

The study of features of the structural organization of the automated information processing system of the collective type

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Abstract. The comparative assessment of the level of channel capacity of different variants of the structural organization of the automated information processing systems is made. The information processing time assessment model depending on the type of standard elements and their structural organization is developed.

1 Introduction

Nowadays the Use of informational technologies and the automated information processing systems (AIPS) in various spheres of economy and the industry showed their high efficiency at the solution of a wide class of tasks [1–4]. At the same time the analysis and study of the processes of assessment and comparison of various forms of the structural organization of the AIPS on the basis of standard elements and different types of program information support is important and critical [5, 6].

2 The theoretical part

In a number of scientific sources the variants of the organization of the automated information processing systems (AIPS) of various functional purposes were considered. In the applied theory of the mass service the mathematical models [5, 6] allowing to receive the quantitative assessments of a number of parameters of functioning of the systems of such class are developed. In the same place it is shown that there are different approaches to the organization of polyphase subsystems of AIPS that allows to combine the program, technical means, information and intellectual support depending on the tasks solved by AIPS, and requirements to the systemic resources. Therefore for the purpose of obtaining recommendations about the use of rational variants of creation of the AIPS with different structure and characteristics of elements we will make the quantitative assessment of their effectiveness in the range of the systemic parameters which are of practical interest.

We will choose the variants of creation of AIPS on the basis of the decentralized and centralized structures as the studied ones (Figure 1).

The presented variants are the main types of structures allowing to create the complex multipurpose AIPS [7, 8]. The mathematical models of processes of their functioning are rather well developed. As the measure of comparison we use the efficiency factor [1] estimating the average intensity of an output informational stream from the standard element of the AIPS. The ratios of the indicators characterizing the superiority on performance level of one variant of creation of the AIPS in comparison with another one will be the criterion of efficiency.



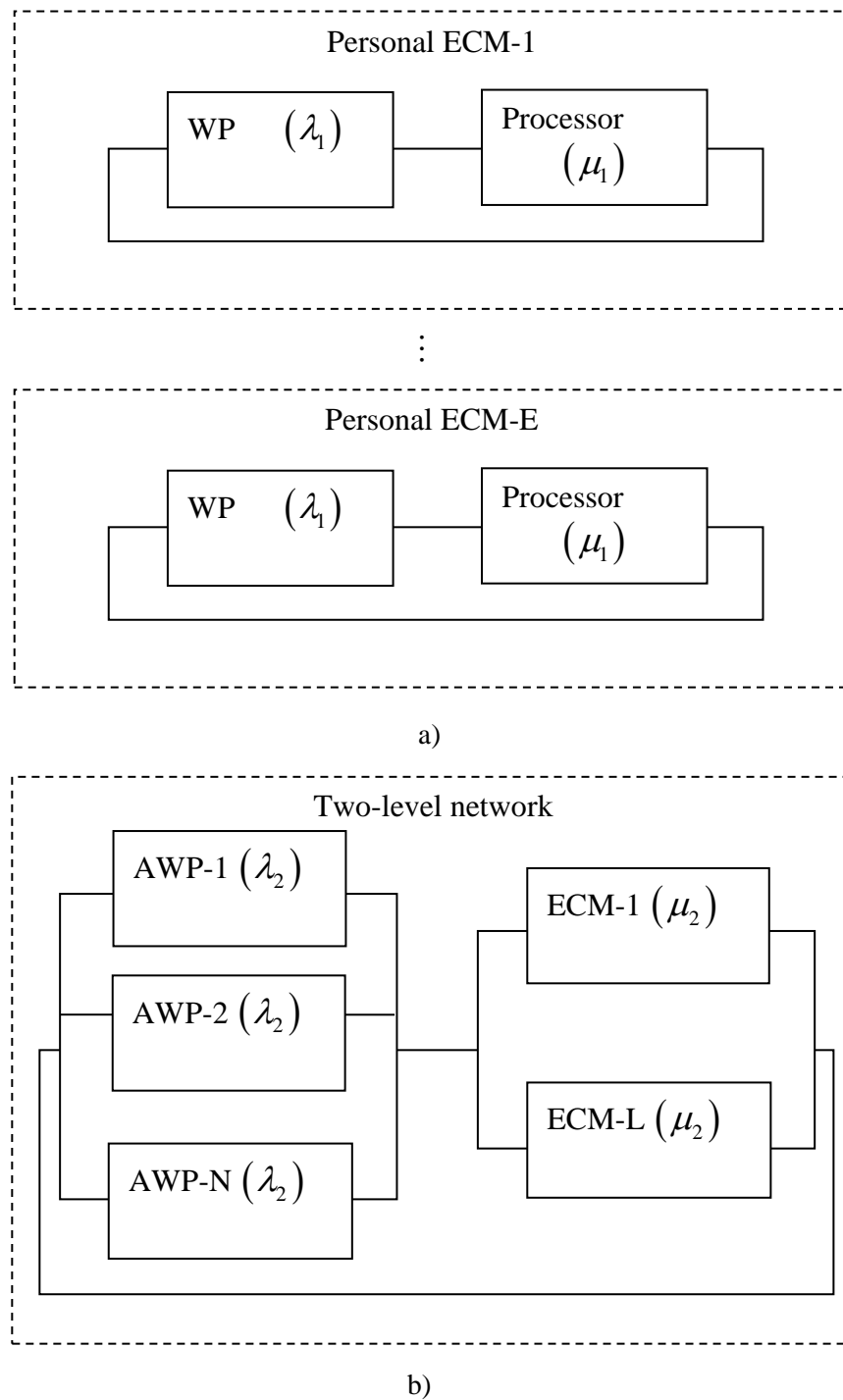


Figure 1. Basic structures of the AIPS of collective type: a) – decentralized on the basis of personal computers; b) – centralized on the basis of two-level network.

With the purpose of study of influence of different structural features of creation of subsystems of the AIPS we will accept the following restrictions and assumptions.

The total intensity of processes of transformation of information at each phase of the system is identical in sense of the following ratios [5, 6]:

$$\sum_{i \in I} \lambda'_i = \sum_{j \in J} \lambda''_j = \lambda; \quad (1)$$

$$\sum_{l \in L} \mu'_l = \sum_{s \in S} \mu''_s = \mu; \quad (2)$$

$$\rho = \lambda / \mu,$$

where I, J и L, S – respectively the number of elements of the competing variants at each level of creation of the system.

At the same time we will accept that the costs of realization of the variants are also equal. Such assumption generally is not true, but it allows to simplify the analysis and to make the quantitative assessment of the influence of structure and characteristics of the variants on channel capacity of the AIPS.

Taking into account the above-said we will take the loss in channel capacity of one variant in relation to another as the measure of comparison [7, 8]:

$$\omega(B) = 1 - B' / B'' \quad (3)$$

or

$$\omega(B) = 1 - \frac{E \mu' \overline{L'_a}}{\mu'' \overline{L''_a}},$$

where μ', μ'' – respectively the intensity of service of applications by the information-computer environment; $\overline{L'_a}, \overline{L''_a}$ – respectively the mean number of the active computers (servers) in the compared variants; E – the number of identical structures in the variant.

The schedules of dependence of the indicator (3) as a function from the parameters E, L, N, ρ are presented at the Figure 2.

As their analysis shows [9,10], at observing the conditions (1,2) and with any values of E, L, N, ρ the centralized structure realized in the form of the collective AIPS in comparison with the variant on the basis of independent personal computers is more preferable on the level of a channel capacity. The difference is the highest in the range of parameters $10^{-1} \leq \rho \leq 10, 1 \leq l \leq 8, 8 \leq N \leq 50$. Here the variant with the centralized structure has the channel capacity by 10÷45 % higher than with the decentralized one. The maximal difference is at the values of the parameters $L = 1, N > 50$ and $\rho = 1-2$ and reaches the value of 50%. At $L = N$, and also in the range of $\rho < 10^{-2}$ and $\rho > 10^2$ essential differences are not observed and the variants are equivalent in the channel capacity. In this case it is necessary to consider other indicators entering the criterion of effectiveness (3).

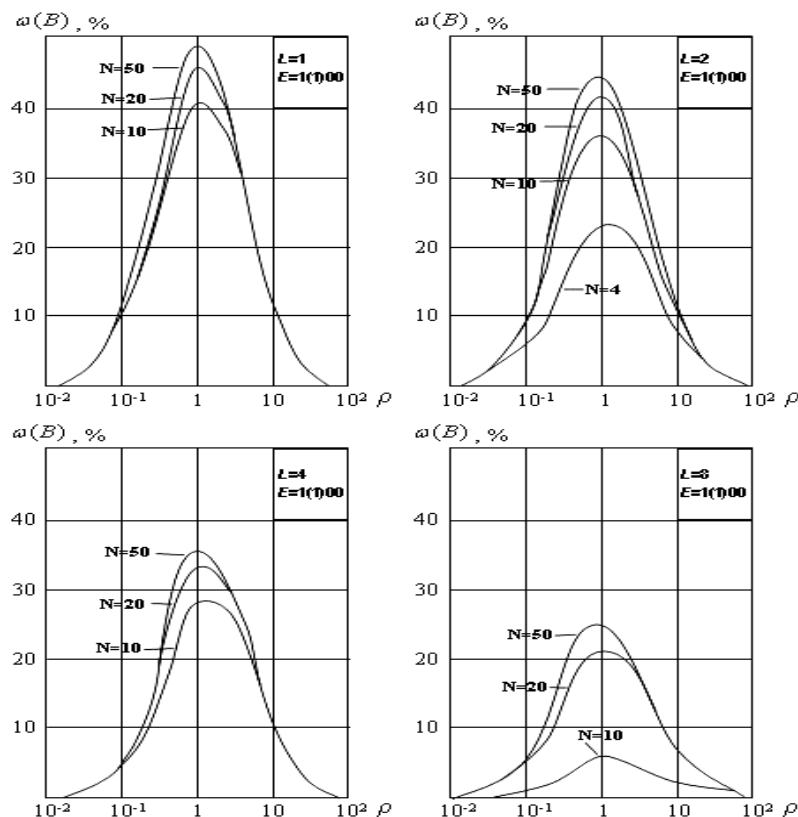


Figure 2. The comparison of the level of channel capacity of the variants of creation of AIPS: the decentralized one on the basis of personal computers of the type $E\{M/M/1(\mu)/1(\lambda)\}$ and the centralized one on the basis of 2-level network.

It is also necessary to notice that the change of the indicator E for the decentralized variant does not influence the value of the expression (3). It is connected with the fact that the increase in number of personal computers linearly increases the channel capacity of the whole system, but at the observance of the conditions (1, 2) the efficiency of separate structure also linearly decreases.

The need of use of hierarchical two-level structure conforms well to the principles of division of tasks and resources.

The best efficiency of the centralized structure is reached due to higher value of the coefficient of use of computing resources. However the centralization of computing tools at $N > L$ leads to emergence of turns at the requirement of systemic resources therefore the time of processing of the array of information increases.

Therefore with the purpose of the study of influence of parameters of the considered variants on the time of transformation of information we will introduce the function [11]

$$\omega(T_{np}) = \frac{\overline{T''_{np}}}{\overline{T'_{np}}}, \quad (4)$$

where $\overline{T''_{np}}$, $\overline{T'_{np}}$ – the mean time of transformation of the array of information in the centralized AIPS on the basis of network and the decentralized structure on the basis of personal computers respectively.

Using the similar approach, we will present the expression (4) as

$$\omega(T_{np}) = \frac{N\mu' L'_a}{E\mu'' L''_a}, \quad (5)$$

where E – the number of personal computers; N – the quantity of ARM in the network.

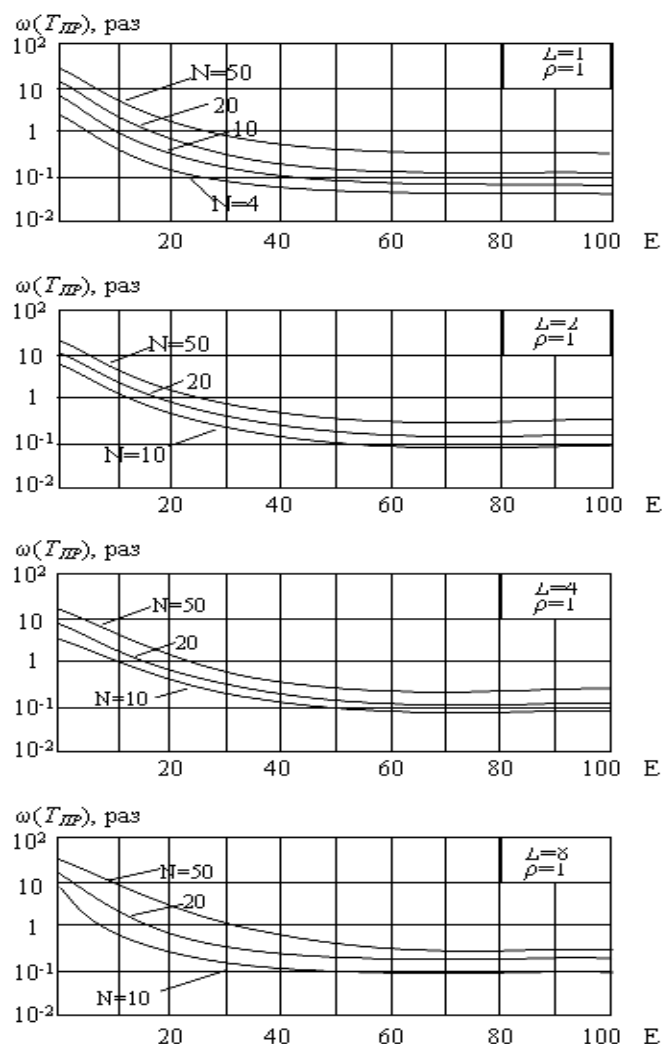


Figure 3. The comparison of the time of transformation of information for different variants of creation of AIPS.

The analysis of results of the study of (5) as the function from the systemic parameters E , L , N , presented in the Figure 3 shows that time of transformation of information strongly depends on the values of the listed parameters.

TSo, at the observance of conditions $N \geq E$ and with any L , N , ρ the decentralized structure on the basis of personal computers will be more preferable in sense of the time of transformation of information, i.e. the inequation $\omega(T_{np}) > 1$ will be true.

At $N < E$ and defined values of the parameters L , N the information processing time in the centralized structure can be less, than in the decentralized one.

The increase in the parameter N leads to the increase in the of values of the function (5), and for the parameter L the inverse dependance is observed, i.e. the higher is the coefficient of centralization of computing means N/L , the less preferable is the network variant of creation of AIPS, than the variant on the basis of personal computers other factors being equal.

In general the duration of transformation of information for the considered variants in the range of parameters $E = 1(1)100$, $L = 1(1)8$, $N = 1(1)50$, $10^{-2} < \rho < 10^2$ can differ by more than two orders.

The made analysis allowed to reveal the regularities and to receive the quantitative assessments of temporary parameters of functioning of the AIPS depending on its structure and characteristics of the making elements.

3 Conclusion

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