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Information Support to Provision Efficiency of the System with the Multi-functioning

Vladimir Gvozdev
Ufa State Aviation Technical University
Ufa, Russia
wega55@mail.ru

Robert Galimov
Public corporation "BETO"
Ufa, Russia
rrgalimov@gmail.com

Aliya Davlieva
Ufa State Aviation Technical University
Ufa, Russia
aliyasr21@gmail.com

***Abstract*—In this paper, an approach to building a system is proposed, the basis of which target efficiency management is use of people's psychological characteristics, and not hardware redundancy. The special case is considered on the example of the telephone conversations registration, where, as a solution to the problem of loss efficiency, this is ensured by a time limit for conducting negotiations. The paper considers cases when the system has 16, 32 or 48 channels. An example is given under what conditions it is necessary to limit the duration of telephone conversations. The case of using a proactive approach as a prediction for estimating a range of requests is described, which will allow solving the problem of managing the flow of requests. The novelty of the proposed approach to improving the efficiency of systems, in contrast to the classical approaches, consists in taking into account the psychological characteristics of people interacting with the technical system.**

Keywords—target efficiency, hardware and software complex, system survivability

I. INTRODUCTION

A feature of modern complex technical systems is that they are characterized by an infinitely large number of internal states. This is due to the infinitely large number of possible combinations of input data and other external influences. This proves the feasibility of approaches to the study of survivability by analyzing the behavior of systems external systems [1-5].

Target efficiency characterizes the degree of compliance of the system functioning with its intended purpose from the user's point [6]. Target efficiency can be used as a metric characteristic of the systems properties compliance with multi-functioning to what is called Voice of Customer (VoC). Given backbone role of software and hardware in the complex systems management of different nature, it can be argued that survivability is one of the key factors for managing target efficiency [7-13, etc.].

The decrease in the target efficiency is a characteristic of the deviation of the actual state of the system from the baseline, in other words it serves as an indirect characteristic of functional vulnerability. The random nature of the state of complex technical systems makes it possible to study target efficiency using mathematical statistics [14-15].

We propose a new approach to ensuring target efficiency in the context of the fact that there are limitations on the technical system, expressed on the management of the structure and characteristics of the system. The paper proposes a new concept of managing target efficiency by taking into account people's psyche.

An example of the proposed approach is the realization of "Law Yarovoi". In view of entry the "Law Yarovoi", the purpose of which is to prevent terrorist acts, as one of the mechanisms is to record all telephone conversations, increases the need for effective functioning of the telephone exchanges, carry out not only the possibility of subscribers, but also a record of all conversations, as well as their storage. The loss efficiency of such a system, either due to overloaded telephone stations, or due to failures of telephone exchanges components can lead to the loss of important data.

The external behavior of a system with multi-functioning operation depends on its internal structure. An example of such systems is a telephone station. The recording of conversations is carried out by means of a hardware-software complex (HSC) designed to record all incoming and outgoing conversations, their conversion and transmission to the server. The operation of the station can be determined in several modes: 1 mode – normal operation when all components are in good condition (no stations are overloaded); 2 mode – overloaded telephone station; 3 mode – failure one of the two processor nodes; 4 – failure of both nodes. When selecting modes, we proceed from the countering possibility the causes of abnormal operation by controlling the properties of the requests flow.

One of the telephone station model is a model built on the apparatus of queuing systems. If one postulates the position that the flow of applications is a Markov process, in compliance with the above condition can be identified (or modes) of the system. For example, the state S_1 – is the state of normal functioning of the system, S_2 – is the state in which some element has failed in the system, S_3 – is the synchronous failure of two parts of the system, S_4 – is the power supply failure in which the HSC fails.

II. CONCEPTUAL BASE OF THE PROPOSED APPROACH

In today's complex technical systems, the software component is an integral part [16], however, for many reasons, for example, restrictions on weight, dimensions, established design approaches, it is impossible to avoid the decrease in efficiency due to the addition of hardware components [17-20].

Loss of effectiveness is expressed in the number of lost conversations. In order to ensure the normal functioning of the system, there are two ways of countering the decrease in efficiency, either through redundancy of the system's hardware or through control of external flows. Restrictions on the possibility of using hardware redundancy are limitations on the dimensions of the recording device blocks.

In this case, the control target efficiency by changing the hardware component objective limitation is imposed. Therefore, a new paradigm is proposed to control the target efficiency of complex technical systems with restrictions on the management of the structure and parameters of the states of technical components, specifically, subject of accounting, which interacts in the system, in other words, to put the subject in such conditions, to act so that the system under the constraints in which it has functioned most effectively. Thereby forcing the subject to interact in such a way as it is beneficial from the view point of the current system state.

From psychology theory [21-24] noted that the limited duration of the conversation affects the essence of the conversation, thus subscribers as soon as possible inform each other. The situation stems from the fact that subscribers are interested in the transfer of information. The limit on the duration of the conversation in this case will only speed up the subscribers to notify each other. Thus, the proportion of perfect conversations will be greater. The restriction in the proposed approach is that the talk time on weekdays, excluding holidays, is considered, since the flow rate of requests on such days increases abruptly.

The management of external flows is based on the fact that at a certain point in time it is possible to limit the duration of calls by notifying the subscribers after how long the connection will be interrupted. Due to this, the number of available channels will correspond to the number of applications, thus the system will ensure targeted efficiency.

The proactive approach aims to identify and eliminate weaknesses in design solutions corresponding to different stages of the life cycle of the HSC. Examples of the implementation of the proactive approach at the detailed design stage are SFMEA [25], SFTA [26]. Examples of the implementation of the proactive approach at the pre-project stage are the methods developed in the framework of convergent management and evergetics [27].

As a proactive approach part to managing the conversations recording, a prediction of the possible number of applications is assumed. On the basis of this forecast and the current state of the internal structure of the system, it is proposed to limit in advance the duration of calls to subscribers. Looking at the dynamics of calls, it is possible to predict at the time Δt how many conversations are expected. The choice Δt is a separate issue and is not considered in this article. But this value is not fixed, but depends on the flow characteristics.

This approach involves the implementation of situational management [28]. It is possible to solve a situational problem, namely: pre-registered, in which modes can be the system as working channels it is based on the transformation to reduce the problem to a situational decision.

III. Analysis Research state

Today, there are quite a lot of work to analyze the survivability of technical systems, for example, [29-33]. In the framework of these works, the survivability of the view point of changes in the internal state of systems due to external influences, or changes in the properties of the structure is mainly investigated. Target efficiency is considered as a sign of vulnerability, which is determined by minimizing the difference of incoming and share of served requests (1).

$$(1-\frac{k}{\tau \cdot N}) \to \min_{\tau} , \qquad (1)$$

where N – is the number of requests, τ – is the average service time for single request, k – is the number of channels available.

As part of this work, we propose an approach to managing the target efficiency of the telephone recording system.

IV. The Formal Statement of the Problem

The challenge is to minimize the number of lost negotiations. This is achieved due to the fact that restrictions are imposed on the duration of the negotiations of subscribers. Formally, this is expressed by the objective function (1).

The study of the compensating possibility for the efficiency loss in one of the system nodes at the expense of its other nodes is described in detail in [34-35]. The algorithm is described in detail in the work [36]. From the obtained results described it can be concluded that compensation for the loss of efficiency in the nodes of the structure is possible due to changes in the statistical characteristics at other nodes. When reducing the stability of the system by increasing the standard deviation, the maximum recovery is achieved by changing the characteristics of the other nodes in the 25-30%.

The initial data for the estimation problem, during which the limitation of the calls duration will be determined:

1) The minimum and maximum possible number of requests N per unit of time.

2) The number of system channels the can be k = 16; 32; 48.

Required: evaluate τ_{cr} for each k.

To solve this problem requires data range of equests $[N^D; N^U]$ in the interval Δt. This data can be obtained on the basis of archived data of telephone stations. The paper generated random numbers N in the range [100; 200]. To find the average service time of a single request, use the formula (2):

$$\tau = \frac{k}{N} . \qquad (2)$$

Next, we need to construct $f(\tau)$ distribution density for each k. The resulting graphs are shown in Fig. 1-3.

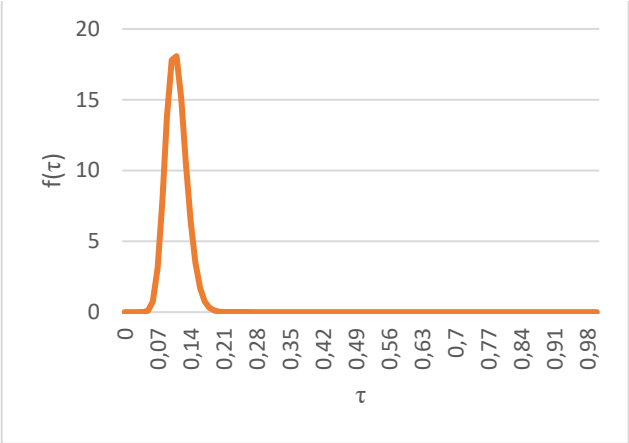

Fig. 1. Distribution density $f(\tau)$ with k = 16

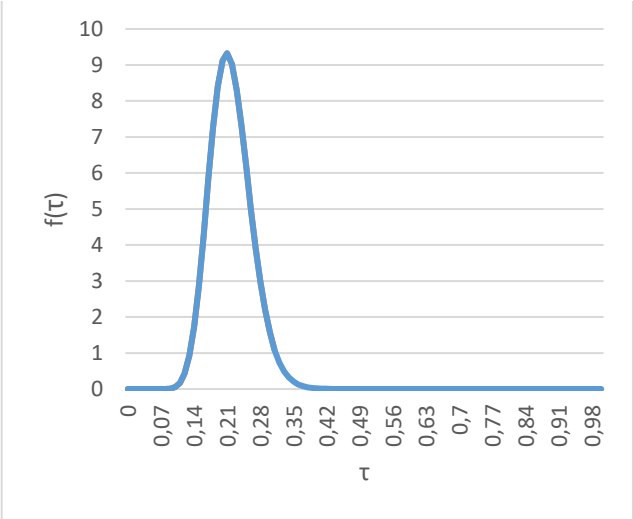

Fig. 2. Distribution density $f(\tau)$ with k = 32

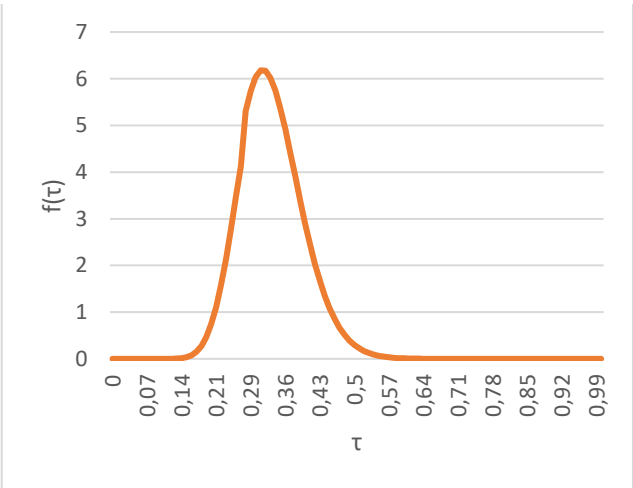

Fig. 3. Distribution density $f(\tau)$ with k = 48

Having $f(\tau)$ and specifying the level β we define τ_{cr}. The data obtained are shown in Table I. β is the maximum level at which the duration of current calls will be limited.

TABLE I. VALUES τ_{cr} AT DIFFERENT K

β / τ_{cr}	**90%**	**95%**	**99%**
with *k* = 16	0.168	0.171	0.194
with *k* = 32	0.315	0.336	0.368
with *k* = 48	0.476	0.495	0.558

Fig. 4 shows an example of the definition τ_{cr} for the case when the available channels in the system are k = 32 and β = 95%.

To solve the situational problem, it is assumed that possible combinations with the possible number of available channels can solve the problem of recognizing the situation model and determining the predict. That is, ready-made solutions can be selected from a table of values from memory, reducing to a situational solution.

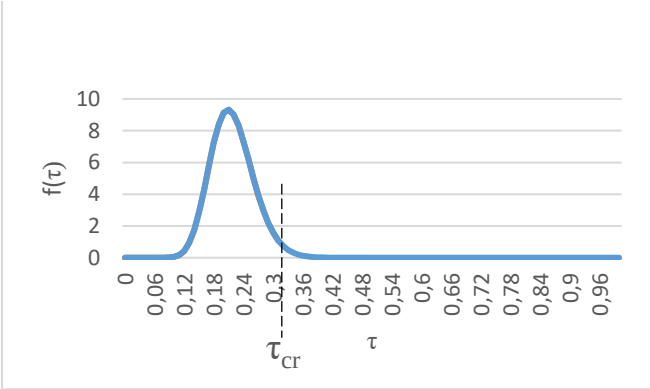

Fig. 4. τ_{cr} for the system with k = 32 and β = 95%.

Thus, knowing the reference range of values $[N_E^D; N_E^U]$ it is possible to determine the coefficient of proportionality α (3):

$$\alpha = \frac{N^U - N^D}{N_E^U - N_E^D}. \quad (3)$$

Formally, this task is reduced to the following definition of the operator A:

$$A: \{[N^D; N^U], \beta, k\} \rightarrow \tau_{cr}^E.$$

Based on the obtained, you can determine for the required situation by multiplying it by a coefficient of proportionality, or

$$\tau_{cr} = \tau_{cr}^E \cdot \alpha.$$

In general, methods for predicting series dynamics in literature [37,38] described a lot. The task of predicting the

number of requests in this paper is not considered, but the analysis can be based on the time series.

Fig.5 shows one of the options for predicting the estimation of the range of requests $[N^D; N^U]$ for a period of time.

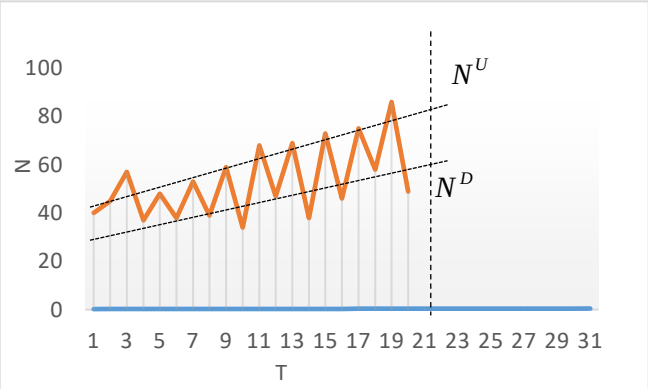

Fig. 5. Predicting the estimation of the range of requests $[N^D; N^U]$

Thus, estimating the possible number of requests will allow us to solve the problem of managing the flow of requests.

V. Conclusion

An approach to the construction of a registration system for negotiations is proposed, which differs from the known ones in that the basis for managing the target efficiency is not hardware redundancy, but the use of people's psychological characteristics, which is expressed in the fact that the time limit for negotiations is imposed.

The basis of the proposed approach was not only technical solutions, but also consideration of the subjective factor that ensures the normal functioning of the system by notifying subscribers about limiting the duration of conversations.

Today, more and more emphasize the consideration of the subjective component in the development of scenarios for managing complex technical systems. But given that now the artifacts are becoming an organic part of our life, it is difficult to draw the line between man and technology. The need for a subjective component is expressed in the fact that a theory of intersubjective control has been developed [39,40].

The novelty of our approach is that the management of technical systems is based on a new principle - based on the psychological characteristics of the subjects interacting with this system, while the classical approach to improving the efficiency of systems is based on managing the state of the components of a technical system or managing its structure.

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