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OPTIMIZATION OF COMPUTER SYSTEMS COMPLETING WITH RELIABILITY CRITERIA

Abstract. Developed programmatic facilities for the automated computer systems completing with the reliability criteria. Gathered data about basic parameters of the models of wide circle of producers, analyzed influence of the price, power and productivity on reliability indexes of the computer systems.

Keywords: computer system, power, productivity, price, reliability, program, optimization, completing.

Reliability maintenance is one of the primary goals of technical systems development. Reliability estimation is carried out at all stages of computer systems life cycle: from the beginning of their creation to guarantee and post-guarantee operation. It's especially important to provide high reliability of systems at a design stage, in particular at a stage of computer systems completing. Thus, the qualitative system cannot be created without authentic knowledge of reliability parameters for completing products. Such knowledge is based on the data, which are gained during exploitation analogous products of concrete firms-manufacturers. In this case, reliability of completing products is characterising by duration of a time between failures, duration of restoration or a complex parameter - an availability factor.

One of the most widespread technical devices nowadays is the personal computer (PC), which has found wide application both in the modern automated control systems, and at household level. Nevertheless, considering functionality of modern PC name them like devices is incorrect. As known [1], the device is calling set of the elements merged in the general finished technical design, which has independent operational appointment. While system is technically proved set of in common acting devices specified for performance of a certain practical problem. In this case, it is possible to consider personal computer components (motherboard, HDDs, power modules, video cards, etc.) as devices, where from sampling of this or that model depends reliability of the separate PC and the automated system as a whole.

According to existing statistical data [2] condition on 2004 Ukraine was on the 100-th place in a rating of the countries behind quantity of computers per resident with index 18 computers on 1000 inhabitants. As informational agency of RBC-Ukraine [3] has informed, only 35% of households in the cities with population over 50 thousand inhabitants have at least one working stationary computer and 8% households, which have no personal computer, volplane to get it till the end of 2008 year. Is informing, that throughout 2006-2007 the quantity of the sold stationary computers increased on 20-25% annually and is predicting that in 2008, in comparison with previous year, the market of desktops will increase on 20%. As a whole, according to condition on the middle of 2008, quantity of the personal computer on 100 inhabitants of Ukraine arrange 13 units and this number continues to increase.

Considering trends of the market and the fact, that two thirds of Ukraine population don't fathom for what necessary computer at all [3], there is a problem of sampling by the buyer some configuration of the PC which would fulfill it from the point of view productivity, reliability and price. Sampling of solutions is small: to consult with the specialist in the given area, to do sampling by guess-work or to spend a lot of time for search the necessary information. However, deficiencies of such solutions is that: to find the specialist isn't simply and by purchasing of any PC, probability of the buyer needs satisfaction is scanty. Accepting to attention fact, that personal computer service, in most cases, occurs fairly from a residence of the buyer, on the foreground stands probability of no-failure operation and price-reliability dependence. At sampling of completing devices it is necessary to consider also parameters such as power and productivity, which is direct or satisfactory are influencing on reliability of computer systems. For example, using devices with a considerable power consumption leads to system excessive heating, assists premature failures or

causes installation of additional chilling devices, that raises a personal computer final price. In turn, raise of productivity of some completing products leads to raise of their power and determination of more powerful power modules, which also are influencing on the price of computer system.

Thus, there is a problem optimization of computer system completing with reliability criteria.

For the task solution is necessary:

- gather information about technical, economic and reliability characteristics of the computer systems basic components;

- define parameters of computer system reliability;

- build optimization function of completing according to parameter price-reliability;

Within the limits of the company «qBox», that is engaged in sales and service for computer and home appliances in Ukraine, gathering and the analysing of the information about quantity of sales and failures of different models of computer accessories was made.

The basic characteristic of technical quality of the component taken the function of reliability (non-failure) for indirect reliability definition $P(t)$, which is equated to probability, that in accepted time interval or within the error-free running time at the set regimes and service conditions, failures in system does not originate:

$$P(t) = W(T), \quad (1)$$

where t – preset time; T – duration of non-failure operation of system; $W(A)$ – probability of event A for which the condition $T > t$ is satisfied.

Let's accept failure of any completing part of the PC, as event A , which probability $W(A)$ is necessary to define. For area of calculations we accept quantity of completing parts, which are testing. Then probability of the device no-failure operation is presenting as follows:

$$P(A) = 1 - W(A).$$

Are known methods for reliability of the difficult systems estimation [4,5], that, as a rule, require knowledge about reliability of separate completing elements of the system. In particular, it is possible pick out likelihood-physical method, where distribution of the PC's error-free running time is presenting by DN-distribution

$$F(t) = \Phi\left(\frac{t - \mu}{\sqrt{\mu t}}\right) + e^2 \Phi\left(-\frac{t + \mu}{\sqrt{\mu t}}\right) \quad (2)$$

and method based on exponential distribution (lambda -method). This law of the PC's error-free running time distribution is presenting by exponential distribution

$$F(t) = 1 - e^{-\lambda t}. \quad (3)$$

The first method, which requires difficult calculations, is characterising by accuracy of results, and second provides simplicity of scalings, but gives a known methodical lapse, which can be considered. Result of comparison both design procedures of the PC, in base complete equipment, reliability [6] with known reliability parameters for completing parts presented in tables 1 and 2.

The methods presented above and authentic data about reliability of separate elements, allow make an exact estimation of system reliability as a whole. Logically also let out, that the increase in the cost of computer accessories should secure raise of their non-failure operation probability [7], so also raise of reliability of the system as a whole.

The solution of a problem optimization of computer system completing was carried out considering that, their making, designing and acquisition, how also other engineering systems, connected with the solution of an alternative problem: on the one hand it is necessary to have system of the maximum reliability, and with second - it is necessary, that its price was comprehensible. In this case, it's necessary formulate the purpose correctly. If purpose is achievement of a certain parameter of computer system reliability, then target function, in this case, minimizes the expenses necessary for achievement of the purpose. If purpose is achievements of the greatest possible parameter of reliability at the set expenses, than these expenses are observing in the form of restriction for target function, which maximizes the parameter of system reliability. In

both cases the way of a problem solution is equal, because in one case "reliability-expense" function is observed, in second - return to it function.

Table 1

Composition and reliability parameters for PC's modules

№	Module	Type	Quantity, m_j , шт	Intensity, $\lambda_j \cdot 10^{-6}$, 1/year	Operating time, $T_j \cdot 10^6$, year
1	Motherboard	Asus M2N-MX	1	4.33	0. 231
2	Processor	Athlon 5600 +	1	3.88	0. 257
3	Memory SIMM	DDR2 1Gb KingStone	1	1.13	0. 882
4	Video card	ATI PE HD2600XT	1	2.51	0. 397
5	HDD	WD3200AAJS	1	2.15	0. 464
6	DVD/RW	NEC 7170A	1	2.31	0. 431
7	Keyboard	Chicony W-0108	1	6.65	0. 150
8	Mouse	Defender 7630	1	2.74	0. 365
9	Power supply	Targa PT-400CF	1	4.91	0. 203
10	Case	KME CX-9387	1	3.86	0. 259

Table 2

Results of the PC's reliability parameters calculation

Reliability parameter	λ -method	LP-method
$T_{cep}, year$	91737	83720
$T_{\gamma}, year (\gamma = 0.9)$	9669	19841
$P(t_{3ad})$	0,967	0,998

From resulted tables 1 and 2, settlement estimations of an average operating time to failure for PC close enough for both methods. The carried out calculations have shown, that more simple classical λ -method for estimation of reliability parameters for developed computer technics does not concede behind accuracy to LP-method (DN-distribution), which is based on two-parametric model of reliability, therefore this method is selected for the created computer program of the automated calculation of computer systems reliability.

On the basis of the information about characteristics of each complete part and its price, computer program has been developed, which represents a set of means and functions for virtual modelling of the planned system from available in programs database complete parts and the further estimation of reliability as separate completing part of computer system, their parties grouped concerning firm-manufacturer or the production methods (for example, graphical processors fig. 1), and the whole computer system with the further optimization of its complete equipment. Thus in attention was accepted dependences the price-reliability, the price-capacity and the price-productivity, which are counted for all types of computer accessories.

With using such program, it is possible even before creation of computer system size up its reliability, correct its complete equipment, size up parameters like: price-reliability, price-capacity and price-

productivity, and the most important thing, optimize system parameters according to the put demands.

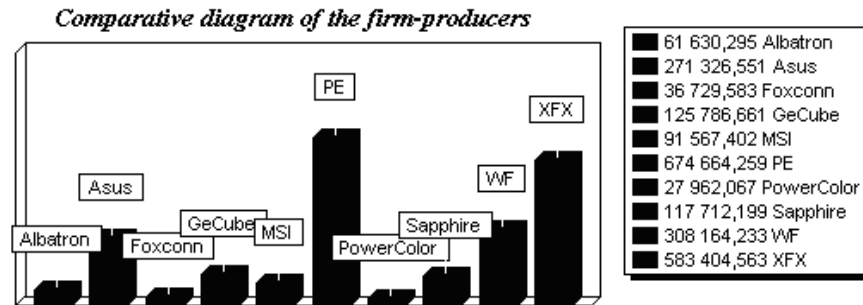


Fig. 1. Error-free running time for graphical processors of the different producers

By results of observations throughout three years was drawn conclusion: reliability of computer accessories, that intended for home PCs, practically does not depend from the price of a completing part. At the best, the availability factor matching type of devices is equal on all price range, and some-where, even, decreases with price growth. Matching results of observations for motherboards are presented on fig. 2.

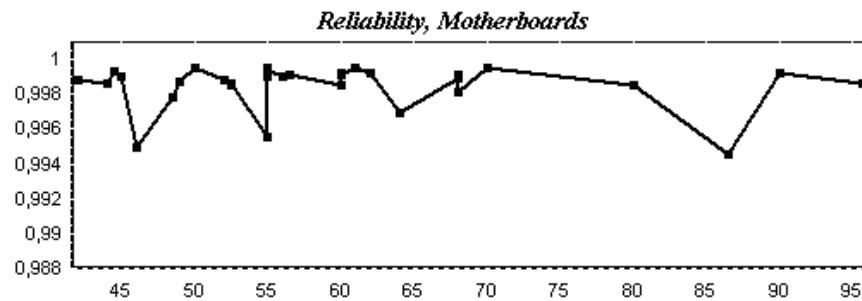


Fig. 2. Dependence of an availability factor on the price of the motherboards

Growth of quantity of the electric power, which necessary for normal functioning of the device, is making extra charge on the power module, that is reduces reliability of computer system as a whole. Growth quantity of the electric power based on growth of the price can demonstrate on an instance of graphical processors (fig. 3). Thus it is necessary to note, that the matching situation does not touch the central processors where producers reduced consumption level of the electric power for their products.

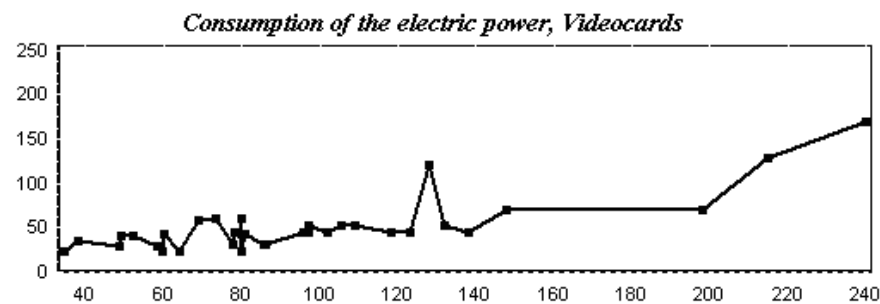


Fig. 3. Dependence of the electric power consumption on the price of the graphical processors

Optimization of computer systems completing was spent also concerning magnitude, which is equated to the relation of quantity of the executed operations by the device to a time, for which they have been executed. It's easy to estimate productivity with the help of the great count already existing software products [8]. Superinduced parameter of optimization directly characterizes system and intuitively clear for the usual user, and also provides universality of decision making concerning sampling of completing products. When parameters of reliability do not provide univocal result, definitive sampling lays on parameters productivity of the system, of course, if these parameters are not superfluous from the point of view of a price policy of the buyer.

Results of calculations have shown, that the expected gain of productivity at increase in cost of a completing part was justified except for the several cases caused by a marketing policy of firms-manufacturers.

Planning disposing of the developed software product on WEB resources, maintenance of continuous updating of data of completing elements reliability, maintenance and development of the design at the expense of new aspects and models of the computer equipment.

Creation of a similar resource considerably will facilitate work of system administrators, operators of server installations, heads of firms and the organizations, which plane purchasing of a new equipment, will divide a time for searching and selection of a necessary configuration behind the set reliability indexes and will provide completing of computer systems taking into account the important parameters: the price, reliability, power, productivity.

Besides, this work can be used for the purpose improvement of servicing for different firms, which are engaged in sale and service of computer technics, allowing them independently to select a configuration, to correct parameters and to choose completing parts according to reliability indexes and the prices; to be guided by data of the program for planning of the future nomenclature of completing products for a configuration of computer systems which will provide their maximum reliability and will allow to minimize expenses of the company for repair and service.

Conclusion. In article the basic methods of computer systems reliability estimation are observed. It was carried out their comparative analysis. It was defined the basic characteristics of computer devices. The optimization methodology of computer system completing with reliability criteria, such as: price, power and productivity – offered. Was developed computer program for virtual completing of the computer systems, estimation of dependences: price-reliability, price-capacity and price-productivity; both as for separate device, and for their group. It was determined ways of development and improvement of the gained achievements.

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