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The Results of the Modified MVA Application

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***Abstract*—The article provides a brief description of the use of the modified method MVA and the results obtained with MVA**

***Keywords*—confidential storage of electronic documents; queuing network; MVA**

I. INTRODUCTION

A large amount of work with paper documents in any organization leads to a logical decision to undertake this work in electronic form. The technical capabilities of this are very extensive and varied. However, the full transition to electronic document is hardly possible, but even partial automation significantly reduces the time to perform administrative processes.

For the organization of electronic document management system (EDMS) is necessary to develop a range of technical tools and solutions, the key of which is the storage of electronic documents (SED). Currently, the storage of electronic documents (in some sources referred to as the electronic archive) is positioned as an independent component that can be a separate hardware-software complex, replacing a paper archive of documents, and the basis for the EDMS. Moreover, this approach allows you to build any system of electronic document from relatively independent modules, which significantly reduces the financial costs, increases flexibility and scalability of this technical solution. Thus, the SED, as the core of any electronic document management system, requires special attention in the creation and implementation.

During the SED designing it must take into account a number of requirements, the most important of which can be combined into two groups: functional (providing the possibility of entry of electronic documents (ED), storage organization, providing ED search capabilities, providing access to the ED with a view to read, modify, delete, retrieve) and regulations. Accounting for these requirements that can affect the performance and structure of the SED, mandatory for all storage of electronic documents, regardless of its destination.

Currently you must also take into account the legal and regulatory requirements in the field of information security of electronic documents that are placed in the repository. Some of these requirements are binding (in terms of storage of personal data, the use of digital signature technology, the protection of trade secrets), the other - a recommendation, but the construction of SED systems without taking into account these requirements significantly narrows the scope of its application. On the other hand, these requirements impose additional restrictions and changes in the structure and composition of functions carried out by SED. In this case we can speak about the confidential storage of electronic documents (CSED) - a system of short-term and long-term storage of electronic documents confidential, providing opportunities for the protection from unauthorized access, access control, to ensure the legal value of electronic documents.

II. RELEVANCE

The introduction of additional requirements in the field of information security, the need to implement labor-intensive cryptographic operations can have a decisive influence on the choice CSED structure and parameters of the technical means. At the same time taking into account the joint effect of various parameters of CSED is a rather serious problem for the designer. To solve this problem it is necessary to analyze the response of the system to changes in parameter values that can be caused by both external and internal factors. In addition, it is often necessary to choose reasonable values of a number of privacy settings ED storage component, with limited financial and time resources that do not allow experiments on the real system. This determines the relevance of this thesis.

The complex structure, multi-stage service, the random nature of the moment of receipt of user requests and the duration of their treatment in CSED predetermine the use of models of queuing networks for analysis and design. There are works devoted to the study of probability-time characteristics, the development of methods for assessing the efficiency of complex information systems, carried out abroad and in our country, including B. Stallings, L. Kleinrock, G.P. Basharin, B.J. Sovetova, J. A. Kogan, V.A. Zhozhzhikashvili, Kureichik V.M., V.M. Vishnevsky, V. S. Lukyanovym, I.V. Cherkovsky A.V. Skakunova, Seltzerom M., B. Lee, J.. Hilstonom, N. Thomas, T. Mosley, J. Zhao et al. At the same time, there are no analytical and simulation models, reflecting the peculiarities of the confidential storage of electronic documents and enabling them to carry out research and analysis.

III. FORMULATION OF THE PROBLEM

The main objective is the development and implementation of the algorithm for calculating the model of confidential storage of electronic documents submitted as a queuing network.

To achieve this goal the following tasks were solved [1], [2]:

- Analysis of functional and regulatory requirements for confidential storage of electronic documents.
- Formalization CSED model using the methodology of functional design IDEF0.
- Development CSED structure based on identified requirements, the definition of messaging options on its sites.
- Formalization of processes CSED functioning as queuing networks.

- Development of an analytical model of a confidential storage of electronic documents with the use of the theory of queuing networks and the study of the developed model.

This article shows the results of calculations of analytical models developed by the modified method of MVA.

IV. THEORETICAL PART

To formalize the CSED as queuing networks, having regard to its functioning, we propose the following diagram (fig. 1) [1]:

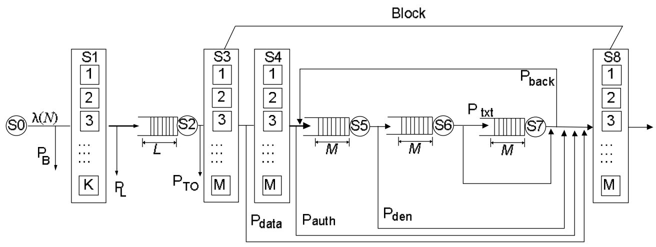

Fig. 1. Open queuing network, normalizes the CSED.

- S0 - center, normalizing the flow of user input messages.
- S1 - center, normalizes the module TCP (transport layer) of the operating system CSED application server when establishing a connection. K - number of service channels, all missing. If at the time of receipt of the message in the center of all K channels are occupied, the message is lost, the probability of this event is P_B.
- S2 - the main stream server application that retrieves messages from the queue to establish a connection. The maximum queue length L is set to the center in the server application. If you receive a message queue all L seats are occupied, the message is lost with probability P_L.
- S3 - flows parallel server providing simultaneous service connections at the stage of network requests. At the center of overflow messages are lost with a probability of P_{TO}.
- S3 and S8 are centers for M service channels (server streams) and at the beginning of the service posts in the i-th channel center S3 is considered occupied until the completion of service in the i-th channel S8 center. Thus, there is a lock S3 and S8 center channel and therefore loss of communications due to the overflow line to the centers S5, S6, S7, and the employment of all serving S4 Device Center does not happen, because more than M centers messages S4, S5, S6, S7 cannot be.
- S4 - client authentication module when accessing CSED.
- S5 - unit testing client permissions when accessing CSED.

In case of unsuccessful authentication and client permissions searched electronic document requested by the user and perform operations on the control of information integrity, verification and presentation of the electronic signature, encryption and decryption. To formalize the process, the index search and full-text search, providing access to ED highlighted S6 and S7 centers respectively.

After a user request is made, there is a transfer to the user response for S8 service center.

The classic approach to the calculation of this model is the use of the method Buzen or MVA method. However, to obtain the results of calculations queuing network characteristics using the methods described must enter a number of assumptions [3]:

- Incoming orders flow should be Poisson.
- Each network center can be represented by one of four types of queuing networks described BCMP theorem.
- The distribution of the duration of application services in a network of centers is exponential in the centers with service discipline FCFS, a general form for centers with IS disciplines, PS, LCFC.
- Queuing network is closed.
- The lengths of the queues are not limited to network centers.
- The number of servers in a multi-line centers is not limited.

The most significant assumptions are limiting the length of queues and the number of service centers devices. These assumptions exclude the possibility of loss of messages due to overflow queues centers and the ability to block messages that is quite difficult to implement in the technical system. The remaining assumptions may well reflect the real picture, which is shown in the works of V.M. Vishnevsky, V.A. Ivnitskii, L. Kleinrock [3], [5].

In order to eliminate a number of assumptions identified in this paper, we propose a modified method for the analysis of average values. This method can be used for calculation of open and queuing network shown applied to calculating CSED analytical model shown in fig. 2. It is based on the MVA algorithm, discussed earlier, the calculation is performed iteratively by N (the number of users working simultaneously with CSED). In one iteration, the following actions are performed:

- Calculate the intensity of the input queuing network (equal intensity S0 center input - λ0out) in accordance with (1) – step 1.

$$\lambda(N) = \Lambda N, \qquad (1)$$

where Λ - Density CSED calls to each user; N - number of users.

- Calculate the message processing time for each center - step 2.
- Intensity of the input stream is calculated for each center λiin - step 3, 4. In general intensity of the input flow is equal to the sum of fluxes coming from the other according to the centers of the routing matrix.

$$\lambda^{in}{}_i(k) = \sum_{j=0}^{R} P_{ji}\,\lambda^{out}{}_j(k)\text{ , i =[1;R],} \qquad (2)$$

where Pij – routing matrix elements.

- However, to make such a calculation is not always possible due to the presence of feedback - for example, from the center to the center of S7 S5 (fig. 1). In this case, we have to consider this as an independent center.
- Determine the number of employees serving in the center of the instrument - step 5.
- If the calculated number of employees exceeds the number of devices the center of the instrument, the intensity of the effluent determined by the intensity of service posts and the number of center devices - Step 7 8. missed the message service or placed in a queue, or lost (if the line is not present or it is full). Otherwise, the intensity of the output stream is equal to the intensity of the input - Step 6.
- If the calculated number of messages in the middle of the queue exceeds the total amount and the number of servers, do not fall on the service and to queue messages are lost - step 10.
- Then you can determine the average length of the queue Li(k) – step 12.

After the calculations must take into account the effect of S3-S8 centers lock. Because the messages in these centers can not be lost (all losses should occur in the centers S1, S2), you can formalize the processing of the messages in these centers as a functioning closed queuing network, located in a stationary mode.

The proposed approach allows the calculation of complex technical systems, formalized in the form of analytical models open queuing network, taking into account possible losses messages due to overflow of the waiting queues and service centers, which are not taken into account in the known method of MVA instruments. However, the proposed method does not give up all of the assumptions that requires further research CSED on the simulation model.

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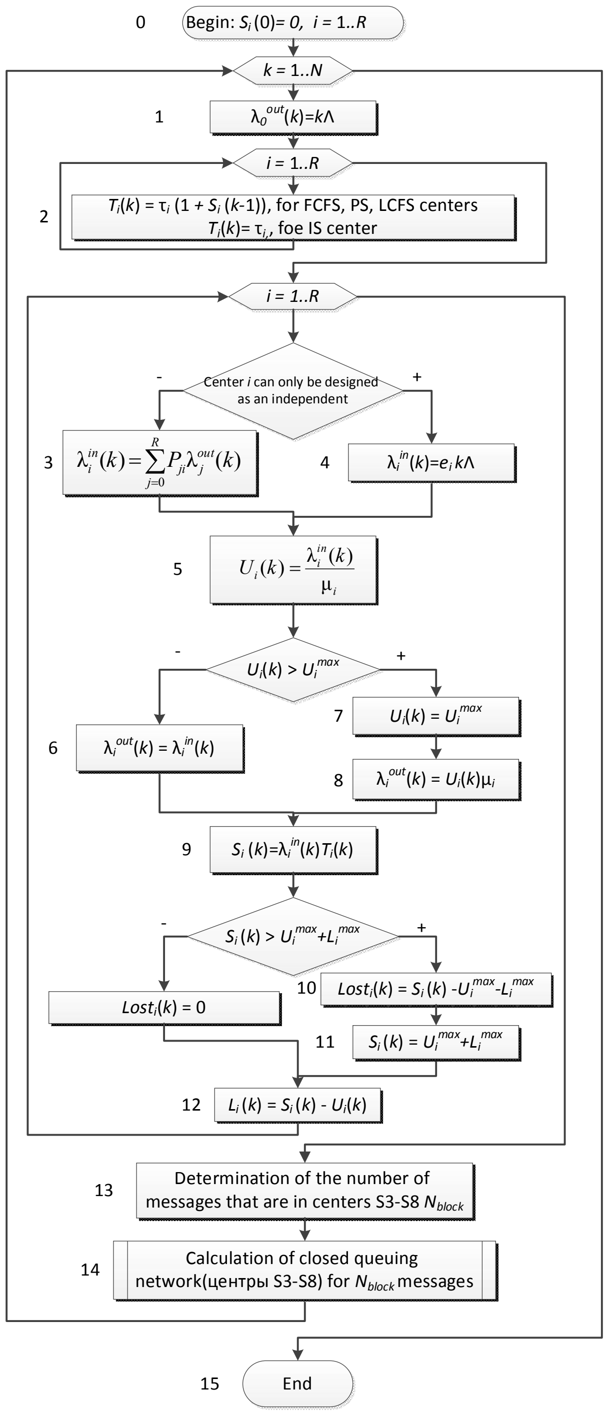

Fig. 2. The algorithm for calculating the open queuing network on the modified MVA.

Additionally produced simulation CSED in AnyLogic environment. Created simulation models allow you to check the results of analytical modeling of both closed and open queuing network. In simulations on the results of the calculation are determined by the characteristics of the entire system, each stream and service device. For the whole system counts the messages received by the system, fully serviced and left unattended messaging system, the average number of messages and the messages stay in the service centers, the average response time, application rates of loss, etc.[4]

The ratios of these values characterize the efficiency of the system at a given workload. The use of simulation provides a number of additional dependencies and to clarify the results obtained in analytical calculations (fig. 3) shows the dependence of the total time of message processing in the system on the number of concurrent users to the system, fig. 4 shows the dependence of the loss of messages on number of users, calculated various methods). In addition, simulation eliminates the assumptions made for the analytical models.

V. PARTICULAR INTEREST

Of particular interest in terms of produced output characteristics, it is the study CSED, formalized in the form of an open queuing network. Comparison of the obtained analytical modeling, using a modified method of the MVA, and simulation showed the closeness of the results obtained. This enables the use of the analytical method proposed in this paper to calculate the main characteristics CSED. However, simulation has the advantage of the ability to study a larger number of output characteristics, and it can be used to update and verify the results of analytical modeling.

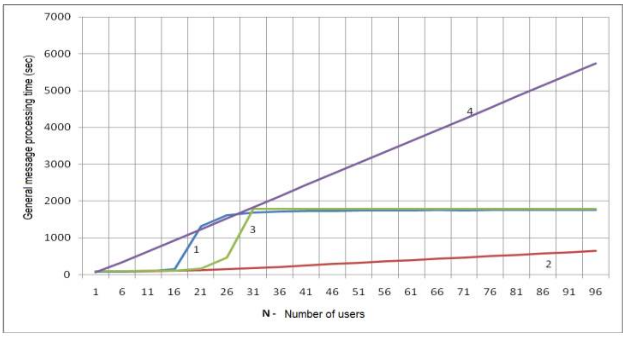

Fig. 3. Total time of message processing in a queuing networks: 1 - simulation model, 2 - analytical model (MVA method), 3 – nalytical model (a modified method MVA), 4 - analytical model (Buzen method)

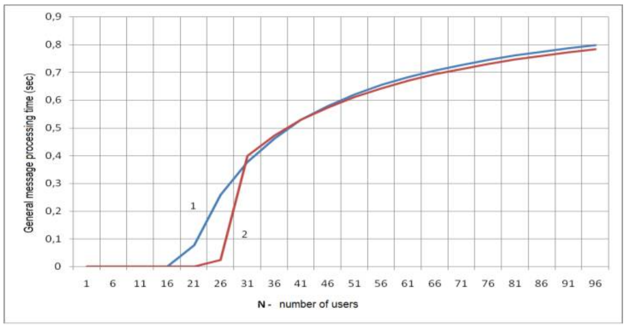

Fig. 4. Ratio of common posts loss: 1 - simulation model, 2 - analytical model (a modified method MVA)

VI. CONCLUSIONS

In this paper, the following theoretical and practical results:

- An analytical modeling using the method Buzen and average values of the analysis method. The study developed an analytical model, under which the new method of calculating the basic characteristics of the confidential storage of electronic documents. The above methods are implemented in software system;
- Developed and investigated simulations confidential storage of electronic documents in the simulation environment AnyLogic 6.4.1.

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