

Solution for Electronic Ticket in Mobile Media

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Abstract

The E-Ticketing System allows customer to select seats and purchase tickets online. The bottleneck for the whole ticketing process comes at the ticket issuance stage, that the current process requires customer to get the printed ticket from appointed ticket agents. Electronic ticket in mobile media becomes the perfect supplement to the E-Ticketing System, as it allows ticket to be downloaded to electronic/mobile media such as smart card and mobile phone. This paper presents the different solutions on using smart card and mobile device as ticket media, and some of the design issue on doing so.

Keywords: *mobile media, e-commerce, smart card, mobile communication*

1. Problems of Traditional Paper Tickets

Paper is a common medium for ticket since long time ago. It is written the service entitled, which means that whoever with a matching identity holding the ticket can obtain the service. Paper ticket comes with some advantages: for customers, it is simple, lightweight, intuitive to use and easy to carry around; for service providers or event organizers, it is easy to produce, low cost, long-accustomed management procedure. However, using paper as tickets exposes certain weaknesses:

- **Easy to forge**
Using high quality printing or photocopying system can duplicate the ticket easily and at low cost. It is hard to detect just by a glimpse of human eyes, or at a short period of time.
- **Fragile**
Although it is much improved, most of the paper tickets are quite fragile. Tickets that are used for multiple passes or days may be even more undesirable.
- **Problematic in management**
To handle paper tickets, it requires human intervention everywhere: ticket distribution, ticket issuance, verification and post-event roundup, etc. These

common operations are likely to perform repeatedly for every event. It is even worse in large event that spans over weeks, and involves over several thousand tickets. Ticket processing time is definitely slow; nevertheless human intervention may increase the possibility of errors.

- **E-Commerce gap**

As confined by physical ticket, customer is required to go to a ticket office or agent to issue ticket after online transaction. Not only it is inconvenient, customer may find it unnecessary to purchase online but go to the agent office directly. This subtle gap between e-commerce transaction and traditional operation actually discourages online transaction.

The perfect solution is to deliver the ticket as an electronic object to customer, which will then be stored in a portable electronic media. This ticket object is verified and marked when customer comes to enjoy service. As everything is digitized, management becomes much easier. This paper introduces the concept of using smart card and mobile phone as the portable/mobile media, and describes the way to extend the E-Ticketing System to support both services.

2. Background

2.1 Smart Card Technology

Smart card was started out as an intelligent token in 1970s [1]. It is small in size to fit in a wallet and carry around. Common smart cards are credit card size embedded with a circuit chip [2]. Because of this integrated chip, smart card is also known as IC card. They can be classified by two different categories: (1) contact versus contactless cards and (2) memory versus microprocessor cards. The most prevalent types adopted nowadays are contactless memory cards and contact microprocessor cards, although hybrid cards (include both contact and contactless interfaces) are also becoming popular. With a miniaturized processing unit and limited memory storage, smart card is able to perform moderate computations solely inside the card, yet sufficient enough to accommodate most of the application requirements nowadays. Smart card is a tamper-resistant device for its highly secure feature. Data in the card can be protected with access PIN (password), biometrics locks and electronic digital signature to prevent unauthorized access [3]. Without underwent proper authentication procedure, break-in to the card system is extremely difficult, though not impossible, which shall involve tremendous effort, time and elaborated equipments. In addition, with a secure key such as private and public key preloaded in the card, different levels of cryptographic operations can be executed entirely inside the card. This fits perfectly into the security

framework of most computer applications.

Smart card's high degree of functional flexibility allows new applications in areas of use that extend beyond traditional card applications. It has been proven successful in extremely diverse areas: banking, medical, transportation, telecommunication, e-commerce, government, educational institutions and private corporations, and many more.

2.2 Mobile Technology

Mobile technologies can be divided into connection technology and application development technology.

Connection technologies like GPRS, CDMA, TDMA provide the data connectivity for mobile application. The advance of these technologies raises mobile application's quality to an acceptable level for general usage. However, these are not under the scope of this paper, and hence will not be discussed further.

Another concerning technology group is development technology. This provides different solution for mobile application development. The simplest of these technologies are SMS and MMS, which are Short Message Service and Multimedia Message Service. Sending these SMS/MMS between mobile phones serves as data/command interaction, which forms the basis of all applications.

Other more advanced development technologies include Java's J2ME and Personal Java, Symbian OS for mobile phone, and WAP. These development environments allow more complicated and powerful mobile applications to be developed. Although they are all different development environment, the concept of designing mobile application remains the same. There is also no particular technology better than the others. The choice of technology depends on the nature of the application, the support of the device and most importantly, its availability.

3. Definition of Electronic Ticket

In our usual context, a ticket is "*a document that serves as a certificate, license, or permit showing that the holder is entitled to certain rights, such as travel on a train or bus, entry to a piece of public entertainment, etc.*"*. Similarly, in the context of electronic ticket, it is a piece of data showing that the user is entitled to certain rights.

* Collins Concise Dictionary and Merriam-Webster Dictionary

The ticket must be readable and writeable electronically. In return for payment the person is given a ticket that they present when they need to use the service in question. The ticket may have associated with it a number of conditions, such as validity period, quality of service, just as real world tickets do [4].

An electronic ticket is modeled as in Figure 1. For security purpose, the ticket must be correctly validated and signed when issued to customer, which guarantees that any modifications on the ticket can be detected whenever it is used [5]. Ticket status indicates whether it was used or not. The status value is updated when customer check in at entrance of the venue (or check out) [6].

Ticket ID	Event ID	Ticket info	Ticket status
Ticket signature			

Figure 1 Data model of electronic ticket

4. Extending E-Ticketing System to Support Smart Tickets

To support smart card in E-Ticketing System, the additional requirements are to design the protocols of downloading and retrieving tickets between the system and the card [6], the way to store electronic ticket and also the proper integration to the ticketing process of the current system.

4.1 Ticket Wallet

The smart card is abstracted as a ticket wallet, in which multiple tickets can be stored. As shown in Figure 2, there are three separate modules, Ticket Manager handles ticket operations (read, write, update, delete, etc.) and Private Data Manager to store customer information and authenticate wallet owner. I/O acts as the access point to the ticket wallet.

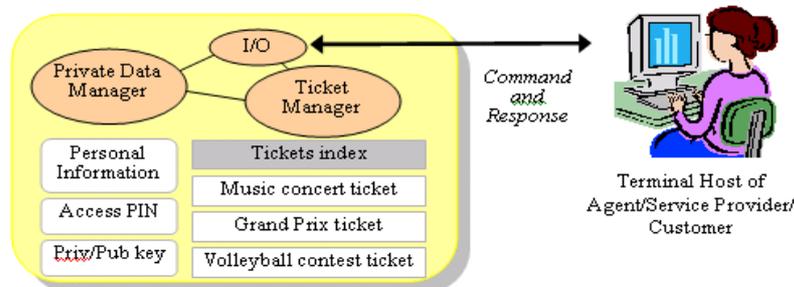


Figure 2 Design of the ticket wallet in smart card

Primary data in the wallet is the electronic tickets. Multiple tickets can be stored in one

card at the same time. Each ticket entry is the realization of ticket data model in Figure 1.

4.2 Ticketing Process using Smart Card

Using smart card as ticket media can automate the entire ticketing process. After the online transaction, customer can issue ticket from a kiosk[†] located in public areas, agent site or venue counter. At the venue entrance gate, customer uses the smart ticket to authorize himself or herself and get pass. The whole process completes without human intervention. While it does not only save the labor force, but also improve checking speed and accuracy.

Card Issuance

A smart card must be initialized before use. It is convenient to customer if card issuance is done at the same time when he or she is issued the first ticket. This card can be used repeatedly for storing all later tickets until the storage is full.

Ticket Issuance

After online transaction, customer can issue the ticket from any nearby kiosk. He or she has to login with the registered username and password to authenticate himself or herself. Followed by simple selection and confirmation, one or more tickets are downloaded and stored into the ticket wallet.

Smart Card Management

Through the kiosk, customer should be allowed to manage the downloaded tickets in his or her card, e.g. view the tickets, delete the tickets if required, change card password, etc.

Ticket Verification

Customer has to put the smart card on the checking machine at entrance gate which will then retrieve the ticket from ticket wallet. This machine is able to identify a genuine and valid ticket from a falsifying one. Finally, checking result should be displayed and indicated by audible sound. For single pass ticket, it is marked as non-consumable after used. For multiple pass ticket, its status should be changed to indicate the remaining usable period.

[†] Kiosk is referred to a computer system equipped with necessary device such as smart card reader and enclosed in a secure box. It can be accessed by public at any time.

The ticketing process of using smart card is intuitive and easy to learn, thus it is suitable for public use in most ticketing situations. On the other hand, the drawbacks of using smart card are that immediate delivery of ticket cannot be achieved now. Customer must have installed a smart card reader and proper software at his or her computer, and have bought a pre-initialized smart card at hand. However, since smart card application is becoming popular, it is conceivable that smart card reader will become a standard device like floppy drive in PC. In that case, ticket can be downloaded to customer immediately after the transaction is completed.

5. Promoting E-Ticketing Service for Mobile Users

Besides using smart card as electronic ticket media, the various mobile technologies as described in section 2.2 also provide good media for electronic ticket. The most popular mobile device used by general public is mobile phone. Using mobile phone as ticket media has the following two major benefits:

1. There is already a very large mobile phone popularity, which saves the procedure of card issuance as in the case of smart card ticket. (Although a ticketing program still have to download to the mobile phone beforehand, no physical card issuance is necessary)
2. Ticket issuance is carried out instantaneously after the purchase transaction. With ticket downloaded to customer's mobile phone, customer does not need to get the ticket from kiosk or ticket agent.

This section describes design issues on how the E-Ticketing Service can be provided to mobile users, which not only provide a ticket media, but also the media of ticket purchasing.

5.1 Differences Between Mobile and Internet Platform

Before understand how the E-Ticketing system can be promoted to mobile service, it is important to know the differences between the Internet platform and the mobile platform.

Limited Resources on Mobile Platform

The most noticeable differences between mobile phone and desktop PC is mobile phone's limiting resources, which includes the following:

1. Processing power: The processing power of mobile phone different from

different manufacturer, however most of the mobile phones will only have processing speed of less than a couple hundred mega-hertz.

2. Memory: Similar to the processing power, which is different from manufacturers, and in general less than 10Mb.
3. Screen Size: Typical mobile phone has a screen capable of displaying a few lines of text, and with limited color depth.
4. Internet connection: Before the real success of 3G technology, Internet connection from mobile phone is still unstable and slow.
5. Physical control: Obviously, there is no mouse and full keyboard for mobile phone, which only supports a simple numeric keypad.

Usage Environment and Behavior

Another difference between Internet and mobile platform is the usage environment. There is a big difference between surfing the web sitting at home with a desktop PC, and punching the mobile phone's keypad while waiting for a bus. This also brings up the difference in usage behavior. Most of the time people will only use the mobile phone with a particular purpose, either making a phone call or, if possible, making a ticket purchase, and they want these operations to be completed fast and simple. However on the other hand, surfing the web can be just for pleasure or killing time, with people carried to whatever sites the links "link" them to. These environment and behavior differences impose a design mindset for mobile application, which is "simplicity".

These limitations on mobile phone pose three challenges on promoting the E-Ticketing system to mobile platform, which are:

1. Application size and processing pattern
2. User Interface
3. Data connection pattern

These challenges will be tackled in the following section.

5.2 Design Issues on Transforming E-Ticketing System to Mobile Platform

The basic idea on transforming E-Ticketing System to mobile platform (say mobile phone) is to install a client application on the mobile phone, which accesses the same Internet server as the standard Web base client. However, as stated on previous section, there are constraints for mobile application, and these can be compromised with careful design.

Content and Information to be Displayed

The content and information to be displayed on a mobile device is limited by the screen size of the device and also the connection stability. With limited screen size and data transfer rate, content and information displayed should be clear and simple. Also avoid using complicated graphics. This is also affected by the user's behavior. With user purchasing ticket using a mobile phone in a bus, procedure should be simple and easy to use. Only relevant information is displayed, with self-explaining screen flow to minimize purchasing instruction.

Seat Selection

One of the main features of the E-Ticketing System is real time online seat selection. This is done by displaying a graphical seat map of the selected program so customer can select the desire seat(s). This is however a very expensive operation in terms of processing time, memory and data transfer. The more economical solution is to select the seat for customer, so customer can only select the amount of seat (ticket).

There are also solutions providing a graphical seat map for mobile phone, however, this also depends on the phone's screen size. If the screen size is too small, then even selecting seat from a graphical seat map will become troublesome.

MVC Pattern

The E-Ticketing System is implemented with the MVC pattern [7][8], this enables the control, data and presentation to be implemented separately. This allows an easy extension for the system to support mobile user. Figure 3 shows the MVC structure of the original E-Ticketing System.

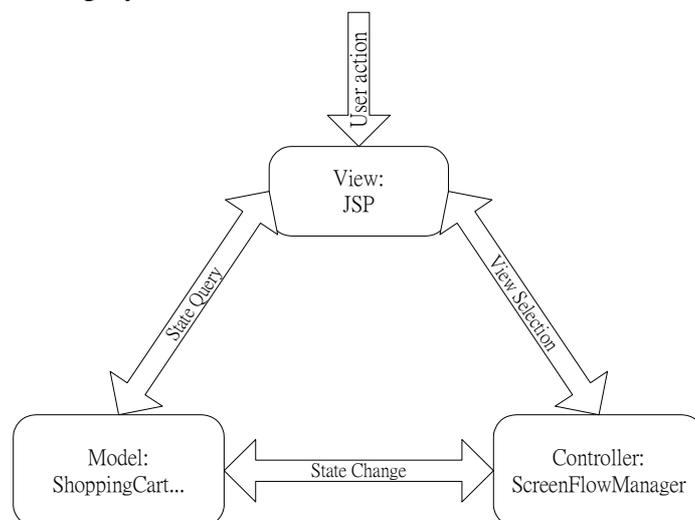


Figure 3 MVC Structure of the E-Ticketing System

Extending the system to mobile platform only require additional views for mobile interface. Since the information to be presented will be a simplified format, with limited graphics, these “mobile views” will mostly consist of textual information.

The “Controller” will be modified slightly to incorporate the additional views. That is to decide whether the client is a standard web client or a mobile client, so to return the corresponding view. Notice that it is not necessary to change the control flow. The “Model” will also be the same, those are logical objects reside on the server side. Figure 4 shows how extra views are added to the structure to accommodate mobile client.

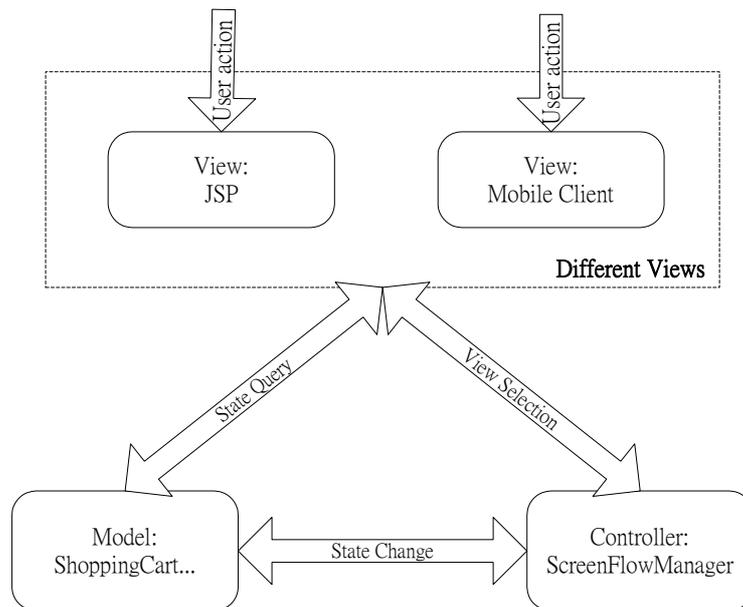


Figure 4 MVC Structure with extra Views for Mobile Client

Internet Connection

There are two possible connection patterns for mobile user:

1. Connect to the server for data whenever necessary.
2. Connect to the server and get all necessary data for the purchasing process, so that no (less) connection is required later on.

There is no absolute best way of connection pattern, which depends on the mobile device’s configuration and also Internet connection’s stability. If Internet connection is stable and data transfer rate is relatively fast, then the first option is preferable, and which is similar to standard web client.

The second option is suitable for unstable Internet connection. Since unstable connection can interrupt the purchasing procedures and can become a frustrating

experience for user. However, this connection pattern requires more memory to store the entire upfront data, and this also incurs a long initialization time.

5.3 Ticketing Process using Mobile Phone

The ticket model used in mobile phone is similar to Figure 1, except a timestamp field should be included, which is used to indicate a short validation period of ticket. The whole ticketing process using mobile phone consists of four steps.

1. Book or purchase tickets with payment: This requires connection to the E-Ticketing system through the telecommunication network to a gateway, browse through the catalog of events or programs, select the desired ticket and buy. Customer would be required to pay by some suitable payment methods [9] [10]. After all, the completed booking or purchase transaction record is stored in server. At any time, customer can view the ticket details by querying the server.
2. Deliver ticket to be used when needed: Ticket is used when customer enters the event venue. Customer should connect the system to retrieve the suitable ticket.
3. Verifying the ticket: Upon receipt of the ticket, the mobile device could immediately forward it to the checking machine at the entrance gate for verification. The connection between mobile device and the checking machine can use some short range wireless technique such as Bluetooth [11][12].
4. Receive result: Based on the information in the ticket, checking machine undergoes a sequence of verification procedure. A valid ticket should have matching information (e.g. Event ID), unused value, effective timestamp and authorized ticket signature. The result of verification is then sent back to customer.

For customer purchase ticket over web browser, he or she can follow step 2 to 4 to download and use ticket through the mobile phone.

The limitation of using mobile phone in ticketing service is its relatively complex operation procedure. Most phone user may accustom to phone dialing action, but not knowing how to access Internet service via the phone, which requires setting, connection, input access address, etc.

Figure 5 gives a complete picture of extending E-Ticketing System to support smart card and mobile services. Depending on the target user, both solutions may be made available to provide the most convenient service.

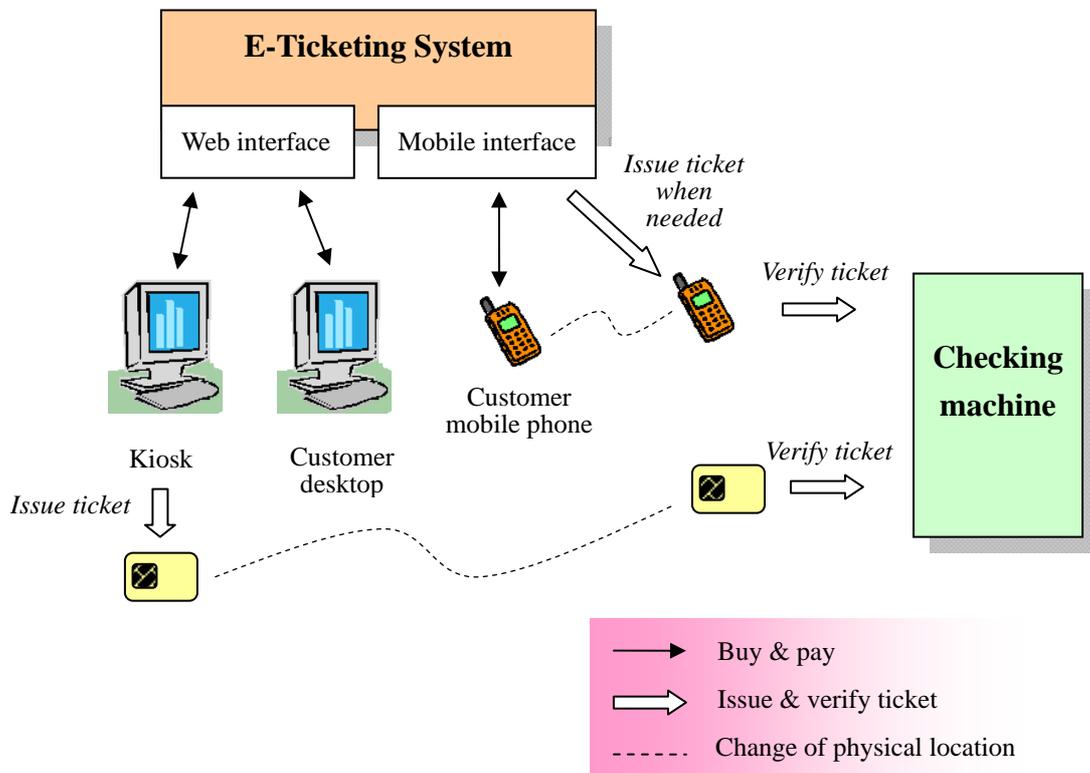


Figure 5 E-Ticketing System supporting smart ticket and mobile ticket

V. Conclusion

With the advance technology of smart card and mobile communication, the long haul problem induced by traditional paper tickets can be avoided. Smart ticket as a secure and accessible media, it is suitable for public use. Allowing mobile access to the E-Ticketing System encourages fast and instant ticketing transaction with a mobile phone at customer's hand, which also acts as a media of retrieving ticket at the service entrance point. Both solutions and their design issues adaptable to the E-Ticketing System are described in this paper.

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Bibliography

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