the client is by applying the functions of MobileC.

The further research for wireless payment system should be popularized not only for card companies but also for bank transactions or mobile communication companies, and it is urgent to develop relevant technology of information security because important personal information such as of credit card is transmitted in the system. Additionally, it requires continuous studies about design and implementation of the connection server that can play intermediary role.

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