MobiQ: Mobile Based Processes for Efficient Customer Flow Management

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Abstract. Queues are still a part of the everyday life, though Internet and mobile technologies are already available. Queues are formed whenever a bottleneck of customer demand for a service appears. There are workarounds for customer flow management or queue management in order to provide a level of freedom to the customers such as queue ticket numbers. However, there can be many more things that can be done to free additional time for the customer until his/her turn comes to be services. In this work, we propose an solution framework for servicing customer flow with *live* feedback. Our goal is to improve customers' experience and Quality of Services (QoS), by integrating mobile access with Short Message Service (SMS) to improve customer flow in popular crowded services, where long queues are created. A fully functioning real life prototype is presented, demonstrating the feasibility and effectiveness in terms of time and effort.

Keywords: mobile services, customer flow management, web services, m-tickets, m-government, mobile queue management.

1 Introduction

The era of globalization or digital world has created a new kind of information society and knowledge-based economy, which changed our human behavior. Information and Communication Technologies (ICT) are considered to be the powerful tool which constitutes an important factor for those changes. The term “e-Services” and respectively “m-Services” for mobile phones and PDAs, refers to the use of ICT to provide and improve everyday services, transactions and interactions with citizens, businesses, and other private or public bodies.

Electronic tickets (e-tickets) are an example of such a class of e-services. Generally speaking, e-tickets are the Internet counterpart of real-world tickets, thus they give evidence that their holder has paid or is entitled to some service [1]. Unfortunately, no matter how widespread the use of ICT is, there is still a great number of services that require physical presence of the customer and cannot be completed using only individual e-Services. Customer Flow Management systems for private and public

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organizations or enterprises fail at facing the problem of the resulting long queues and waiting times. Such cases include banks, pharmacies, post offices, hospitals, shopping malls, police stations, employment services and in a variety of contexts from travel, to entertainment or healthcare. [2]

In these cases, customers first enter the reception area and then get a ticket that puts them in a waiting queue until their time to be served comes. Finally, they are informed to enter the service area. These systems have a number of deficiencies which adversely affect users' experience and are mentioned below:

1. First of all, customers have to enter the reception area first, in order to get a ticket. No electronic tickets production system exists for customers to receive e-tickets before they arrive at the building, either while being at home or when being on the road, moving in the city and doing chores at different services.
2. Furthermore, customers have to wait in the facilities of the organization or enterprise until they are served, due to the fact that no system exists to inform them whenever they want about their refreshed waiting time. In other words, customers/citizens take a risk to lose their turn, if they leave the queue in order to perform some other task as they have no "live" feedback which would allow them to perform any sort of time management.

The use of mobile phones allows people to perform time management and face the two problems stated above. This works especially well when it comes to small groups of people coordination and agenda aligning. For example, friends call each other to setup a meeting while being mobile on the road and agree to update themselves in case of small schedule or place changes until they meet. The mobile phone then becomes a leading artifact for temporality in a flexible society. More and more, the mobile phone replaces the calendar and the watch as they incorporate and enhance them both [3]. Of course, when it comes to service organizations and its customers, then the "live" and constant update through phone calls is practically impossible as it requires much effort and becomes expensive and complicated (in terms of both money and time). Studying customer queues particularly includes the ways of delivering the waiting time by steps. In the proposed solution we re-engineered ways of delivering waiting time through Internet and GSM [4].

In this work, we propose m-Services which are based on mobile data access and Short Message Service (SMS) messages, to provide an integrated solution framework for servicing customer flow management with live feedback. A fully functioning real life prototype is also presented and discussed to show the feasibility and effectiveness of the software approach. The prototype is adapted to the business model of Banking sector [5], [6], however this has no impact on the generality of the architectural approach. In short, the m-Services allow e-tickets creation before customers reaching the servicing area using three different options:

(i) via mobile web access specially adapted to mobile phones,
(ii) using stand alone mobile applications downloaded at the mobile devices and
(iii) using SMS messages sent from a mobile phone.

Moreover, the m-Services include functionality to provide “live” feedback to the e-ticket holders about their up-to-date, updated waiting time at the queue through all the

above access options (i-iii). Additionally, in order to present holistic software architecture the proposed framework also provides its services (iv) via desktop internet based access. To the best of authors' knowledge, this framework constitutes one of the first attempts in managing customer flow through mobile devices with all different possible means.

Waiting time is an important issue and has strong effect on customer satisfaction [7], [10]. It is argued that queues engender a loss of personal control and an overestimation of time spent in waiting as well as boredom and physical discomfort for many visitors. Delivering different queue forms or physical incorporation of queues into operational space and attention to physical comfort has been used to improve satisfaction [8]. Having customers additionally informed proves to be helpful [9]. The key concept of the proposed solution is to re-engineer the queue waiting process and introduce new means to improve user experience such as software based time announcements through the Internet and mobile networks. It is important to have in mind that the proposed solution adds and extends existing queue management systems that use paper tickets (numbers that show who is next). We show that using mobiles and the Internet there is an improved and alternative way to provide the queue management service.

Overall, the discussed prototype is adapted to the business model of Banking sector, yet causing no impact on the generality of the architecture. Briefly, mobile services allow e-tickets derivation for customers who are not present at the servicing area, providing an interim solution for those services that require physical presence. Moreover, mobile services provide "live" feedback to e-ticket holders, informing them of their updated waiting time at the queue. The evaluation results are encouraging and the prototype has got much attention by the Greek e-Gov community.

The rest of the paper is organized as follows: Section 2 discusses related work about flow management services and m-Services. Section 3 presents the key aspects of the mobile framework proposed. Section 4 discusses theoretical background behind customer flow management and queue management. Section 5 discusses the functionality of the real life prototype for the different available access options (mobile web, mobile applications, SMS and desktop web). Finally, section 6 concludes the paper and provides future ideas for further investigation.

2 Related Work

Organizations and enterprises provide, in many cases, a wide variety of e-Services which include internet services and services for mobile devices. These services involve business and financial transactions as well as information services. However, the former e-Services rarely don't include services for customer flow management using e-tickets, for customers who choose to be served locally in the shops, company or organization branches. Practically nonexistent are services that allow e-ticket holders to get updated about the current-refreshed waiting time at the queue, thus providing "live" feedback.

Proponents of m-Services argue it can help make public information and services available "anytime, anywhere". An example of such beneficial use of mobile technologies would be sending a mass alert to registered citizens via short message service,

or SMS, in the event of an emergency. To quote m-Services theorist and proponent Ibrahim Kuchshu, "As e-business evolves towards m-business, e-Government seems to follow the trend with a few but significant mobile government (i.e. m-Services in general) applications" [11].

2.1 E-Tickets for Purchasing

In order to present the key differences between queue tickets for customer management and traditional e-tickets for product and services purchasing a short description is given below. E-tickets are the Internet counterpart of real-world tickets and give evidence that their holder has paid or is entitled to some service (e.g., entering a place of entertainment, upgrading software from the Internet).

Users can acquire e-tickets by purchasing them from a web server, or simply receiving them from a vendor, as part of a promotion, or from another user who previously acquired them. E-tickets can be stored in a desktop computer or in a personal digital assistant (PDA) for future use [12]. They are very popular nowadays in the airline industry. An e-ticket is a paperless electronic document used for ticketing passengers, particularly in the commercial airline industry. E-Tickets have been introduced in road, urban or rail public transport as well.

2.2 Customer Flow Management

Before proceeding further, we shortly present existing business ready solutions for customer flow management follows, in order to show the current state of the art business and software approaches. Below, we present two of the most popular customer flow management systems: Q-Matic and Nemo-Queue.

Q-Matic Customer Flow Management Systems has created a Customer Flow Management (CFM) system for private and public organizations and enterprises, which face the problem of big queues and waiting times [15]. It's all about managing the flow of customers and their experiences from their initial contact with the company, through to service delivery as well as seeking their feedback and views after they've received the service they need.

Nemo-Queue Customer Flow Management Systems is a pioneer in customer flow management and queuing systems, with experience from thousands of installed systems throughout the world. CFM systems can be used in several different areas where the customer flow management can be improved such as: banks, pharmacies, post offices, hospitals, shopping malls, police stations and employment services [16].

The problems that the aforementioned systems (and similar ones) can't solve, have been described analytically in the previous section and refer to the fact that customers (a) have to enter the reception area to acquire a ticket and (b) have no "live" feedback to perform any sort of time management.

2.3 SMS Based Solution for Information Services

System Pandora [14], which uses SMSs to provide services related to education, is presented bellow as an example of novel SMS based m-Services. This system, which was developed in the Aegean University, provides a network place in which the user

can create an account, so that he/she acquires access in the provided services. In the next level, the user can subscribe to some service and regularly receive informative SMSs, with the only pre-requisite being an e-mail address of the Aegean university.

Abilities of activation of an account via the system network place and renewal of the balance with the use of cards from well-known mobile telephony companies of Greece are offered. The balance renewal is accomplished with the dispatch of a suitable SMS and each renewal suffices for a relatively big number of uses of the provided services. Descriptions and details for the provided services exist to the panel of services allocated in the network place as well as in the examples that present their syntax. The system offers its users the flexibility to be informed and act via mobile phones both for issues of academic interest and for various other issues of interest.

2.4 Time Management Using Mobile Devices

An attempt to provide time management for service provision and organization directly by the customers is the work presented in [3]. A mobile application downloaded and installed locally at the mobile phone is utilized to facilitate service meetings and transportation timelines. Unfortunately at the time of development, mobile data access and throughput was not enough to support the idea of the authors efficiently.

In this work, all possible different mobile access possibilities are given in order to schedule and get updates about customer queues and flow management. Specially designed mobile web access, internet accessing mobile applications locally stored and SMS based communication are employed, in order to provide flexibility in the communication and support for a wide range of different mobile phones and carriers. Next, we present the key concepts of the proposed software approach.

3 Customer Flow Management Extending to Mobile Devices

To ease the readership and to provide more clear flow of concepts, we discuss ideas and techniques for the prototype's case applied to the banking sector. This does not narrow at all the application spectrum and generalization of the solution and it is meant to assist flow of ideas.

The proposed solution in short allows e-tickets creation, via internet applications and applications for mobile phones, before customers reach the servicing area. Moreover, it informs regularly or ad-hoc upon request the e-ticket holders about their updated waiting time. MobiQ approach provides users with a ticket-code that determines its holder's position in a waiting queue at a specific date/time. It works in fact as an electronic version of «paper tickets» citizens/ customers use in order to obtain their positions in waiting queues.

In the case of the paper ticket, the waiting time written on it is calculated only once, when customer gets the ticket, so he is informed of the time he will have to wait before served by a teller. This waiting time is indicative and often not accurate, so customers are "trapped" in the bank waiting for their turn (see Fig. 1(a)), "anxious" and possibly "afraid" to lose their turn in the meantime in case they leave the bank to perform other tasks (see Fig. 2(a)). On the contrary, the e-ticket holder can be informed of the renewed waiting time, at any time (see Fig. 1(b) and Fig. 2(b) – The

MobiQ solution). The MobiQ solution allows the customer the flexibility to allocate his time as desired, until his service time arrives, and to be informed, whenever he wants, for the new waiting time, which may have changed significantly due to the nonlinear service execution time.

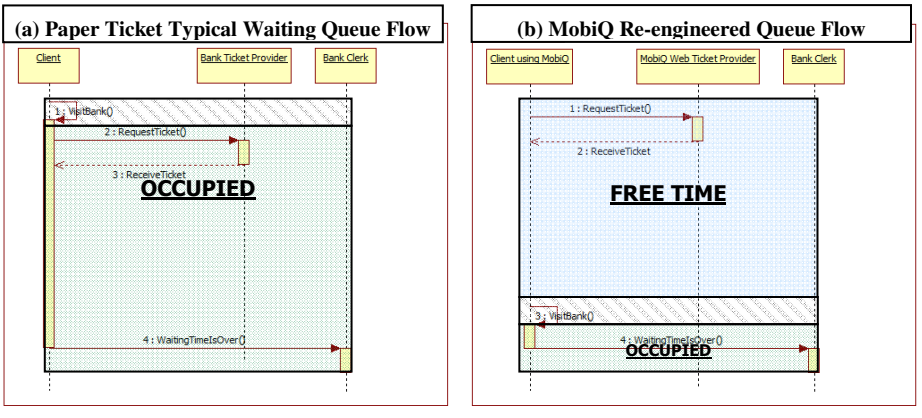

Fig. 1. (a) Paper Ticket Queue, (b) MobiQ Re-engineered Queue

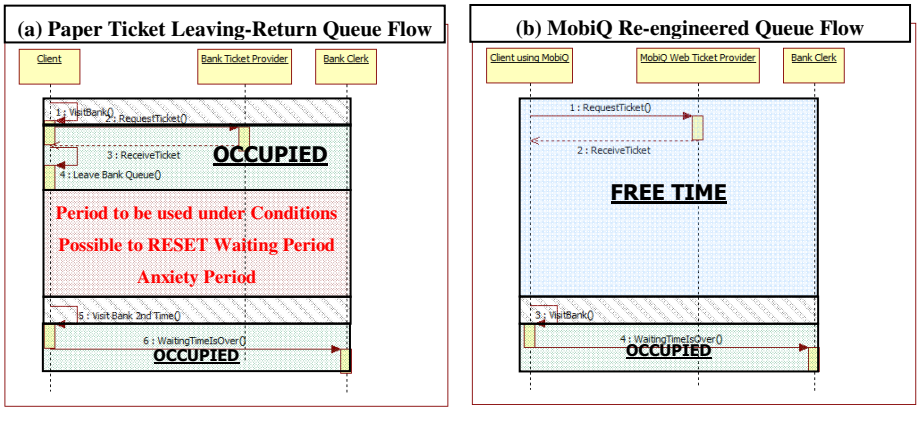

Fig. 2. (a) Paper Ticket Leaving-Returning 2nd Time to the Queue, (b) MobiQ Re-engineered Queue

The anonymous user has the option to request and receive an e-ticket in various ways. He may receive it either through a website, which is designed both for desktop PCs as well as for access through a mobile device. Additionally, a customer can be served through a portable handheld device (e.g. mobile phone/ PDA), running a local application supplied by the bank (i.e. service) or its mobile carrier. Moreover, the same services are provided through SMS technology. Likewise, he/she may request information for his/her ticket's waiting time, either through the website, with an SMS or through the mobile local application, at any time. When the customer uses a mobile

device to obtain an e-ticket, some additional features are available, such as storing e-tickets in the local database and managing them (insertion of new tickets and ticket deletion). The SMSs are also available anytime as an evidence for the user.

The m-Services proposed have mechanisms for the daily calculation of the current average waiting and service time for each bank service, at regular intervals. The framework also includes two Web Services which provide a set of functions to the applications they exchange data with.

The Websites are connected to one of the web services, while the mobile local application and the SMS Server are connected to the second one. Both applications use these web services to receive the current waiting time for a bank service, request and receive e-tickets, but also to receive the renewed waiting time of an existing e-ticket. The web services in turn, communicate with the database in order to perform the functions requested. This service oriented approach allows us to initiate as many service instances as needed, in order to evenly distribute the workload to them.

Finally, the m-Services framework is accompanied by a simulation tool for testing purposes. This application simulates the service process of e-tickets stored for the current day, for every company/organization, bank in this case. This simulation allows the calculation of the final waiting and service time of each e-ticket, in order for the mechanisms mentioned above to operate properly. The communication between the application and the database is achieved through a web service.

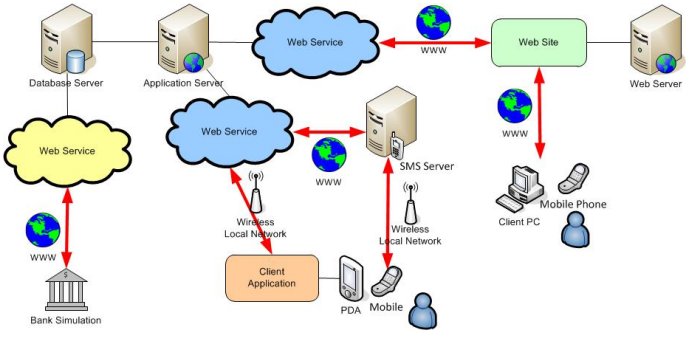

Fig. 3. The Architecture of the Integrated System: Components Interconnection

The general architecture of the proposed m-Services regarding its components interconnection is shown in Fig. 3. In Fig. 4 the general architecture of the integrated system with regard to the set of services it offers is presented.

4 Theoretical Background

This section presents the theoretical background used for the computation of the average waiting and service times for each Bank Service, as well as the renewed waiting time for an e-Ticket after its holder's request. Assume that there exists a bank service

with L servers – desks. Assume that a new customer C arrives. The moment he requests a new e-Ticket, there are NW customers waiting and some customers are being served. We assume that until that moment, NS customers have already been served from the beginning of the process. Assume that the service time of the i-th customer is xi. Until that moment, the average service time for the current day is:

$$\bar{x} = \frac{1}{N_S}\sum_{i=1}^{N_S} x_i \tag{1}$$

where:

N_S is the number of customers who have been served until that moment

x_i is the service time of the i-th customer, $1 \le i \le Ns$

In order to compute the average service time, we must take into account the service times of the previous days. If we take into account the past five days, Eq. (1) is transformed into:

$$\bar{x} = \frac{1}{2}\left[\left(\frac{1}{N_S}\sum_{i=1}^{N_S} x_i\right) + \left(\frac{\overline{x_{n-1}}+\overline{x_{n-2}}+\overline{x_{n-3}}+\overline{x_{n-4}}+\overline{x_{n-5}}}{5}\right)\right] \tag{2}$$

where $\overline{x_j}$ is the average service time of the j-th previous day. In Eq. (2) we presume that the two addends are equivalent.

In order to calculate the waiting time for the customer C who wants to get an e-ticket, we calculate the time that will pass until all customers who are at the current moment in queue or in desks are served, taking into account the number of desks. The waiting time W_C for the new customer C is:

$$W_C = \frac{N_W \cdot \bar{x}}{L} + \bar{x} = \frac{\bar{x}(N_W + L)}{L} \tag{3}$$

where:

N_W is the number of waiting customers until the current moment

$\bar{x}$ is the average service time calculated by Eq. (2)

L is the number of desks

Eq. (3) represents the worst case where the entire service time for customers who are served the current moment is taken into account. However, if we take into account only the customers in the waiting queue, Eq. (3) becomes:

$$W_C = \frac{N_W \cdot \bar{x}}{L} \tag{4}$$

When the queue is too long in regard to the number of desks, that is $N_W >> L$, then Eq. (3) tends to become Eq. (4).

In case, customer C is already in a waiting queue and wants to be informed for his renewed waiting time, we can use Eq. (3) again, taking into account that term N_W refers to customers waiting in queue and precede customer C.

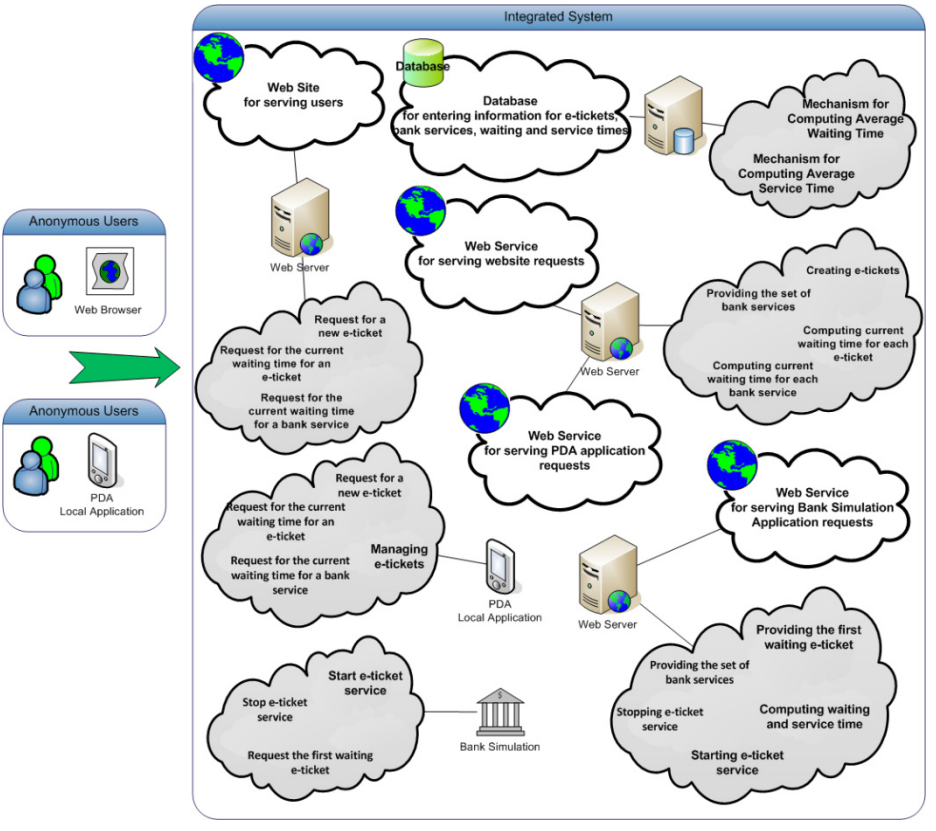

Fig. 4. The Architecture of the Integrated System: Set of Services

5 Functionality and Prototype

5.1 Web Services for Serving Requests from the Website and the Mobile Local Application

The mobile services include two types of XML Web Services which provide a set of functions to the applications with which they exchange data. The Websites are connected to the first web service, while the mobile Local Application and the SMS Server are connected to the second one. Both applications use these web services to receive the current waiting time for a bank service, request and receive e-tickets, as well as receive the renewed waiting time of an existing e-ticket. The two web services in turn, communicate with the database in order to perform the functions requested.

The services provided by the two Web Services connected to the Websites the SMS Server and the mobile Local Application, are:

- Providing the Set of Bank Services
- Creating e-Tickets
- Computing the Current Waiting Time for a Bank Service
- Computing the Current Waiting Time for an e-Ticket

5.2 E-Ticket Structure

The e-ticket code is the number that corresponds in an electronic ticket and is returned in the user who requested the electronic ticket. With this code the user can be informed for his new waiting time. The code is composed of 13 digits and has the following form: YYYY MM DD SS NNNN, where:

- YYYYMMDD is the date during which the e-ticket is valid. It is expressed in year (YYYY), month (MM), day (DD).
- SS is the Bank – Service the electronic ticket is requested for.
- NNNN is the number of the electronic ticket.

5.3 Websites

Website for Access through Mobile Devices. The m-Services include a Website, via which anonymous users can request e-Tickets and be informed at any given time for the renewed waiting time that corresponds to their ticket or the bank branch that interests them, using access to the Internet from their mobile device. Snapshots of the procedures are shown in Fig. 5 and Fig. 6.

One can observe that the web pages of the presented web site contain merely the information that is absolutely essential: there are only few and simple graphics and in general the interface is less impressive than the ones we are accustomed to explore from our personal computers. This way of designing is essential because the screen of many mobile devices (mostly old ones) have limited space, the keys are difficult to use in comparison to the mouse or a touch screen and finally the memory and the processing power of a mobile device is usually limited. The Website provides the following services for its users:

- Request for current Waiting Time for a Bank – Service
- Request for New Electronic Ticket
- Request for the current Waiting Time for an Electronic Ticket

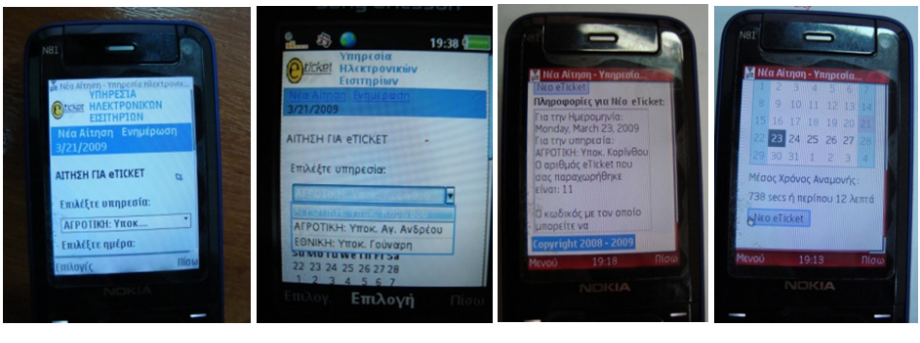

Fig. 5. Captions on Nokia and Sony Ericsson mobiles

Fig. 6. Snapshots on simulator for the mobile Website

The mobile services has also a second Website through which anonymous users can request e-Tickets and be informed whenever they want for their renewed waiting time (Fig. 7). It is designed for desktop pc users.

The Websites are connected to the corresponding Web Service to receive the current waiting time for a specific Bank Service, to request and receive an e-Ticket, as well as to receive the renewed waiting time for a specific e-ticket.

5.4 Locally Stored Mobile Application

The Integrated System has a mobile Local Application through which users who have installed it in their mobile devices can request e-Tickets and be informed whenever they want about their renewed waiting time (Fig. 8). This application offers additional functionality, such as storing e-Tickets in the local database and managing them (new ticket insertion, ticket deletion).

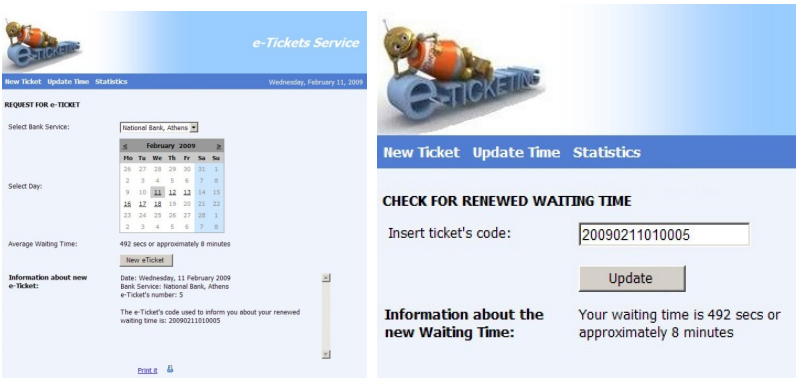

Fig. 7. Snapshots of the Website (a) right after the creation of the e-Ticket and (b) after user's request for the renewed waiting time

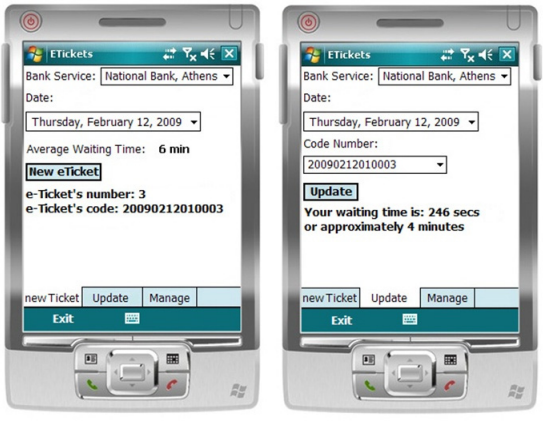

Fig. 8. Snapshots of the mobile Local Application (a) right after the creation of the e-Ticket and (b) after user's request for the renewed waiting time

The mobile Local Application is connected to the corresponding Web Service in order to receive the current waiting time for a specific Bank Service, to request and receive an e-Ticket, as well as to receive the renewed waiting time for a specific e-ticket. The services provided by the PDA Local Application are:

- Request for receiving the Current Waiting Time of a Bank Service
- Request for a New e-Ticket
- Request for receiving the Current Waiting time of an e-Ticket
- Management of the locally stored e-Tickets

5.5 SMS Server Application

The m-Services have SMS based tools. Any mobile phone can be used to receive this kind of service and the only thing the user has to be aware of is the available services and the telephone number providing these services. It is worth mentioning that unlike the alternatives, SMSs constitute a proof of the entitled service themselves. The users only have to bring their mobile phones along. The following table shortly presents the available services, with the parameters that they receive and a short description for each one of them.

For the service of a new ticket we use as parameter the bank name, for example tickets of the National Bank of Greece are offered (with coding ETE) or Agricultural Bank of Greece (with coding ATE) etc. The city name is used as a parameter as well, for example Patras (with coding PAT) or Athens (with coding ATH) etc., the address, for example Corinthu (with coding KOR) and finally the date. In the case of the city we consider the city of Patras to be the predefined one and in the case of the date, when one is not provided by the user we assume the current date is the desired one. The process of using the services and corresponding answers are presented in Fig. 9.

Table 1. Services offered through SMS

Service Code	*Service Name*	*Service Parameters*	*Details*
NEW	New Ticket	<Bank> <City> <Address><Date>	Returns a new Ticket Number, for a specific Bank Branch as well as a specific date
TIM	User's Waiting Time	<Ticket Code>	Returns the waiting time for the specified user, whose Ticket Code is provided as the service parameter in the SMS sent by the user.
TAV	Average Waiting Time of a Branch	<Bank> <City> <Address><Date>	Returns the Average Waiting Time for a specific Bank Branch, which is specified by the user.

6 Evaluation Process and Outcome

In this section we present the results of validation of the proposed system in a realistic scenario. For this purpose, we have used the services provided by the secretariat of the department of Computer Engineering and Informatics instead of a bank as presented above. The evaluation is small scale and includes two services; applying for a new certificate and applying for a grading sheet. The proposed approach can scale up to include all the available services of the secretariat either in a single queue, in case there is only one employee interacting with the students or more than one queues to support time-consuming procedures seperately from the others aiming at .

The overall satisfaction grade for the services (on a scale of 5 = very satisfied to 1 = very dissatisfied) ranged from 4.0 to 5.0, with an average value of 4.8 and provided some noteworthy results. The users evaluated the provided feedback for their waiting time to be very helpful. Many of them stated that the implemented integrated system effectively meets an important need of theirs and in less time than before. Within the campus, it is often usefull to be aware of the waiting time for different services in order to be able to schedule liabilities in a less tedious way. This is a feature that can be even more important in a greater extend, e.g. in a city center. Moreover, a notable proportion of the participants mentioned that it is importanted to have different means of access to the system available, in order to spend affordable amounts of money by allowing utilization of technology any user can have access to.

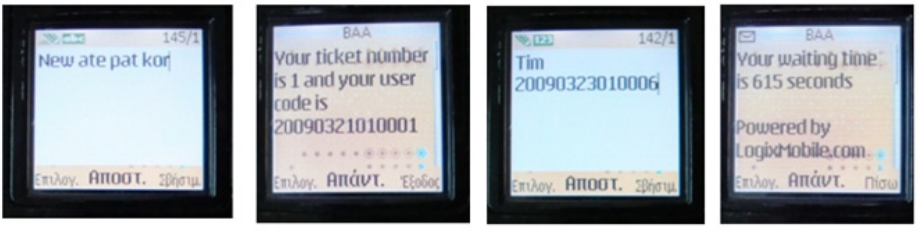

Fig. 9. Snapshot of the SMS services

7 Conclusions and Future Work

In conclusion, the objective of the proposed work constitutes the study, planning and implementation of techniques and algorithms for more efficient management of applications and services of electronic government with use of techniques for network-oriented information systems and mobile phones in particular. We have proposed an integrated queue management with live feedback directly to the citizens mobile phone or web access device. Businesses could benefit further from the proposed approach while using it for implicit developing a customer database and or combining it with loyalty card system besides customer satisfaction. The presented prototype serves as a proof of concept that the approach is feasible and efficient. The key feature of the solution is that it is designed to take advantage of all different mobile phones already existing and maximize the effects of their wide penetration. The abstract design of the approach allows its use in a wide variety of e-gov and e-services applications.

Future steps include enhancing the alert mechanisms using Multimedia Message Systems (MMS) in order to be able to give voice updates which would be especially usefull for visually impaired and elderly users. Moreover non-GSM based solutions are also interesting such as local bluetooth transmission, though there is an extra research issue as bluetooth applications have not received wide acceptance by the public. Interesting is the case of multiple queue management and workflow optimization using the mobiles in order to generalize the case presented in [2].

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