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Simulation Modelling Application in Real-Time Service Systems: Review of the Literature

Lev Faingloz*, Juri Tolujew

Transport and Telecommunication Institute, 1 Lomonosov St., LV-1019 Riga, Latvia

Abstract

This paper presents the problem of using simulation modelling - both with a view of assessing the efficiency of online service systems control and improving such efficiency by applying simulation models within the framework of the corresponding control algorithms. In the first case, the model is used in emulation mode when it is used as a tool for creating various situations in servicing environment which interacts with the already used algorithms of dispatching and control. In the second case, the model is used in the real-time mode when it is used as a tool for checking candidate solutions to be taken in a specific on-the-spot situation. A review of literature is presented showing the experience of using simulation models both in emulation mode and in the mode of tracking real-time processes.

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Keywords: real-time service systems, real-time simulation, emulation

1. Introduction

Systems in which vehicles are involved for prompt staff delivery to stations, where arises a need in execution of corresponding works, are often referred to as real-time service systems. As an example of such systems, Rescue Service (telephone number 112) could me mentioned as well as systems for repair and maintenance of various types

* Corresponding author.
E-mail address: lev.faingloz@tsi.lv

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of engineering equipment: electrical power networks, gas circuits, water supply networks and elevator facilities. To provide real-time control of such systems, dedicated software products are developed, the efficiency of which is not subject to any rigorous test as a rule. Any company using such a software product remains satisfied with its properties if the product helps to develop at least some physically realizable call service schedules when handling incoming calls on a real-time basis.

There are, however, quite a lot of studies in which authors try both to verify and to improve efficiency of management processes in the systems of real-time servicing. The most successful surveys in this area are related to the development and application of simulation models, and herewith are allocated two methods to work with the models. The first method is called an emulation mode, in which the model simulates behaviour of service environment, from which it receives service requests. These requests are processed through dispatch and management algorithms used in an actual operational service system. In this case, the model serves as a substitute for the real world and is used for testing and debugging the corresponding dispatch and management algorithms. The second method is based on work with the model in a real-time mode when, by means of it, are checked variants of decisions, which are taken within the conditions of a specific operational situation. In this case, the model serves as a means of forecast of the development of the situation in the real-time service system for a short period of time, starting from the moment of taking a decision to implement specific actions.

The article provides an overview of the works related to the described above methods of application of the simulation models. The first part of the review reflects the fact that the largest experience of such a modelling, at present, has been accumulated in cooperation with such services as emergency, and with other types of medical care. The second part of the review reports on the experience of work with simulation models in a real-time mode, in cases when such models are used to solve tasks of short-term scheduling and operational management in industrial, transport and logistic systems.

2. Literature review

Marmor *et al.* (2009) believe that emergency departments (ED) require of availability of advanced support systems to monitor and manage their processes: clinical, operating and financial ones. A necessary condition for creation of such a system is an availability of comprehensive and exhaustive operational information (for example, the waiting time in the queue, resource loading, etc.). Marmor *et al.* (2009) propose to use simulation in a real time mode to support decision-making in the EDs. The authors suggest the use of a two-stage procedure. At the first stage, ED manager assesses the current state of the ED, basing on historical data and the simulation. At the second stage, on the basis of information of the current state, the simulation helps the manager to make decisions, forecasting future scenarios of development of a situation in the ED.

Espinoza *et al.* (2014) describe the use of the simulation for perfecting the operational activities of the emergency room. The described simulation model should adequately reflect the current state of the system in spite of periodically occurring unplanned events. In the course of medical care provided to a patient, workflow management system (WfMS) collects patient's data at various stages of treatment. However, this system does not take into account activities of staff, which is not directly related to patient care. In addition WfMS collects data on the duration of service time, but does not consider waiting time and transition time of a patient. Thus, the available information, which characterizes the flow of patients passing through the emergency room, is incomplete. This circumstance should be considered when scheduling data input into the real time simulation system. Espinoza *et al.* (2014) note that in order to provide an adequate initialization of the model, they have used two types of the input data. Firstly, the information has been used, obtained in the real-time mode, prior to the event which triggered the need for making a decision. Secondly, retrospective (accumulated) data have been used, basing on which, are predicted possible future states of the system. Further on, corrective actions are simulated, which are necessary at the time of the occurrence of the unanticipated event, and their efficiency is evaluated. Since there has been used incomplete information in the considered model, the missing piece of information is generated at random and is subsequently combined with the data obtained in the real-time mode. Espinoza *et al.* (2014) called it “mixed” input simulation, the main purpose of which was an exact reproduction of the current system state.