Formalization of the Structural-functional Synthesis Problems of Information Security Systems

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Abstract: Modern information systems tend to increase the number of nodes and users, use fog, edge and cloud computing, spread across the territory of different states. This circumstance makes it difficult to apply the old approaches to the synthesis of information security systems, which are based on an combination of options. The situation can be corrected by the structural and functional synthesis of systems, during which both the structure and functions of the system are synthesized the same time. The purpose of the article is to formalize the tasks arising in the course of structural and functional synthesis. The article introduces the concept of a basic pattern as a necessary attribute for structural and functional synthesis, identifies options for searching for an approximate form of the basic laws. The corpuscular and wave properties of the system are determined. Corpuscular properties characterize the system as an object of the material world, wave properties describe the functions of the system. The possibility of transforming the corpuscular properties of the synthesized system into wave and vice versa is shown. The requirements are substantiated and the axioms of the operation of structural-functional synthesis, problems of the first, second and third kinds are formulated. Examples of the application of the proposed formalisms for the structural-functional synthesis of a cryptoconverter are given.

1 INTRODUCTION

Modern information systems (IS) tend to become more complex and distributed in space-time, with the emergence of the Internet of Things, cloud, edge and fog computing. Enterprises are transforming to the Industry 4.0 mode, which implies the integration of information systems of enterprises from different cities and even countries. Together with IS, information security systems (ISS) are becoming more complex. At the same time, approaches to the synthesis of information security systems are mostly based on an combination of possible options, which was justified for IS at the end of the last century, but is not quite suitable now due to the large number of possible options.

The problem of choosing from a large number of options is due to the very applied system synthesis process. Currently, the synthesis of systems is performed approximately according to the following algorithm (GOST 34.601-90, 1992; Koller, 1976; Muha et al., 2003):

1) to determine the purpose of the system;

2) to design the properties of the system;

3) proposing an instance of the structure, the properties of the structure are studied (structural synthesis is performed);

4) looking for functions that can be implemented on the proposed structure (functional synthesis is performed);

5) according to a certain rule, candidate elements are selected (mainly through a survey of experts);

6) the satisfaction of the result obtained will be checked. If the result satisfies the customer of the system, then the system is manufactured "in metal". At the same time, there is no guarantee that the obtained solution is optimal according to the selected

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quality indicators. If the result does not satisfy the customer of the system, then go to step 3.

7) if all options are exhausted, and the system does not satisfy the customer, then the expected properties of the system are adjusted and steps 3-7 are repeated.

Depending on the method used to synthesize the system, steps 3-5 can be swapped or repeated iteratively. In some cases, the search is directed. This approach to synthesis is of little use for complex systems such as modern information security systems. They include a large number of subsystems, which in turn are complex systems.

By a complex system we mean such a system, the elements of which are other systems (subsystems) (Kalinin, 2011). All systems containing subsystems are metasystems for subsystems.

Another important disadvantage of the existing methods for the synthesis of systems is "static". Those. “The development of a model of any system is carried out on the basis of a typical set of blocks (elements), determined by the subject area and the formulation of the task. And any typical set is actually a made decision. As a result, the area of possible variations in constructing the structure of the system immediately narrows and the process of optimizing the selected solution is difficult, which leads to the impossibility of obtaining the required parameters at the output of the system” (Muha et al., 2003). "Static" makes it difficult to automatically design the information security system and change it in real time. This is a significant limitation for ISS, because the environment in which ISS operates is aggressive, focused and, most importantly, rapidly changing.

2 RESEARCH METHODS

Applying the methods of systems theory to the synthesis of ISS, we can say that the structural-functional synthesis of systems will allow to remove the indicated shortcomings. When performing structural-functional synthesis, the choice is made not from ready-made structures with some functions, but from the elements on the basis of which the necessary structures are built. It is assumed that with the correct implementation of the structural and functional synthesis, the resulting structures immediately provide an opportunity to implement the necessary functions.

Summarizing the above, we can say that the modern synthesis of systems goes in three directions (Kun, 2003):

1. Synthesis of the structure for given functions and algorithms of the system (structural synthesis, functions are known).

2. Synthesis of functions, algorithms of functioning and rules of behavior of elements of a given hierarchical system (functional synthesis, the structure is known).

3. Synthesis of the structure of complex systems, including both the optimization of the functioning of the system, and the distribution of functions among the nodes of the system and the choice of their composition (structural and functional synthesis, the purpose and criteria for evaluating of the system are known, it is necessary to find both the functions of the system and the structure on which these functions can be implemented).

The second direction received the greatest elaboration. The issues of the first direction have been worked out to a lesser extent. However, in this direction of research, important general scientific results were also obtained. In the third direction, as noted in his works by one of the leading scientists Tsvirkun A.D., there are no systemically stated results. One of the main reasons for this, in our opinion, is the absence of a language suitable for structural-functional synthesis, and without language it is impossible to develop a theory (Cvirkun, 1982). A similar idea is expressed in (Sokolov, 2007). So, for example, Boolean algebra became the language of discrete mathematics and the theory of finite automata, the language of the theory of digital signal processing - matrices and actions with them. In systems theory, the language of set theory and elements of mathematical structures are used as a basis, and then languages of other theories are used to obtain specific results in applied fields (group theory, differential calculus, calculus of variations, graph theory, etc.). But the very designation of the synthesis operation is absent. Instead of the term “synthesis”, the term “choice” is mainly used, while it is assumed that all the regularities are known, on the basis of which a choice can be made from a set of alternatives, or the algorithm by which it is necessary to make a choice. The formation of the selection result is usually denoted by the symbols $\cup$, Σ. But the operation of combining does not say anything about the properties of the elements, the way of combining the elements into a system, the connection of the properties of the elements with the properties of the entire system and the goals of the entire system. The only those systems can be formed by the sum of the elements, in which there are no emergent properties.

3 RESEARCH RESULTS

From our reasoning, it becomes clear the importance of concepts such as the goal and property of the system. Let us consider them in more detail, then we will formulate the problem of structural-functional synthesis of systems and show what properties the operations should have, allowing to carry out structural-functional synthesis.

3.1 Basic Definitions of Structural-functional Synthesis

Many works are devoted to the concept of property, which are mainly philosophical. Having studied such works, one can understand the meaning of the concept, but it is difficult to use it in formalized operations. Mathematicians and scientists of natural sciences, as a rule, study some specific properties: properties of functions, groups, matter, light, etc., and not the concept itself, as such.

In (Encyclopedic Dictionary, 2009), the property is defined as follows.

PROPERTY - a feature inherent in an object and allowing it to be included in a particular class of objects. Distinguish between essential (substantial) properties of an object and insignificant, accidental - accidents.

PROPERTY, a philosophical category that expresses the relationship of a given thing to other things with which it interacts. Property is often viewed as an external expression of quality.

We will refer to the substantial properties as properties, without which the object will not be able to realize its purpose (to achieve the goal of its existence). It follows from the definition that a property is manifested only in interaction and is its characteristic (expresses a relation). In mathematics, the rule that characterizes the interaction is called a mapping. Let us formulate the definition of a property in set-theoretic form. Property - is a mapping of a set X (an object, the owner of a property) into a set Y (an object with which interaction is organized):

$$X \rightarrow Y$$

It follows from the definition that the appearance of a new object with which interaction is organized can lead to the appearance of new properties in the original object. This is true. For example, any object in the dark has a black color, and the color scale appears only in the presence of light (interaction of the object and light). A computer without an energy source has no performance, however, when energy is supplied, productivity appears (the interaction of a computer and energy).

In nature, as a rule, all studied subjects are systems, therefore we will further understand a subject as a system. Any system consists of elements. We classify the properties of the system on the following grounds and describe them in the proposed notation:

- by the way of creating:

- properties of the system, which are reduced to the properties of the elements of the system according to a certain rule. Such properties are specified by mapping the elements of one (original) set to the elements of the same set or a set obtained by combining elements from the original set: $R: X_{ev} \longrightarrow X_{ev} \cup B(X_{ev})$, where X_{ev} is the set of properties of elements, $B(A)$ is a boolean, given on the set A. For example, mass (formed by the sum of the masses of elements), volume (formed by transforming the volumes of elements), the probability of no-failure operation (formed by transforming the probabilities of no-failure operation of elements), a binary function (0 and 1 are fed into the input, 0 and 1) etc.

- system properties that are not reducible to element properties are emergence property: X_{ep}, $X_{ev} \cap X_{ep} = \emptyset$. For such properties, the mapping of elements of one set to elements of another set is specified: $R: X_{ev} \cup B(X_{ev}) \rightarrow X_{ep}$. For example, the maximum speed of a vehicle (engine power, drag coefficient, mass, etc. is assigned a new element - speed). The maximum flight altitude (energy capacity, aerodynamic characteristics, engine power, etc., the new element is assigned the distance to the Earth's surface), etc.

- by the way of presentation (let's draw an analogy with the wave-particle concept):

- corpuscular X_k - characterizing the system and its elements, as an object of the material world: reliability, color, mass, etc.

- following the laws of formal logic, we must divide the properties into corpuscular and non-corpuscular, among the latter to single out wave. However, at the moment, no other ways of representing an object, except for corpuscular and wave, are known, therefore we will assume that all non-corpuscular properties are wave X_f and characterize the functions of the system.The set of all properties of the X_S system can be represented as follows: $X_{ev} \cup X_{ep}$, or $X_S = X_k \cup X_f$.

Let us call the mapping R, which allows us to obtain the properties of the entire system from the properties of the elements, the basic law of the system's functioning. Any other laws are not basic for the system. Basic laws are described in terms of theories from which the system is considered. For example, for an unmanned aerial vehicle, the basic laws can be Newton's laws (as for a kinematic system), Kirchhoff's and Ohm's laws (as for an electrical system), laws in pattern recognition theory (as for an intelligent system), economic laws (as for an object with a value) etc. Please note that we have not said anything about the mapping type. It can be anything: function, functional, clear, fuzzy, etc.

In the theory of systems, dynamical systems are considered, as a rule, given in the terminal form:

$$S = \{T, Q, X, Y, \varphi, \psi\} \quad (1)$$

where

T is the set of points in time at which the system operates.

Q is the set of input situations, determined by the set of system inputs. The only tool to influence the properties of the system.

Y is the set of output situations, determined by the set of outputs of the system, we will call it simple properties, i.e. properties that can be measured directly.

X - a set (space) of states of the system - the motion of a dynamic system - constitutes internal properties.

ψ: T × Q × X⟶Y is the output mapping. A transformation according to which simple properties can be derived from intrinsic properties. If there is a transformation that makes it possible to obtain internal ones from simple properties, the system is an observable according to Kalman.

φ: T × Q × X⟶X is a transition mapping. A transformation that directly affects the intrinsic properties. If with its help it is possible to achieve any state from the set of admissible ones, then the system is controllable.

Let us call such representation (1) wave, i.e. representation of the system through its functions. If the system is given in the form of a graph, a reliability scheme, etc., then such a representation will be called corpuscular, i.e. representation of the system through its structure. Applying the above to the operations of synthesis, let us say that as a result of structural synthesis we obtain a system in a corpuscular representation, as a result of functional synthesis - in a wave representation. Obviously, the result of structural-functional synthesis should be a wave-particle representation of the system, or such a representation of the system, from which it is easy to pass to the corpuscular or wave one.

The concept of the goal and quality of the system helps to single out the substantial ones from all the properties of the system.

The goal (Lopatnikov, 2003) in economic cybernetics, systems analysis is the desired state of system outputs (final state) as a result of a controlled process of its development. It is set by the goal determination unit, which is included in the control subsystem. The states of the system (as well as its trajectories) are evaluated from the point of view of their conformity or inconsistency with goal. The mathematical expression (model) of such an evaluation is the objective function or the quality criterion of the system (in the case of system optimization, the optimality criterion).

In other words, the goal of the system's functioning is specified by forming in the sets T, Q, X, Y the values of interest to the creator of the system: $t^* \in T, q^* \in Q, x^* \in X, y^* \in Y$. In the general case, the values of interest are sets, and the goal itself is supplemented by criteria P, according to which the best is selected from the set of possible movements of the system leading to the goal.

Quality is the degree of conformity of an object to its purpose (Petuhov, 1989).

Mathematically, the presence of quality in a system can be written as $\exists t^* \in T, q^* \in Q, x^* \in X, y^* \in Y$, i.e. the properties of a quality system always allow the system to reach its goal.

If several variants of the system and its movement are possible, leading the system to the goal, you need to choose the best option according to the criteria set when formulating the goal. In order to assess the possible options for the system, consider such a property as integrity.

To determine the integrity, we will use the description given in (Hoode and Machol, 1962).

"Every large-scale system has a certain integrity. Although the system may not be tightly controlled from one central location, all parts of the system serve some common purpose; in a sense, they all contribute to the development of a certain set of optimal outputs from a given set of inputs, and the optimality is assessed according to a certain criterion of efficiency". Using the above, we define the integrity of the system ($R^{\propto}$) as a property showing how consistent the elements of the system are with each other, how they help the system to achieve the goal of its functioning. In other words, are the functions ϕ and ψ optimal according to the established criteria P, i.e. how efficiently (fast, cheap, accurate, etc.) they bring the system to the goal $t^* \in T, q^* \in Q, x^* \in X, y^* \in Y$. We define $R^{\propto} = 0$ for complete inconsistency of system elements and $R^{\propto} = 1$ for complete consistency.

The considered concepts are enough to formalize the problem of structural and functional synthesis.

3.2 Formalization of the Problem of Structural-functional Synthesis

Structural synthesis $\Sigma_S^\propto$ is an operation that results in the formation of the corpuscular properties of the system.

Functional synthesis $\Sigma_F^\propto$ is an operation that results in the formation of the wave properties of the system.

Structural-functional synthesis $\Sigma^\propto = \left\{\Sigma_S^\propto \overset{R}{\leftrightarrow} \Sigma_F^\propto\right\}$ is an operation that results in the formation of both corpuscular and wave properties of the system. Includes operations of structural and functional synthesis, interconnected through basic laws.

By the number of known initial data, the problem of structural and functional synthesis has varying complexity.

3.2.1 The Third Kind of Structural-functional Synthesis Problems

The initial data are maximal. The classical optimization problem, i.e. the problem of choosing from a variety of alternatives.

Given

$s \in S_{ev}$ - a set of elements available for synthesis with X_ev properties.

$X_S^* = \{X_{ep}, X_{ev}\}$ - required system properties.

$t^* \in T, q^* \in Q, x^* \in X, y^* \in Y$ are the goals of the system.

P - criteria for choosing the best version of the system.

R - basic laws that allow obtaining the properties of the system from the properties of individual elements.

It is required to find

$S = \Sigma^\propto(X_S, R, S_{ev}): x_i \geq x_i^*, \forall x_i \in X_S, R^\propto \to 1$ is an optimal system with X_S properties, synthesized from available elements with X_{ev} properties.

The solution to the problem of the third kind is currently the most studied. A typical example is the synthesis of systems, the functions of which can be written down analytically. In these cases, the form of the function, as a rule, immediately defines the structure: finite automata (Boolean function), control systems (transfer function), etc. The converse is also true, i.e. a ready-made structure defines a function that is implemented by the structure.

An example of the formulation of the task of synthesizing an information security system in (Hoode and Machol, 1962) "from the set of possible options for information security with given external system relations for control and interaction in the structure of the organizational and technical system (OTS), it is required to determine the set of admissible options for information security that ensure the specified efficiency of using the OTS in a conflict" .

The problem of the third kind for the synthesis of an information security system using graph theory is solved in (Mistrov, 2009). In the article (Kustov, Jakovlev and Stankevich, 2017), the author reduces the problem of synthesizing the information security system to the optimal justification of quantitative and qualitative requirements for the information security system at an acceptable cost. In the study (Tatarnikova, 2013), on the basis of the terminal model of the communication management system, the actions of a social engineer violating information security are synthesized, communication tools and methods are linked, the requirements for the structure and feedback of communication are substantiated, the necessary communication algorithms are selected depending on the observed reaction of the communication object.

3.2.2 The Second Kind of Structural-functional Synthesis Problems

Given

$s \in S_{ev}$ - a set of elements available for synthesis with X_ev properties.

$X_S^* = \{X_{ep}, X_{ev}\}$ - required system properties.

$t^* \in T, q^* \in Q, x^* \in X, y^* \in Y$ are the goals of the system.

P - criteria for choosing the best version of the system.

It is required to find

R - basic laws that allow obtaining the properties of the system from the properties of individual elements.

$S = \Sigma^\propto(X_S, R, S_{ev}): X_S \geq X_S^*, R^\propto \to 1$ is an optimal system with X_S, properties, synthesized from available elements with X_{ev} properties.

In the process of solving a problem of the second kind, the most difficult thing is the search for basic laws, which is carried out, as a rule, in various fields of science. For example, for a spacecraft, the basic laws will be the laws of mechanics, and electrical engineering, and discrete mathematics, etc. After the basic laws have been established, the problem of the second kind is simplified and becomes a problem of the third kind.

The problem can be partially solved if the basic law is sought approximately. In this case, we are talking about the use of neural networks, genetic algorithms, adaptation, etc. In (Gryzunov and Bondarenko, 2018), a DDoS attack detection system is synthesized. Different traffic properties are fed to the method input: the sequence of packet arrival, time intervals between packets, etc. The basic law by which the ISS is synthesized is not known, is sought in an approximate form using Kohonen maps. In the study (Chistohodova and Sidorov, 2017), in the form of basic laws, interscheme properties are generated, which are generated with the help of an intermediary in a semi-automatic mode.

The paper (Palopoli, Terracina and Ursino, 2000) considers the structural-parametric synthesis of an information security system from elements certified by FSTEC. The synthesis is carried out on the basis of a genetic algorithm in stages: the choice of the structure, the selection of parameters. The ISS requirements are set by the user in the form of the required IS security class.

3.2.3 The First Kind of Structural-functional Synthesis Problems

The initial data is minimal.

Given

$t^* \in T, q^* \in Q, x^* \in X, y^* \in Y$ are the goals of the system.

P - criteria for choosing the best version of the system.

It is required to find

$s \in S_{ev}$ - a set of elements required for synthesis with X_{ev} properties.

$X_S^* = \{X_{ep}, X_{ev}\}$ - required system properties.

R - basic laws that allow obtaining the properties of the system from the properties of individual elements.

$S = \Sigma^{\propto}(X_S, R, S_{ev}): X_S \geq X_S^*, R^{\propto} \rightarrow 1$ is an optimal system with X_S properties, synthesized from available elements with X_{ev} properties.

The problem of the first kind is the most difficult and demanded one. In this case, the customer of the system describes the purpose of the system (goals), formulates the criteria for choosing the best version of the system (performance criteria). According to the requirements and restrictions put forward, the properties of the system are formulated, the search for basic laws and the selection of elements made up the system are made.

Thus, in the process of solving the problem of structural-functional synthesis, it is necessary to solve all the existing problems of scientific research (Kalinin, 2011) (modeling, analysis of properties, observation, choice). Let us consider the operation of structural-functional synthesis itself in more detail.

One of the steps to solving the problem of the first kind is presented in (Zhukov, 2016). The authors propose the rules by which the hierarchy of information protection efficiency indicators is formed: from indicators of individual elements of the system to the indicator of the efficiency of the system as a whole.

Attempts to synthesize an intrusion detection system by solving a problem of the first kind are presented in (Dzhogan, Kurilo and Shimon, 2011). Researchers in (Gryzunov, 2006) synthesize a safety management system for a technosphere object.

3.3 Operation of Structural-functional Synthesis

The operation of structural-functional synthesis must meet the following requirements:

- to provide the ability to dock the corpuscular and wave representations of the system;
- to be scalable, applicable to all levels of the system hierarchy;
- to have variable arity, since at the beginning of the operation it is not known how many elements the finished system will contain.

The range of the operation definition is a set of properties of the X_S system. The operation binds the properties of the system to each other, therefore the range of values of the operation is also X_S.

The operation is defined over a set, which means it forms an algebraic structure. Let us introduce the basic axioms of the operation (Burlov, Andreev and Gomazov, 2018).

Existence of a neutral element

In the system, you can always find such a property that does not in any way affect the final result we expect. Such a property will be a neutral element $\exists e \in X_S, \forall a \in X_S: \Sigma^{\propto}(e, a) = \Sigma^{\propto}(a, e) = \Sigma^{\propto}(a)$.

The presence of a reverse element

Analysis of existing systems shows that death processes always coexist with the processes of reproduction, that for any body there is an antibody, etc. This allows us to make the assumption that there is always an inverse element in the system. $\exists a^{-1} \in X_S, \forall a \in X_S: \Sigma^{\propto}(a^{-1}, a) = \Sigma^{\propto}(a, a^{-1}) = \Sigma^{\propto}(e)$.

Associativity

In general, $\Sigma^{\propto}$ is not associative, therefore, groups cannot be formed on its basis. Algebraic structures that are not groups, as well as operations with variable arity, are currently the least studied, probably this is another reason for the poor study of issues of structural and functional synthesis. However, in those cases when it is possible to impart associative properties to the synthesis operation, and to form groups or even Abelian groups, structural-functional synthesis is relatively simple.

Let's consider an example of the application of the introduced concept.

4 RESULTS DISCUSSION

Formalization of the problem of structural-functional synthesis of the first kind

Suppose we need to synthesize a cryptographic transformer (CT) with a final performance Ω. Objective $\Omega \in \{\Omega_1, \Omega_2, \Omega_3\}$, performance evaluation criterion $P: \Omega \to max$.

Formalization of the problem of structural and functional synthesis of the second kind

Let CTs with capacities $\Omega_1, \Omega_2, \ldots, \Omega_{32}$ be available to us. This problem can be solved using 3 CTs with performance $\Omega_1, \Omega_2, \Omega_3$, which can be switched on parallel or serial.

An additional property of the i-th CT is (works / does not work) $\{L_i = 1, \overline{L_i} = 0\}$.

$$X_S^* = X_{ev} = \left\{\{\Omega_1, \Omega_2, \Omega_3\}, \{L_1, \overline{L_1}\}, \{L_2, \overline{L_2}\}, \{L_3, \overline{L_3}\}\right\}$$

Formalization of the problem of structural and functional synthesis of the third kind

The number of operating CPs will be called the configuration of the final CT $Q = L_1 + 2L_2 + 4L_3$. When the elements are connected in parallel, the actual performance does not exceed the total $R_1: \Omega \leq \sum_{i=1}^{3} \Omega_i$. With serial $R_2: \Omega \leq \min_{i=1;3} \Omega_i$. $= \{R_1, R_2\}$.

The formalization of the problem of the structural-functional type of the third is completed.

The solution to the developed problem is a parallel and, possibly, serial and mixed connection of the CTs. Given our criterion for evaluating efficiency, we choose a parallel connection. The solution can be written in the form of a logical-dynamic operator that simultaneously sets the corpuscular (fig. 1) and wave representation (fig.2) of the final cryptographic transformer.

$$\Sigma^{\propto} = \left\{{\Sigma^{\propto}}_S \overset{R}{\leftrightarrow} {\Sigma^{\propto}}_F\right\} = L_1\Omega_1 + L_2\Omega_2 + L_3\Omega_3$$

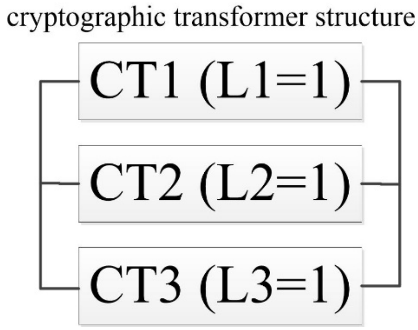

Figure 1: The corpuscular representation of CT.

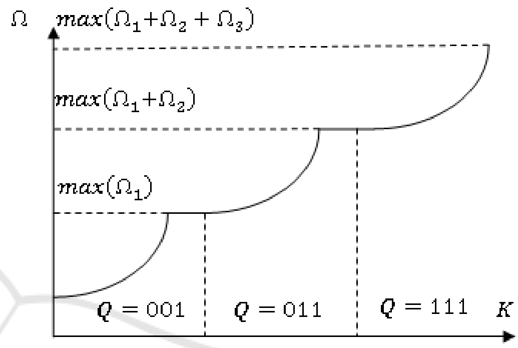

Figure 2: The wave representation of CT (CT phase space).

K is the number of tasks solved by the final CT.

For the practical implementation of structural-functional synthesis, appropriate methods are required.

5 CONCLUSIONS

The development of structural-functional synthesis is impossible without an appropriate language. Depending on the completeness of the initial data, three kinds of problems of structural-functional synthesis are possible. The problem of choosing from a variety of alternatives, which is being solved today in the process of systems synthesis, is part of the problem of structural-functional synthesis. The basic law required for synthesis can be found approximately using neural networks, genetic algorithms, methods of adaptive control theory, etc.

The operation of structural-functional synthesis forms an algebraic structure that is not a group, does not have associativity, has variable arity, neutral and inverse elements.

Further, for the practical application of the concept, it is necessary to develop:

- methods of formalizing the target purpose of the functioning of the system, searching for criteria for evaluating the system;
- methods of basic laws searching;
- methods that make it possible to reasonably deduce the requirements for the elements from the basic laws (the required number of elements, the main functions of the elements, etc.).

The concept proposed in the article can be used not only for the synthesis of information security systems and technical systems, but also for any other dynamic systems, for example, chemical elements, troops, state structure, etc., for this it is necessary to formulate the basic laws and develop appropriate methods.

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REFERENCES

Aleksandrov, P. (2008). Introduction to Group Theory, Bureau Kvantum Publisher. Moscow.

Burlov, V., Andreev, A. and Gomazov F. (2018). Safety Management of the Technosphere Object, based on the Law of Conservation of the Object Integrity. In *Technical and Technological Problems of the Service*,1 (43): 56-60.

Chistohodova, A. and Sidorov, I. (2017). The modernized method of low-rate distributed ddos attack detection. In *Achievements of Modern Science*, 1(12): 169-175.

Cvirkun, A. (1982). *Fundamentals of Synthesis of the Structure of Complex Systems. In Institute of Management Problems.* Nauka Publisher. Moscow.

Dzhogan, V., Kurilo, A. and Shimon, N. (2011). Features of the Synthesis of Performance Security Information in Computer Systems. In *Bezopasnost` Informatsionnykh Tekhnologiy*, 18(4): 170-175.

Encyclopedic Dictionary, 2009. URL http://dic.academic.ru/dic.nsf/es/51601/%D1%81%D0%B2%D0%BE%D0%B9%D1%81%D1%82%D0%B2%D0%BE. .

GOST 34.601-90. 1992. Information Technology. Set of Standards for Automated Systems. Automated Systems. Stages of Development

Gryzunov, V. (2006). Structure-Functional Synthesis of the Model of Intrusion Prevention System. In Problems of information security. Computer systems, 2: 31-38.

Gryzunov, V. and Bondarenko, I. (2018). A social engineer in terms of control theory. *In Third International Conference on Human Factors in Complex Technical Systems and Environments (ERGO)s and Environments (ERGO)*, pages 592-597. https://ieeexplore.ieee.org/document/8443835

Hoode, H. and Machol, R. (1962). *System Engineering*, Soviet Radio Publisher. Moscow.

Kalinin, V. (2011). *Theoretical Foundations of System Research: a Short Author's Course Lecture for Adjuncts of the Academy*, VKA named after A. F. Mozhaysky Publisher. Saint-Petersburg.

Koller, R. (1976). *Design Method for Machine, Device and Apparatus Construction.* Moscow. http://www.metodolog.ru/instruments.html#KOLER.

Kun, T. (2003). *The Structure of Scientific Revolutions. Logic and Methodology of Science*, AST Publisher. Moscow.

Kustov, V., Jakovlev, V. and Stankevich, T. (2017). The information security system synthesis using the graphs theory. In *XXIV International Conference on Soft Computing and Measurements (SCM'2021),* 1: 215-218.

Lopatnikov, L. (2003). *Economic and Mathematical Dictionary: Dictionary of Modern Economic Science*, Delo Publisher. Moscow, 5th edition.

Mistrov, L. (2009). Stating the problem of synthesis of information protection system in organizational-technical systems. In *The bulletin of Voronezh Institute of the Ministry of Internal Affairs of Russia*, 4: 137-145.

Muha, Ju., Avdejuk, O. and Koroljova, I. (2003). Algebraic *Theory of Complex Systems Synthesis*, VolGTU. Volgograd.

Palopoli L., Terracina G. and Ursino D. (2000). The System DIKE: Towards the Semi-Automatic Synthesis of Cooperative Information Systems and Data Warehouses. In *ADBIS-DASFAA Symposium*, pages 108-117.

Petuhov, G. (1989). *Fundamentals of the Theory of Efficiency of Purposeful Processes*. Part 1: Methodology, Methods, Models, MO USSR. Leningrad.

Sokolov, B. (2007).*Theoretical Foundations of Managing the Structural Dynamics of Complex Technical Systems.* http://masters.donntu.org/2007/feht/hudoshin/library/ar_7.htm.

Tatarnikova, T. (2013). The problem of synthesis of an integrated security system in GIS. In *Proceedings of the Russian state hydrometeorological university,* 30: 204-211.

Zhukov, V., Zhukova, M., Timokhovich, A. and Volkov, D. (2016). Program System of Structural and Parametrical Synthesis of An Information Security System. In *Software & Systems*, 4: 118-124.