2nd International Conference on Problems of Logistics, Management and Operation in The East-West Transport Corridor (PLMO 2023) Baku, Azerbaijan
DOI:10.54381/plmo2023.36

Research efficiency of the autotechnical services using the concept logistic systems

Bayram IBRAHIMOV*
Department of Radio Engineering and Telecommunications
of Azerbaijan Technical University, Institute of Control Systems, Baku, Azerbaijan
Aziz TALIBOV
Department of Fundamental Sciences Research Institute,
National Defense University, Baku, Azerbaijan
Allahverdi ORUJOV
Department of Energy Efficiency and Green Energy Technologies
of Azerbaijan Technical University, Baku, Azerbaijan
**Corresponding author*. E-mail: bayram.ibrahimov@aztu.edu.az, i.bayram@mail.ru

Abstract. The effectiveness of the functioning autotechnical services and the theoretical concept logistics systems in the field transport, telecommunications, resource management and message transmission systems are analyzed. The efficiency criteria autotechnical services are selected when using the concept logistics and information transfer systems. In this article, the subject research is the effectiveness of the functioning systems for processing information flows automotive services based on the architectural concept subsequent communication networks (NGN, Next Generation Networks) using modern information and logistics technologies. As a criterion for the effectiveness of the functioning logistics systems, the performance information flow processing systems in the field transport was chosen. The latter characterizes the following complex indicators as the throughput of the system hardware and software in the exchange various types messages, the probabilistic-time characteristics useful and service traffic, the reliability of the system automotive services when using the concept logistics and methods information transmission systems. The purpose this work is to study the efficiency of the functioning automotive services when using the concept logistics and messaging systems for information flows automotive services using NGN technologies. As a result of the study, a mathematical model was proposed, taking into account the nature of the transmitted transport traffic and the presence of a variety of network and channel resources, on the basis which the performance indicators of the operation autotechnical services were analyzed using the concept logistic messaging systems. Analytical expressions are obtained that allow to evaluate the indicators quality of service and the reliability of the system functioning when transmitting various traffic in the logistics system. On the basis numerical calculations were carried out and graphical dependences of the probability of trouble-free operation of the system on the failure rate of software and hardware nodes and the dependence of the average length packet queue on the value of the system load factor were constructed.

Keywords: *concept logistics systems; information flow transmission systems; reliability; productivity; autotechnical services; quality of service; security threat*

1. INTRODUCTION

The rapid development network infrastructures of the digital economy and the creation of strategic plans "Digitalization Roadmap" require the rational organization and management resources transport enterprises that ensure the efficient functioning information flow transmission systems for automotive services [1].

In [1, 2, 3], methods for improving the characteristics of the bandwidth capabilities of a hardware and software system and algorithms for protecting information from unauthorized access were analyzed. In [4, 5, 6], the quality of functioning information processing systems automobile services was investigated using the architectural concept and next generation network technologies, and their main network and channel indicators were identified.

However, the task researching integrated indicators of the efficiency processing information systems automotive services in the exchange useful and service transport traffics has not yet been fully resolved.

Considering the foregoing, this paper discusses the objectives researching the performance indicators automotive services using the concept of logistics systems and messaging systems.

2. PROBLEM STATEMENT AND SOLUTION METHODS

To assess the performance indicators of the system for processing information flows automotive services, it is necessary to develop a mathematical model that takes into account the nature of the transmitted traffic and the presence multiple network resources [1, 4, 6].

Assume that the incoming packet flow in the service system has Poisson оов ove distribution laws with a parameter λ_i, the duration of the service traffic has an arbitrary distribution function $B(t)$ with moments b_i, $i=\overline{1,n}$. The investigated system performance is determined by the number transmıtted traffic packet streams per unit time under the conditions of a given reliability and information security, which are functionally described by the following dependency [1]:

$$E_{AS}(\lambda_i) = F[C_{\max}(\lambda_i), K_i, N_{qu}(\lambda_i), I_i], \quad i=\overline{1,n} \quad , \tag{1}$$

where $N_{qu}(\lambda_i)-$ the average waiting time of a packet in the service queue in the system, taking into account the rate of incoming flow λ_i in processing the $i-$th traffic, $i=\overline{1,n}$;

$E_{AS}(\lambda_i)-$ system performance hardware and software, taking into account the rate incoming flow λ_i during processing $i-$th traffic, $i=\overline{1,n}$;

$K_i -$ fault tolerance factor hardware and software during stream processing $i-$th traffic, $i=\overline{1,n}$; $I_i -$ information security coefficient of the functioning hardware and software when processing the flow $i-$th traffic, $i=\overline{1,n}$;

$C_{\max}(\lambda_i)-$ bandwidths system hardware and software during stream transmission $i-$th traffic, $i=\overline{1,n}$.

Expressions (1) define the essence of the new approach under consideration, taking into account the intensity transport traffic, on the basis which mathematical model is proposed to analyze the performance indicators of the information systems processing automotive services.

3. RESEARCH INDICATORS AUTO TECHNICAL SERVICES IN THE DATA TRANSMISSION SYSTEM

In order to adapt the operation of the logistics management system in autotechnical services to the given principles and requirements, it is divided into stages according to the level subordination of the information processing units and the nature of the information. The proposed logistics management system meets modern requirements in terms structure and operating principles and can ensure the implementation information logistics in the field autotechnical provision with effective indicators.

In the sphere autotechnical logistics service, the effective, obstacle-resistant, reliable and safe transfer of the load created by different sources to the necessary addresses through different communication channels is considered one of the important issues. In such processes, the determination, selection and evaluation of the quantitative indicators of the transmission speed are considered important aspects for the transfer load of the processing systems [1, 6, 7].

In order to solve the problem under consideration, the mathematical expression intensity of the load created by the flow calls entering and serving the information transmission systems in the field auto-technical logistics management systems is determined as follows:

$$Y_{AX}(\lambda_i) = N_{mm} \cdot C(\lambda_i) \cdot T_m, \qquad i = \overline{1,n} \quad , \tag{2}$$

where N_{mm} – the total number data sources in the autotechnical logistics service system; $C(\lambda_i)$ – is the average number of calls in the field autotechnical logistics service and depends on the average intensity of the package streams entering the service λ_i center, $i = \overline{1,n}$;

T_m – is the time spent by the service system on a single call.

Functional dependence, which characterizes the quality of indicators telecommunication networks used in automotive logistics systems and includes its effectiveness parameters, can be defined as follows:

$$Q_{KX} = [T_m, C_{\max}(\lambda_i), P_e, Y(\lambda_i), T_{gm}(\lambda_i), P_{BER}], \qquad i = \overline{1,n} \tag{3}$$

here P_e – possibility loss in telecommunication networks used in auto-technical logistics systems; $T_{gm}(\lambda_i)$ – the delay period during the transmission information through the communication channel in the system; P_{BER} – is the probability error during the exchange and reception of data streams in the system; $C_{\max}(\lambda_i)$ – the maximum throughput of the information system during transmission type *i*- data in telecommunication networks used in automotive logistics systems and the maximum throughput during *i*-type data transmission in telecommunication networks used in autotechnical supply logistics systems is determined by the following formula:

$$C_{i.\max} = \eta_i \cdot \Delta F_i \cdot \log_2 \left(1 + \frac{P_s}{N_0 \cdot \Delta F_i} \right), \quad i = \overline{1,n} \quad , \tag{4}$$

where ΔF_i – is the width frequency band of the channel necessary for the transmission of information streams of the type used in the logistics systems autotechnical provision, $i = \overline{1,n}$, Hz; N_0 – is the shallowness power of the spectral signals interference sources, expressed as follows: $N_0 = P_m / \Delta F_i$, Vt/Hz; η_i – is a coefficient that characterizes the activity telecommunication channels used in autotechnical support logistics systems for the transmission type information streams, $i = \overline{1,n}$.

The maximum throughput telecommunication networks (4) in autotechnical support systems is a quantitative indicator, and according to C. Shannon's information theory, it is considered the maximum speed of the channels used in these systems [1, 8].

The obtained expression (3) is considered an important characteristic of the operation switching nodes for the exchange of information streams in the field autotechnical logistics service. At the same time, in expression (3), it is determined by the maximum information release capacity during the transmission *i*-type data in the communication networks used in the auto-technical logistics service system:

$$C_{\max}(\lambda_i) = 1 - Y_{AX}(\lambda_i), \qquad i = \overline{1,n}. \tag{5}$$

As can be seen from the proposed expression (5), if $Y_{AX}(\lambda_i) \geq 0.20$ Erlang is accepted, the intensity value of the load information exchange systems should be less than 0.20 Erlang for the quality of operation of the information processing network in autotechnical logistics systems. The physical meaning of the considered case means that 20% of the capacity of the system is used for information transmission, and 80% remains unused as a resource. Maximum system throughput may be used during operations or by other related services.

Conventionally, the automotive logistics management system is divided into five information and signal networks, and control data is transmitted in the form packets through the signal network.

The assessment of the load caused by useful and service traffic for the considered case was carried out according to the following mathematical model:

$$L_{AX}(\lambda) = \sum_{i=1}^{k} L_i(\lambda_i), \qquad i = \overline{1,n}, \tag{6}$$

where $L_{AX}(\lambda) -$ is considered the total amount of data that can be transferred in autotechnical logistics systems; $L_i(\lambda_i) -$ the volume of data that has intensity λ_i in autotechnical logistics systems is considered.

According to the proposed statement (6), the volume of service data $q(\lambda_i)$ with intensity λ_i in autotechnical logistics systems is determined as follows.

$$Q(\lambda) = \sum_{I=1}^{k} q_i(\lambda_i), \qquad i = \overline{1,n}. \tag{7}$$

According to the statements (6) and (7) of the mathematical model, $q_i(\lambda_i)$ is the probability of useful and service traffic in the subsystems that is considered to correspond to $L_i(\lambda_i)$, $L_i \to q_i$, $i = \overline{1,n}$.

Thus, on the basis of the mathematical model, according to expressions (6) and (7), the assessment of the load created by useful and service traffic in the logistic transport systems can be shown in the form of a table 1 as follows. According to table 1, $L_{AX}(\lambda_i)$ and $Q(\lambda_i)$ systematic price sequence is given.

Tabl.1

Table for evaluating the load generated by useful and service traffic

$L_i(\lambda_i)$	L_1	L_2	L_3	. . .	L_n
$Q_i(\lambda_i)$	q_1	q_2	q_3	. . .	q_n

Based on the above table and mathematical model, the average length $L_{AX}(\lambda)$ useful and service traffic in subsystems is determined as follows:

$$L_{AX}(\lambda) = \sum_{i=1}^{n} q_i \cdot L_i(\lambda\ ), \qquad i = \overline{1,n} \tag{8}$$

Mathematical model and $L_i \to q_i$, $i = \overline{1,n}$ average length of service traffic based on dependency $L_{AX}(\lambda)$ as well as by accepting the transmission speed $V_k \geq 2048,\ldots,155$ *Mbps*, the expressions for calculating the average transmission time of the total information $T_m(\lambda_i)$ have been obtained.

It is considered that when there is a probability error $P_{BER} \to 0$ in digital communication channels and the transmission speed is 1024 *Kbps*, the value of the load created by subsystems in information exchange systems is determined as follows:

$$Y_{AX}(\lambda) = (\lambda_{i.u} + \lambda_{i.x}) \cdot \frac{1}{V_k} \cdot \sum_{i=1}^{n} q_i \cdot L_i(\lambda_i), \ i = \overline{1,n}, \tag{9}$$

According to the algorithm of the proposed mathematical model, the price of useful $\lambda_{i.u}$ and service load $\lambda_{i.x}$ in information exchange systems of different subsystems is determined as follows:

$$Y_{AE}(\lambda) = \frac{\lambda_{i.u} + \lambda_{ix}}{T_{cm}} \cdot \frac{L_{AE}(\lambda)}{V_k}, \qquad i = \overline{1,n} \quad . \tag{10}$$

here T_{cm} – useful and service information transfer time.

In accordance with the calculation algorithm of the proposed mathematical model, the prices of useful and service load are determined separately in the transport information exchange systems different subsystems.

References

1. Ibrahimov B.G., Talibov A.M. (2019). Researches efficiency functioning systems processing's information flows automobile services. *T-Comm*, vol. 13, no.5, pp. 56-60.
2. Bianchi G. Performance Analysis of the IEEE 802.11 Distributed Coordination Function» // *IEEE Journal on Selected Areas in Communications.* Vol.18, No.3, 2000, pp. 535-547.
3. Ibrahimov B.G., Namazov M.B., Quliev M.N. Analysis performance indicators network multiservice infrastructure using innovative technologies // Proceedings of the 7-th International Conference on Control and Optimization with Industrial Applications (COIA-20). Vol. II. 2020, pp. 176-178.
4. Braun W., Menth M. Software-defined networking using OpenFlow: Protocols, applications and architectural design choices // *Future Internet.* Vol. 6, No 2, 2014, pp. 302-336.
5. Masuev M.A. Designing of automobile transport enterprises: textbook. manual for university students. M .: Publishing House "Academy", 2007, 224 p.
6. Yusifbayli N., Guliyev H., Aliyev, A. Voltage Control System for Electrical Networks Based on Fuzzy Sets // *Advances in Intelligent Systems and Computing.* 1323 AISC. 2021, pp. 55–63
7. Giechaskiel B., Alessandro A., Zardini A.A., Clairotte M. Exhaust Gas Condensation during Engine Cold Start and Application of the Dry-Wet Correction Factor// *Applied Sciences.* Vol. 9, no. 11, 2019, pp. 1-15.
8. Ibrahimov B.G., Ismaylova S.R. Research and analysis performance indicators multiservice signal networks NGN/IMS // *International Journal of Engineering Sciences & Research Technology*. Vol.6, Issue 12, 2017, pp. 295-300.