SOFTWARE TOOL FOR EVALUATION OF RELIABILITY AND SURVIVABILITY OF COMPLEX TECHNICAL SYSTEM BASES ON LOGICAL-PROBABILISTIC METHODOLOGY

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I. INTRODUCTION

The paper presents software tool for evaluation of reliability and survivability for complex systems based on the logical-probabilistic approach. The correctness of suggested method and software tool was shown by computational experiments on some onboard equipment systems of small satellites (SS) similar to Belarusian SS, later compared with “Arbitr” software complex (certified by Rostechnadzor, RF [1]) results.

The software tool was integrated into the system of methodologies and software tools for evaluation, analysis and prediction of the values of reliability and survivability indicators for complex system. The system was integrated with the distributed software system for multi-objective assessment, analysis and prediction of values of reliability and survivability for OE SS developed in SPIIRAS (Saint-Petersburg, RF).

II. THE LOGICAL-PROBABILISTIC METHODOLOGY

In logic-probabilistic methodology a Boolean function as a logical model of system reliability and survivability is applied. It is called a logical function of the system operability (FSO).

A logical function of the system operability represents a set of states in which the system implements an appropriate criterion of its functioning (system health state). A logical criterion can be determined by different properties of the system.

The initial data for determining a logical FSO are:

- diagram of functional integrity (DFI),

- logical criteria of functioning (LCF) of system.

The features and restrictions of complex system design allow to apply one of the simplest methods of direct analytic substitution for FSO construction.

It provides a consistent replacement in the logical FSO of all integrative functions by their equations selected from the system. Such substitution is performed until there are no undeclared functions in the resulting expression. In other words, all integrative functions will be replaced by simple logical variables.

The functional elements commute with each other only through logical elements. Introduction of these vertices does not change the probability of failure-free operation and the reliability and survivability of the systems at all. As a rule, the scheme is created on the basis of four logical constructions (see Fig.1).

In order to create more complex structures, logical elements can be commuted with each other in any quantity. The width and depth search algorithms are used for graph navigation.

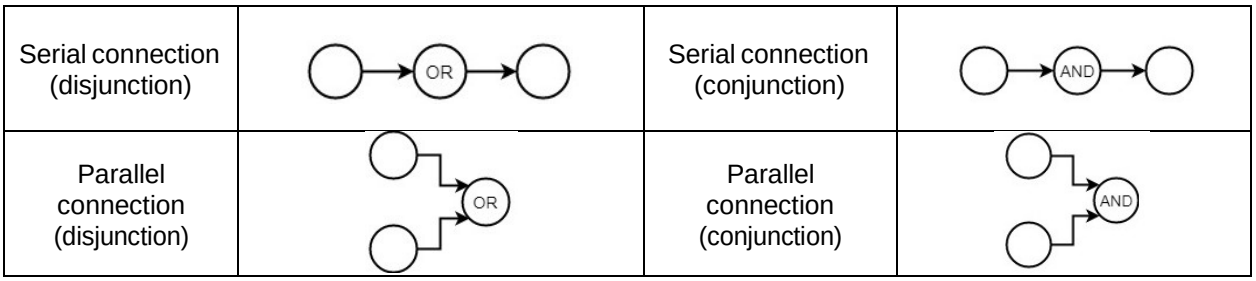

Figure 1. Basic types of logical constructions

At each stage for each structural node, the probabilities of failure-free operation and survivability are recalculated and transferred to the next vertex. Thus, each vertex contains information about calculations on all previous vertices. And whenever we get to any vertex, we can always get the probabilities obtained for the previous vertices.

Correspondent software tool, based on the logical-probabilistic approach and the proposed algorithm, was developed in two versions: a desktop version and web one. The software tool was designed to automate the process of evaluating the reliability and survivability of complex systems. The tool implements the following functions:

- graphical input and editing DFI representing a device under analysis (Fig.2);
- input and editing the system elements;
- calculating the single value of the system reliability for the given single arguments of failure-free operation probability for structural nodes;
- reliability analysis – calculating the values of the complex systems reliability for the series of elements probability arguments and drawing graphics (Fig.2), in this case elements probability parameters are equally changed by step;
- survivability analysis – calculating the survivability of complex systems with full and partial failure and drawing graphic, the damaging factor is applied to randomly selected *k* elements which reduces the probability of failure-free operation p_i of these elements to 0 in case of full failure and in case of partial failure to $\tilde{p}_i < p_i$ that can OE set throw interface. The experiment is repeated *N* times.

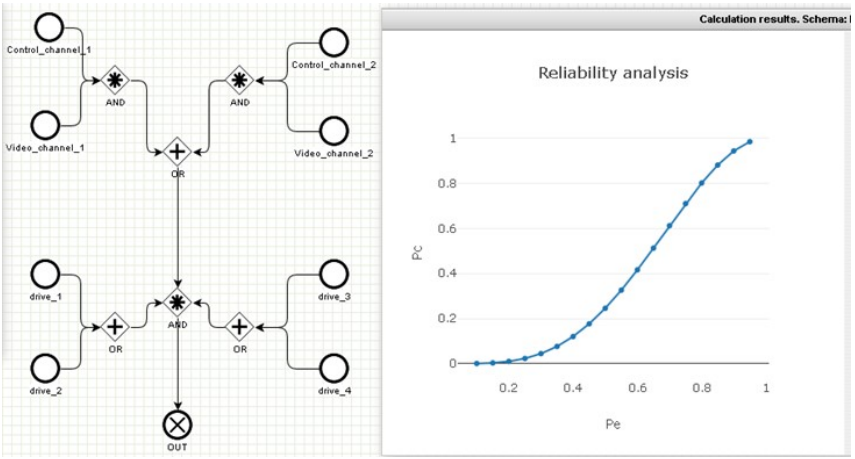

Figure 2. Window for calculating, reliability analysis (web-interface)

III. CONCLUSIONS

The evaluation of reliability and survivability of the complex technical systems, like BE SS is an important task of their safe and reliable design and operation. The logical-probabilistic theory of reliability and survivability allows objective identification of the "thinnest" and most dangerous places, causes and preferred combinations of initiating conditions, the protection against which prevents the system from getting into a dangerous state. Therefore, suggested approach and tool could be applied at the step of the development and modeling complex systems for project reliability and survivability assessment.

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REFERENCES

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