AN ENHANCED SERVICE PROVIDER COMMUNICATION INTERFACE WITH CLIENT PRIORITIZATION

Case Study on Fast-food Chain Restaurants

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Abstract: With the increased dynamics of modern life, the efficiency and reliability of everyday services is emerging to be a fundamental concern. On the other hand, modern telecommunication technologies, like wireless Internet access, are penetrating all segments of our life. However, many every day activities and services still do not fully exploit new technologies. We propose an approach that enables increased deployment of E-commerce concepts in the fields where their usage was either small or negligible. Moreover, in the scope of the same concept, we introduce prioritization of clients in services where it was not commonly present to date.

A solution for enhanced communication interface between service provider and customers is developed. As a case study, the system is designed and optimized for an implementation in a fast-food chain. The proposed solution is aiming at increasing of quality of service for customers, and at the same time increasing the operational efficiency of the provider. The main idea behind this approach is to enable customers to use their mobile devices, such as cell phones or PDAs, for browsing offered services or goods, viewing current service conditions and placing orders. We will detail theoretical concepts underneath and describe the implementation on both server and client side.

1 INTRODUCTION

Millions of people daily face different kinds of problems in common situations. These issues range from unpredictable traffic and parking problems to big waiting times in restaurants due to inefficient order/payment service. The rapidly growing urban population additionally increases pressure on service providers. We look for a response for these problems by incorporating e-Commerce concepts into service provider - client chain.

The basic idea of service order/payment process automation relies on the rapid increase of number of portable devices that are able to access Internet, and on the growth of the popularity of e-payment methods. It is estimated that in the next two years all manufactured cell-phones will be equipped with WiFi modules which will boost the availability of Internet services. Other broadband wireless services like UMTS and WiMax are becoming more widely available and affordable and the number of mobile users that will use these services will increase. Moreover, the number of online payments is constantly increasing and this way of payments is expected to be widely accepted in very near future. Putting all together, integration of all aforementioned services is logical consequence of technology development and of the evolution of users' habits.

In this paper we detail, based on case study on fast food chain, a possible solution for incorporation and automation of the service scanning, ordering, payment and execution that increases efficiency, cutting the costs and bringing many other benefits for all sides involved in the process. Our aims are the improving of existing Quality of Services (QoS) in fast food restaurants, and at the same

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time providing greater flexibility for both the service provider and consumers. We propose a fully integrated system that incorporates many different technological aspects, ranging from Internet browsing and e-payments to service performance evaluation and workflow scheduling. The final result is a novel communication interface that brings many new features and benefits to the client, like better service overview, waiting time prediction (service availability overview), prioritizing of clients, multilingual support, etc. On the other side, it cuts costs for service providers in terms of staff reducing, better insight in demand and market overview coupled with market profiling and targeted marketing. For now no experimental results are provided.

The paper is organized as follows: In Section 2 we summarize current state of technology and different types of its usage that are in scope of interest of this work, in Section 3 we present an overview of the overall architecture of the system. Algorithms and techniques used in realization of proposed concepts are detailed in Section 4. Finally, Section 5 presents conclusions and future work.

2 STATE OF THE ART

In parallel to development of communication technologies many different service providers have been adopting them to facilitate the interaction with clients, to provide new services or increase operational efficiency. On the other side mobile technologies such as WiFi, UMTS or WiMax as well as web access standards and protocols are more and more oriented toward better support for increased need for mobile Internet availability. In that sense many mobile web standards such as Wireless Markup Language (WML), Extended Modeling Language (XML) or XHTML etc. have been developed. Moreover, the development of AJAX (AJAX, 2008) has enabled exchange of small amounts of data between client and server, hence increasing the interactivity, speed and usability without the need to reload the entire contents of web page. This is especially valuable when devices have scarce computational and communication capabilities. By having more and more mobile devices online many new concepts got enabled. This especially concerns social networking (Eagle and Pentland, 2005), mobile commerce (Varshney et al., 2000) or intelligent wireless web (Alesso and Smith, 2001).

The most recent world-wide trend regarding wireless Internet access is deploying of WiFi Internet access at variety of locations such as airports, hotels, restaurants and so on (Friedman and Parkes, 2003); in some cases even free of charge (Smithers, 2007). At the same time online payment methods are getting widespread across wide range of activities (Weiner, 2000),(Ghosh and Li, 2007). Coffees and restaurants have made steps towards exploitation of WiFi at local service points (Friedman and Parkes, 2003) and some fast-food chains started using touch-screens deployed at tables (eTable) for offer browsing and order placing (VanLeeuwen, 2005).

We propose a novel solution for prioritization of clients using and enhancing different experiences and implementing them in fields where until now these technologies have not been commonly used. In order to provide better quality of service we model prioritized orders execution and service provider capacity with a well know operating systems task scheduling. The theoretical concepts adopted for purposes of our work will be discussed in detail in Section 4.

3 SYSTEM OVERVIEW AND IMPLEMENTATION CONCERNS

We envision a system that integrates WLAN access, priority order scheduling based on demand prediction and delivery automation that provides user-friendly interface to the client. For the purpose of the client-server communication we propose WiFi wireless Internet access technology since it is widely used and already deployed at many fast food points around the world. WiFI access represent an optimal compromise between simplicity and efficiency. The coverage, throughput and level of security are considerably greater than in the case of Bluetooth. On the other side it is very easy to deploy and cheap to use (from clients' point of view it is free) in comparison to other broadband services as UMTS and WiMax. The range of the WiFi AP also makes it perfectly suitable for use in a local service point (a restaurant in this case). Nevertheless, the system is conceived in such way that it can be easily ported to other communication mediums. By using secure communication and already established methods of electronic payment, we will also provide high level of security that is necessary.

Figure 1 shows the overall organization of the system. The main components are servers in service points, central data warehouse and a connection to e-payment servers. The local servers are responsible for processing clients' orders and updating central data warehouse. Payments are performed using secure connection to e-payment servers or by using in-house e-payment system. In the following subsec-

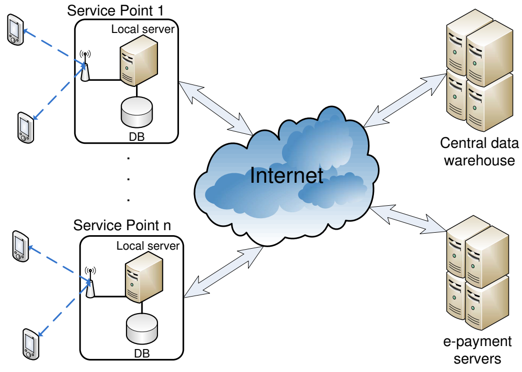

Figure 1: Proposed implementation of the system.

tions and we will also discuss the system from the participants' point of view (both clients' and service providers'), we will discuss the technology involved together with different implementation aspects.

3.1 Client's View of the System

Client devices are PDAs or smart phones that are capable of running a web browser. User interface is implemented in HTML, and it is accessible from each web browser, so there is no need to install a special purpose application. Figure 2 shows the UML sequence diagram of the users' interaction with the system. At the beginning, the client chooses appropriate WiFi Access Point (AP) that will consent him to access the services provided in the restaurant. Upon the entry to the network, clients are redirected to the start page from where they can browse the available services and current conditions of the system. There is a possibility to supply the client with additional information that traditional ordering methods cannot support (i.e. expected waiting time, multilingual interface etc.). The calculated expected waiting time coupled with delivery automation brings a possibility of introducing **prioritization** in the fast food service. For more details see Section 4.

From the start page clients will continue to the menu with products that are available in the restaurant. Trough simple web forms clients can make a choice, and communicate the selection to the server in the service point when the order is completed. The system sends back the information about the order and order number. The payment can be done through SSL secured connection using credit-card payment, pay-pal and other methods of e-payment. In this case, a request for payment is communicated to the payment gateway (paypal server or bank server in case of credit card payment) that processes it and gives the confirmation. Another option is to use vendor provided vouchers that can be issued in the form of fidelity card, and can be used exclusively for payments inside the system, and they function in form of deposit or credit.

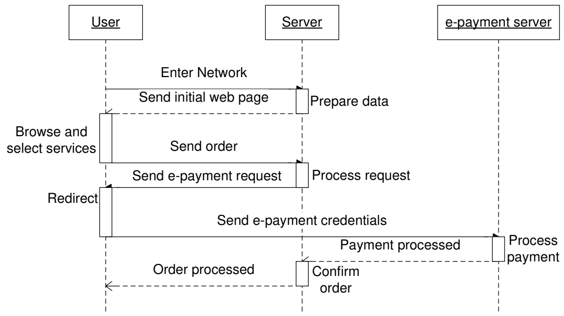

Figure 2: Interaction between the client and the system.

Once the payment is completed and the delivery is ready, it is placed in a delivery slot and the client receives a code associated with the order. The client types the code using keyboard on the delivery slot that is labeled with appropriate order number or with clients name. These slots can be implemented as parts of rotating table, where each slot has a protective cover. Once the correct code is inserted, the service is considered to be completed. The time between order placement and code insertion is considered as 'service time'. This information is taken and used as correction factor for statistical processing and for calculation of the expected time of servicing.

3.2 Service Provider's View of the System

The system in a service point processes e-Commerce orders in parallel with traditional ones (Figure 3). Requests from both sides go to the same server and their execution is scheduled in order of submission. The local server that processes orders is responsible for handling client requests and for scheduling the delivery of orders. Scheduling and delivery are performed taking into account also the priority of the clients. The algorithm for calculating waiting times is applied each time a new client enters the restaurant and this information is communicated to the client.

The technology used in the service point is rather simple and cheap, and it involves a server computer, wireless AP and Internet connection that will be used for communication with the central server. The algorithms that are used are described in subsequent sections.

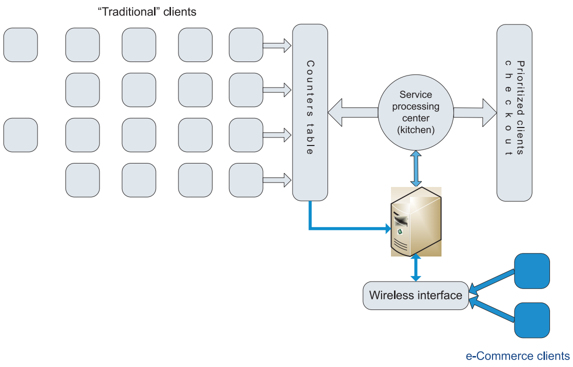

Figure 3: Overview of the service points' organization.

4 SERVICE DEMAND AND SERVICE TIME PREDICTION MODEL

In this section we present mathematical concepts proposed for calculation of expected average service time considering prioritized clients. The main contribution reflects in the exploration of scheduling mechanisms in order to meet the deadlines - guarantee service. We briefly expose possible service classification concepts and compare them. The chosen concept is described in detail.

4.1 Definition of the Server and Client

We consider the server - service execution unit that takes the order, executes it and performs the delivery of the requested service or product. The server is characterized as multiple parallel process execution unit with a given total capacity - service power. The clients could be clasified in three groups with two levels of priority:

1. Traditional clients served at the service line in a traditional way (worker at the counter table is serving one client after another from the FIFO - first in, first out, queue), taking low priority (priority equal 0).
2. Regular e-Commerce clients, performing orders through wireless system, taking low priority.
3. Prioritized e-Commerce clients, performing priority service orders through wireless system, taking high priority (priority equal 1).

Initially a certain server capacity is given to the prioritized clients. This capacity is dynamically adjusted during service execution in order to guarantee projected waiting time for prioritized clients and therefore quality of service (QoS). We have adopted following naming convention to describe different issues related to times spent in different phases of the order processing process:

- Queuing time - time spent in the line/queue while waiting for the order placing.
- Service execution time - time required to execute the requested service by the server.
- Service waiting time - the time that passes from the moment of performing the order to the moment in which the order is completed.
- Total service time - the time from the moment the client has entered service point to the moment when the required services are obtained.

4.2 Classification of Services by Processing Power Requirements

Almost all orders differ from each other in type of services requested, its quantity and quality which results in different service processing power requirements. Any order can be further decomposed in set of 'atomic services'. We assume 'atomic service' to be the simplest possible single order (i.e. an ice cream or coffee). In that sense every order can be seen as a composition of various 'atomic orders'. The most precise way of modeling the orders would be representing them in form of number of atomic services requests. Unfortunately this method would introduce huge computational overhead and the entire system would be very complex to implement. For the sake of the simplicity and better efficiency but without losing generality we classify orders according to number of atomic services requested into five classes ranging from small to huge ones. Each of those order types are assigned certain evaluated average service time. This evaluation is constantly updated by newly obtained data from the system.

4.3 Service Time Prediction Model and Scheduling for a Guaranteed Execution

Here we describe empirical model for run-time calculation of service expected time. This time is provided to clients as additional information and this property of the system is one more original feature that enhances existing services. The service time is modeled as a statistical variable with two components:

1. Non-stochastic component measuring the necessary service time for non-prioritized and prioritized services with a given scheduling scheme.

2. Stochastic component that incorporates the additional service time related to the average number of prioritized clients that are arriving during the time slot defined with non-stochastic component. The additional service time is added into the scheduling scheme as a prioritized process and a total service time is acquired after the probe scheduling execution. This component is acquired by processing empirical data related to number of prioritized clients and their orders that are dynamically updated every day. During the phase of initial system deployment these data are unavailable and therefore a worst case estimation is taken instead of statistical component.

The order execution inside the server is scheduled according to non-preemptive task execution scheduling. We consider this scheme to be the most suitable in case of fast food restaurants as preemptive service would cause disorder in execution of currently executed services and also would require different working concept inside the server (i.e. specialization to atomic tasks execution and work division that could support this would result in inefficient use of working power).

In case that prioritized tasks are not schedulable within dedicated server capacity for prioritized tasks, the amount of dedicated server capacity is increased to the minimal value that guarantees schedulability of prioritized tasks. This has a consequence of increase in waiting time for non-prioritized clients. However, QoS for prioritized clients is guaranteed.

Any practical scheduling algorithm in multiprocessing server systems presents a trade-off between performance and computational complexity. However, in our case scheduling computation time is not an issue (because it can be in the range of seconds) and we can explore the more complex scheduling schemes. Scheduling could be regarded as soft real-time or even non real-time problem. The Earliest Deadline First (EDF) algorithm is the most widely studied scheduling algorithm for real-time systems (Balarin et al., 1998).

EDF is more efficient than many other scheduling algorithms, including the static Rate-Monotonic scheduling algorithm. However, when the processing server is overloaded (i.e., the combined requirements of pending tasks exceed the capabilities of the system) EDF performs poorly. Researchers have proposed several adaptive techniques for handling heavily loaded situations, but they require the detection of the overload condition. Least Laxity First (LLF) algorithm (Ramamritham and Stankovic, 1994) is non-preemptive and selects the task that has the lowest laxity (the maximum time that a task can wait before being executed; laxity = total service time - service execution time) among all the ready ones whenever a processing server becomes idle, and executes it to completion.

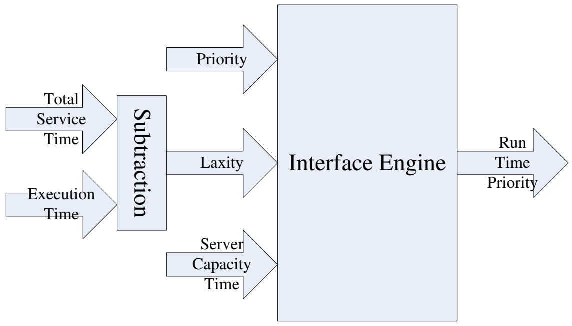

Figure 4: Inference model

Lee et al. (Lee et al., 1994) presents a fuzzy scheduling algorithm. Their proposed algorithm uses task laxity and task criticality as system parameters and doesn't consider fairness. Their simulation model contains small number of tasks on a uni-processing unit system and they did not consider system overloads.

Chen et al. (Chen et al., 2005) proposed a scheduling model and a related algorithm that is suitable for both uni-processing and multiprocessing servers. They provide a method to detect work overloading and try to balance load with task dispatching. We propose to use model presented in (Hamzeh et al., 2007) using a fuzzy interface engine. The model we propose has a slight modification considering that there are only two levels of priority defined as ”high” and ”low”. As shown in Figure 4, the major factors considered in used approach to determine the scheduling are task priority, total service time, service execution time, and used server capacity time. The notion of laxity is used in the proposed approach to facilitate the computation.

In proposed algorithm as shown in Figure 5, a newly arrived task will be added to the input queue. This queue contains the remaining tasks from last cycle that has not yet been assigned.

Fuzzy scheduler processes each task separately, computes its run-time priority and sends it to task dispatcher's priority queue. In a multiprocessing system, this queue offers tasks to dispatcher by their run-time priority order (as shown in Figure 6). Dispatcher offers a new task whenever one of the processing units of the system finishes its current task.

1. For each task in input queue
   (a) Feeds task's run-time priority using fuzzy inference engine
2. While a server has a free processing unit
   (a) assign the task with highest run-time priority to the processing unit
3. Loop forever
   (a) If a processing unit event occurs endenumerate
      i. Go to 2
   (b) If scheduling event occurs
      i. Update tasks parameters
      ii. Go to 1

Figure 5: Proposed algorithm

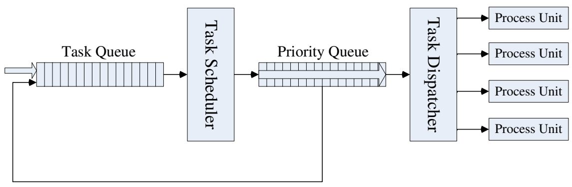

Figure 6: System view of real-time fuzzy scheduler

5 CONCLUSIONS AND FUTURE WORK

In this work we have proposed a solution for deployment of e-Commerce concept in the fast food restaurant chain that brings more convenience for both service provider and clients. The novelty of the work lays in possible implementation of client prioritization based on a well-known computer science concept of operating system task scheduling, that will perform the best under the assumption that we have enough information considering stochastic component of service time. For such a credible statistics we need to have the insight of a system in a long run. The proposed system brings numerous benefits to both parties involved in the service process.

The system will boost the efficiency of the service by eliminating ordering waiting time and will cut costs by decreasing staff needed for order acceptance and delivery performing. It will also increase the visibility (if coupled with Internet - browsing and positioning) of the services, and enables better demand insight that brings more flexibility. Moreover, it will enable market profiling and targeted profiling, and gives the possibility to offer more e-services according to clients' need.

There are many benefits for the clients also. They will achieve precise insight in offer and service condition, the queuing time will be eliminated and they will have the possibility to get delivery in short time as prioritized users. They will also have more payment options, and multilingual interface.

Our future work will focus on collecting and thoroughly analyzing statistical data. In the early phase of system deployment, realistic assumptions for worst case scenario needs to be made. Also, tuning of scheduling algorithm needs to be performed with a detailed testing with realistic data versus other scheduling schemes.

REFERENCES

AJAX, A. (2008). http://www.asp.net/ajax/.

Alesso, P. and Smith, C. (2001). *The intelligent wireless Web*. Addison-Wesley Prof., London, 2nd edition.

Balarin, F., Lavagno, L., Murthy, P., and Sangiovanni-vincentelli, A. (1998). Scheduling for embedded real-time systems. *IEEE Design and Test of Computers*, 15(1):71–82.

Chen, G., Chen, G., Ozturk, O., and Kandemir, M. (2005). An adaptive locality-conscious process scheduler for embedded systems. In *Proc. 11th IEEE Real-Time and Embedded Technology and Applications Symposium*.

Eagle, N. and Pentland, A. (2005). Social serendipity: Mobilizing social software. *IEEE Pervasive Computing*, 4(2):28–34.

Friedman, E. and Parkes, D. (2003). Pricing wifi at starbucks – issues in online mechanism design. In *Proc. Fourth ACM Conf. on Elec. Commerce (EC'03)*.

Ghosh, S. and Li, X. (2007). Critical factors affecting the acceptance of e-payment services in emerging economies. In *Proc. Decision Sciences Institute Conference*.

Hamzeh, M., Fakhraie, S. M., , and Lucas, C. (2007). Soft real-time fuzzy task scheduling for multiprocessor systems. *International Journal of Intelligent Technology*, 2(4):211–216.

Lee, J., Tiao, A., and Yen, J. (1994). A fuzzy rule-based approach to real-time scheduling. In *Proc. 3rd IEEE Conf. Fuzzy Systems*.

Ramamritham, K. and Stankovic, J. (1994). Scheduling algorithms and operating systems support for real-time systems.

Smithers, R. (2007). Mcdonald's to offer free wi-fi in restaurants. *Guardian*.

VanLeeuwen, S. (2005). Taking food service into 21th century. In *eTable Inc.*

Varshney, U., Vetter, R. J., and Kalakota, R. (2000). Mobile commerce: A new frontier. *Computer*, 33(10):32–38.

Weiner, S. E. (2000). Electronic payments in the u.s. economy: An overview. *Computer*.