

MODELING AND OPTIMIZATION OF A COMPUTER CORPORATE NETWORK WITH PRIORITY SERVICE "ELECTIONS"

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Analyzed indicators modeling and optimization of a computer corporate network with priority service "Elections". The urgency of designing corporate computer networks and providing quality of service (QoS – Quality of Service) is based on the fact that the work was carried out in accordance with the design plan of the State Automated Information System "Elections" and the application new equipment and technology. The purpose of the work: development of methods for calculating the probability denial of the flood inquiries in corporate computer networks and the probability of timely delivery preparation proposals on the selection and effective use telecommunications equipment when creating corporate computer networks development methods for optimizing the parameters of telecommunication nodes operating with different service systems. Using analytical models of a computer corporate communication network, the probabilities loss and timely delivery of requests are determined. The work of the corporate communication network "Elections" of the Republic of Azerbaijan has been studied.

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I. INTRODUCTION

One of the topical directions in the development of a modern unified information infrastructure is the construction promising multi-service corporate computer networks based on innovative technologies using the efficiency their bandwidth resources. The efficiency using channel and network resources, and the distribution bandwidth resources hardware and software systems, which are a key indicator in the analysis and study of multiservice computer corporate networks with priority service [1, 2, 3].

Taking into account the above tasks, research and optimization of the performance computer corporate networks with priority service and channel resource management on converged networks using new SDN, IMS, LTE, NFV and NR technologies are the most relevant [4, 5]. However, in this case, among the above-mentioned modern technologies for building computer corporate networks with increased efficiency based on NGN (Next Generation Network) and FN (Future Network), a special place is occupied by SDN, IMS, LTE (Long Term Evolution), NFV (Network Functions Virtualization) and NR technologies in the provision of the "Elections" service.

In [2, 4, 5], the performance multiservice telecommunication and computer networks based on the architectural concept of NGN и FN using

infocommunication technologies was investigated and their main network and channel indicators were identified, taking into account QoS and QoE (Quality of Experience).

Our study is devoted to the analysis of single and complex indicators of the performance public networks and the efficient allocation of resources in switching nodes for the provision of multimedia services – "Elections", taking into account numerous parameters.

II. STATEMENT OF THE RESEARCH PROBLEM

To solve the above tasks and taking into account the importance of the interaction of information technology, a mathematical model (MM) is proposed for analyzing the indicators computer corporate networks with priority service "Elections" [4, 6]. The mathematical formulation of the task of the proposed MM for evaluating the performance indicators of computer corporate networks is described by the following objective functions:

$$W_{EF} = E[\text{Arg max}_j (T_{j,P}(\lambda))], \quad j = \overline{1, n}, \quad (1)$$

$T_{j,P}(\lambda)$ – a function that takes into account the indicators of the probabilistic-temporal characteristics of computer corporate networks with intensity λ when servicing the j -th flow «Elections» traffic packets and is equal to

$$T_{j,P}(\lambda) = F[T_{j,c\delta}, P_j, \rho_j], \quad j = \overline{1, n}, \quad (2)$$

where $T_{j,c\delta}$ – average time delay in the transmission of traffic "Elections"; P_j – probability of loss of requests in the j -th communication path of the load.

Expressions (1) and (2) define the essence of the new approach under consideration, on the basis which a mathematical model for analyzing the functioning computer corporate networks in the provision multimedia services "Elections" [4].

III. METHOD RESEARCH AND ANALYSIS
PROBABILISTIC-TEMPORAL CHARACTERISTICS
OF THE NETWORK

The operation of an analytical model of a computer corporate network is studied, the probabilities loss and timely delivery of requests are determined. The work of the computer corporate network "Elections" of the Republic of Azerbaijan has been studied. Analyzes corporate computer networks (telephone communications, digital networks with integrated services, etc.) are well described in [4, 5, 6].

The use optimization methods in network planning can reduce the cost project implementation by up to 20% [1]. There are stages of strategic, long-term, medium-term and current planning. Long-term (medium-term) planning determines the transition to a new communication network structure according to the criterion minimum total capital costs.

According to the position of the theory of systems, optimization of networks is decomposed on the problem of structural and parametric optimization. The first task is to select the optimal network structure, taking into account the requirements for its bandwidth, reliability, survivability and the types of computer equipment used. The second task is based on the development of mathematical models of the network and its elements, optimization of channel distribution.

At present, multichannel queuing systems (QS) of the M/M/S type with failures are used to model computer corporate networks. To describe the stationary mode of operation such QS, the Erlang distribution is used, and the quality of service indicator is the probability losing requests [2, 3]:

$$P_j = \frac{\rho_j^{s_j}}{s_j!} / \sum_{n=0}^{s_j} \frac{\rho_j^n}{n!}, \quad n = \overline{0, s_j}, \quad (3)$$

where ρ_j – is the intensity of the load entering the j – communication path and equal $\rho_j = \lambda_j / \mu$; λ_j – the intensity of the incoming flow in the j – communication path; μ – service intensity; s_j – the number of channels in the QS that characterizes the j – communication path.

The results of calculations by formula (3) are shown in Figure 1.

As can be seen from fig. 1. based on the choice of requirements for the quality of service requests P_j and on the basis of load planning ρ_j , you can choose the number parallel channels.

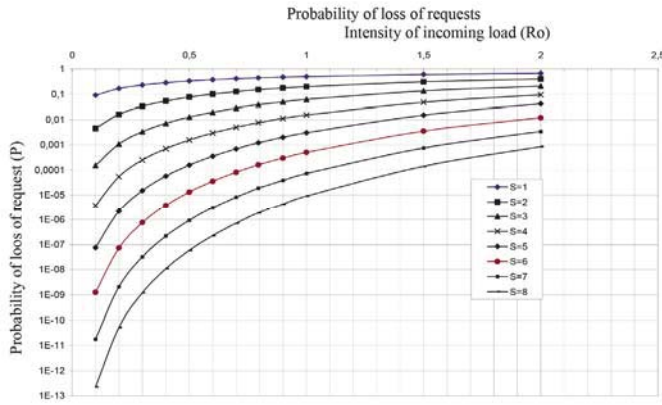


Figure 1. Dependence of the probability of loss requests P_j on the change in the incoming load in the j -communication path ρ_j and on the number of parallel channels s_j

An integral characteristic of the quality of service for requests in the communication paths computer corporate networks is the probability of timely delivery of messages, which is determined by the expression [2, 3]:

$$Q = \frac{\bar{\mu}}{c_j + \mu} \cdot \frac{\bar{\eta}}{v + \mu} \cdot (1 - P_j^*), \quad (4)$$

where $\bar{\mu}$ – is the average service intensity; c_j – failure rate;

T_j – allowable average delay time and is equal to $\gamma = 1/T_j$;

$\frac{\bar{\mu}}{\bar{\mu} + \tilde{n}_j}$ – the probability that during the transmission of the mes-

sage the j -communication path will not fail; $\frac{\bar{\mu}}{\bar{\mu} + \gamma}$ – the

probability that the message will not lose value; P_j^* – is the stationary probability of loss of requests in the j -m communication path with unreliable serving devices.

Consider a link with a bandwidth 19.2 Kbps, an average traffic 14 packets per second, $\lambda = 14$ and an average packet size of 800 bits. Packet service rate – packet/s. The throughput of such a link is 24 packets per second, so the delay in this link is

$$T_j = 1/(\mu - \lambda) = 1/(24 - 14) = 100 \text{ msec.}$$

IV. NUMERICAL RESULTS

On the basis of the obtained analytical expressions, a graphical dependence was constructed, probability timely delivery of messages $Q_j = W(c_j, P_j)$ from the probability loss of requests j -m communication paths with an unreli serving device.

Taking into account the above data, according to formula (4), dependences of the change in the quality of service Q_j on the stationary probability of request losses P_j^* – for different values of

the failure rate c_j figure 2 are constructed. As can be seen from the characteristics obtained, the failure rate c_j has little effect on changes in the quality of service Q_j .

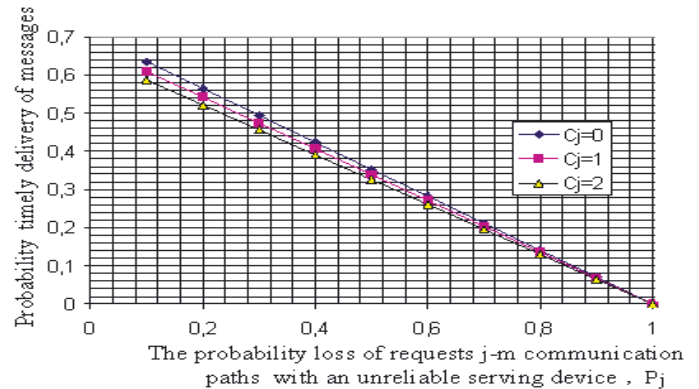


Figure 2. Graphical dependence quality of service on the probability loss of requests

V. RESULTS and DISCUSSIONS

The results of this work were used in the design, development and operation of the computer corporate network “Elections”. The computer corporate network “Elections” was created by order No. 528 of the President of the Republic of Azerbaijan dated September 3, 2000 on the design of the state automated information system (SAIS). According to the created structure of the state automated information system (Fig. 3), the voting process and automatic transmission of information are carried out at three levels:

- At the Information Center of the Central Electoral Commission (CEC).
- In the information section of the district election commission (DEC).
- In the information section of the precinct election commission.

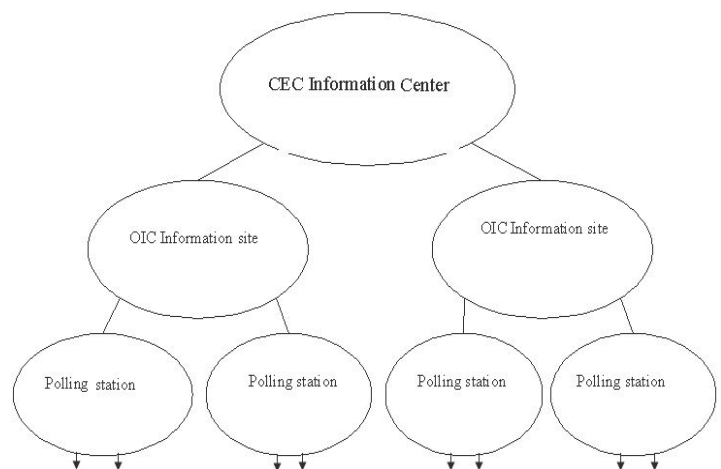


Figure 3. Block diagram of the state automated information system

To organize the work of the SAIS, an information center "Elections" was created at the central election commission. The information center "Elections" is equipped with modern computer equipment, a webcam, telecommunication equipment and a special screen. The Center, using the state computer communication network, receives information from the district and district electoral commissions.

The information center can simultaneously receive information from 125 constituencies. At present, according to the "Strategic Roadmap for the Development of Telecommunications and Information Technologies in the Republic of Azerbaijan", approved by the Decree of the President of the Republic of Azerbaijan dated December 6, 2016. The GAIS uses long-distance telephone channels and automatic telephone exchanges Ministry of Communications and High Technologies of the Republic of Azerbaijan (Ministry of Digital Development and Transport of the Republic of Azerbaijan). The information of the district election commission is sent to the information center "Elections" at a speed of 19.2 kbps.

CONCLUSION

The work is confirmed by the fact that it was carried out in accordance with the plan for the design of the state automated information system "Elections", with the plan of the Ganja Telecommunications Department for the introduction of new equipment and technology [2].

Precinct election commissions use a special electronic box in which a scanner is installed, from which information is read into a computer.

The electronic ballot box makes it possible to automate the transfer of information about the voting process to the district election commission and to the central information center "Elections". This makes it possible to conduct elections democratically, transparently, openly and quickly. This experience can be carried out in other countries.

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МОДЕЛИРОВАНИЕ И ОПТИМИЗАЦИЯ КОМПЬЮТЕРНОЙ КОРПОРАТИВНОЙ СЕТИ С ПРИОРИТЕТНОЙ УСЛУГОЙ «ВЫБОРЫ»

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Аннотация

Проанализированы показатели моделирования и оптимизации компьютерной корпоративной сети с приоритетной услугой "Выборы". Актуальность проектирования корпоративной компьютерной сети и обеспечения качества обслуживания (QoS - Quality of Service) основана на том, что работы проводились в соответствии с планом проектирования Государственной автоматизированной информационной системы "Выборы" и применения нового оборудования и технологий. Цель работы: разработка методики расчета вероятности отказа от флуда запросов в корпоративных сетях и вероятности своевременной подготовки доставки предложения по выбору и эффективному использованию телекоммуникационного оборудования при создании корпоративных компьютерных сетей и разработка методов оптимизации параметров телекоммуникационных узлов, работающих с различными системами обслуживания. С помощью аналитических моделей компьютерной корпоративной сети связи определены вероятности потери и своевременности доставки запросов. В работе изучена корпоративная сеть связи "Выборы" Азербайджанской Республики.

Ключевые слова: компьютерная сеть, расчет, нагрузка, расположение ожиданий, приоритет, алгоритм, цифровые линии связи, коммутационные устройства.

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