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Performability evaluation of emergency call center

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HIGHLIGHTS

- We evaluated the availability and performance of an important call center in Brazil.
- Our work uses heterogeneous and hierarchical modeling strategies (RBD and SPN).
- We show the system cost and proposed a new architecture to improve the availability.
- This work comprises an analysis of the impact of downtime in performance.
- The total number of missed valid calls was analyzed in relation to the discards.

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ABSTRACT

Emergency call centers serve people in utmost circumstances; hence they should be highly dependable. Availability and performance are key aspects in call centers. Architectural models, service policies, and redundancies are attributes for defining and evaluating the overall operation of such systems. In this work, we performed the performability evaluation of an important emergency call center located in a large city in Brazil. The results showed that the system's downtime is considered high, so, we proposed a new architecture to improve the system's performability. The results obtained in this paper can be used to provide support for decisions on interventions in the emergency call center to improve its performability. It is expected that the models presented in this paper will be useful in a variety of emergency call centers.

1. Introduction

Emergency call centers usually serve a town, country, state or other political entity. The provided services are offered to people in order to help them in critical situations. For example, by calling these call centers, a person can have access to fire department, civil and military police services from any telephone. A downtime or outage duration of these emergency call centers refers to a period of time when these services fail to provide their primary function. So, it is necessary to evaluate this time based on the available resources of each system. The performability evaluation of such systems is the key activity in the system capacity planning which combines the results of the availability and performance evaluation. A well-designed system will further reduce the effects of an outage as it allows planners to define where the investments should be applied.

The northeast region of Brazil is full of industries that have attracted many professionals and also important events, such as hosting the FIFA World Cup 2014. The increase in the estimated flow of people over the years requires carefully planned

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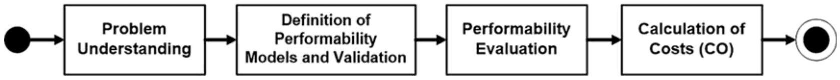

Fig. 1. Flow for performability evaluation.

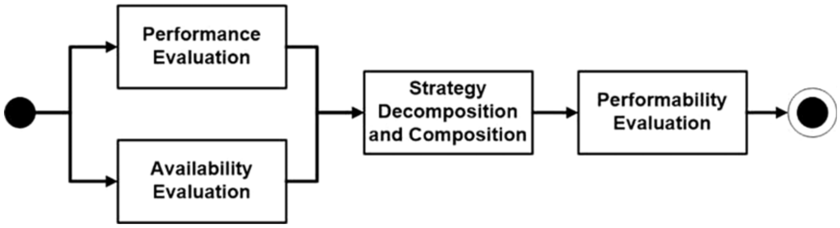

Fig. 2. Flow for decomposition and composition.

expansions and adjustments to the local emergency call systems in order to handle the expected demand and increase the levels of performability required.

This work presents a hierarchical heterogeneous performability model for emergency call centers, analyzes the impact of lost calls related to downtime and discards and performs an evaluation of the architecture cost. We followed four steps to perform the performability and cost analysis of emergency call center infrastructures. Besides, we propose a modeling approach that can be used for evaluating a variety of emergency call centers.

The paper is organized as follows. Section 2 describes the material and methods used to evaluate the performability of the call center. Section 3 presents the basics concepts and terminology. Section 4 shows the structure of the emergency call center system. Section 5 presents the proposed availability and performance models. Section 6 shows the results. Section 7 presents a discussion of the obtained results. Section 8 includes some concluding remarks and future works.

2. Material and methods

The methodology used for assessing the performability and infrastructure costs of the emergency call center consists of four steps and its activity diagram is shown in Fig. 1. The first step concerns the understanding of the system, through its components, interfaces and interactions. The second step was aimed at defining the performability models (RBD and SPN) with the support of tools. Once models have been created, the performability evaluation was conducted (third step) and costs were calculated (step four).

The performability evaluation step (step three), shown in Fig. 1, used a strategy of decomposition and composition, which aimed at reducing the complexity of the evaluation process. This strategy is composed of a hierarchical decomposition technique that divides the performability model in two different models [1].

The strategy combined an availability model, which considers fault events and repair processes in the system, and a set of performance models [2,3]. Therefore, the performability evaluation was carried out through the composition of the results of the metrics defined for the assessment of availability and performance. Fig. 2 presents the flow for the decomposition and composition. It is noteworthy that the proposed modeling approach can also be used to evaluate a variety of emergency centers.

3. Basic concepts and terminology

In this section we explain the basic concepts and terminology used in this work.

3.1. Dependability

Dependability is a generic concept which includes availability, reliability, security, integrity and maintenance [4,5]. The steady state availability of a system is defined as the fraction of the time when the system is available to serve users requests. The time when the system is not available is called downtime; the time in which the system is available is called uptime [6]. The availability of the system may be obtained by the *Mean Time To Failure* (MTTF) and *Mean Time To Repair* (MTTR).

Reliability is the system's ability to perform the functions for which it was designed in a satisfactory way for a certain period of time under operating conditions. Through transient analysis or simulation, the reliability is obtained, and, then, the MTTF can be calculated [7].

The Reliability Importance (RI), or Birnbaum importance [7], is a measurement used to evaluate, as its name suggests, the importance of the component to reliability, allowing the establishment of comparisons between the roles of each of them in the system and to determine which components should be redesigned in order to improve the system reliability.