MB-C: Check-in Mobile Application using Barcodes

Mohammed Samaka, Qatar University, Doha, Qatar, samaka.m@qu.edu.qa
Mohammed Hassan, Qatar University, Doha, Qatar, mohdali@qu.edu.qa
Ahmed Ould Mohamedou, and Mohammed Al-Sada, Qatar University

Abstract

This project involves the design and development of a mobile application, called Mobile Bar-Code (MB-C) that uses the bar-code concept in the process of check-in to the provider's venue or facility. The MB-C integrates both web and wireless technologies. It provides a wireless service, over the cellular network that sends a barcode containing the check-in details, directly to the client's mobile handset via SMS or MMS. The barcode is then verified via a scanner at the security control point (or the check-in counter) prior to accessing the venue or using the facility. The MB-C can be implemented in many real-life situations that involve either a client or a vehicle in a check-in process due to security needs.

Keywords: Mobile, wireless, security, Barcodes.

1. Introduction

Wireless communication is the fastest growing field in the telecommunication industry. Wireless services were integrated in the first generation to handle only voice communication. This was due to the low data transfer rate of around 4.8 Kbps. This transfer rate was soon superseded by improvements and upgrades applied to communication networks. With the advent of the second generation and then GPRS (2.5 generation) the data rates reached 115 Kbps. However, those rates were still insufficient for extensive data transmission applications. Now with 3G revolution and pre-4G upgrades, data rates have reached 2 Mbps for still devices [1]. This revolution has opened the door for innovative applications to take place in the world of wireless and mobile computing.

Wireless technology is now bringing the power of communications, the Internet and the World Wide Web into the hands of users worldwide. Wireless communications are no longer limited to making phone calls and sending and receiving messages. They also allow for the exchange of critical information, business cards, and software applications, and offer the best services to businesses and consumers. For example, people can use Push technology to make live voice conversations or to order their favorite meal. They can also find bus tracks and taxi stands using the Global Positioning System (GPS) in a handset with GPRS capability [2].

Recently, many commercial organizations have been using barcodes in mobile applications. Currently, Lufthansa airline uses barcodes in a wireless application as part of the traveler check-in process. This wireless application allows frequent travelers holding an electronic ticket, to check-in and receive an electronic barcode-based boarding pass on the display of their WAP-enabled mobile phone. With the barcode-based boarding pass the passengers can bypass the check-in counter and speedily board their flight. The barcode on the mobile display is verified via scanners at security and boarding control points prior to boarding the flight [3].

InfoLogix implements an application called a "Mobile Wireless Point of Care System Solution for Medication Administration" [4]. This application is used at the bedside using wireless communication for real-time decision making, which is based on bar-code scanning for verification of medications. In addition, Infologix sees future use of RFID (Radio-frequency Identification) technology by itself or in conjunction with barcodes to further increase accuracy related to patient and medication interactions.

2. Project Overview

The project described in this paper involves the design and development of a mobile service application that uses the barcode concept in the process of check-in to the provider's venue or facility thus enabling the client to bypass the human-monitored check-in counter. This Application is called Mobile Bar-Code (MB-C). The architecture of the MB-C application is designed to support the unique capabilities of achieving a high quality mobile solution that meets the security needs for almost any business or activity that involves a client check-in process.

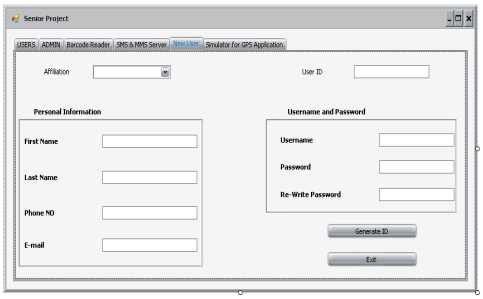

Fig 1. Web form used for on-line registration

The methods of using the MB-C application are described in the following scenario:

1. Every person (potential client) that is required to check-in to the provider's venue/facility has to register on-line through the provider's web site (refer to Figure 1). During the registration process, the potential client enters many details, which are then stored on the database connected to the provider's server. The server then sends back to the client an SMS message (via the GSM/GPRS modem attached to the server) confirming the registration. This message also includes a unique code generated at the provider end based on the client details that were entered earlier during the on-line registration process.

2. When a client reaches the intended venue/facility to check-in, he/she sends an SMS message to the provider, including the unique code provided earlier by the provider's server. This SMS message is received by the GSM/GPRS modem attached to the provider's check-in server. Immediately following, the barcode generator program in the provider server generates a barcode image using the registration details entered by the client in Step 1. The barcode image is then transmitted to the client mobile device through the GSM/GPRS modem via an MMS message.

3. When the bar-code image is received and appears on the screen of the client mobile device, the client then scans the image using the bar-code reader of the provider's check-in point.

The activities described in this scenario are shown in Figure 2

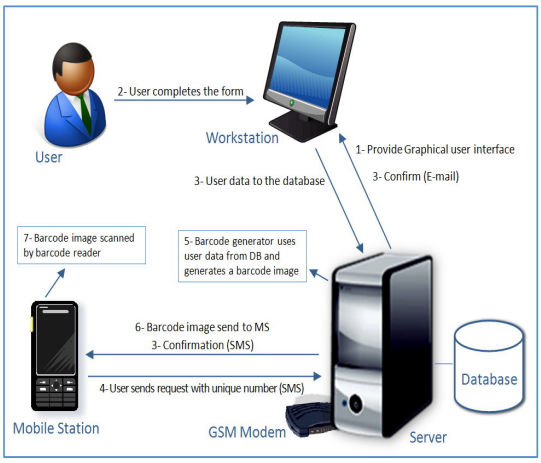

Fig 2. MB-C in Action

The above scenario using the MB-C can also be applied to the check-in process that involves a vehicle. The vehicle should be equipped with a GSM/GPRS modem and a Global Positioning System (GPS). During the check-in process, when the GPS in the vehicle identifies the location of the provider's venue, it then triggers the GSM/GPRS modem in the vehicle to send an SMS message to the other GSM/GRPS modem attached to the provider's server. This SMS message contains the unique number that identifies the vehicle (see Step 1, above). This check-in process continues taking similar actions to those described above in Steps 2 and 3.

3. The MB-C Architecture

The architecture of the MB-C system involves many components. Each component was built or customized, then integrated with other components to achieve the defined set of functions described in the above section. Such components are:

- A 3-tier client server website. This website was built using the C# programming language within the integrated development environment (IDE) of the Visual Studio, and ASP.NET for the middleware. The potential client uses this website to register on-line and to enter the essential information required by the provider. This information is stored in a secured database attached to the provider's server.
- A check-in server attached to the provider venue/facility.
- A program that generates bar-code images. This program runs in the provider's server and uses the information entered earlier by the client during the on-line registration session. A bar-code image generated by this program changes periodically due to security needs.
- Two GSM/GPRS modems. One is attached to the provider's server, the other is used when the check-in process involves a vehicle (refer to Section 2 above).
- A bar-code reader is used in this project for scanning the bar-code image displayed on the screen of the client's mobile device.
- A GPS is also used when the check-in process involves a vehicle that identifies the location of the provider's venue (refer to Section 2 above).

Barcode

A barcode is a machine-readable representation of information in a visual format on a surface. Originally barcodes stored data in the widths of printed parallel lines, but today they also come in patterns of dots, concentric circles or hidden within images. Barcodes can be read by optical scanners called barcode readers.

The mapping between messages and barcodes is called a symbology [5]. The specification of a symbology includes the encoding of the single digits/characters of the message. It also includes the start and stop markers into bars and space, the size of the quiet zone required to be before and after the barcode as well as the computation of a checksum.

In this project, the Data Matrix (2-D) symbology is used. It is a two-dimensional matrix barcode consisting of black and white square modules that represent bits, arranged in either a square or rectangular pattern. Depending on the situation a white module is a 0 and a black module is a 1, or vice versa, as shown in Figure 3. The information to be encoded can be text or raw data. Usual data size is from a few bytes up to 2 kilobytes. The length of the encoded data depends on the symbol dimension used. Error correction codes are added to increase symbol strength; even if they are partially damaged, they can still be read. A Data Matrix symbol can store up to 2,335 alphanumeric characters.

Fig 3. An example of a Data Matrix (2-D) Barcode

4. MB-C Design

The MB-C application was developed in this project using the C# programming language and Microsoft Visual Studio 2005. It was also connected to the Microsoft SQL Server 2005 that stores and manages the client's registration data. With close integration with Microsoft Visual Studio 2005, the SQL Server 2005 aims to allow developers to develop more secure, and reliable storage for a relational database format [6].

The database for the MB-C application has four main tables: 'Users', 'Barcode Reader', 'Administrator', and 'Vehicles'. In the 'Users' table, the system records client's essential data. In this respect the 'Users' table has the following fields: *first name, last name, ID, phone number, e-mail address, login name, password , affiliation, PIN,* and *barcodeID.*

The last two fields are the most important for the MB-C activities as they are used to identify each client attempting to access the provider's facility. The '*PIN*' is a four digit number and used by the user to request a barcode image through MMS. A '*barcodeID*' is a ten digit number that is used to generate a unique barcode image (also called Encoded Data) for each user. The reason behind making a '*barcodeID'* a ten digit number is to ensure that each barcode image is only valid for one hour. Periodically, the barcode reader subtracts the time and date from encoded data (which is retrieved from the barcode image) and looks in the database for the result in the '*barcodeID'* field. If it can not find the same result in the database, it means that the barcode image is no longer valid (exceeded one hour).
In the database two more tables were also developed: the 'authorizedUsers' and the 'authorizedVehicles'. They are used to map between the client (or vehicle) and the venue/facility that the client intends to access.

5. MB-C System Structure and Implementation

When designing and implementing the MB-C mobile application the layering approach was used. In this approach, layers are ordered in such a way that each layer depends only on the layer immediately below and is independent of the layers above. The MB-C structure is composed of three layers: (1) the Physical Layer at the bottom, (2) the Interpretation Layer in the middle, and (3) the Processing Layer at the top. In the following sections the functions, and the implementation of each layer of the MB-C, are briefly described**.**

Physical Layer

This layer communicates with the clients using the GSM/GPRS modem, the GPS receiver, a camera and the Graphical User Interfaces. It performs the following functions:

a. Capture an image on a user's mobile screen
b. Receive data provided by the GPS satellite system
c. Send MMS messages through the GPRS modem
d. Send SMS messages through the GSM modem
e. Interact with users through GUIs

a. Capture an image on a user's mobile screen

For this function the webcam Logitech-QuickCam is used. It can generate images of up to 4 MP (Mega Pixels). To communicate with the webcam the *avicap32.dll* is used [7]. This is basically a software module that contains functions for the Windows API used to capture objects, such as images, AVI movies and video from web cameras and other video hardware. In this regard, the *user32.dll* module is also used which contains the Windows API functions for the Windows user interface.

b. Receive data provided by the GPS satellite System

For this function the device SONY-GXB5210 is used [8]. It is a 12-channel GPS receiver module that includes all the modules required for the GPS and a passive antenna. It is also ideal for use in various types of portable applications as well as automotive

systems. To communicate with this device the 'Scientific Component GPS TOOLKIT.NET' is also used to translate the sentences of NMEA-183 protocol (used to communicate with satellites).

c. Send MMS messages through the GPRS modem
In the Interpretation layer the ActiveXperts MMS Toolkit [9] is used to create and send MMS message objects.

d. Send SMS messages through the GSM modem
In the Interpretation layer, the mCore module [10] is used to establish the connection with the GSM Network and to send the SMS messages.
For the MB-C the GSM/GPRS modem is used for sending SMS and MMS messages is the WAVECOM Fastrack M1306B [11].

e. Interact with users through GUIs
In this project, several graphical user interfaces (GUIs) were developed for either the client to interact with the provider's website, or for the administrator, at the provider's end, to use and examine many functions for the M-BC application. Examples of the GUIs are given in Figures 4 and 5.

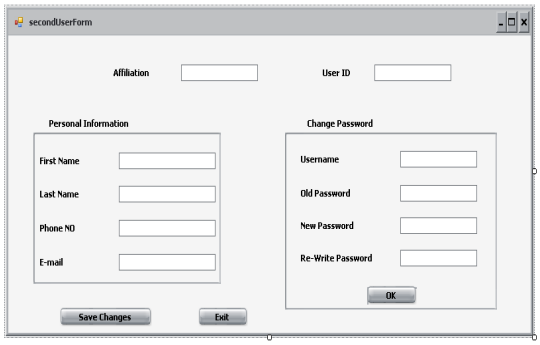

Fig. 4: The GUI that allows the client to update his/her profile

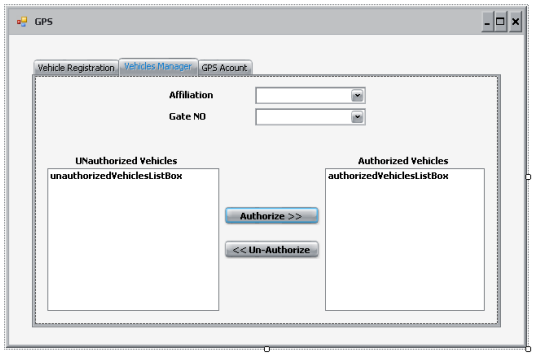

Fig.5: GUI through which the administrator can register and authorize vehicles

Interpretation Layer
This layer has the following functions:

a. Read and write barcode images
b. Create MMS messages
c. Create SMS messages
d. User's Input/Database verification

a. Read and write barcode images
The LEADTOOLS Version 15 component [12] is used to read images that contain barcodes (DataMatrix). The same component is also used to write barcode images.

b. Create MMS messages
As mentioned before (see 5.1.3), ActiveXperts MMS Toolkit is used to deal with MMS messages.

c. Create SMS messages
As mentioned before (see 5.1.4), the component mCore is used to deal with SMS messages.
d. User Input/Database verification
The data entered by the client should be verified for being consistent. For example the text field assigned to a phone number should not include letters. Even if the client enters his/her data correctly, the data should not conflict with any other data in the database, for example, two users must not have the same phone number.

Processing Layer
This layer has the following functions the following functions:

a. Generate the user's Personal Identification Number (PIN)
b. Access and update the database
c. Validate the user's access

a. Generate user Personal Identification Number (PIN)
For each user a unique PIN of four digits is used by the client to request the barcode image. It is generated during the registration process.

b. Accesses and updates the database
To communicate with the Database, the DataSet and TableAdapter are used. The DataSet, is an in-memory cache, used for data retrieval from the database. It is a major component of the ADO.NET architecture, and consists of a collection of DataTable objects. Also, the data integrity in the DataSet can be enforced by using the UniqueConstraint and ForeignKeyConstraint objects. On the other hand, the TableAdapter provides communication between the application and the database. More specifically, the TableAdapter is responsible for: connecting to a database, executing queries, retrieving a new DataTable and filling an existing DataTable with the retrieved data. In addition, the TableAdapter is used to send updated data from the application back to the database.

c. Validates the user's access
Before the system replies to the client's SMS message that requests a barcode image, it first checks the user's PIN (in the message) for being authorized to access the facility. On the provider's server, the barcode reader program also checks if the barcode image is still valid by examining the current time with the time when the latest image was sent, i.e., making sure that the period of time during which the image is still valid has not been exceeded.

6. Conclusion

This paper describes a project that involves developing an application called MB-C that integrates mobile and wireless technologies. It uses the bar-code concept in the process of check-in to the provider's venue or facility. The MB-C provides a wireless service, over the cellular network through which it sends a barcode image containing the check-in details directly to client's mobile handset via an MMS message. The barcode is then verified via a barcode scanner at the check-in point of the provider's facility. Through this the client is able to bypass the human-monitored check-in counter.

In this project, the MB-C application was developed using the C# programming language and the Microsoft Visual Studio. It is also connected to the Microsoft SQL Server 2005 that stores and manages the client's registration data.

For the MB-C system, the Data Matrix (2-D) symbology is used. It is a two-dimensional matrix barcode that can store up to 2,335 alphanumeric characters. For each client, the barcode generator on the provider's server uses ten digits, (corresponding to the client registration record in the database) to generate a unique barcode. The barcode image is only valid for one hour.

The MB-C system was composed of three layers: the physical layer, the interpretation layer, and the processing layer. Each layer of the MB-C has different functions from those of other layers. All layers collectively function to achieve the role of the MB-C application. The layering approach was used in the design of the MB-C in order to make the implementation phase clearer and to prevent changes in one layer from affecting the other layers in order that they could develop more quickly.

The architecture of the MB-C application is designed to meet the security needs for almost any business or activity that involves a client check-in process. The barcode code in the database from which the barcode image is generated, was designed to be changed periodically. It makes sure that the barcode image on the screen of the client's mobile station is valid for one hour only.

The MB-C was tested over two situations based on the scenario discussed in Section 2. However, the check-in process of a vehicle was simulated using a GSM/GPRS modem and a Global Positioning System (GPS). Both tests were successful and achieved the functional requirements defined for the MB-C system during the analysis phase. Finally, it is planned in the future to use a high resolution camera so that the system can recognize other barcode symbologies. Also, it is planned to test the check-in process for a vehicle in a real-life situation

7. References

[1] J. Schiller: *Mobile Communications*. Addison Wesley, 2003.

[2] Y. K. Kim and R. Prasad: *4G Roadmap and Emerging Communication Technologies.* Artech House, 2006.

[3] Lufthansa Announces a New Barcode Check-in Process Using Wireless Application Protocol Phones and Handheld Devices
Retrieved February 8, 2008
from:http://findarticles.com/p/articles/mi_m0IGV/is_7_3/ai_77379490

[4] Infologix Mobile Intelligence, Healthcare Solutions
Retrieved February 9, 2008
from:http://healthcare.infologixsys.com/products/Resources/Bar-code/JCAHO-Medication-Management-Standards/default.asp

[5] Wikipedia Encyclopedia
Retrieved February 8, 2008
from: http://en.wikipedia.org/wiki/Barcode

[6] Microsoft Developer Network
Retrieved December 5, 2007
from: http://msdn2.microsoft.com/en-us/default.aspx

[7] Audit My PC
Retrieved December 5, 2007
from://www.auditmypc.com/process/avicap32.asp

[8] SONY GPS GXB5210
Retrieved January 2, 2008
from:http://www.sony.co.jp/~semicon/english/img/sony01/a6808867.pdf

[9] Network Management Solution
Retrieved January 5, 2008
from: http://www.activexperts.com/mmstoolkit/

[10] Logix Mobile
Retrieved January 8, 2008
from:http://www.logixmobile.com/

[11] WaveCom
Retrieved December 4, 2007

from: http://www.wavecom.com/

[12] Lead Technology
Retrieved December 4, 2007
from: http://www.leadtools.com/SDK/Document/