Full-scale Online Event Ticketing System
The Design and Implementation

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ABSTRACT

The paper analyzed the system requirements for online shopping in general and specific requirements for event ticket online selling systems. The paper discussed the critical design and implementation issues for Electronic Event Ticketing System and prospective issues for fully automated Electronic Event Ticketing with high availability. The research is based on the real medium size Event Ticketing project for selling entertainment tickets in Macau.

I. INTRODUCTION

The rapid growth in Electronic Commerce (EC) places strong demands on business to meet customer needs in timely and efficient manner. EC is the sale of goods and services by electronic means. There are three categories of EC, Business to Business E-commerce (B2B), Business to Consumer E-commerce (B2C) and Consumer to Consumer E-commerce. B2C often refers to retailing that involves direct purchase on the Internet. Online ticketing is the most popular B2C E-commerce service, which is one of the five product categories with the highest online retail rates; the others are software, music, books and media. B2C event tickets on-line sale will reach 2.8 billion US dollars in the year 2003 at the United States, which is about 150 times of it in 1998. The online event ticketing will occupy about 20% of total ticketing retail in 2003 at United States predicted by Forrester Research Inc [1].

On request of Macau government, University of Macau is appointed to develop an Internet based on-line ticket sales system aiming to promote Macau's culture and tourism to the world by means of high technology. At this moment, the system will be used for important events and activities held in Macau annually, which are International Festival of Music, Art Festival, World Women Volleyball Games, International Car Race. These events are organized by different government departments, referred as *event providers* in the paper. The system provides services flexible to all target customers. Both the online purchase and booking services via the Internet, and booking over the phone networks via agents must be provided. The paper focuses on online services; it is the task of ticket agent to transfer online service to phone customers.

The paper discussed the critical design and implementation issues for Electronic Event Ticketing Systems (EETS) and prospective issues for fully automated Electronic Event Ticketing with high availability.

II. SPECIFIC SYSTEM REQUIREMENTS FOR ELECTRONIC EVENT TICKETING SYSTEMS

The online purchase for event tickets of entertainments share all common requirements with most online shopping systems, however, there are critical requirements to EETS, which are not common for other online shopping systems.

1. Open architecture

EETS is an online selling system with multiple service providers, operated in different environments and at different platforms. The actual sell activities are performed mainly by the agents. Agents may range from a simple desktop with dial-up connection to an enterprise network with fully Internet connections. The system should provide services to all kinds of customers with different ways of Internet access or even with no means of Internet access. The system must be easy for other service providers and agents to join and it should minimize the modification of software for providing other kind of E-services rather than Ticketing. The proposed architecture provides standard web interfaces to all system users, adopts platform independent development tools and environment, and XML as data presentation for exchanging information in the heterogeneous environment [2][3]. The details will be discussed in section V.

2. High service availability

Same as other systems, EETS must perform system backup periodically and adopting certain redundant approach in order to guarantee the system recovery within the shortest time as possible. However, it is not enough for some kinds of event, which requires zero downtime when the event is on. For those events, the online selling must keep in operation till the event is over. In addition, large amount of customers may

purchase or collect their tickets shortly before the game begins. Fully redundant system for hot backup is not the solution for most systems due to high cost and system complexity. Fortunately, this critical requirement on availability is only for some particularly services, the ticket purchase, issuance and printing are the most critical ones in the event ticketing systems. EETS provides the Service-oriented disaster tolerant mechanism to guarantee the high availability.

3. Fully automate the online event ticketing service

Although the web-based EETS provides online booking, purchase and payment to facilitate customers, there are still some parts of the selling process must get human involved. Most of the tickets are printed on papers so that the ticket must be delivered by post mails, which may cause delivery delay and the ticket have to be examined by human when the customer consumes it for the events. This may provide chances for fake ticket holders. Adopt the electronic ticket is the solution. The electronic ticket can be stored in the portable media such as smart card or mobile. With the electronic ticket, full automation of ticket purchase, delivery and check in could be realized. The electronic ticket design issue will be discussed in section V.

4. Scalability

The E-ticketing systems vary from system to system in event types and geographic locations covered. Some EETS sell tickets for various kinds of events in national or international wide while most of them are for particular cities or even for particular venues. The paper proposed an open architecture system with scalability, which supports various events, multi-event providers and multiple agents.

III. MAIN FUNCTIONAL MODULES-THE SUBSYSTEMS

1. Functional requirements

The fundamental functions of the EETS is to provide web-based on-line booking and purchase services to individual customers and ticket agents. Customer-centricity is the heart of E-Commerce, the system must provide services flexible to all target customers, local and abroad, Web online users and conventional phone network services users, and mobile phone users. The system supports Internet on-line purchase and on-line booking, electronic purchase through agents and on-site purchase at ticket agents (buying on behalf of phone service users or walk-in customer). The ticket agents and individual customer can book and buy tickets of events through the Internet at anytime in any place directly via the Internet access.

The E-ticketing system provides services to four types of users, the web-customers, the event providers, the agents and the system administrator shown in Figure 1.
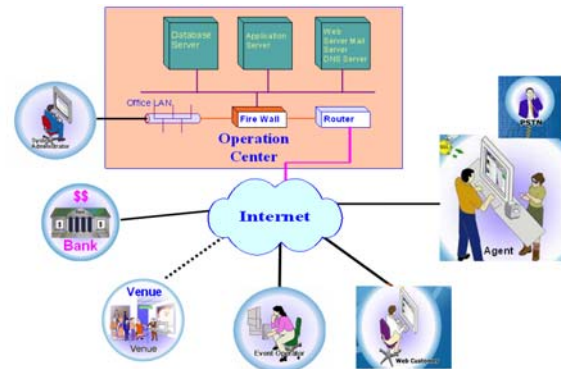

Figure 1 EETS system overview

The EETS is composed of four subsystems and two offline module to realize the sophisticated requirements, the online booking and purchase subsystem, event management subsystem, agent management subsystem, and the system administrative subsystem, the seat chart generation module and the offline disaster recovery module shown in Figure 2 [4].
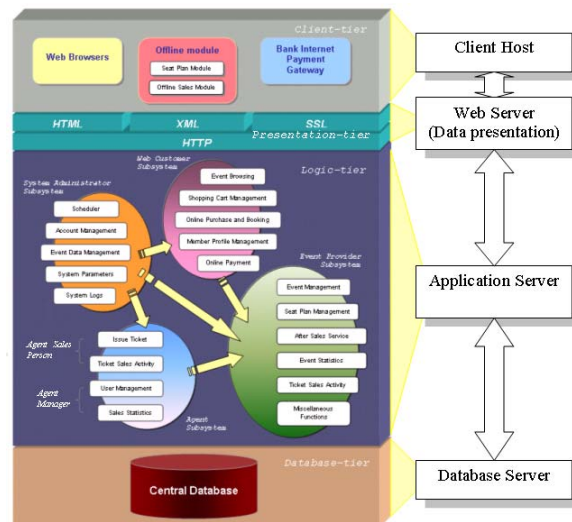

Figure 2 The multi-tier system architecture

2. Online booking and purchase subsystem

The heart of the ticketing system is to process booking and purchase requirements. In addition to provide registration, booking, purchasing functions, the system provides customer flexible discount, payment and ticket delivery functions. It processes customer booking and purchase orders based on available seats, price and discount policies, issue tickets. It is a very user-friendly system even with Interactive Seat

Selection function and purchase consolation function, those are seldom seen form most of ticketing systems. Almost all of the on-line ticketing systems declare that it is purchase without consolation and the customers can only select rows or zone by click or text description.

(1) Interactive Seat Selection

The system provides on-line seat chart for customer to choose interactively. Customers are free to select individual seat available just by a mouse click. The seat finally confirmed after the ticket is paid. The certain amount of time is allocated to purchase transaction to prevent concurrent users to compete for the same seats. An event may have multiple programs, and each program may have different show times and at different venues. The seat chart is event/program-specific even with the same the physical venue.

(2) Discount schemes

The system provides customer a various discount choices. In edition to quantity discount, package and other discount are configurable by the event provides.

(3) Ticket printing (issuance)

All information about each ticket sold or booked is stored at the central database. Each ticket has assigned a ticket ID associated with particular customer. The ticket printing is under centralized control, each ticket can only be printed once at any agent or venue. An offline selling and printing tool is provided for service recovery in case of system failure. The details will be discussed in section V.

(4) Payment

Customer has choice to pay on-line or on site at the agent. Customers are free to choose any of the payment methods acceptable. The online payment is handled by the bank systems, the E-Ticketing system provided an interface to the Bank Internet Payment Gateway. It is ready for event providers and agents to use upon they opened their accounts at the Banks providing the services.

3. Event (service) provides management subsystem

The system provides functions for event providers to create, post event information and to manage the event conveniently via standard Web interface. Event providers can arrange seat chart, schedule event, announce prices and discount policies. A seat chart generation tool is provided for event provider to make zoning and the pricing arrangement.

The complex discount policies can be configured flexible and easily. The online reports provide various statistic report on purchase. After-seals function provides seals details to facilitate event providers to handle business issues with the agents.

4. Ticket Agent subsystem and Venue subsystems

The agent sell tickets on behalf of event providers, on the other hand, the Agent purchase tickets on behalf of all kinds of customers, mainly for the non-web-customers. Agent has all functions assigned to web customers, in addition, they can issue and print tickets. With the management tools provided, the agent can easily manage seals activities at each agent brunch at the level of individual seals person.

The venue is a special agent system providing all agent functions to customers. The venue system plays an important role in disaster recovery. For a large venue or a large event, the venue subsystem acts as the backup system. All purchase service related data for a particular event /program will be updated and stored so that it can be put in operation for selling and printing tickets immediately upon after system failure happens. The disaster recovery issues will be discussed in section V.

IV. ARCHITECTURE OF EVENT TICKETING SYSTEMS

1. Multi-tier architecture

EETS has tight requirements on the system's speed, scalability, security, and reliability. One way to meet this need is to use a multi-tier model where a thin-client application invokes business logic that executes on the server. An important advantage of multi-tier is the reusable middle and back-end services that speeds up implementation of new applications. As shown in Figure 2, these tiers are both logical and (actually) physical division of the system. Client programs communicate with the database through the web server and application server using high-level and platform independent calls. The application server responds to the client requests, makes database calls as needed into the underlying database, and replies to the client program as appropriate.

The Client-tier contains the client user interface, which can be any internet web browser, applet or standalone applications. Presentation-tier provides all presentation logic, which are required by the client (user). It dispatches user requests and constructs the response. Logic-tier provides the core business functions provided to the user. All business logic is centralized into this tier, which allows loose coupling between tiers and the underlying platform. (Hence any of the tier's platforms can be changed without major modification). Session and transaction handling are resided in this tier. Database-tier is the central storage of system data and business transaction records.

2. Platform independent

The system provides standard web-interface to all subsystems. It provides the platform independent bases for all kind of users to interact with the system. There are no special platform requirements to all event provider's native management system. JAVA as the main development language implemented main modules

3. XML based data exchange suitable for heterogeneous environment

The XML file is the main means of data exchange among subsystems and the central ticketing processing system. Seat chat and ticket information are exchanged in XML file format.

V. DESIGN ISSUES FOR ENHANCEMENT FUNCTIONS

1. Disaster recovery — offline ticket selling

For some events, there is no deadline for ticket selling. The ticketing counters may setup several hours in advance at the venues for the walk-in customers to buy or collect their ticket paid online. This short period is considered as a very critical moment for the system to support the ticketing operation. Any kind of system failure may introduce bad results to the customers and operators.

The system failure may come from any part of the system, ranging from hardware components of the database server, application server, web server, networking devices like hubs, firewall, network interface cards, and routers, to software components like the operating systems, middleware, bugs of the ticketing system, and even the data communication links, and external environmental factors like power shortage etc. Therefore it is nearly impossible to implement the system with 100% of reliability, and the cost will be huge.

To cater different kind of system failure, firstly, the latest seals information details must be backup in multiple systems. Secondly, The seals records must be provided for issue(printing) the tickets. Thirdly, The seals activity must be managed and integrated into the database to keep the data consistent.

In this ETT system, all purchase details are logged. Together with the latest purchase log file, the seat plan file, and the ticket layout file should be presented for the offline subsystem to perform. For higher flexibility and interoperability, those files are constructed as standard XML documents. With those information, the offline selling environment can be reconstructed as shown in Figure 3.

In the current version, the offline seals module is just for standalone desktop to operate. The distributed service-oriented disaster recovery function will be provided in the next version.
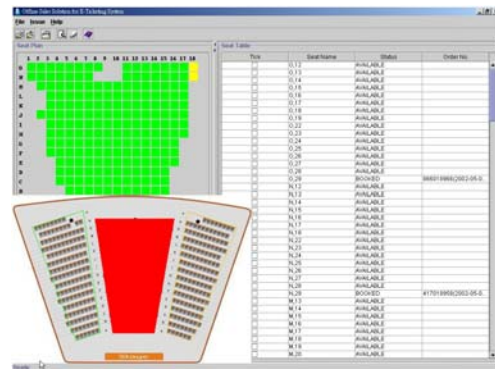

Figure 3 Offline ticketing subsystem

2. Design of ticket wallet and the electronic ticket

Smart card is a credit card sized plastic card embedded with an integrated circuit chip. It is a tamper-resistant device for its highly secure feature. It offers facility to process cryptographic operations entirely inside the card. It is small size, low cost, portable and more durable that makes it possible for individual to carry certain amount of data in their wallets All these features and strengths make the smart card the ideal container of electronic tickets.

The smart card is abstracted as a ticket wallet, in which multiple tickets can be stored. As shown in Figure-4, 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.
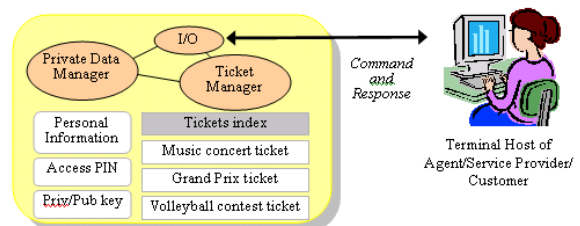

Figure 4 Design of the ticket wallet in smart card

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-5. The electronic ticket must be officially signed by the event provider when issued; hence, modifying the ticket would automatically invalidate it. To make the ticket state changeable, the

ticket status represents the current consumable value of the ticket, indicates whether it is used or not. Ticket status is updated when customer check in at entrance of the venue.

Event Provider ID	Event ID	Ticket info	Ticket properties	Ticket status
Ticket signature				

Figure 5 Data model of electronic ticket

VI. CONCLUSION

The EET system has been fully implemented. The over all system analysis and, design flowed software engineering development lifecycle. The Object-oriented UML is adopted as the tool of analysis and design. The system passed all functional tests. The system performance tests obtained the satisfactory results. The system will be put in use upon the real case trial run completed. To improve system performance, to provide access to PDA users and fully automated electronic Event Ticketing process and to provide distributed service-oriented disaster recover function are the goals for the feature research and development.

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