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The proposed planning method as a parallel element to a real service system for dynamic sharing of service lines

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ABSTRACT

This paper presents a solution to the bottleneck problem with dynamic sharing or leasing of service capacities. From this perspective the use of the proposed method as a parallel element in service capacities sharing is very important, because it enables minimization of the number of interfaces, and consequently of the number of leased lines, with a combination of two service systems with time-opposite peak loads. In this paper we present a new approach, methodology, models and algorithms which solve the problems of dynamic leasing and sharing of service capacities.

1. Introduction

This paper presents a new possible use of the developed method in the role of an element for dynamic sharing, leasing and releasing of server capacities. The idea stems from practical needs arising daily in various service systems. Such systems include highway toll-collection systems, banking service systems, border crossing systems, service systems in supermarkets, etc. The wide range of systems in which the new method can be used brings about a new dimension to the latter (aside the existent ones: planning, optimization, worst-case scenario, real system load, etc.). This new dimension is the inclusion of the method into a loop which is parallel to a real system, such as for example a mobile transactions service system. The problem of passability needs to be solved in such systems, and it can be solved in two ways: with dynamic leasing of service lines or with dynamic sharing of service lines among two or more service systems.

The parallel method functioning regime is supported both by simulation and emulation. This means that in simulation we recreate a synthetic transaction with the use of a real transaction type and transfer medium [1–3]. This way we recreate the events on a synthetic pattern while simultaneously recreating real events with emulation, on the basis of which decisions on leasing and releasing capacities are made. The expression "transaction" is here universal and includes data transactions, cash transactions etc. This means that transactions in different service systems have different durations, but they can be described with the same methodology. The duration of a general transaction in a general service system can be described with the use of probability theory and distribution functions, considering the "amount" of data, the interaction of integrated units, the bandwidth of the transfer medium, and connections between integrated units (in case of data transfers). It is also necessary to consider the quality of the transfer and repetitions influencing the final occupancy time of a line or a place in a general service system. This methodology can be by analogy applied to other service systems. This paper does not focus on planning [4,5] or optimization [6,7] of service capacities, but only on the aspect of dynamic (active) "in-time" leasing and sharing of service resources among systems with opposite peak loads. The aim of such leasing and sharing is to rationalize leasing costs for service lines and to minimize the costs of implementation and investments in hardware, considered from the financial perspective of modern companies.

The main objective of this study is to find a solution which additionally optimizes existent service systems and fulfils the criterion of rational use of leased service lines with the help of dynamic relocation or sharing among existent service systems with time-opposite peak loads. This process is discussed in seven sections.

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1.1. A short description of the paper structure

Section 2 is devoted to a detailed presentation of the structure of mobile transactions service systems and their elements supporting mobile payment transactions. We emphasize the segment of service capacities or service lines as this is the area where we introduce the developed method with an additionally implemented function of dynamic service capacities leasing. This part also presents the most important aspects, reasons and facts which justify research in this area. Section 3 provides some detailed mathematical definitions of used models and sub-models, which have not been explained in [4]. The prototype of the method and its use for the purposes of dynamic leasing or sharing of service capacities are presented in Section 4. Together with this description we also provide a detailed explanation of the concept of dynamic sharing, which is carried out with the developed tool including a modified method. In this section we also give an example of method validation, an example of validation of recreated synthetic patterns with real patterns, and system responses for both examples. We explain and argument practical experiments ("in-time" regime, predictive regime, results of the method reaction, etc.). Section 5 sums up the findings and conclusions in terms of the proposed general solution's potential usefulness. In Section 6 we shortly present the criteria with which we filter the systems for which the proposed method could be used (planning, optimization, capacity sharing, etc.). Section 7 provides the guidelines for future research and thus concludes the paper.

1.2. Authors' previous contributions to this research area

The fundamental part of the proposed planning method, which was upgraded with new functionalities at this stage, has already been presented in [4]. In that scientific paper we presented the basics of MIMO (Multiple Input, Multiple Output) service system model and the used algorithms. Research was continued with practical experiments with which we estimated service system occupancy with different load patterns, including worst case scenario. This research was published in [5], which also described the validation of model output on the basis of real system output. Because we have met with some limitations when executing these experiments (explained in [7]), we have decided to expand our research to different approaches which would help us avoid those limitations. These approaches were implemented and presented in [7], and are a crucial part of the basic method. This paper presents a further step in our research in this area, and puts the proposed solution into a new role (decision making). With the use of analogies our method has also been tested in other fields [6]. Our work is also further elaborated in the last section where guidelines for future research are given on the basis of existing work.

1.3. A short overview of existing solutions

A review of the scientific papers base shows that similar solutions already exist, but are quite specific and not universally applicable (our goal). The most interesting comparisons to our approach, method, methodology and developed simulator/emulator tool [4] are described in [8–23].

An analysis of the listed solutions shows their specificity, i.e. the solutions are intended for a specific problem or a specific segment. Searching for new solutions and approaches in this area has been a fruitful research niche in the last decade. For the purposes of active adaptation to the needs of clients, end-users and the market we have developed a method and a tool, which aside from the functions of planning, optimization and prediction also have an added function of dynamic sharing or leasing and releasing of service capacities among mobile payment service systems, which is our original contribution in the abovementioned area. This means that with parallel inclusion of the method into a real system we close the method into a loop, which is a novel approach. The method can be used with some of the above-mentioned state-of-the-art systems, because the developed method offers several other functionalities, which is not however true of the other direction. The multiple possible uses and the possibility of use with several other systems and areas (banking systems, highway systems, charging systems, waiting rooms, call centers etc.) were the main motives for our research.

2. A presentation of a mobile telephone transactions service system, the sets and the considered segment

Cashless payments with mobile phones became a new market trend in the past years, because of the wide circulation and multipurposeness of mobile phones. Different technologies of mobile payments have been developed. Margento [24] is one of these mobile payments systems. The system is based on data transfer between the payment terminal ((1) – Fig. 1) and the processing centre ((5) – Fig. 1) through a voice channel (audio modulated data signals) [1–3] in different types of networks, such as GSM, CDMA and UMTS. The processing centre has a limited number of inputs, determined by the number of leased phone lines through which data is transferred.

The user calls with his mobile phone[2] the Margento Telecommunication Access Point[4] through the mobile network centre[3]. MTAP responds with interactive voice response (IVR), which includes instructions for the user, or with data signals of the Margento processing centre, which the terminal[1] needs to start the transaction.

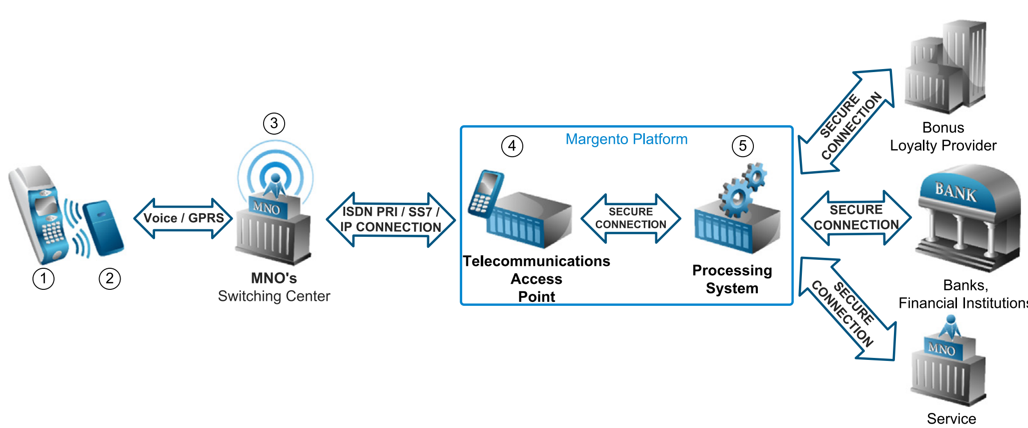

Fig. 1. A block diagram of the Margento transaction system elements.