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ARCHITECTURE OF NETWORK KNOWLEDGE BASE OF A COMPLEX MILITARY SYSTEM

Introduction

Problem statement. A complex military system in modern conditions should have a synergistic effect of interaction between components and elements in a conflict environment, taking into account the adaptability to the conditions and state of the troops in the following main areas [1, 2, 12]:

– a single methodological approach to build the organizational structure of the military system with a network knowledge base is using of modern special software, mathematical models and problems to support real-time management decisions, creating all levels of a single background;

– ensuring the adequacy of forces to perform the task as assigned, the coordination of actions of the forces with information and technical compatibility of the elements of the system (units), the elimination of tasks duplication and management functions in the group of troops;

– building the organizational structure of the military system with a network knowledge base during the transition to the states, systematization of knowledge, experience and development of leaders' thinking, organization of information and psychological struggle, ensuring timely response to changes and possible stressful circumstances during hostilities, increasing timeliness forces due to the maneuver, ensuring the balance of time to develop a plan of action in terms of their ephemerality, uncertainty and difficulties of a comprehensive assessment of the situation, its' generalization, etc**.**

Analysis of scientific research and publications.

In [1] the synthesis of adaptive structures of systems of anti-aircraft missile and artillery cover of military objects is considered, which is reduced to search of structure of components and elements of system and communications between them through network mathematical models which realization allows to satisfy the established requirements to efficiency of functioning of difficult organizational military systems with known resource constraints, etc.

Theoretical foundations of formation and degradation of complex organizational and technical systems [2] provide a description of this system without components, and in [4, 12] there is a problem of synthesis of the structure of a complex organizational system of military purpose and properties, but the knowledge base is not considered.

In [3] the basic concepts of the theory and practice of the Armed Forces of Ukraine on armed struggle in air and space, the basic definitions of a complex system, but not all terms of properties are used in the sense in which they are laid, new approaches to the analysis of properties and synthesis of the organizational structure of complex systems.

The architecture of the subject-oriented knowledge base of the intelligent system [5] is the knowledge base as the basis of any intelligent system. This is primarily due to the fact that the data model embedded in the knowledge base should be easily integrated with the data model embedded in the system itself. Most often, these models coincide. The knowledge base is considered as a set of software that provides search, storage, conversion and recording in memory of complex structured information units (knowledge). In general, the architecture of an intelligent system can be represented as an interface of user interaction with the knowledge base.

The ontology of design is provided in [6] on the construction of a model of the subject area by probing the service Google Scholar Citations

In [7] the representation of knowledge in the information system and methods of artificial intelligence and knowledge representation are considered, the basic concepts of artificial

intelligence and knowledge representation, various methods, basics of Prolog language, descriptions of OntoStudio and MatLab packages for solving problems and cluster analysis.

In [8, 9] the basic concepts of artificial intelligence and knowledge representation, various methods, basics of Prolog language, descriptions of OntoStudio and MatLab packages for solving problems are described, the textbook description presents a systematic presentation of the basics of knowledge representation theory in artificial intelligence systems. The description of the most significant currently models and technological aspects of designing systems based on knowledge is given. Particular attention is paid to the problems of knowledge engineering, and as the main approach to their solution is the author's method of situational analysis and design of the model of the subject area (knowledge base), but insufficient attention is paid to the network knowledge base.

In [10, 11] provided artificial intelligence systems as models, methods and technologies based on knowledge, artificial intelligence as the basis of future control networks regarding the use of computer technology, she believes, has already led to a huge number of unfinished design decisions digital systems. Opposing techno-chauvinism and social illusions about the saving role of technology. Only by understanding the limits of computer technology will we be able to dispose of them in such a way as to make the world a better place.

The unsolved part of the general problem concerning the knowledge base of a complex system of military purpose is the construction of the architecture of the network knowledge base in the subject area of militar arts, to which this article is devoted.

The research aims and objectives: to provide an interpretation of the basic concepts of the architecture of the network knowledge base and the construction of the organizational structure of a complex military system.

Statement of basic materials

In modern conditions, the greatest influence on the change of forms and methods of hostilities, globalization and implementation of the results of the scientific and technological revolution have tendencies of information and psychological struggle, ensuring timely response to changes in combat and possible stressful circumstances in complex military systems.

The military system consists of components and elements.

Components of the military system are its subsystems: fire, intelligence, control, engineering, technical support, etc.

Elements of the military system are military formations, with their capabilities for specific conditions.

The assessment of the effectiveness of the functioning of a complex organizational system for military purposes is carried out taking into account three axioms: at first, weapons and military equipment have certain tactical and technical characteristics; secondly, military formations have appropriate combat capabilities; thirdly, the military system has its own properties (synergy effect, hierarchy, emergence, efficiency and stability, adaptability, operational readiness, communicativeness, secrecy, reflectivity, validity, continuity, rationality, controllability, etc.) [2, 4, 12].

Tactical and technical characteristics of armaments, combat capabilities of military formations, properties of the military system are characterized by indicators, criteria and standards.

A complex system of military purpose is a set of interacting, simultaneously functioning components and elements built according to a single conception and plan, each of which performs one or more functions when military formations perform assigned tasks.

For the description and formalization, the complex military system is presented as [4, 14]

$$S = S\left(C, I, E, A^{i}, A^{ie}, A^{ei}\right),$$

where $C = \{C_1, ..., C_k\}$ – the set of components S;

$I = \{I_1, ..., I_p\}$ – the set of internal elements S;

$E = \{E_1, ..., E_q\}$ – the set of external elements S;

A^{i} – relations of elements (internal structure S);

A^{ie}, A^{ei} – relations between the elements (the structure of the links between the internal and external elements of S and vice versa).

At the present stage, the purpose of creating a military system is to ensure the effective use of groups of troops (forces) within a single system, regardless of their departmental affiliation and the rational use of existing resources.

The structure of the military system is the mutual location of its elements and the set of connections and relations between them, ensuring the integrity of this system and the ability of formations to perform tasks taking into account the basic properties of interacting subsystems and elements according to conditions and forces (Fig. 1) [1, 2, 8].

The input data of the system include data on external influence and management (A^{ei}, A^{i}). Management data correspond to commands to change the values of structural parameters to change the combat task of a group of troops, for example, commands to change the positions of units, teams to change the objects of cover, etc. Data on external influence on the military system include, for example, the values of the parameters of the preliminary reconnaissance of the composition and condition of the enemy, the values of the parameters of the enemy's strike, and others.

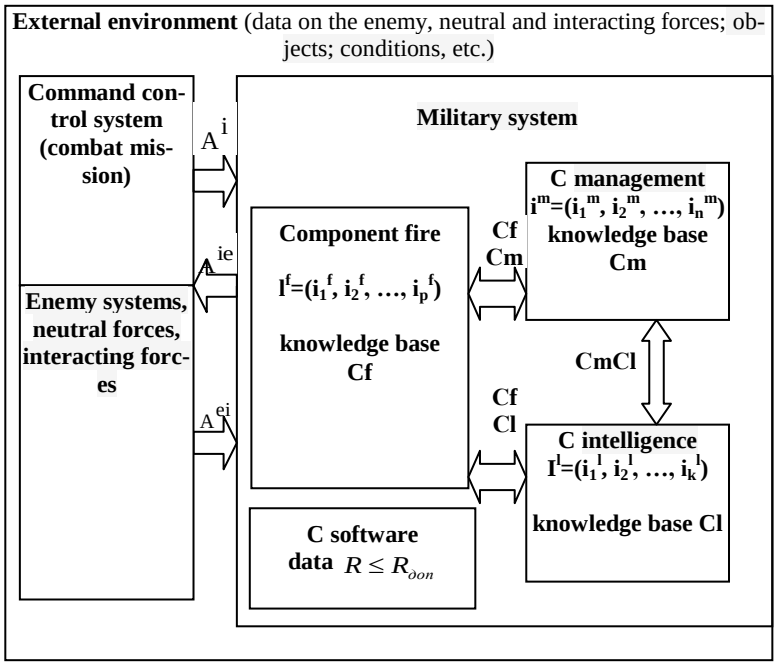

Fig. 1. Block diagram of a complex military system

To the initial data of the military system (A^{ie}) include, for example, the values of parameters for the effectiveness of hostilities, the structure of the system, etc.

The fire system as the main element of the structure is characterized by a set of values of indicators (spatial, temporal, probabilistic) $i^f = (i^f_1, i^f_2, \ldots, i^f_p)$, which determine both its structure and state parameters. Construction of the fire system is achieved by deploying elements of a group of troops in combat order.

The components of the fire system are the realized fire zones of the units located on the battle positions. Therefore, the structural parameters include the characteristics of the weapons in service (i^f_1), the coordinates of the main and reserve positions of the units (i^f_2), the area of fire (i^f_3), and others. A fair assumption about the inclusion of environmental parameters in the internal parameters of the fire system. For example, the terrain can be taken into account in the characteristics of the

weapon (i^f_1) in the form of a realized zone of fire for the entire spectrum of altitudes, and weather conditions in the form of the attenuation coefficient of radio waves and others.

Virtually all parameters of fire, intelligence and control systems should be determined by indicators that can be deterministic or stochastic.

Evaluation of the effectiveness of a complex military system and its components based on the results of modeling the actions of the parties creates a number of problems in terms of non-stochastic uncertainty of the parameters of the situation and actions of different parties, consisting of two classes: analysis tasks; problems of synthesis of the structure of a complex system (component).

When creating the structure of the system should be guided by the principles, among which it is possible to distinguish general and specific [3].

Thus, even in one subject area there are a large number of tasks on the elements of the military system that require the development and application of mathematical models. However, solving these problems encounters a number of serious difficulties. First, these tasks are solved at different times by different organizations and institutions. Second, often even in one organization, different tasks in the same subject area are solved using different models. Third, a single methodological approach to building the organizational structure of a military system with a network knowledge base is often impossible even in a group of troops.

To eliminate these contradictions, it is necessary to solve interdependent problematic issues: to develop tools for a military system with a network knowledge base, focused on a particular class of methods; to develop sufficiently universal models, with the help of which it is possible to solve all or at least most of the problems in one or another subject area and to achieve their approval as industry standards; develop specialized models to solve individual problems that provide an estimation of all or part of the input parameters of the universal model.

This technology of construction and evaluation of the effectiveness of a complex military system with a network knowledge base avoids existing shortcomings, and most importantly, can significantly increase the adequacy of models and tasks, consistency and effectiveness of decisions.

Knowledge base is a special kind of database designed to manage knowledge (metadata), ie the collection, storage, retrieval and dissemination of knowledge. Knowledge-based systems are implemented on the basis of the following intelligent algorithms: expert systems; neural networks; fuzzy logic; genetic algorithms [5, 11, 12].

Expert systems are considered together with knowledge bases as models of behavior of experts in a certain area of knowledge using the procedures of logical inference and decision making, and knowledge bases – as a set of facts and rules of logical inference in the chosen subject area of heuristics activity.

The main task of heuristic activity is to build models for the process of finding a new problem for a given object (phenomenon, process). There are different types of such models, among them are some options: the model of blind search, which is based on the method of trial and error; the labyrinth model in which it is possible to solve a problem is considered as a labyrinth, and process of search of the decision – as wandering on a labyrinth; structural-semantic model, which is based on the fact that the basis of heuristic activities for solving the problem is the principle of building a system of models that reflects the semantic relationships between the objects included in the problem [5, 7, 8].

The most well-known class of such programs are expert systems designed to find ways to solve problems in a particular subject area, based on knowledge base records and a user-defined description of the situation. Simple knowledge bases can be used to create expert storage systems in the organization: documentation, manuals, technical support articles.

The main purpose of creating a knowledge base of the military system – to help the commander to find an existing description of the method of action of units (strategy) to determine the design of hostilities in any difficult situation.

Regarding such a model, the knowledge base should solve the problem: search for the necessary information to the commander (both embedded in the database and indirect information derived from

existing); transformation of the received information into a model of knowledge used within the intellectual system of military purpose and interacts with the knowledge base as an interface of interaction of the commander with the knowledge base; timely updating of knowledge inside; maintaining the integrity and adequacy of information on the implementation of combat missions by assigned units.

Such a subject area of the knowledge base of the military system can be provided in the form of a subject-oriented model, which is based on the fact that the algorithm of logical-analytical activities of the commander and the principle of building network models to support decisions on combat or other decisions that significantly affect to perform a combat mission.

Research and modeling of the management process show [1, 3, 4, 12] that the decision support process should be considered consistently in the form of image of the process: plan-schedule; algorithm; network schedule; network model.

When developing the algorithm of logical-analytical activity of the commander and the staff, the following features are taken into account: this algorithm must correspond to the general system approach to the preparation and conduct of hostilities; the algorithm is divided into separate logical-analytical, informational and computational problems, the solution of which determines the order of application of automation tools, models, methods; the algorithm should be implemented programmatically.

The construction of network schedules for decision support is a continuation and detailing of the algorithm of the commander and staff by determining the required and available time of their work and units that have random values. The network schedule corresponds to the sequence of tasks and functions of management of officials.

To graphically describe the network model, we will use the following notation "goals" and "relationships" (Fig. 2) [1].

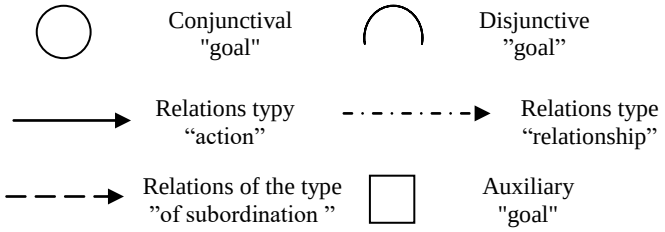

Fig. 2. Graphical notation of "goals" and "relationships" of the network model

An example of a mathematical network model to support combat decisions is given in [1].

The network model in the form of defined "goals" and "relationships" most fully reflects the order of the governing bodies when deciding on hostilities and other activities. It can be informationally detailed according to the stages of this activity of officials on the tasks, the solution of which is assessed by partial indicators of importance, reliability, completeness, accessibility, detailing of information.

In general, the architecture knowledge base of the intelligent military system can be represented as the interface of interaction of the C-commander (E-expert, O-operator) with the network (Fig. 3).

The internal imagination of knowledge in the knowledge base (formal program-logical content) should be implemented in the form of a matrix of contiguity, reflecting the relationship and interconnection between the target institutions, as well as a set of such directories [1]:

– catalog of target installations (CTI);

– catalog of initial conditions (CIC);

– catalog of resources (CR) of groups of troops (time, material, combat and quantitative composition) used, their costs and replenishment;

– catalog of rules of resource consumption (CRC) and the choice of criteria for their allocation in the process of use.

When replenishing the knowledge base, it is advisable to control the correctness of the changes, their compliance with the concept laid down in meta-knowledge, control the contradictions with the existing structure of target settings. Extraction of knowledge from the knowledge base is carried out by the algorithm of logical inference in the process of synthesis of the system structure during decision making and the algorithm of comments (explanations) when disclosing logical and factual premises, on the basis of which these recommendations are formed.

The composition and relationship of all formal and logical means of knowledge base to support decisions on the preparation and conduct of hostilities are shown in Fig. 3 [1, 3].

The structure of the knowledge base is a three-dimensional array of matrices, each plane of which corresponds to one of the above directories. It is advisable to define the following arrays corresponding to the directories:

– matrix of relations between target installations with initial conditions;

– matrix of resources used;

– matrix of compliance with the rules of resource consumption and the choice of criteria for their allocation.

Separating the relationship between initial conditions and target settings in different matrices may initially seem illogical, as they are inextricably linked and form a single integral network, but in the process of logical inference with time constraints, this can significantly reduce the dimension of the problem and time.

The size of the adjacency matrix is determined by the number of vertices (target installations) of the mathematical network model of making decisions on the preparation and conduct of hostilities and the initial conditions that determine the achievement of target installations.

Matrix elements are sets that consist of indices of the corresponding elements, which reflect the relationship and relationship between "goals" according to their numbering in the catalogs. If it is necessary to extract knowledge from the knowledge base, sampling is performed from the appropriate directories according to the indices contained in the elements of the sets.

Replenishment of knowledge (or their correction) is carried out by adding formalized knowledge to the appropriate catalog, changing (if necessary) the dimensionality of the adjacency matrix and establishing the relationship between new "goals" by filling (changing) in the specified matrix of relevant elements.

The initial synthesis of a mathematical network model of knowledge is carried out using synthesis procedures. The theoretical basis for constructing such procedures is the search for a guaranteed strategy.

Directly related to the knowledge base is a group of algorithms for its management [1]: examination, synthesis of a mathematical network model for making decisions on the preparation and conduct of hostilities, control of the correctness of the knowledge base, preparation of source information.

This set of algorithms is used only at the stage of replenishment (correction) of the knowledge base by the officer-programmer, and in the process of combat operation does not participate.

The expertise is designed to organize a dialogue with experts on the preparation and conduct of hostilities and the transformation of information in the process of replenishing the knowledge base.

Tasks to be solved: organization of dialogue with experts in the process of replenishing the knowledge base; transformation of information from the language of communication with experts into the internal language of formalization of the knowledge base; transformation of the received regularities into target installations, initial conditions, relations, rules of use of resources.

The basis of the examination algorithm is a natural language interface that transforms from a limited natural language of communication into the internal language of the expert system. The natural language interface consists of a linguistic processor and a knowledge base about the language of communication [1].

The linguistic processor is provided by modules of the corresponding analysis of the entered information. These is word processing module, morphological analysis module, parsing module,

semantic analysis module, internal image synthesis module. Modules have both semantic and grammatical information about individual semantic component situations for decision making.

Ultimately, the expertise algorithm provides the formation of binary relations between the vertices that characterize a certain state of the system for publication by their expert. The expert approves or rejects the presented relations or forms a new state of the system, which are not included in the catalog. Interaction is carried out by means of the corresponding menus. The given order of functioning actually provides realization of functions which structure can be given by special modules of separate word forms for experts concerning situations of decision-making.

Synthesis of a mathematical network model of decision making will provide a change (correction) of the structure of target settings while replenishing the knowledge base.

Tasks to be solved: selection of vertices and relations from the set of generalization information with experts while replenishing the knowledge base; replenishment of knowledge base catalogs; making changes to the adjacency matrix in accordance with the newly discovered or changed relationships between the target settings.

The formation and transformation of the structures of the target settings allows you to reasonably determine or significantly supplement the structure of the target settings of the system using which the decision is made. A necessary element of the synthesis of a mathematical network model for making decisions on the preparation and conduct of hostilities is to build a structure of target systems of the system for a specific situation.

The following principles are the basis for building mathematical network models for making decisions on the preparation and conduct of hostilities (establishment of binary relations between target installations), which characterizes the actions of management bodies, etc.: purposefulness; massaging resources; maneuverability; unity of management; security; secretiveness; simplicity of design.

Based on an expert survey, a catalog of target settings is compiled and the essence of the relationship between them is clarified. The synthesis of a mathematical network model for making decisions on the preparation and conduct of hostilities begins with a state, the achievement of which ensures the achievement of the ultimate "goal", ie with the "goals" of the highest level of the hierarchy. The synthesis of structures of target installations is carried out until the required level of specificity is reached, ie until the target installations are reached, the conditions for achieving which are only the initial conditions. The truth of the initial conditions can be determined by solving a finite set of calculation problems or on the basis of information from a combat service person.

The theoretical basis of the means of formalizing the synthesis problem is a mathematical apparatus that allows to establish the truth of the relationship between the target settings and to describe the structure of the network model itself. The target settings are divided into conjunctive, disjunctive, conjunctive and disjunctive achievable. As a result of these actions, we obtain the structure of target installations for making decisions on the preparation and conduct of hostilities for the initial conditions.

Building the structure of target installations, making decisions on the preparation and conduct of hostilities is carried out with the help of formal rules by transforming the structure of target installations. The transformation of the structure of the "goals" of the management process begins with the "goals" of the highest level of the hierarchy and is carried out sequentially until the target settings are reached, which are determined only by the initial conditions. At the same time there can be a situation when as a result of the specified transformations the necessary level of concreteness is not reached. In this case, further construction of the structure of target installations to make decisions on the preparation and conduct of hostilities is carried out on the basis of searching for fragments of the structure of target installations in the catalog, describing the dynamic qualities of the process.

The described technique is valid for the initial formation of structures of target installations at the stage of system creation. In the process of functioning of the expert system at change of structure of knowledge base only correction of earlier created structure of target installations is carried out.

Control of correctness of knowledge base is carried out at replenishment of knowledge base: detection of contradictions in structure of target installations at modification of this structure; search and detection of contradictions of the semantic network graph according to the available resources and time; checking the completeness of the graph of the mathematical network model; issuance of identified contradictions to the expert and their elimination. The peculiarities of the control of the correctness of knowledge, provided in the form of target settings, is the need for a joint analysis of the whole set of target settings and the initial conditions in their relationship. To do this, you combine the target relationship matrix and the initial condition relationship matrix.

Detection of contradictions in the structure of target installations in the construction of a mathematical network model, its structure determines the nature of the relationship between target installations and the presence of contours on the graph of the network model, which is evidence of incorrect model and leads to a clear contradiction. The search for the contours of the mathematical network model is carried out by summarizing a generalized matrix of adjacency of target settings and initial conditions.

Checking the completeness of the graph of the mathematical network model consists of detecting "hanging" vertices and their correction. The definition of "hanging" vertices is reduced to checking the presence in the generalized matrix of adjacency of the network model of zero columns. Possible variants of the "hanging" vertex x_i are disjunctive, conjunctive or initial condition.

Checking the correctness of a mathematical network model according to resources and time in the process of achieving a "goal" can reveal a situation where resources are not enough to simultaneously perform certain actions. Control of the correctness of the network model according to resources and time is reduced to identifying options for achieving "goals", which meet the following conditions: the intensity of consumption of each type of resource does not exceed the set value without contradiction of the states of contractors; the total cost of each type of resources in the process of achieving "goals" does not exceed the established value; the available time to achieve the "goal" should not exceed the required time.

The definition of the initial conditions is to determine their truth, which determines the possibility of achieving the appropriate target settings.The connection of the algorithm for determining the initial conditions is carried out periodically by the algorithm-dispatcher according to predetermined parameters, which in the process of combat operation of the system can be quickly changed.In order to reduce the amount of computing resources used for the definition, all procedures for determining the initial conditions are divided into three groups:

– models of representation of knowledge in the form of calculation of predicates and statements, calculation and information problems, the results of which are used repeatedly for specific operational and tactical situations. Tasks of this class use the initial data which arrive both in the form of results of the decision of problems of management process, and those which arrive by communication channels from external sources of information;

– or are connected once as necessary, the results of which are used once. In this case, the information for the definition comes as a result of solving the problems of the management process, or from automation, if such procedures of the management process are not available;procedures for determining the initial conditions, the source information which is the operational information of combatants, are not present in the communication channels of automation, which is introduced immediately after receiving it. After entering such information, the connection and initialization of decisions (tactical tasks), for which it is the source.

The definition procedures are reduced to a catalog that is formed at the development stage. Adjustment of this catalog is carried out at the stage of exploitation.

The formal and logical content of the procedure for determining the initial conditions is reduced to a separate software module, which is performed on a modular basis. The connection of the corresponding definition procedures is carried out by the algorithm-dispatcher from the set of features of the source information in accordance with the above classification and the form of these procedures from the catalog. The form defines the list of features that at the same time are the implementation of the rule of choosing the procedure of the definition to be solved.

Definition procedures are multi-purpose and are used both independently in solving partial problems and to ensure the proper functioning of the intelligent system.

The database is an integral part of the system database using elements of intelligence designed to store, replenish and retrieve data that are the source for solving partial management problems and used in the process of logical inference and comment when receiving requests to the intelligent system.

A database is a set of data arrays and software modules that allow you to manipulate data (perform their replenishment, storage and production) in accordance with the concept, such as a relational database, which provides the following tasks: receiving information interactively from combat service personnel and from sources of information in automatic mode; recording and storing the received information in the form of recording on hard media; recording and storing information, which is repeatedly used in the process of solving computational problems, in database arrays stored in RAM; search and retrieval of information by key; issuing information grouped in accordance with the received request (key) in the form of arrays, or sequentially with the discreteness specified in the key; review of the content of data sets according to the granting of relevant rights (authorized access); organization of priority access when receiving requests for data issuance.

Input and output information to replenish the database can come in two ways: through an interactive dialogue of combatants using the procedures provided by the database management algorithm; from automation tools and external sources and other consumers.

In the process of accessing the database, a number of conflicts may occur, which are determined by the impossibility of simultaneous answering of questions by several consumers and the impossibility of simultaneous writing and reading: conflict between data consumers in the process of simultaneous access to the database; conflict between sources of information in the process of recording data while accessing the database; conflict between sources and consumers of information while accessing the database.

The concept of building a database is based on the image of its logical structure in the form of sets of two-dimensional tables with the following properties: each element of the table represents one data element, repeating groups are absent; the elements of each column are instances of one concept; columns have names; there are no two identical terms in the tables; rows and columns of tables can be viewed in any order and in any sequence, regardless of their information content.

The peculiarity of the database is its functioning in the following time modes: real-time mode - replenishment of the database from communication channels of information sources and automation tools, data issuance to programs operating in this mode; time allocation mode - when replenishing the database from workplaces or viewing reference tables.

Certain data sets, which are repeatedly used in solving computational problems, have high requirements for the speed of sampling (issuance) of information stored in them. Such arrays are placed in RAM when the system is initialized.

The group of tables of structures and connections includes the following: tables of structures; entry connection tables; extension link tables [4, 5].

Structure tables contain information about the classes of structures in the system: objects, connections, processes, conditions and properties. These structures were selected based on the analysis of configuration modeling methods and model data representations.

These structures will allow you to fully describe all the main components of the existing model representations of knowledge. Tables of occurrence relationships allow you to establish occurrence relationships between structures. This is necessary to describe complex structures containing sub-structures.

Inheritance relationship tables allow you to establish inheritance relationships between structures. This is necessary in order to avoid an excess of information in the system, the structure data using these tables can be represented as data on the selected structure and data taken from the base structure.

The tables of these models contain information that relates exclusively to a specific model of knowledge representation. For an ontological model, these can be tables of structure names and their ontological descriptions. For the frame model, these are tables of connections of slots and structures. This organization of data will logically divide the representation of data between models and organize their search methods for each model, while leaving the opportunity to use common search methods for all models [5].

The ontology clarifies the fundamental problems of existence, the development of the essential, the most important, which is the formal specification of the conceptual (abstract) model of the military system, taking into account the functional groups of combat service [6].

Ontology consists of classes of entities of the subject area, the properties of these classes, the relationships between these classes and statements constructed from these classes, their properties and relationships between them.

Frame – a structure that contains a description of the object in the form of attributes and their values, the representation of a conceptual object. Information related to the frame is contained in its constituent slots. To ensure the integrity of the knowledge base, which contains several models of knowledge representation, it is necessary to create tables that reflect both the essences of different types and the relationship between them [5].

The user interface will provide control of the logical output of knowledge for the implementation of intelligent control functions.

Tasks to be solved: determination of possible ways to achieve the set target settings on the basis of the received request, in accordance with the defined set of the specified initial conditions; choosing the best, in a sense, way to achieve the set targets; determining the order of consumption of resources in the sequence that ensures their rational use in the process of achieving a given target setting; formation of the structure of achievement of target settings for the algorithm of formation and issuance of comments; synthesis and issuance of recommendations for achieving the set targets.

The input information of the logic control algorithm is the results of determining the initial conditions; data on the parameters of resource consumption; data on the actual state of resources; information about the available time reserve to achieve the target installation; query information that determines the direction and "purpose" of the inference.

The output information of the logic control algorithm is: information about the possibility of achieving the target setting in accordance with the request for a given set of initial conditions; information on the order of expenditure of resources to ensure the achievement of a given "goal"; structure that characterizes the order of achieving a given "goal" (for the algorithm for forming comments).

The logical inference procedure is implemented on the structures of target settings, stored in the knowledge base and selected in accordance with the mode of operation of the system and the nature of the request. The logical conclusion is made in the following sequence: selection of the target installation in the state of the general structure in accordance with the received request; selection of all possible structures to achieve this target setting for the specified set of initial conditions; fixing the selected structure for transmitting the algorithm for forming comments; formation and issuance of a response to a request (issuance of recommendations).

At formation of possible structures of achievement of the set target installation the operative redistribution of the resources used in the course of achievement of target installations - according to the rules stored in knowledge base is carried out. The rules of redistribution of resources are divided into constant, due to meta-knowledge and laid down at the stage of system development, and variables, for which it is possible to adjust them when replenishing the knowledge base. The selection of the best structure for achieving a given target setting is carried out according to several criteria, the most important of which are: the minimum time to achieve a given target setting; minimum consumption of system resources to achieve it; the minimum number of intermediate goals that are part of it.

The preparation and issuance of comments is carried out in order to increase the level of detail of the results of solving both computational and informational, and logical and analytical tasks issued to combat personnel.

Synthesis and issuance of comments is carried out in the modes of automatic preparation and issuance of comments and explanations, which, in turn, is carried out as part of the conclusion of the results of settlement and information problems (automatic synthesis), and at the request of military personnel.

Automatic preparation and issuance of comments on the results of solving settlement and information problems is carried out on the basis of a form and a catalog of comments, which reflect the affiliation and possible level of detail of the information provided. The form and catalogs put in accordance with specific models and calculation and information tasks a set of procedures for forming comments, the order and conditions of their connection. This approach allows you to change the order and composition of the comments issued, without changing the main software modules of calculation and information tasks in the case of new requirements.

Issuance of comments in the appropriate mode is based on the results of logical inference. The source information in this case is the structure of achieving a given target installation in the form of its adjacency matrix and the corresponding directories. Comments are formed by passing the arcs of the appropriate structure and a sample from the catalog of initial conditions and target settings of the content of the relevant "goals". The issued comments allow to trace all logic of the conclusion, its objective preconditions, structure and the order of use at various stages of resources, etc.

The display and pre-processing of information must comply with the principles of information display, which affect the characteristics of the promotion of information to persons involved in decision-making in a critical situation during the preparation and conduct of hostilities. These are: the availability of perception and the completeness of the information displayed; natural imagination; ergonomics of information display; flexibility of information display.

The output information for the algorithm of display and pre-processing of information comes in the form of solving computational and information problems, intellectual problems, in the process of replenishing databases and knowledge, as well as comes from the workplaces of combat personnel.

The controller is designed to organize the computational process in accordance with the purpose of the mathematical network model for making decisions on the preparation and conduct of hostilities. The manager provides the following tasks: software initialization; organization of information exchange with information sources; organization of priority allocation of resources for computational-informational and logical-analytical tasks; distribution of resources of automation means in accordance with the set tasks; organization of display and documentation of results of solving problems; organization of interaction of software modules on input and output information.

The manager implements the absolute and relative scale of program priorities. Absolute priority is given to real-time software modules in relation to modules operating in time distribution mode. Relative priority is given to modules within one class in accordance with the importance given to each degree. Manager is the core of the software, created as a separate module and is one of the most complex components.

The results of research on the architecture of the network knowledge base of a complex military system (Fig. 3) presented in the article when compared with the results of research in [5, 7, 8] are given as follows:

– mathematical network models for decision supporton the preparation and conduct of hostilities.

– catalog of target installations (CTI);

– catalog of initial conditions (CIC);

– catalog of resources (CR) of groups of troops (time, material, combat and quantitative composition) used, their costs and replenishment;

– catalog of rules of resource consumption (CRC) and the choice of criteria for their allocation in the process of use.

– matrix of relations between target installations with initial conditions;

– matrix of resources used;

– matrix of compliance with the rules of resource consumption and the choice of criteria for their allocation.

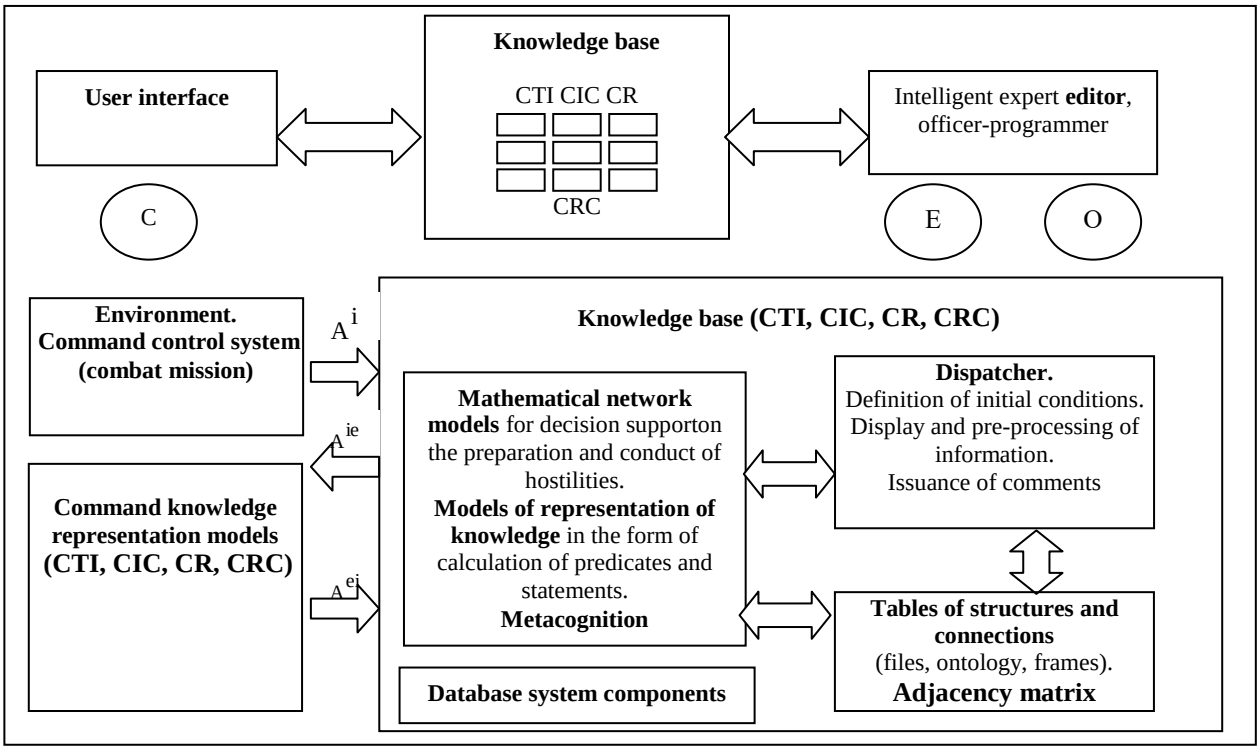

Fig. 3. The architecture of the network knowledge base of a complex military system

Conclusions

In this manner, a complex system of military purpose with a network knowledge base, which is built when creating a group of troops (forces) and will support it in a state when it is able to solve the tasks assigned to it. This requires in-depth elaboration of issues not only of modern armaments and sustainable and continuous management, but also of even more complex issues of scientific substantiation of network knowledge base architecture and structure of complex military system, organization of joint use of automation and weapons.

A practical approach to building the architecture of the network knowledge base and organizational structure of a complex military system can be implemented by substantiating the components and elements of the system when creating a group of troops (forces) and maintaining it in a state where it can solve its tasks.

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