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CLASSIFICATION OF THE BASIC PARAMETERS FOR ESTIMATION OF RELIABILITY AND DIAGNOZABILITY OF COMPUTERS SYSTEMS

The classification of the basic kinds of parameters for rating of reliability and diagnozability of computer systems is given in this article. Such parameters were considered: of non-failure operation, of maintainability, of durability, of operational readiness, complex parameters diagnozability. The classification of failures has been presented.

computer system, failure, diagnozability, reliability, maintainability, longevity, operating readiness, reliability of software

Introduction

For the last two decades complexity and computer speed were increased in ten thousands times. The task which required years of calculations in 1983, it is solved for an hour today, and the modern pocket computer is far more powerful than personal computers then. But one has to pay for progress and improvements of the computers systems (CS). The more difficult CS is becoming, the more unsteadily and unreliably they function. The personal computers hang up regularly, internet sites pretty often stop to work. New software (SW) developed for the increase of CS productivity, from point of reliability frequently only worsens the situation. As a result annual expenses on support and repair CS much more exceed the total cost of equipment and SW both for individual users and for corporations. Traditional measures on the increase of CS reliability are counted on that operators operate without errors, and now in many cases exactly the system falls out on longer time precisely through their mistake, than through any other defects in the equipment and SW. The questions relating to the reliability estimation and CS diagnozability were examined in many works. For example in [1] the various aspects of dependability, principles of dependable CS construction are given, determinations of system primary properties are given: failure-free performance, readiness, serviceability, authenticity, functional safety, vitality, integrity, confidentiality. In [2] the analytical review of existent expert systems (ES) built-in in passive facilities of diagnosing of computer networks has been realized, advantages and disadvantages of ES has been considered to determinate the expediency of their use to solve the tasks of corporate computers networks diagnosing. In the article [3] the application of real time expert systems in the diagnostics has been investigated the computers systems.

Presentation of the problem. The time-out of CS cost too expensive, and sometimes they are even impossible. A the complex with the reliability in five "nines" works without failures time 99,999%, I.e. it is a standstill approximately 2 hours for 25 years in general. Transition from two "nines" to five allows to save nearly 90 working hours in a year. That's why the classification of basic types of parameters for reliability estimation and CS diagnozability on the different stages of life cycle is an actual task.

CS failure classification

One of major characteristic of CS reliability is failure-free performance – property of the object to save continuously working capacity during some time or error-free running time. The failure of CS is considered as event which consist in stopping of object ability to carry out required function. Classification of basic types

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of CS failure is given below:

– emergence failure: in hardware or program part;

– changes of CS parameters on time before failure: sudden (characterized by the salutatory value variation of object parameters) or gradual (arising as a result of gradual values change of parameters);

– character of failure existence on time: the failure (self-correcting or momentary failure which is removed by insignificant operator intervention) alternated (repeatedly occuring self-correcting failure of the same character), steady (not bringing to the stop until its reason is removed);

– possibility of detection: obvious or hidden;

– conditionality by other failures: dependent or independent;

– possibility of working capacity reconstruction after the failure: irremovable, removable on exploitation place, removed at the specialized repair plant;

– reason of emergence: constructive, manufacturing, operating;

– weight of consequences: critical (when the threat appears for the life and health of people, for the environment, considerable economic losses or non-fulfillment of responsible task) or uncritical.

CS parameters of Faultless work

As the failures in the computers systems are random events, value characteristics of CS diagnozability have probabilistic character, and their numeral values are determined and analysed by statistical and probabilistic methods. Let's consider the basic parameters of CS non-failure operation:

– mean frequency of failures, a (t_1, t_2) – the attitude number ratio of breakdown wares in time unit to the primary number of the tested wares on condition that all deffective are not restored;

– operating time – the duration or work volume of object, measured in any undecreasing sizes;

– mean operating time to failure (MTTF), $T_{cp} = \int_0^\infty P(t)dt$ – mathematical expectation value of object operating time to the first failure (makes sense only for the being restored systems);

– failures intensity, $\lambda(t) = \frac{1}{P(t)} \frac{dP(t)}{dt}$ – the conditional closeness of probability of object failure occurrence, determined on condition that the failure does not take place to the examined moment of time;

– mean time of the defective state(MDT) – the time expected value of object finding in the defective state;

– mean operating time between failures (MTBF), $T_0 = {}^{t}\!/_{M\{r(t)\}}$ – the ratio of total operating time of the restored object to the mathematical expectation of number value its failures during this work;

– the probability of faultless work, $P(t_{б.р.}) = P\{\tau > t\}$ – the probability that the failure of object will not occur within the limits of the set operating time.

CS maintainability parameters

Maintainability is the property of object, consisting in adjustability to maintenance and restoration of capacity for working state through technical service and repair under the condition of object operating, and also the conditions of maintenance service and repair procedure realization. Let's consider the basic parameters of CS maintainability:

– restoration probability, $P(t_в)$ – the probability that the time of efficient status object restoration will not exceed the set value;

– mean restoration time (MRT) – mathematical expectation of restoration time of object capacity for work after the failure;

– mean time to repair (MTTR), $T_в$ – the mathematical expectation of restoration time of object capacity for work after the failure.

CS durability parameters

Durability is the property of object to maintain the efficiency state before coming maximum state when the system of technical service and repair is set. The basic parameters of CS durability are represented below:

– resource – total operating time of object from the beginning of its exploitation or its restoration to the transition into maximum state;

– service life, T_{cc} – the calendar duration of exploitation from the beginning of object exploitation to transition into maximum state.

Operating readiness parameters

Operating readiness is the property of object, reflecting both the appearance of failures and the time of defective state. Property of operating readiness is properties combination of failure-free performance and object maintainability. Let's consider the basic parameters of operating readiness:

– mean coefficient of operating readiness, $\bar{A}(t_1, t_2)$ – the probability, averaged out on a given interval, that the object will be efficient at the given moment of time counted off from the beginning of work;

– mean coefficient of operating unreadiness, $\bar{U}(t_1, t_2)$ – the probability, average out on a given interval, that object will be unefficient at the given moment of time counted off from the beginning of work;

– mean time of the defective state(MDT) – the mathematical expectation of object time being the defective state.

Complex parameters of diagnozability

Let's consider the following complex parameters of diagnozability:

– coefficient of readiness, $K_{\Gamma} = T_0 / (T_0 + T_B)$ is the probability that the object will be in working capacity state in the arbitrary moment of time, during which the application of object on purpose is not foreseen;

– coefficient of operative readiness, $K_{O\Gamma} = K \cdot P(t_{б.р.})$ is the probability that the system will appear in the working capacity state in the arbitrary moment of time, except the planned moments, during which application of the system on purpose is not foreseen, and since this moment will work reliably during the given time;

– coefficient of the technical use, $K_{TИ} = T_0 / (T_0 + T_B + T_П)$ is the ratio of the mathematical expectation of time intervals of system staying in the working capacity state for some period of exploitation to the sum of the mathematical expectation of time intervals of the system staying in the working capacity state, downtime stimulated by technical service, and repairs for that period of exploitation;

– coefficient of efficiency saving, $K_{эф}$ – the ratio of efficiency parameter value for the certain duration of exploitation to the rated value of this parameter, calculated under the condition that the failures in the system do not appear during that period of exploitation.

The generalized circuit of choice of given parameters of diagnozability

In given tabl. 1 and tabl. 2 the choice of the nomenclature of non-failure parameters, maintainability or complex for objects of kind I and II accordingly.

Reliability parameters of CS software

Let's consider the following reliability parameters of CS software:

– the amount of program errors is the number of errors discovered in the program beginning with its exploitation to the moment examined;

– probability of the program faultless work is the probability that within the limits of the given operating time a program error will not be displayed;

– flow intensity of program errors is the conditional density of error emergence in the program, determined under the condition that error did not appear to the moment examined.

Table 1

Choice of nomenclature parameters for the objects of kind 1

Objects classification according to indications determining the choice of parameters				
According to assignment	According to the mode of functioning	According to the possibility restoration and services		
		Restored		Nonrestorable
		Served	Unattended	Served and unattended
Objects of concrete assignment	Objects of continuous long application	$K_г$ или $K_{т.и.}$, $T_о$, $T_в$	$K_г$, $T_о$, $T_в$	$P(t_{б.р.})$ или $T_{ср}$
	Objects of repeated cyclic application	$K_{ОГ(t_{б.р})} = K_Г \cdot P(t_{б.р.}), T_B$		$P_о$ и $T_{ср}$
Objects of general assignment	Objects of continuous long application and objects of repeated cyclic application	$K_{т.и.}$, $T_о$, $T_в$	$K_г$, $T_о$, $T_в$	$T_{ср}$
	Objects of unitary application	–	–	$P_о$

Table 2

Choice of nomenclature parameters for the objects of a kind II

Objects classification according to indications determining the choice of parameters			
According to assignment	According to the possibility renewals and services		
	Restored		Nonrestorable
	Served	Unattended	Served andunattended
Objects of concrete assignment	$K_{эф}$, $T_в$		$K_{эф}$
Objects of general assignment	$K_{т.и.}$, $T_о$	$K_г$, $T_о$	$T_{ср}$

Conclusions

It is advisable to use the considered parameters reliability and CS diagnozability on the stage of the automated planning of the diagnostic CS provision. It will allow to carry out more effectively the search of possible appearing defects on the stage of CS exploitation.

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