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MODEL-BASED ANALYSIS OF THE ESTIMATION OF INTEGRAL LEVEL OF SECURITY OF THE INFORMATION SYSTEM

Hnatiienko Hryhorii[1], Vialkova V[2].
1-2 Taras Shevchenko National University of Kyiv, Kyiv, Ukraine

ABSTRACT. Providing the functionality of the security system of any modern information system is relevant in every conceivable environment and in all areas of human life. Solving the problems, which encountered in relation to protection of the information, is a complex process, which is based on the system method that is used to create an integrated system of protection information. For developing a model of information security, we will assume that the intended purpose of the system consists of the sequential or parallel execution of tasks that provides the reliable functioning of all elements of the system. It suggested raising of task and different models of evaluation of informative strength of the system security. For the decision of task application of methods of theory of decision-making and artificial intelligence is envisaged

Keywords: information system, security level, integral security level

The problem of providing information security is important and currently central due to the intensive development of technologies and increased competition in market environment and international relations. Providing the functionality of the security system of any modern information system is relevant in every conceivable environment and in all areas of human life [1]. Solving the problems, which encountered in relation to protection of the information, is a complex process, which is based on the system method that is used to create an integrated system of protection information [1]. The quality of the functioning of the information security system depends on the quality of the functioning of the system elements. Therefore, model-based analysis of the integral level of the security of the information system is an actual strand of research and also an assessment of the quality of the functioning of the system elements, which is a reliable mechanism for determining the level of security of the information system generally .

For research investigation of the functioning of systems such models as theoretically-gaming, probabilistic, graph and matrix models are traditionally used [2]. For the assessment of the quality of the functioning of a complex information system, we will apply the tasks of collective ordering of objects, which is a wide class variety of tasks for modeling of practical situations in various subject areas [3]. Among the tasks of the adoption of decisions , the problem of organizing objects is distinguished by a large number of specific applications and is relevant as ever .

It should be reminded that a complex information system consists of hundreds of elements that complete thousands of tasks and can have different nature: for example,

providing information security of the system, maintaining the survivability of the information system, timely diagnosis of economic security, determining the level of physical security, a map of business processes organization, algorithms of interaction of some hierarchical system, etc.

Problem definition

For developing a model of information security, we will assume that the intended purpose of the system consists of the sequential or parallel execution of tasks that provides the reliable functioning of all elements of the system. Let us suppose that there is the resultant (aggregated, collective) seriation n of tasks $R^* = (a_{i_1},...,a_{i_n})$, $i_j \in I = \{1,...,n\}$, $j \in I$, which is based on some logic conclusions that characterizes the processes of functioning of some information system. This seriation R^* is based on the individual ordering of tasks that are accomplished k by the elements of the system $R^i = (a_{1_i},...,a_{n_i})$, $i \in J = \{1,...,k\}$, where $n_i, i \in J, -$ are the numbers of tasks in the individual ordering that are accomplished by the $i-$ elements of the system. Let us denote that $A^i, i \in J$, -subset of tasks that are accomplished by the $j-$ element of the system.

Considering that R^* represents the logic of solving a collective problem, tasks in the individual segregation could have indices , which are out of phase with the positive integers .For example, tasks $a_2 \succ a_5 \approx a_1 \succ a_6$ have conditional segregation R^1, at the same time tasks $a_4 \succ a_3 \approx a_7$ have conditional segregation R^2.The enumeration of tasks of the comlex of the information security emphasizes on the sequence of tasks in the functioning of the system.In the event if it is indicated that ratio in tasks is when $a_i \succ a_j$, $i, j \in J$, this means that in order for the system to function properly, these tasks must be realized consistently. In the event if $a_i \approx a_j$, $i, j \in J$, the tasks of ensuring the qualitative functioning of the system could be realized in a parallel way.

For this purpose ,tasks which are realized by various elements of the system and are not duplicated, i.e $n = \sum_{i \in J} n_i$ –i.e each task in the system is unique and each task in the segregation R^* appears only one time : $A^{i_1} \cap A^{i_2} = \varnothing, i_1, i_2 \in J$, where $\varnothing -$ the empty set.

Each task of providing qualitative and secure functioning of the information system from the set of tasks $A = \{a_1,...a_n\}$ is characterized by two parameters:

c_i^0 – the face value of fulfilment or nominal demand for resource , $i \in I$;

t_i^0 – the nominal time of fulfilment , $i \in I$.

The nominal resource requirements, particularly , price and time of completing the task, are the same values that are acquired during completing information security task routinely- - when it is realized by a system element that completes the task according to the a priori approved staffing schedule and none of the elements of the system is capable of completing this task better,besides it. For specific applications, the maintenance of a reliable operation of the information system could have additional options, but we will take in account this region under consideration according this work .

During the realization of $i-$ task $j-$ component of the information system ,it is known:

c_i^j – the real price of this task, $i \in I,\ j \in J$;

t_i^j – the real time of completing the task, $i \in I,\ j \in J$.

Each component of system routinely complete the tasks ,which are estimated for it and has limited capabilities for completing all of its subset of tasks:

$$\sum_{a_i^j \in A^j} c_i^j = C^j, \quad j \in J, \tag{1}$$

$$\sum_{a_i^j \in A^j} t_i^j = T, \quad \text{for } \forall j, j \in J. \tag{2}$$

The remarkable thing is that for some tasks it could be some restrictions,

$$\sum_{a_i^j \in A^j} t_i^j = T^j, \quad j \in J,$$

when for each element of the system or group of elements are applied limits on resources for the time of completing the task. When approaching these limits, the quality of providing information security of any element of the system is significantly reduced and appear threats to the information security of the entire system.

Restrictions (1) are the appraisement of completing the tasks as an element of the information system - an employee's analogue in the simulation of business processes, and restrictions (2) are limited by time-an analogue of the monthly norms of the number of working time in the functioning of organizations.

During the fulfilment of normative tasks, determined by the nominal tactical and technical characteristics of the information security system, the needs of the system and its elements in resources (1) - (2) are constant, and the quality of the tasks performed by all subsystems and the system as a whole is 100%. In practice, the

providing of such situation requires the usage of substantial resources and in some cases, is unattainable.

Nominal tactical and technical characteristics of the information security system are characterized due to the requirement of a variety of resources, in many organizations the most important of which are:

$\sum_{i=1}^{n} c_i^{0i} = C^0$ – the budget operation of system ,

$\sum_{i=1}^{n} t_i^{0i} = T^0$ – the general demand of time for completing system functions

Due to the fact that tasks are not duplicated, there is no need for direct redundancy.

Redundancy of the ability to complete tasks with different elements of the information system is potential, hidden: the functional moves to another element of the system, when the element, which according to the norm should perform the task, can not do this. But this is due to ancillary charges despite of a limited resource that uses the information security system.

It is necessary to develop a model that will reflect the system's reaction on various types of environmental influences and changes in the status of system elements. In this case, the quality of the functioning of the information security system and its elements should be evaluated, depending on the state of the system elements.

According to [1, 4], the most common methods in the field of information system security are three main methods of protection of the system: formal, static and classification. The assessment of system security is needed to create a mechanism and conditions for prompt response to threats to information security and manifestations of negative trends in the functioning of the system.For this, should be used a set of measures and countermeasures. The increasing of the objectivity and complexity of appraisal facilities of information protection based on the formalization of expert data has a promising future.

Developing a model of decision-making situations for information system security

During the process of functioning in real conditions, the situation described in the statement of the problem, could significantly differ from the normative. For example, in the case of a big organization, there are always employees involved in the information security system, which currently

- are at the hospital;
- are on vacation;
- sent on business trips;
- absent for unknown reasons;
- officially issued rejections;

- dismissed from work for various reasons;
- violate labor discipline and do not observe the order of the day;
- not due to force majeure circumstances;
- undergo adaptation and therefore do not perform qualitatively enough tasks;
- reduce the quality of functioning due to conflict situations;
- insufficiently high-quality work is carried out due to the influence of various factors of demotivation, etc.

For all the reasons stated above we could estimate, heuristic determine the current level of performance of each task and evaluate the quality of each task at the 100 percent scale.

If it happens a temporary or long-term failure of the system element, all functions that must be fulfilled by this element are not fulfilled by the system. For their implementation, it is necessary to make decisions about redistribution of functions or their replacement. For example, in the absence of an element of the system in time, its tasks can be:

- distributed to perform among other elements of the system;
- passed to execute one element of the system;
- ignored as such, without which the information system will not significantly lose its level of functionality.

Model 1. Distribution of tasks between the elements of the system.

Distribution tasks can be carried out only between those elements that can execute the tasks of providing of informative safety, in accordance with their qualification, present certificates and others like that. In this case necessarily it follows to take into account a few features.

At the decision of tasks that are not for the element of the system normative, undoubtedly quality of implementation of these tasks goes down by new elements that intended for temporal implementation of tasks. The level of quality of performance of objective is set individually for every case and can fold, for example, 80%. At a necessity the decision of the system of additional tasks an element, there is a situation of overload of element and that is why quality diminishes:

a) implementation of own normative tasks, for example, to the level of 90-95%;

b) implementation of additional tasks taking into account Heuristic 1.

Cost of resource of kind (1) in case of redistribution of tasks in connection with absence of one of elements of the system, can increase in an interval from 101% to 115% - for the increase of motivation of new elements to execute additional tasks. After taking into account of the features marked higher there is a count of resources that is needed for implementation of tasks of providing of informative safety in new circumstances. Clear that new values will substantially differ from normative. Thus quality of implementation of tasks, and consequently, and quality of functioning of the system will largely differ from ideal 100%.

Model 2. Transmission of tasks of absent element for their implementation by other element of the system.

At the considerable additional loading at the element of the system, that the tasks of absent element passed for implementation, largely go down not only quality of implementation of new tasks but also tasks that he executed normatively to it. In such model it follows to take into account additional features.

At the considerable additional loading on the element of the system, quality of implementation to them of additional tasks falls substantially, for example, after a linear function the parameters of that can be appointed separately for every situation of decision-making.

Loading on the elements of the system can not exceed some set size, for example, 2*T, where T is limitation at times, set by a formula (2).

It follows to weigh such on that a function can not be executed by the new element of the system on a greater percent, than percent of her payment is for every element.

At application of the described features determination of new levels of quality of implementation of tasks and quality of functioning of the system of informative safety comes true on the whole. In addition, there are changes in requirements in resources, that is needed for implementation of tasks that stand before the system, in new terms - at the transmission of all tasks of absent element of the system to other element.

Model 3. Ignoring of tasks, that was executed by the absent element of the system

If it is known that a system element is temporarily absent, and an experienced person understands that there is no urgent need for the task of this element, a temporary moratorium may be made to perform the relevant tasks.

If there is not an element accountable for the performance of autonomous objective, quality of performance of objective falls gradually, during some time. Conformity to law of falling of quality of implementation of tasks can be set separately for every individual case.

If a task for that a performer is not certain is not autonomous, id est, other tasks depend on her implementation, the function of change of quality of implementation of dependent tasks is set separately for every certain situation of decision-making.

A decision-making about ignoring of tasks, that temporally remained without a performer, is very responsible and needs the permanent monitoring from the side of person that makes decision or the inspector appointed by him. At each monitoring iteration, an assessment is made of the change in the quality of the functioning of the information system in accordance with the above-mentioned features.

Calculation of results of evaluation of strength of the informative system security.

After making decision about the redistribution of functions between the elements of the system or their substitution, the new values of resources for the tasks of the system and even qualities of their functioning settle accounts. On the basis of the got values, the function of belonging of levels of quality of functioning of the system to the fuzzy set (0,1) is determined. Going near determination of functions of belonging and algorithms of construction of functions of belonging on the basis of analysis of

frequency of values is driven to works [3, 5]. Id est quality of functioning of the system as a result of application of the described procedure will be characterized the function of belonging to the fuzzy set. In-process [4] it is suggested for realization of estimation of the system of informative safety to apply procedures of unclear expert evaluation of elements of the system that also can be used in future for perfection of model of estimation of informative strength of the system security.

It is thus possible to compare the level of providing of informative safety depending on application of decision about personalization of performance of objective. It maybe also to build functions for the linguistic variables entered a priori with such by an orientation names: "critically possible informative strength security", "risk functioning of the system", "sufficient informative strength security", "high informative strength security" and others like that.

Table of contents of base of knowledge of evaluation of quality of functioning

Practical meaningfulness of offer models will rise considerably, if to give to the person that makes decision, instruments for the evaluation of different variants of decision-making in relation to providing implementations of tasks, that had to be executed by the absent elements of the system. For the use of the described models of evaluation of quality of functioning of the informative system it is necessary to create the base of knowledge with such reference filling:

- interchangeable elements of the system and degrees of their interchangeability at a decision-making about substituting for elements;
- a limit on possibility of implementation or delegation of implementation of tasks, related to the hierarchical copulas in the system;
- a decouplig of tasks in the elements of the system and potential distribution of tasks for critical elements;
- functions of change of capacity of elements of the system at non-normative overloads;
- information about possibilities of duplication of some tasks by the separate elements of the system;
- priority of duplication of tasks by a few elements - in case of possibility and necessity;
- possibilities of temporal moratorium on implementation of some tasks;
- formulas of count of loading for the elements of the system;
- plugged of tasks in processes, criticism of implementation of some tasks, estimation of loss of level of quality of functioning of the system;
- an estimation of decline of quality of functioning of elements in default of co-ordination from the side of elements that carry out a management in the hierarchical system;
- taking into account of factors of falling of quality of functioning of the system: insufficient competence of element, that temporally executes a task, or overload of element by additional tasks.

Possibilities of application of different classes of models to the evaluation of informative strength of the system security

On the first stage of design the elements of the system can answer a non-orientable count - the fact of presence of tasks is specified only, without the gone into detail description of entrances-exits.

For the systems, that execute tasks among that there is a substantial order of implementation, it is necessary to apply the models of strict segregation of tasks, described in this work.

If the parallel processes of implementation of tasks are designed, then there can be the applied models of unstrict segregation - for the deeper working out in detail.

When there are cycles in intertask communication, it is necessary to apply the individual matrices of sequence of implementation of tasks - in such cases a resulting matrix of pair arrangement of tasks will be block-diagonal and substantially rarefied.

The metrical matrix of pair arrangement of tasks is used in the cases when substantial is pointing of terms between the offensive of events or beginning of implementation of tasks - for example at description of diagram of Gant with the help of matrices.

If these terms of implementation of tasks are unclear, then for the design of such systems there can be the applied matrices of pair arrangement of tasks with elements as functions of belonging.

The prospects of increase of adequacy of design of informative strength of the system security

For more complete taking into account of features of the real systems must be complicated the described mathematical model. In particular, it can take place by taking into account of such factors:

- an appropriation to the elements of the system of grades, determination of subordination between elements;
- establishing hierarchical connections between the elements of the system and determination of levels of influence of one element on other or absence of such influence;
- determination of a priori priority of tasks regardless of their ponderability from the point of view of cost or term of implementation:
- taking into account of coefficients of competence of elements of the system;
- an increase of working out in detail and level of model adequacy by description of sub-tasks; it is description of processes that set intercommunication between tasks and sub-tasks.

Directions of further researches

On the basis of the described approach the new raising of tasks and certain new going can be worked out near the increase of design adequacy:

- a priori evaluation of reliability of functioning of the system in the safe mode;
- determination of borders of decline of margin of safety of the system, estimation of threats of her to informative safety;

- an estimation of possible level of decline of informative safety of functioning of elements of the system and level of implementation of tasks;
- taking into account of presence or absence of connections between tasks: to influence of task on quality of functioning of other tasks;
- a decision of optimization tasks of prognostication of quality of functioning of the system, cost of providing of this quality and calculation of possible charges of time;
- proceeding in AQL of functioning of the system on leaving from the line-up of a few her elements: determination of necessary operating conditions.

Conclusions

It suggested raising of task and different models of evaluation of informative strength of the system security. For the decision of task application of methods of theory of decision-making and artificial intelligence is envisaged. The prospects of design the brought class over of tasks and application of new methods are certain for the increase of adequacy of models to the real informative systems.

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