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THE IMPLEMENTATION OF STRUCTURAL-PARAMETRIC SYNTHESIS OF DYNAMIC MONITORING SYSTEM IN CRISIS SITUATIONS

The article defines the criteria requirements for the implementation of structural-parametric synthesis of the dynamic monitoring system and the formalization of the problem of structural-parametric synthesis is conducted using a mathematical description: of a conflict situation; system of information processing for each of its separate elements (AWS) as a technical system without considering the impact on its properties; the information sources distributed in space; a description of the requirements for the implementation of the synthesis and evaluation of the system effectiveness. The system of equations is determined, which are the criterias of the system synthesis and can be used as indicators of efficiency of its functioning, and overall assessment and the condition measure the reflection in the system of crisis situations to resolve it.

Keywords: monitoring; criteria; information sources; crisis situation; structural-parametric synthesis; situational center.

The introduction

Local and global system of dynamic monitoring should ensure achievement of targets in conditions of dynamic changes of the external environment, the analysis of many factors, handle a large information arrays received from heterogeneous, distributed in the space information sources (InfS) with the adequate and relevant response to crisis situation (CS), which arise in this case. The variety and the a priori uncertainty on the type of CS requires using the situational principle of construction of the dynamic monitoring systems. The central component of such systems is the situation center (SC), which accumulates information from different InfS, it is automated processing and decisions are formed.

The analysis of existing approaches

The synthesis of complex multipositional information systems (MPIS) and accumulation system of the target information (information systems (IS)) involves the determination of their structure and parameters which are considered in the works of A. D. Tsvirkun, I. V. Kuzmin, Y. K. Ziatdinov, G. L. Baranov, T. G. Brahman, N. P. Buslenko, A. M. Voronin, V. S. Chernyak, E. Churov, Y. H. Vermishev, G. S. Antusheva and others. Traditionally, for the synthesis of structures MPIS optimization problem is formalized in one criteria form, or does not include obtaining analytical solution that does not ensure the incorporation of external conditions and flexible association of the meters in a single system.

On the basis of the specified systems for dynamic real-time environmental monitoring need to develop methods of structural-parametric synthesis of ergatic complex distributed information systems of monitoring and the accumulation of the target information using the methods of multicriteria analysis to take full account of the influential external factors and reflected the current situation in the structure of the system which is synthesized.

The purpose of the work

Depending on the content and substance of a controlled situation, it is necessary to develop methodological foundations of effective structural, situational synthesis of the monitoring system in conditions of high dynamics of changes of the current situation and the flux density of the CS. To create situationally structurally-parametrical configuration of the overall system to: determine available or suitable for using InfS and composition of SP; selection of executive elements.

Presenting main material

For the synthesis of the structure and determine the parameters of the monitoring system, we will carry out the distribution, respectively, at the level of InfS; systems of information processing and decision making; consumer information actions are aimed at addressing the CS. Formalization of the problem of structural-parametric synthesis begins with its mathematical description.

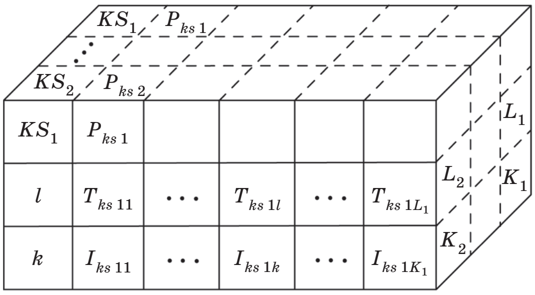
Description of the conflict situation is implemented as follows. Let may i-th ($i = 1,\dots, I$) КС — KS_i is characterized by many (the secure), consisting of triples: P_{ks} — a sign of the CS, which is unique for each type alphanumeric; T_{ks} — set (list) of partial tasks of the system for elimination of the arisen situation (to be generated, based on the objectives of the overall system and individual tasks AWS); I_{ks} — set (list) of the information needs of the system to eliminate the CS (agreed with the possibilities InfS). Then secure the set is given by the CS

$$KS_i = \left\{P_{ksi}, T_{ksj}^{KS}, I_{ksf}^{KS}\right\},\ i = 1, \dots, I,\ j = 1, \dots, J,\ f = 1, \dots, F; \qquad (1)$$

In turn, the set of partial tasks on elimination of the CS and the list of information needs for the CS can be represented as subsets:

$$\begin{aligned} T_{ks\,j}^{KS} &= \left\{T_{ks\,i1}, T_{ks\,i2}, T_{ks\,i3}, \ldots, T_{ks\,il}, \ldots, T_{ks\,iL_i}\right\},\ l = 1, \ldots, L_i, \\ I_{ks\,f}^{KS} &= \left\{I_{ks\,i1}, I_{ks\,i2}, I_{ks\,i3}, \ldots, I_{ks\,ik}, \ldots, I_{ks\,iK_i}\right\},\ k = 1, \ldots, K_i. \end{aligned} \tag{2}$$

The secures of the CS are stored in the database which is modified and updated in the system operation process of dynamic monitoring. As an example of the structure of the database, the CS can be represented in the form of a geometric model (draw. 1).



Draw. 1. The geometric model database structure of the CS

In the secure of the CS elements of sets $KS_i - T_{ks\,il}$, $I_{ks\,ik}$ — acquire the binary values according to the corresponding unit in the list of tasks to eliminate CS ($T_{ks\,il} = 1$), and corresponding information needs ($I_{ks\,ik} = 1$) and zero otherwise.

Linguistic characteristics parameters $T_{ks\,il}$, $I_{ks\,ik}$, are necessary for the performance of tasks by staff ergatic system dynamic monitoring contained in the knowledge base (KB) about the CS that is stored on the server side hardware supporting the SC.

Examples of the generated secures, the CS is presented in the formulas (3), (4):

$$\begin{gathered} KS_1 = \left\{P_{ks\,1},\ T_{ks\,1}^{KS},\ I_{ks\,1}^{KS}\right\},\quad P_{ks\,1} = a_1, \\ T_{ks\,1}^{KS} = \left\{\frac{T_{ks\,11}}{1}, \frac{T_{ks\,12}}{1}, \frac{T_{ks\,13}}{1}, \frac{T_{ks\,14}}{0}, \frac{T_{ks\,15}}{1}\right\},\ L_1 = 5, \\ I_{ks\,1}^{KS} = \left\{\frac{I_{ks\,11}}{1}, \frac{I_{ks\,12}}{1}, \frac{I_{ks\,13}}{1}, \frac{I_{ks\,14}}{0}\right\},\ K_1 = 4; \end{gathered} \tag{3}$$

$$\begin{gathered} KS_2 = \left\{P_{ks\,2},\ T_{ks\,2}^{KS},\ I_{ks\,2}^{KS}\right\},\quad P_{ks\,2} = a_2, \\ T_{ks\,1}^{KS} = \left\{\frac{T_{ks\,21}}{1}, \frac{T_{ks\,22}}{1}, \frac{T_{ks\,23}}{1}, \frac{T_{ks\,24}}{1}, \frac{T_{ks\,25}}{1}\right\},\ L_2 = 5, \\ I_{ks\,2}^{KS} = \left\{\frac{I_{ks\,21}}{1}, \frac{I_{ks\,22}}{1}, \frac{I_{ks\,23}}{1}, \frac{I_{ks\,24}}{1}\right\},\ K_2 = 4; \end{gathered} \tag{4}$$

The formula (3) shows that the CS with an alphanumeric sign, which is stored in the database by the first number, provides for the implementation of the SP five possible partial tasks, which required for implementation are first, second, third and fifth. For their implementation must be available in the system to three ((1) – (3)) of the four NFC.

Description of the system of information processing is implemented for each of its separate elements (AWS) as a technical system without considering the impact on its properties the efficiency of the operator is taken as a constant value regardless of the time interval of operation of the SC staff and the tension of the CS.

A mathematical description of the arm is done in terms of the form of the CS, since it is on these grounds will be structural-parametric synthesis system as a whole and for item-level information processing in particular. Each arm is characterized by many (the form AWS) from the list of tasks and information needs

$$ES_j = \left\{T_{ks\,j}^{ES},\ I_{ks\,j}^{ES}\left(I_{ks\,f}^{ID}\right)\right\}. \tag{5}$$

The elements of the set (3): $T_{ks\,j}^{ES}$, $I_{ks\,j}^{ES}\left(I_{ks\,f}^{ID}\right)$ — in expanded form, can be represented in the formula (4), and the functional designation $I_{ks\,j}^{ES}\left(I_{ks\,f}^{ES}\right)$ characterizes the relationship of information needs *j* AWS, that provides by information capabilities *f* InfS. The formation of specific descriptions of AWS in the form of sets (5).

In this case, the subset $I^{ES}_{ks\,f}$ carries a list of the *information needs* of the *j* AWS for the realization of potential possibilities of the CS post.

Description of information sources is characterized by the set of pairs (a secure of InfS): I^{ID}_{ks} — the list of (set) information capabilities of InfS; TC — a list of (set) technical specifications (TC) InfS, which are providing its capabilities:

$$ID_f = \left\{ I^{ID}_{ks\,f},\ TC_f \right\}. \tag{6}$$

The parameter I^{ID}_{ks} has similar to the foregoing description. The list of the same values (5) and (6), which are formed in accordance with (3), may not be the same. The TC-set includes, primarily, traditional for a particular type of media characteristics of the *individual* TC. To TC should include technical properties of InfS that arise (or are derived from the basic characteristics) when activated, the system dynamic monitoring and (or) in case of the CS. For example, the time of source availability, the efficiency of obtaining the necessary information, ensure completeness of information needs and the like, hereinafter called the *TC system*.

Forms of AWS (5) and InfS for each CS has known facts, previously included in databases and knowledge bases, which have relational and logical connection with the form of the CS.

Description of requirements for the implementation of the synthesis and evaluation of the effectiveness of the system. The solution of the problem of synthesis of this class systems must provide a definition of such its structure that the display of form of the CS on the description of AWS processing system in cooperation with InfS provide with high efficiency of elimination of the CS. Therefore, the description of the effectiveness of the system should include a list of parameters and criteria related to the level of reflection in its structure to the requirements of the form of the CS.

In general, the system, which is synthesized, must follow next requirements:

1) to provide a minimum amount of time spent on the removal of the CS, $t_{ks} \to \min$;

2) to have high reliability solutions, which are formed to eliminate the CS, $D_{ks} \to \max$;

3) to provide the best information redundancy for making decision to eliminate the CS $IN_{ks} \to \max$.

Thus, we have criterial requirements for the implementation of structural-parametric synthesis system dynamic monitoring (7):

$$\begin{cases} t_{ks} \to \min, \ \text{when} \ \ t_{ks} \le t_{ks\,POR}, \\ D_{ks} \to \max, \ \text{when} \ \ D_{ks} \ge D_{ks\,POR}, \\ IN_{ks} \to \max, \ \text{when} \ \ IN_{ks\min} \le IN_{ks} \le IN_{ks\max}. \end{cases} \tag{7}$$

Ensuring high reliability solutions requires an increase in the number InfS. This, in turn, *increases the time spent* on the implementation of the technological process of acquisition, transmission and processing of information about the CS. Thus, the system of criteria (7) is controversial, and the problem of structure-parametric synthesis system dynamic is given by multiobjective shape.

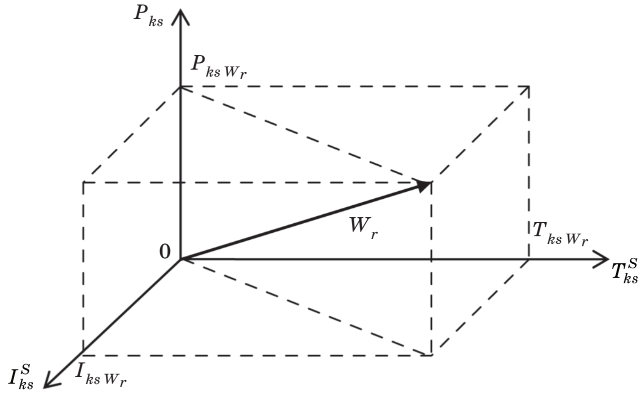
The limitations specified for partial criteria (7), are explained thus. The time of removal of the CS t_{ks} may not exceed a certain limit that correlates with the time of its existence, and should provide near real-time operation of the system. The accuracy of solutions to address the CS cannot be below a certain threshold, as determined at the design stage of the system and provide the level of information processing and the effectiveness of put in the basis of algorithmic components. The InfS choice with providing the best information redundancy IN_{ks} should be implemented within the constraints determined by information availability and adequacy of data on the CS.

The performance indicators that are directly or indirectly interconnected with parameters forms the CS, AWS and InfS, namely: the list of subproblems of the *overall system* — T^S_{ks}; the list of information needs for elimination of the CS — I^S_{ks}. Their relationship in the form of mathematical relations can be obtained by specifying the system type and the scope of its application. Binding the value of these indicators can be the number of AWS systems of information processing and, consequently, needed for the functioning of InfS.

Then, through some numerical scaling of the signs of the CS — P_{ks} (for example, proportional to the degree of closeness of the current situation of the benchmark database the CS), it is advisable to introduce *the vector of solutions* to address the CS — W_r. A graphical representation of the vector W_r is shown in draw. 2, and the procedure for calculating the numerical measure (length) — expression (8):

$$W_r = \sqrt{P^2_{ks\,W_r} + T^2_{ks\,W_r} + I^2_{ks\,W_r}}\,. \tag{8}$$

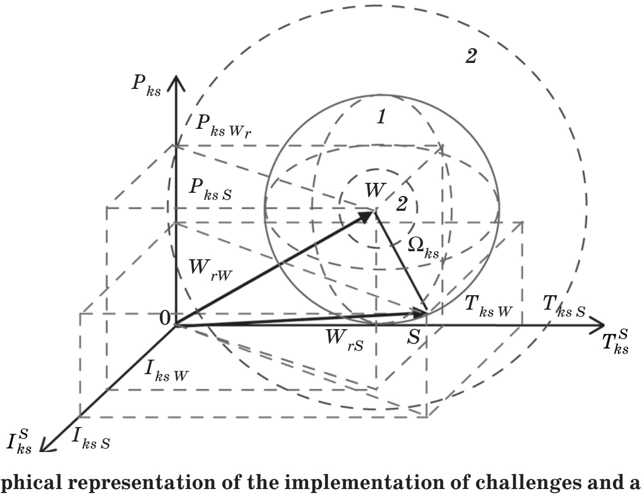
According to fact set the configuration of the system dynamic monitoring should introduce two concepts: *a vector of decisions* — $W_{r\,W}$ that determined the form of the CS and describes the system requirements, configurable by reflected in the structure of the current situation; *provide a vector of decisions* — $W_{r\,S}$ that characterizes the degree of reflection in the structure of the synthesized system this situation.



Draw. 2. A graphical representation of the vector of solutions to address the CS

In the general case, the vectors $W_{r\,W}$, $W_{r\,S}$ will not match, due to the factors of the two groups. The first should include the factors are based on the implementation of criteria requirements (7). So, for example, providing better information redundancy of the system response to the CS generates motion vector solutions in the plane $P_{ks}0I^S_{ks}$, and providing high-reliability solutions in the plane $I^S_{ks}\,0T^S_{ks}$. The displacement of solutions vector in the plane $P_{ks}0T^S_{ks}$ can be the result of the operation of the new system (like known) of the CS. In the event of a discrepancy between the *required and provided* vectors can be characterized by the *execution of the task*, which reflects the *deviation of the system*. The second group of factors of mismatch vectors $W_{r\,W}$, $W_{r\,S}$ should include the reason the three categories: errors, failures, external action. The first one includes the error: input data (measurements); system configuration; those that arise in the work of the software; generated by staff (operators AWS processing systems, actuators and InfS). The second category includes failures that occur in the work: equipment system (internal and external) channels of data from information sources to executive elements); energy supply system, etc.

The category of «external action» includes: the impact of complex electronic environment on the system (intentional or unintentional); the actions ergetico component. The discrepancy of this nature will characterize the *region of failure*, displays the *errors of the system*. The sizes of the areas of implementation and non-implementation tasks are defined at the system design phase, simulation methods with further adjustment for the operational phase of the real system. A graphical representation of the areas of performing and non-problem presented in draw. 3. In draw. 3 the notation: $P_{ks\,W}$, $P_{ks\,S}$ — a sign of the CS established the system requirements and provide a synthesized system respectively; $I_{ks\,W}$, $I_{ks\,S}$ — the need and provide the information needs of the system; $T_{ks\,W}$, $T_{ks\,S}$ — the necessary and performed confguraton system tasks Troubleshooting the CS; Ω_{ks} — *reject the system*. Set the coordinates form a parallelepiped, hereinafter called *a parallelepiped solutions*. Restrictions «above» the field of non-problem is conditional. In fact, the argument Ω_{ks} can serve as a measure of execution configuration system tasks according to his purpose.



Draw. 3. A graphical representation of the implementation of challenges and areas of errors
(*1* — execution task; *2* — field of failure)

The value of the system deviation is defined as the distance between two spatial points with known coordinates $W\left(T_{ksW};\ P_{ksW};\ I_{ksW}\right)$, $S\left(T_{ksS};\ P_{ksS};\ I_{ksS}\right)$ (draw. 3) according to example

$$\Omega_{ks} = \sqrt{\left(T_{ksW} - T_{ksS}\right)^2 + \left(P_{ksW} - P_{ksS}\right)^2 + \left(I_{ksW} - I_{ksS}\right)^2}\,. \tag{9}$$

For a specific system response to the CS, we can define limit values $\Omega_{ksPOR}^{\min}$ and $\Omega_{ksPOR}^{\max}$, what is the radius of the inner and outer spheres with center at the point W. Their surfaces delimit the field of implementation and failure to meet system targets. Then the condition that configuration system problems troubleshooting the CS will look like.

$$\Omega_{ksPOR}^{\min} \le \Omega_{ks} < \Omega_{ksPOR}^{\max}. \qquad (10)$$

The threshold $\Omega_{ksPOR}^{\min}$ represents the situation where the minimum requirements of the form of the CS for one reason or another are not met with configuration system, and the threshold $\Omega_{ksPOR}^{\max}$ is determined by the potential capabilities of the system response to the CS. It is shown that the region's failure to meet system objectives absorbs the scope of its execution. In this regard, we can argue about the complexity in a clear distinction between the concepts of deviation and error of the system. Therefore, when assessing the effectiveness of the system configuration and capabilities of its intended use to analyse the mismatch vectors W_{rW}, W_{rS} and borders of the area perform tasks, abstracting from the reasons behind it.

Conclusion

Thus, the system (7) is a criteria of the synthesis system and can be used as indicators of efficiency of its functioning, and overall assessment (9) and (10) serve as a measure of reflection in the system of the CS to resolve it. In a formalized form of structural-parametric synthesis of the dynamic monitoring system is formulated. In a formalized form of structural-parametric synthesis of the dynamic monitoring system is formulated as follows. To rectify the CS with the known form $KS_i = \left\{P_{ks\,i}, T_{ks\,j}^{KS}, I_{ks\,f}^{KS}\right\}$ must perform the configuration of the system response to the CS by determining the composition of the AWS system of information processing that is described by set $ES_j = \left\{T_{ksj}^{ES}, I_{ksf}^{ES}\right\}$, as well as InfS the set $ID_f = \left\{I_{ksf}^{ID},\ TX_f\right\}$. The system, as configured, must ensure that the task of eliminating the CS with efficiency, which satisfies the requirement (7) and the condition (10).

The solution of the multicriteria problem of *structural-parametric synthesis* will be carried out using methods of multicriteria analysis in two stages. The first determines the optimal quantitative composition AWS (structural synthesis system for quantitative composition) of the system of information processing in accordance with the criteria (7). This indirectly would place limits on the quantitative composition used InfS. The second phase is the choice of a particular workstation and InfS to ensure the fulfilment of the condition (10) that implements the synthesis of *qualitative structure of the system response to the CS*.

From the perspective of a system-wide approach system dynamic monitoring of environmental parameters should be considered as a complex distributed ergetico information system from a combination of elements: information tools (gauges, sensors, or sensors), the system of accumulation and processing of information with erational component; consumers of the output data or decisions. The functioning of this system is determined by the adequacy and completeness of structural models of synthesis, measurement information processing and decision support.

Bibliography

1. ***Tolubko, V. B.*** *The effective management of prospective networks / V. B. Tolubko, L. N. Berkman, L. O. Komarova // Link: industry-research-and-production magazine.— K.: SUT, 2013.— № 4 (104).— P. 3–8.*
2. ***System*** *dynamic monitoring of environmental parameters / [Yu. G. Danyk, V. S. Stogniy, M. M. Klymash, L. O. Komarova] // The problems of creating, testing, use and maintenance of complex information systems: col. works.— Zhytomyr: ZMI NAU, 2012.— Edit. 6.— P. 5–12.*
3. ***Monitoring*** *of the objects in conditions of a priori uncertainty of information sources: monograph / [Yu. Ya. Bobalo, Yu. G. Danyk, L. O. Komarova a. o.].— Lviv: Publisher Ukrainian Academy of Printing, 2015.— 360 p.*
4. ***Komarova, L. O.*** *An effective structure of the dynamic monitoring system of telecommunication network objects using mobile measuring devices in real-time / L. O. Komarova, V. B. Tolubko, O. O. Ilin // Telecommunication and Information Technologies.— K., 2014.— № 1.— P. 5–12.*
5. ***Komarova, L. O.*** *Methods of information and communication clusters in crisis situations: monograph / L. O. Komarova.— K.: SUT, 2014.— 395 p.*

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ВИКОНАННЯ СТРУКТУРНО-ПАРАМЕТРИЧНОГО СИНТЕЗУ СИСТЕМ ДИНАМІЧНОГО МОНІТОРИНГУ У КРИЗОВИХ СИТУАЦІЯХ

У статті визначено критеріальні вимоги щодо реалізації структурно-параметричного синтезу системи динамічного моніторингу та здійснено формалізацію задачі структурно-параметричного синтезу за допомогою математичного опису конфліктної ситуації; системи обробки інформації для кожного її окремого елемента — автоматизованого робочого місця (АРМ) як технічної системи без урахування зовнішнього впливу на її властивості; джерел інформації, розподілених у просторі, а також опису вимог до реалізації *синтезу та оцінювання ефективності системи. Побудовано систему рівнянь, що являють собою критерії синтезу системи і можуть використовуватися як показники ефективності її функціонування. При цьому узагальнена оцінка та умови ефективності характеризують ступінь відображення в системі кризової ситуації з метою її усунення.*

Ключові слова: моніторинг; критерії; інформаційні джерела; кризова ситуація; структурно-параметричний синтез; ситуаційний центр.

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ОСУЩЕСТВЛЕНИЕ СТРУКТУРНО-ПАРАМЕТРИЧЕСКОГО СИНТЕЗА СИСТЕМ ДИНАМИЧЕСКОГО МОНИТОРИНГА В КРИЗИСНЫХ СИТУАЦИЯХ

В статье определены критериальные требования по реализации структурно-параметрического синтеза системы динамического мониторинга и проведена формализация задачи структурно-параметрического синтеза при помощи математического описания конфликтной ситуации; системы обработки информации для каждого ее отдельного элемента — автоматизированного рабочего места (АРМ) как технической системы без учета внешнего воздействия на ее свойства; источников информации, распределенных в пространстве, а также описания требований к реализации синтеза и оценке эффективности системы. Определена система уравнений, которая является критериями синтеза системы и может использоваться в качестве показателей эффективности ее функционирования. При этом обобщенная оценка и условия эффективности служат мерой отражения в системе кризисной ситуации с целью ее устранения.

Ключевые слова: мониторинг; критерии; информационные источники; кризисная ситуация; структурно-параметрический синтез; ситуационный центр.

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АНАЛІЗ ОСНОВНИХ ЕТАПІВ УПРАВЛІННЯ В ТЕЛЕКОМУНІКАЦІЯХ: СИСТЕМА УПРАВЛІННЯ СКЛАДНИМ ОБ'ЄКТОМ

В основу будь-якого управління покладено інформацію про те, який необхідно мати об'єкт управління, тобто множину цілей такого управління. Ця інформація визначає об'єкт і систему управління. Тому ключовим завданням при проектуванні систем управління є проведення аналізу найважливіших її характерних особливостей та основних етапів управління складним об'єктом.

У статті здійснено алгоритмічний аналіз управління, за результатом якого ухвалюється рішення про створення системи управління і ступінь її автоматизації.

Ключові слова: система управління; телекомунікації; складний об'єкт; етап управління; множина цілей.

Вступ

Завдання управління телекомунікаціями полягає в забезпеченні тривалої та високоякісної роботи засобів і мереж телекомунікацій у процесі їх постійного вдосконалення та розвитку в умовах різноманітних змінних впливів.

Управління — це багатофункціональний процес. Загалом управління мережами та послугами телекомунікацій відповідно до його функціонального призначення можна згрупувати як *технічне*, *функціональне*, *оперативне* та *координаційне* (адміністративне управління та управління розробками й розвитком) [1].

Ці види управління мають здебільшого таке призначення:

- запобігання та усунення відмов обладнання, підтримка безперервної готовності системи до роботи (***технічне управління***);
- підтримка та узгодження робочих функцій і стимулювання продуктивності (***функціональне управління***);
- забезпечення високої якості обслуговування та адекватної реакції на зміну ситуацій у мережі (***оперативне управління***);
- запобігання та залагодження внутрішніх конфліктів, забезпечення високої продуктивності, безперервного підвищення рівня організації (***адміністративне управління***);
- висування нових ідей та визначення шляхів для їх технічного та організаційного втілення, оцінювання результатів (***управління розробками***);
- екстенсивний та інтенсивний розвиток мережі, розширення кількості користувачів і номенклатури послуг (***управління розвитком***).

З огляду на те, що наведені види управління взаємозв'язані, розвиток управління в цілому має здійснюватися вдосконаленням процесу виконання кожної з його функцій.

Розробці методів синтезу систем управління складних систем присвячено багато наукових праць вітчизняних і зарубіжних учених [1–9]. У науковій літературі здебільшого досліджуються різноманітні концепції побудови складних систем управління телекомунікаційними мережами, які в основному придатні для однорідних мереж, тоді як сучасні інфокомунікаційні мережі мультисервісні, тобто характеризуються широким спектром різноманітного обладнання, умов функціонування.