Problems In Creation Of The Mathematical Insurance Of High Technology Systems

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Abstract: **In this paper we investigate technical difficulty for creating by mathematical insurance of high technology systems, function in limited interval of time. These difficulties according to authors represent basic reason for realize by enterprise for this systems.**

We make analysis by basic arguments for followers and opponents of realization for these systems.

Key words: **mathematical insurance; function in limited interval of time; high technology systems**

INTRODUCTION

Lately the interest about the problems in creating reliability working mathematic insurance of High Technology Systems (HTS) for security of the society increase suddenly. In row publication on the West and on the East appeared developments of that problem. Those questions became subject of discussions in the committee about strategic and tactics nuclear forces in the Senate in the USA and in the Public word in Russia.

PROBLEM FORMULATION

Main difficulty in creating of that mathematical insurance is it's huge volume. Even the small programs for computers are rarely written without mistakes and they usually demand a lot of time for control and remove the errors in them. In the American press different valuations about the capacity of the mathematical insurance of HTS were citationed – from some millions to ten millions lines (operator for „Fortran", C^+, C^{++} in and other program languages).

Different valuations about the number of the possible errors in one thousand lines from the program were adduced – from 300 to 1 mistake. No arguments were emphasized for proving these dates. Paying the necessary attention on the traditional American love to the ciphers, we have to mark that the work is not only in them. One mistake in one thousand lines – is it many or not? And one mistake in ten thousand lines? One million lines for the program – how difficult is that to be done?

It seems that the questions, which are brought up in the American press, are not asked correctly. But, of course, the most important thing is not how many lines there are in the program, but how much work of high-qualified specialists is necessary for it's writing. Neither is important how many mistakes there are, but what could happen if there is only one mistake in the program.

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Nowadays there are scientific methods [2], which give the possibility to be valuated the volume of the program and the possible number of the mistakes in it. Of course, such valuations have statistic character. The comparisons of theoretical prognosis with parameters of really written programs in [2] show good condition.

PROBLEM SOLUTION

Let's try to value the volume of the program for mathematical insurance, the volume of the operation system in the central processor and the number of the mistakes in the mathematical insurance of HTS, using Holsted's methods [2]. If the total number of the independent incoming and outgoing parameters η_2 is known, then the number of the operators in the program is calculated by deciding the following equations:

$$\eta_2 = \eta_2^*.\log_2\left(\eta_2^*/2\right)\left(\eta_1 - 2\right)/\left(\eta_2^* + 2\right) + \eta_2^*, \qquad (1)$$

$$\left(\eta_2^* + 2\right).\log_2^2\left(\eta_2^* + 2\right) =,$$
$$\lambda\left(\eta_1 \log_2 \eta_1 + \eta_2.\log_2 \eta_2\right).\log_2\left(\eta_1 + \eta_2\right) \qquad (2)$$

where: λ - parameter, which characterize the program language (for "Fortran", C^+, C^{++} the middle value of $\lambda = 1{,}14$); η_2 - number of the operands in realization of the program (collective number outgoing, incoming and middle parameters, initiated during the process of realization of the program); η_1 - number of the operators in the program.

For better understanding the meaning of the initiated variable we will mark that on the operators in the program can be put in the appropriate verb tenses from the spoken language, and on the operands – the nouns. If we зададем $\hat{\eta}_2$ and λ, after we calculate equations (1) and (2), we can find the value of η_1 and η_2 and after that the total number of the symbols in the program (the dictionary of the program) $\eta = \eta_1 + \eta_2$ and the length of the program N:

$$N = \eta_1.\log_2 \eta_1 + \eta_2.\log_2 \eta_2 \ . \qquad (3)$$

Let's investigate what will happen, if we examine utmost decentralized case of the processor, connected to group of five sensors, and think, that the mathematical insurance of the whole HTS is integrated. From that assumption follows that the number of the incoming and outgoing parameters will increase about 50 times [1], i.e. we calculate that:

$\eta_2^* = 303.10^3$; $\eta_1 \approx 1{,}4.10^9$; $\eta_2 \approx 2{,}4.10^{10}$; $N \approx 8{,}4.10^{11}$. (4)

By that way it is received absolutely unthinkable for realization length of the program of ten milliard lines. From the shown values we can see, that for creating of mathematical insurance with sensible sizes is necessary utmost decrease of the parallelism of the operations. If we examine, what will be the volume of the work in programming and how many mistakes must be expected in programs with similar size, we will receive the time for programming $T_{ПР}$ formula [2]:

$$T_{PR} = \frac{N^2.\log_2\left[(\eta_1 + \eta_2)/2\right]}{4S}, \quad (5)$$

where: N, η_1 and η_2 are defined from (3), and S is parameter of Straud, which is changeable from 4 to 20 [2].

Formula (4) gives the possibility to be received for the first of the examined cases, where $\eta_2^* = 6060$, time for programming is $T_{ПР} \approx 10^{12}$ man's lives. The number of the mistakes in programming can be defined from [2] following:

$$B_{MIS} = \frac{N.\log_2(\eta_1 + \eta_2)}{3000}. \quad (6)$$

For The first of the inspected cases we get $B_{MIS} \approx 5.10^5$. For elimination of such number of mistakes will be necessary time exceed the time for writing the programs. Recently in the American press and in many European governmental it is militant discussed the problem with the mistakes in programming, and the principal possibility of creating a HTS. To that problem were devoted statements in the Subcommittee of the Senate of the USA about the tactical and strategic nuclear powers of two eminent specialists in the field of the communications and their program insurance – doctor David Koen (from the institute in informatics) and Salomon Buksbaum (from the laboratory of company "Bel"). They have announced themselves in protection of the program for construction of HTS for security [3; 4].

Let's scrutinize their arguments. Doctor Koen, disproving the dates, published in an article in newspaper "New York Times" from 1995 (where is made an valuation of the number of the mistakes in mathematical insurance – 300 in 1000 lines from the program), says that real relative number of the mistakes must be valuated with magnitude from 1 to 3 in 1000 lines from the program. In very attentive control of the program that number can be decrease to 0,1 mistakes in 1000 lines in the program.

Holsted's theory shows, that the relative number of the mistakes depends on the length of the program: in big lengths it increase approximately proportionally to the logarithm of the its length. The computations made earlier shows that in length of the program $\approx 10.10^6$ lines the relative number of the mistakes is 60 in 1000 lines from the program, i.e. is considerably higher from the number pointed from D. Koen. From Holsted's theory it turned out, that the numbers pointed from D. Koen, are valid only for relatively small programs, but nothing is said about the real lengths of the programs which insures the mathematical cover of HTS. However only one mistake in the program (without talking any more about 10^4 mistakes) can be reduced to zero effectiveness of HTS. Simultaneously Koen expresses certainty, that the huge difficulties which stands on the way of creation of the system in question can be surmounted, by the methods for creation of auspicious elements, used especially in the telecommunication's nets [5].

Analogical idea develops in his statements Solomon Baksbaum. He suggests HTS to be examined as a similarity of telephone net. And talking about the reliability of a work of the telephone centrals, which functioning is ensured from big computer programs with volume some millions lines, Baksbaum mentions, that exists methods for decreasing the number of the mistakes in the work of the telephone net. They reduce to duplicate of the elements and their own control.

Based on that he makes the conclusion, that the creating of auspicious mathematical insurance of HTS is possible, but he doesn't reject the extraordinary complexity of the task. Actually, the ideas of Karl Shanon and John von Noyman [6] about creating of reliable devices from reliable elements, by reserving the systems, are also well known. Wonderful example about that are the over fast computers, where the problem for the reliability of the triggers in integral execution is considerable.

But when Buksbaum talks about the trustworthiness of the big technical systems, he substitutes the task. The main difficulty in that case is the dependability of the material part (the hardware), not the mathematical provision and it's programming (the software), so it's the availability of algorithmic and program mistakes (failure in the meaning of reliability). For the present there are no means for fully excluding of the algorithmic mistakes, which are known. The elimination of the program mistakes is a constructive work, which demand very good, qualification of the programmers.

Here is the moment for making the analysis with a purpose-composing an analytical model of the effectiveness of functioning of HTS compound of N_{HTS} on number HTS. The whole HTS undoubtedly is an adaptive complicated system. The time t_i for advent of another failure in the whole system can be expressed by the time $t_i(H_i)$ for staying in relevant condition H_i, in agreement with formulas:

$$\begin{cases} t_1 = t(H_0), \\ t_2 = t(H_0) + t(H_1), \\ \ldots\ldots\ldots\ldots\ldots\ldots \\ t_N = t(H_0) + t(H_1) + \ldots + t(H_{N-1}). \end{cases} \quad (7)$$

For random i number of the failure ($0 < i \le N$), we get:

$$t_i = \sum_{j=0}^{i-1} t(H_j), \tag{8}$$

which permit us, in constant interval for normalize, to write an formula for effectiveness $E[T_{R\max}(N_{HTS})]$ of HTS considering N_{HTS} in number HTS in their maximal technical resource $T_{R\max}(N_{HTS})$:

$$E[T_{R\max}(N_{HTS})] = \frac{1}{N_{HTS}.T_{R\max}(N_{HTS})} \sum_{i=1}^{N} \sum_{j=0}^{i} \bar{t}(H_j) \tag{9}$$

where: $\bar{t}(H_j)$ is the mathematical hope of the time for staying of the complicated system from HTS in j condition.

For lineal process of maturing of HTS (which must be supported by respective service, considering the responsibility of the system), can be written:

$$\bar{t}(H_j) = \bar{T}(H_j) = \frac{1}{\varpi_{N_{HTS}}(\Delta t)}, \tag{10}$$

where: $\varpi_{N_{HTS}}(\Delta t)$ - middle intensity of the flow of failures in N_{HTS} for observing interval of time Δt.

Respective for the maximal technical resource $T_{R\max}(N_{HTS})$ of the system from N_{HTS} on number HTS can be written:

$$T_{R\max}(N_{HTS}) = \sum_{i=0}^{N} \frac{1}{\varpi_{PER}(\Delta t)}, \tag{11}$$

where: $\varpi_{PER}(\Delta t)$ - permissible intensity of the flow of failures in N_{HTS} for examined for interval of time Δt.

Therefore the effectiveness $E[T_{R\max}(N_{HTS})]$ of HTS will be defined from formula

$$E[T_{R\max}(N_{HTS})] = \frac{\sum_{i=1}^{N} \sum_{j=1}^{i} \frac{1}{\varpi_{HTS}(\Delta t)}}{N_{HTS} \cdot \sum_{i=0}^{N} \frac{1}{\varpi_{PER}(\Delta t)}} \to \frac{\bar{T}_{0,HTS}}{T_{R\max}(N_{HTS})} \tag{12}$$

Consequently the effectiveness of HTS will be defined asymptotic from the attitude:

$$E[T_{R\max}(N_{HTS})] = \frac{\bar{T}_{0,HTS}}{T_{R\max}(N_{HTS})}, \tag{13}$$

where: $\bar{T}_{0,HTS}$ - middle time for flawlessly work of one HTS from the whole observing extract.

Formula (13) is an analytical model of the effectiveness of functioning of HTS made from N_{HTS} on number HTS. From if follows a conclusion, that it is inefficient creating of a complicated system like HTS, functioning in unlimited interval of time.

Simultaneously on the increasing of the relative number of the mistakes in rising length of the programs must be paid attention, because it's extremely dangerous tendency, which put under doubt the principle possibility for formulation of programs with length above 10^8 lines. Until now that fact was skipped. The requirement for calculating tasks, connected with writing of program with similar length is a new approach to the programming, and may be a new method to the architecture of computers. The human brain is easily coping with such tasks, but in all probability it works on completely different principles and is self programming biological pattern.

Another approach for building of HTS is by using contemporary technologies for their construction. Data Mining (DM) is similar technology where implicit information with a huge volume database is pulling up. This is a new mighty technology with a big potential, which must help to the creating process where the attention is focused on the most important information from their database [7].

DM uses technologies like neuron nets, tree of resolutions and statistic techniques, for finding the biggest quantity of useful information – knowledgee. In HTS can be found techniques like [7]:

- Artificial Neural Networks (ANN);
- Classification and Regression Trees (C&RT or CART);
- Memory-Based Reasoning (MBR).

A new direction in the methodology of the projecting and constructing of such tape systems is the automation of that process using different types CASE (Computer Added System Engineering) means [8]. CASE means allows the time for development of the information systems to be curtailed many times, significantly to decrease the possibility for mistakes, by automation the first stage of constructing of the information system, to be insured the possibility for coordination and management of the work in a team.

By the medium of using CASE can be used the advantages of the structure approach in the detached stage in the vital cycle of the system. This is very common for the complicated information HTS [7]. That can be systems with multilayer architecture; the information systems based in the Internet, the information systems that use the contemporary technologies Data Warehouse, Data Mining, OLAP and others. Besides the process of projecting is quiet shortened, automation the activity of the system-analysers and the designers of the information systems; the documentation of the project of the information system is made easier; the value of the project is tracking. The connection between the different stage of the vital cycle are followed unstoppable, automatically a part from the program code during the creating of the diagrams and others is generated. These instrumental devices are common for projecting of existing information systems also.

CONCLUSION

1. In this paper is compound analytical model of the effectiveness of functionality of High Technical Systems. New approaches for their construction are suggested.

2. Because of the particular complexity of the programs for mathematical insurance, of the electronic chains, of their mutual connections inside the single component and between them, of High Technical Systems with big degree of probability is typical inner instability.

3. The creation of complicated systems like High Technology Systems, functioning in unlimited interval of time is ineffective.

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