UDC 621.396

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THE CONCEPT OF THE ORGANIZATION OF INTERACTION OF ELEMENTS OF MILITARY RADIO COMMUNICATION SYSTEMS

In article offered new science concept, with the help of which the organization of interaction and coordination models of the elements of military radio communication systems.

Keywords: *telecommunication system, graph model, system solution.*

Introduction

Modern military radio communication systems (MRCS) are complex systems with distributed multi-contact structure, which uses the whole set of existing information transfer technologies and different combinations of communication channels, and also communication and technological equipment [1–4]. In addition, MRCS must function in a complex electronic environment under the influence of selective fading, the complex of natural and intentional interference [5–7].

Now there is no established, universal, unified methodology, which can be used to carry out the whole complex of measures on modeling, creation and adaptation of such systems. The lack of methodology leads to the emergence of a variety of approaches to their implementation that are based on intuition and experience of the developers, it uses a variety of technologies, standards, various methods and models, which leads to increased system cost.

Analysis of the known methods and techniques [8–11] showed that in them is revealed the issues of interaction of the individual elements MRCS in the synthesis of the whole system.

Therefore, the aim of this work is to develop a scientific concept for the organization of interaction of elements of the military system of radio communication.

Presentation of the main part

The creation and adaptation of MRCS associated with optimization and decision making, both at the level of several individual tasks and for the system as a whole. The main attention here should focus on the choice of alternative system solutions, mechanisms of their implementation and identify the most effective or basic version of the system. Therefore, we need methods that would at the earliest stages of creation and adaptation MRCS enough to correctly choose their parameters and structure, as well as to evaluate different quality attributes in order to obtain the system solution that does not require major changes in the future.

The problem of creating and adapting MRCS largely similar, so adapting existing systems should be based on multivariate synthesis of system solutions taking into account already existing systems and changing circumstances, in accordance with the principles of modularity and standardization [9; 12; 13].

Process multivariate synthesis of conceptual system solutions represented in fig. 1.

Implementation of the modeling system is proposed based on multilevel representation MRCS – hierarchical system of several interacting level, which correspond to a certain class practical task creating and adaptation with criteria-based quality assessment.

Our database of standard models are the models and parameters MRCS at each level of the hierarchy, and also necessary background information. In addition, the base includes network solutions and existing strengths in this area.

The most important module is the organization of interaction of the models of elements MRCS. Its functional purpose – the organization of the analysis module parameters and models, calculation module, accuracy assessment and calibration of the models. It implements the processes of interaction models of network elements. The analysis of characteristics models, analysis and harmonization of units of measure of input and output parameters of the models of elements of the system in the process of each specific task in the development of options MRCS. Analysis of the entire system on the basis of the hierarchical complex is carried out using a graph model.

The functionality of the analysis module parameters and models – determine the necessary system parameters at the decision of private tasks of creating and adapting and plotting on the criteria of quality assessment for each level of the system hierarchy.

Computation module designed to receive on the basis of theoretical calculation methods of the values of system parameters and characteristics, which can be a source of data for subsequent calculations MRCS in general and for each system element separately.

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Organization of interaction of models of network elements under different synthesis system solutions includes the following steps:

definition of parameters and characteristics of a software system;

analysis of the relationship between parameters and models of system elements based on the hierarchical structure of the modeling system;

calibration of the models, matching of input and output parameters of the system models and its elements, that is, the selection of appropriate tasks create and adapt (the definition of classes and subclasses of problems) identification of facilities of each system parameter to specific models;

the construction and analysis of graph models of military radio communication systems.

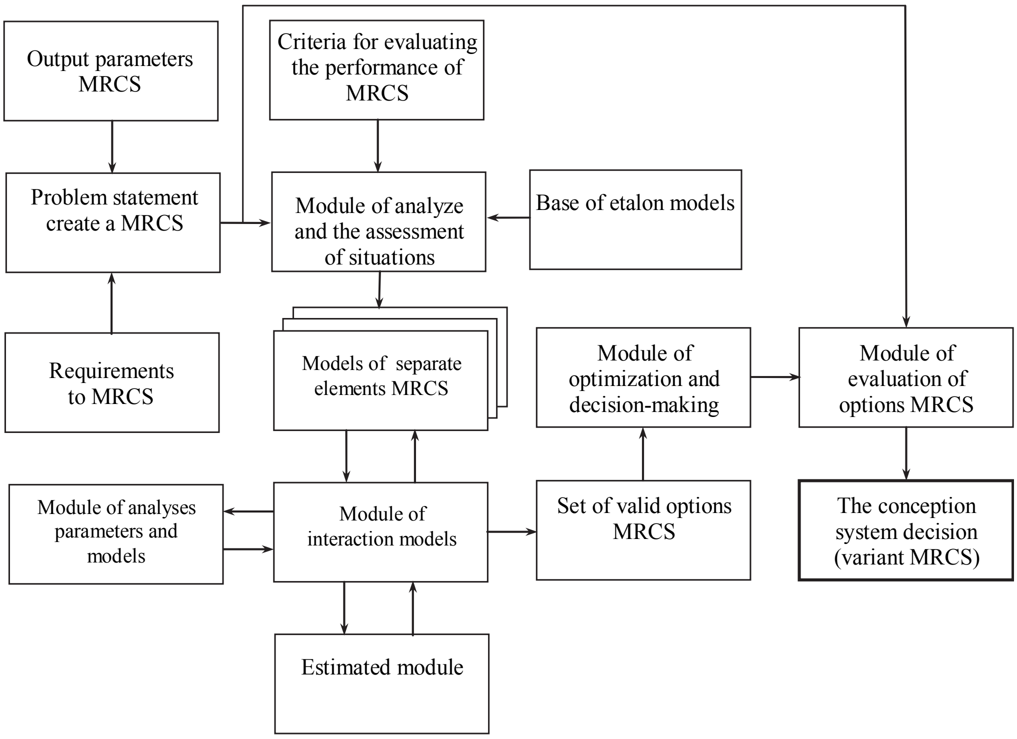

Fig. 1. Process multivariate synthesis of conception system decision of variant creation MRCS

MRCS presented in the form of a global managed network, telecommunication, consisting of numerous local subnet of the radio (fig. 2). Each subnet is characterized by the count $G_q(\mathbf{V}^q, \mathbf{E}^q)$ $(q = \overline{1, Q})$, where $\mathbf{V}^q = \left\{V_i^q\right\}$ – many nodes, and also $\mathbf{E}^q = \left\{E_{ij}^q\right\}$ – many areas of communication or separate radio links (radio channels) between nodes V_i i V_j. The nodes can perform the functions of senders, recipients or relays messages. In the future, we will consider the nodes and the channels that they are connected in the subnet radio q-th level MRCS.

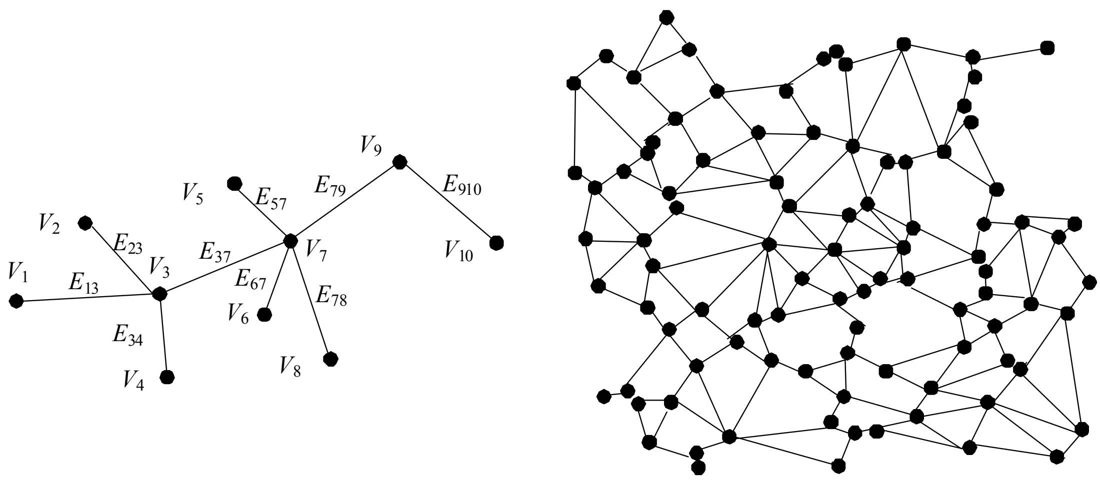

Fig. 2. Examples of structure models MRCS

The initial conditions for the solution of the problem of constructing adaptive MRCS is [3; 9]:

site settings V_i : the mode of operation of the radio communication means, signal power, probability of erroneous reception of signals, the dimension of the ensemble signal, the speed correcting code, the value of the code distance, the speed of information transmission; the number of active sub-carriers (orthogonal frequency multiplexing), the operating frequency, the speed of the algorithm and the frequency-hopping mode pseudo-random adjustment of working frequency;

radio channel parameters: frequency response estimate of the multipath channel, the signal/(interference + noise); the width of the channel bandwidth, the protocol multiple access channel bandwidth of intentional interference; the amplitude of the intentional interference; intentional interference.

The most important characteristics determining the count of the global network $G(\mathbf{V}, \mathbf{E})$, is:

matrix connectivity dimension $N \times N$:

$$\mathbf{S}(t) = \left\| s_{ij}(t) \right\|, \quad (1)$$

the elements of which are defined as

$$s_{ij}(t) = \begin{cases} 1, & \text{if } E_{ij} \in \mathbf{E}, \\ 0, & \text{if } E_{ij} \notin \mathbf{E}; \end{cases}$$

matrix-the column coordinates of locations of individual nodes (INL) in the space of size $(N \times 1)$:

$$\mathbf{K}(t) = \left\| k_i(t) \right\|, \quad (2)$$

where elements $k_i(t)$ – coordinates INL $R_i (i = \overline{1, N})$;

the matrix of mutual distancing INL size $N \times N$:

$$\mathbf{R}(t) = \left\| r_{ji}(t) \right\|, \quad (3)$$

in which elements $r_{ji}(t)$ – the distance between INL V_i i INL V_j $(i, j = \overline{1,N};\ i \neq j)$.

The dependence of matrix elements (1–3) time refers to the fact that the structure and topology of the global network radio can change during normal operation (for example, under the influence of the opposing system).

Denote by $\mathbf{R}_{ij} = \cup R_{ij}(m)$ many possible routes of transmission of message flows from INL V_i to INL V_j $(i, j = \overline{1,N};\ i \neq j)$ with the number of compiled plots t = 1, 2 (discussed only direct radio channels and workarounds using only a single relay messages). Then the connectivity of the switched full-mesh global network radio $M_{ij} = \left| \mathbf{R}_{ij} \right| = N - 1$.

Spend a hierarchical decomposition MRCS. In a distributed structure, the global public switched network radio select on the basis of operational purpose or regional basis Q local subnet radio $(Q > 1)$, each of which is characterized by undergraph $G_q(\mathbf{V}^q, \mathbf{E}^q)$ $(q = \overline{1, Q})$, where $\mathbf{V}^q = \left\{ V_i^q \right\}$ – many INL, and also $\mathbf{E}^q = \left\{ E_{ij}^q \right\}$ – many areas of communication or the individual radio links between INL V_i and INL V_j , in q-th subnet $(i, j = \overline{1, N_q};\ \sum_{q=1}^{Q} N_q = N;\ i \neq j)$. At the same time for $\forall q,\ p = \overline{1, Q};\ q \neq p$ rightly $\mathbf{V}^q \cap \mathbf{V}^p = \varnothing,\ \mathbf{V} = \bigcup_{q=1}^{Q} \mathbf{V}^q$.

If the transfer message flows in any of the routes involved in this area q-th subnet, it is impossible (for example, due to abrupt change of the propagation conditions on the track or interference operation), to transfer information to the addressee allocated to the radio links, used to work in a different, in particular, p-th subnet. The number of possible routes of transmission in each q-th subnet $M_q \leq N_q - 1$, and also the total number between the two INL in global network $M \leq N - 1$. All possible alternative routes of transmission of messages between any two INL any subnet of a radio communication using INL other subnets form a plurality of ribs

$$E' = E / \bigcup_{q=1}^{Q} E^q .$$

Size Q decomposition of the structure MRCS can be interpreted as the number of levels of hierarchy INL or the number of possible service areas communications (subnet radio with a variety of direct and compound channels between INL this subnet) in global communication networks. In principle, at the planning stage MRCS you can always ensure that the number of service areas was equal to the number of hierarchy levels INL on their operational aspects.

A hierarchical structure (or a structure with a rigid hierarchy) the radio network will be called the sequence of partial graphs (undergraph) $G_q (q = \overline{1, Q})$, comfortable with relationships of strict dominance

$$G = G_1 \succ G_2 \succ \cdots \succ G_q \succ \cdots \succ G_Q , \quad (4)$$

where $G_Q = G_Q(\mathbf{V}^q, \mathbf{E}^q)$.

Due to possible failure and recovery of a set of elements of the global network of radio communication initially established a hierarchical relationship between INL may be broken randomly. Therefore, in General case, the structure of radio networks will be of a probabilistic nature.

The accident of finding any partial graph of the subnet G_q on p-th level $q, p = \overline{1, Q};\ q \neq p$ leads to ensemble **A** hierarchical global structures of radio networks, characterized by graph G (**V**, **E**). Each structure a_q in ensemble **A** it is possible to assign the probability of its implementation, and therefore, determine on an ensemble of **A** the probability distribution function $P(a_q)$, where $a_q \in \mathbf{A}, q = \overline{1,Q}$.

Thus, a probabilistic hierarchical structure of the global telecommunication network will be called the ensemble **A** hierarchical structures with given it a probability distribution function $P(a_q)$:

$$P = \left\{\mathbf{A}, P(e_q) / a_q \in \mathbf{A};\ q = \overline{1,Q}\right\}. \qquad (5)$$

Such a representation MRCS allows to conveniently formalize the structure MRCS and to simplify quantitative assessment of the structural stability of the system.

In the process of organization of interaction of the models of elements in the creation and adaptation MRCS depending on the specific tasks and to save time and computing resources is the decomposition of the hierarchical multi-level graph model of the system based on the number of ties and analyzed in separate undergraphs. Next, set the required mathematical relationships between undergraph and, then, analyzes the system as a whole. Using multi-level graph model MRCS the creation and adaptation of the system you can start with any job (model), which corresponds to the vertex of the graph (one or more).

Conclusion

In this article proposed new scientific concept for interaction of the models of elements of military radio systems in the hierarchical structure of the complex, allowing to carry out the organization of interaction between the disparate models and their agreement on the parameters and characteristics MRCS, during the calculations, accuracy and units; to operate with the existing models, and to include in the complex of the newly generated model, enabling the possibility of replenishment, improvement and updating of models; to integrate the model of the complex depending on the specific situation, create and adapt; to model the network and their elements; to produce a variety of calculations and multilevel modeling; effectively measure the network parameters and characteristics.

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Надійшла до редколегії 20.01.2017

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КОНЦЕПЦІЯ ОРГАНІЗАЦІЇ ВЗАЄМОДІЇ ЕЛЕМЕНТІВ ВІЙСЬКОВИХ СИСТЕМ РАДІОЗВ'ЯЗКУ

І.О. Романенко, А.В. Шишацький, Р.М. Животовський, С.М. Петрук

В роботі запропонована нова наукова концепція, за допомогою якої здійснюється організація взаємодії і узгодження моделей елементів військових систем радіозв'язку.

Ключові слова: *система радіозв'язку, графова модель, системне рішення.*

КОНЦЕПЦИЯ ОРГАНИЗАЦИИ ВЗАИМОДЕЙСТВИЯ ЭЛЕМЕНТОВ ВОЕННЫХ СИСТЕМ РАДИОСВЯЗИ

И.О. Романенко, А.В. Шишацкий, Р.Н. Животовский, С.Н. Петрук

В работе предложена новая научная концепция, с помощью которой осуществляется организация взаимодействия и согласование моделей элементов военных систем радиосвязи.

Ключевые слова: *система радиосвязи, графовая модель, системное решение.*