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FORMATION OF A UNIFIED INFORMATION MODEL OF DATA REPRESENTATION IN INTELLIGENT INFORMATION ENERGY SYSTEMS

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Abstract
The article carried out a systematic analysis of the functioning of data representation structures in existing energy systems. Based on the results of system analysis, problems and shortcomings of data representation structures in energy information systems were identified, for the elimination of which the use of an intelligent information energy system was proposed. Using the methods of system analysis and the methodology for forming a common information model, a block diagram of information support and a generalized information model of intelligent information energy systems have also been developed. To solve the problems of functioning and development of a unified energy system, an adequate information model has been developed, which is built on the basis of a multidimensional, hierarchical information system consisting of subsystems united by many functional links. It is these connections that make it possible to assess the functional state of subsystems and the system as a whole. In this paper, a new integration mechanism for organizing information interaction of heterogeneous information systems of a single energy system is considered.

Keywords: system analysis, model, management, problem, process, task, structure, function, information system, database.

Introduction
In the world, special attention is paid to the development of solutions to the problems of effective management of consumption, cost reduction and control over the flow of fuel and energy resources (FER) through the use of information and communication technologies. “The results of studies conducted by the European Energy Research Alliance show that most of the losses (up to 90%) in the distribution and consumption of fuel and energy resources at enterprises of fuel and energy complexes (FEC) are associated with the consumption of fuel and energy resources, and the remaining 9-10% of losses in the transmission resources." At present, one of the priority tasks of many of the largest fuel and energy companies in the world is the development of

methods for efficient consumption management, savings and control of fuel and energy costs. In particular, in the fuel and energy complex enterprises of Russia, the USA, Iran, Iraq, Brazil, Norway, Mexico and other countries, much attention is paid to research on the creation of models, algorithms and software tools for the control system, which allow to effectively manage consumption, savings and control the costs of fuel and energy resources.

The Unified Electric Power System (UES) of Uzbekistan, created more than sixty years ago, is a unique organizational and technical facility, the structure and management of which is built according to a hierarchical principle, which ensured a balanced unity of generation, distribution and consumption of electricity in the territorial context to ensure the energy security of the regions and the possibility of intersystem exchange of power and energy flows in normal and emergency modes to improve the efficiency of the energy association. At the same time, it should be noted that the UES, which was created a long time ago, needs a serious modernization of fixed assets and renewal, both in terms of replacing almost 50% of physically and morally obsolete equipment, and in the application of new technologies and equipment, information and diagnostic systems. The restructuring of the electric power industry, the market conditions for the functioning of the electric power industry bring their own characteristics and problems. To solve these problems, it is necessary to create and use an intelligent information energy system (IIES), which ensures a reduction in costs in the production and transmission of electricity, a decrease in the level of losses in the transport of heat and electricity, and optimization of the size and placement of reserve capacities [11].

The implementation of the IIES concept implies a huge increase in the volume of information flows from various sources that generate the most heterogeneous data that require continuous processing and transmission between different applications in real time. Clearly, a powerful communications platform and sophisticated information technology (IT) are required to manage the new volumes of energy data. The problem of energy conservation is one of the most actively studied in world science. The implementation of the concept of sustainable development, the global significance of which has been increasing in recent years, the popularization of its ideas and fundamental principles necessitate more in-depth research in the field of energy efficiency in IIES. It becomes quite obvious that this direction needs to be studied multilaterally, since this is a complex task that requires the application of multidirectional scientific knowledge. The unifying platform for solving the problem of increasing energy efficiency in the IIES is research in the field of energy saving management (ESM), since only competent managerial methodological solutions can ensure the interaction of its technical, technological, production, economic, organizational, managerial, psychological, social and other aspects. Currently, research in this area is actively carried out by foreign and scientists. According to a systematic analysis of the literature, ESM in the system of general enterprise management is proposed to be considered as a purposeful activity to achieve energy results by solving an interrelated set of tasks in the planning, organization, motivation and control process aimed at improving energy efficiency and reducing energy consumption by applying modern methods of rational use of fuel and energy resources [1-4].

Method

For the effective functioning of the IIES, information is needed about the state of the controlled object, the environment, and the accepted control actions. The necessary conditions for the functioning of the IIES, the optimal volumes of information that are promptly received by various control units, the distribution of information flows in time and space, which significantly depends on the optimality of building information support (IS). The main functions of the IS IIES are the functions of collecting, controlling, transforming, storing, making reliable decisions, distributing and transmitting information from sources to its consumers. The block diagram of the IS is developed to determine the composition of the IIES database (DB) elements and their interrelations in order to provide the possibility of building a rational information and computing processes, choosing the direction for ensuring information compatibility of the components interacting in the IIES, as well as the rational organization of reliable decision-making processes [12].

IS of the tasks of synthesis and operation of the IIES is proposed to be considered based on the information model. Modern requirements for the representation and use of information in the IIES make it expedient to use a new information technology - the so-called Common Information Model (CIM) - systems. The generalized information model CIM - hereinafter CIM - is a certain conceptual model for describing various objects (subjects) of the surrounding world, using object-oriented terminology. If until recent years the concepts of object-oriented technology were related to programming languages (C ++, Java, etc.), then CIM expands these concepts to describe data, deliberately using such terminology of object-oriented programming as classes, properties, methods and associations. In essence, CIM is an information model, the task of which is a single unified representation of data structures, regardless of the source of data origin and the purpose of their use (Fig.1).

In this paper: - a new integration mechanism for organizing information interaction of heterogeneous information systems of the UES - the so-called CIM-systems - is considered; - Investigated the benefits of using such systems; - Analyzed the methodology for building CIM models in relation to energy applications, as well as data access interfaces in CIM systems. In the future, work will be carried out to adapt international standards for CIM systems to the real UES, a number of methodological documents will be developed that determine the possibility, rules and techniques for building information models, for the first time CIM for interactive creation of information models [5-7].

The CIM can be used in a variety of ways. Ideally, task information is organized so that it can be used by disparate groups of people. This can be achieved with an information model that represents the details needed by people working in a particular field. An information model requires a set of legal assertion types or syntax to capture a representation, and a set of expressions to control general aspects of the domain (in this case, complex computer systems). Because of the general focus, the Distributed Management Task Force (DMTF) refers to this information model as the CIM, the Common Information Model. For information about the current core and general circuits developed using this metamodel, contact the DMTF.

Management schemas are the building blocks for management platforms and management applications such as device configuration, performance management, and change management. CIM structures the managed environment as a set of interconnected systems, each of which consists of separate elements. The CIM provides a set of classes with properties and associations that provide a well-understood conceptual framework for organizing information about the managed environment. We suggest that any programmer who writes code to work with an object schema, or any schema developer who intends to put new information into a managed environment, should have a good knowledge of the CIM.

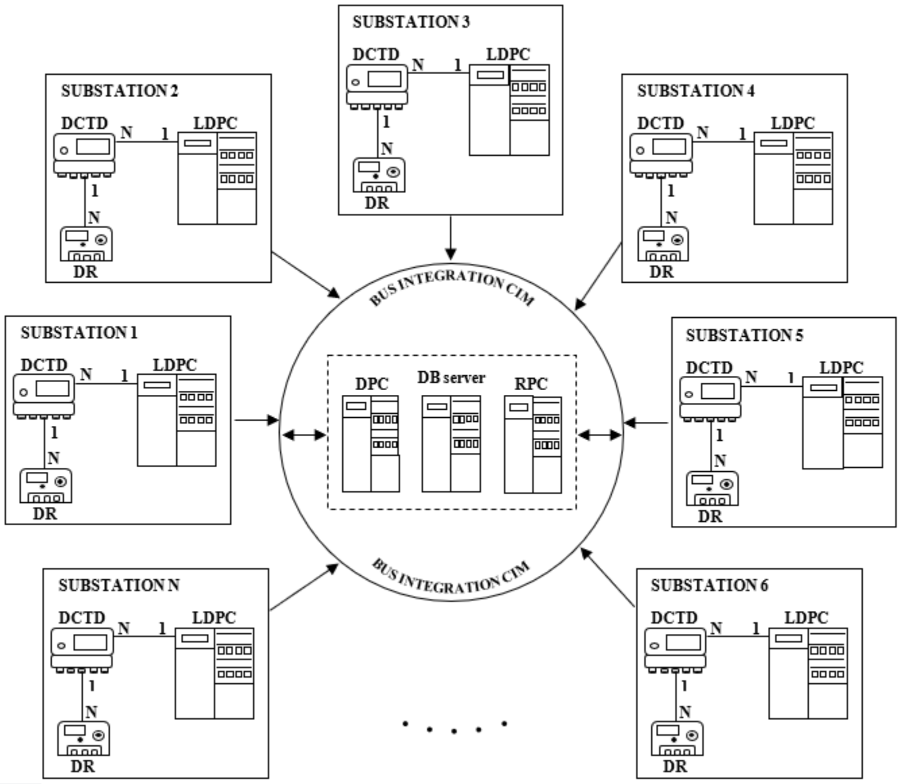

Fig.1. Relationship diagram when applying the CIM model in IIEPS (DCTD-data collection and transmission device; LDPC-local data processing center; DR-data recorder; RPC-request processing center; DB-database; CIM- common information model)

Because the CIM is not implementation-specific, it can be used to exchange control information in a variety of ways; four of these methods are shown in Fig. 2. These communication methods can be used in combination in the control application [8].

Results

In domestic and foreign practice, attempts were made to resolve only certain aspects of the issues of creating a comprehensive information model for the functioning and development of the UES. In the current situation, in the absence of a single toolkit, it is impossible to solve the existing problems of managing the UES. That is why it is fundamentally necessary to create tools for monitoring power equipment and assessing the functional state of power equipment.

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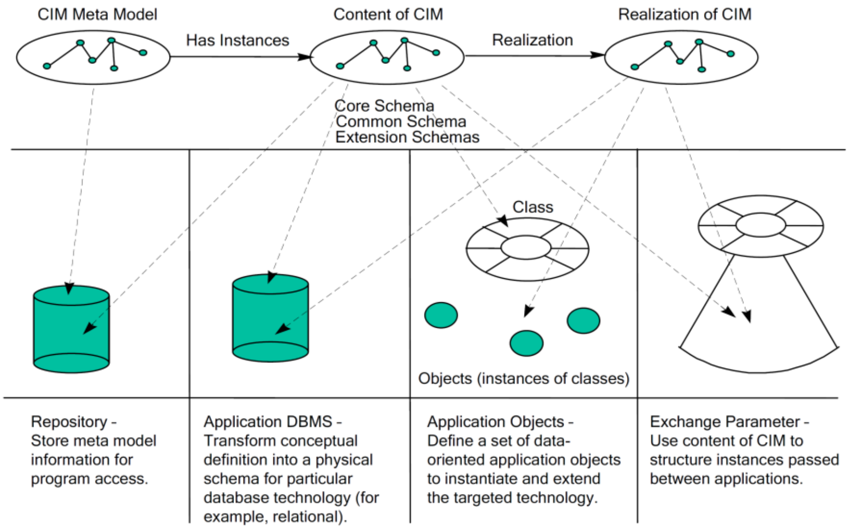

Fig. 2. Four Ways to Use CIM

The information system that provides support for decision-making on the development and operation of the IIES should satisfy such an important requirement as the availability and reliability of the information used. This means that the models and decision-making methods used must be provided with information. The requirement of information security significantly affects the formation of mathematical models and methods used to solve energy problems. Part of the necessary information may be missing for objective reasons related to the impossibility of obtaining it (lack of measuring systems, lack of communication channels, etc.). In addition, the lack of information is associated with the shortcomings of the information system of the enterprise of fuel and energy complexes, the fragmentation of its information subsystems, the lack of exchange between databases and software systems.

As already noted CIM - the model uses a standard object-oriented visual representation. The main elements of the CIM model are classes, associations, and packages. The class is the main element of the CIM model. A class is an abstract description of some objectively existing entity of an electric power system. Examples of classes are «transformer», «load», «ac line», «dc line», «measurement», etc. The fundamental difference between the concept of a class in CIM and object-oriented programming languages is that in CIM a class describes only an interface and is completely independent of both the computer technology platform and the implementation. The main properties of a class are encapsulation, polymorphism, and associations. Encapsulation means concentrating all the properties of a class as its attributes within the class declaration.

Polymorphism means that the same symbolic attribute name can be used in different classes, but the class name must be unique.

The methodology for generating a CIM model of power supply system objects is presented below.

1. Highlighting voltage levels and designating them as objects of the "VoltageLevel" class.
2. Grouping the elements of the power supply circuit according to the voltage level.
3. Allocation of AC power line segments into a set of objects of the AC Line Segment (ACLineSegment) class.
4. Combining objects of the AC Line Segment (ACLineSegment) class into objects of the Line class according to a geographical feature.
5. Converting transformers into a set of objects of classes "Power transformer (PowerTransformer)", "Transformer winding (TransformerWinding)" and "TapChanger" provided that the transformer is with a split winding.
6. Fixing the connection between the objects of the class "Transformer winding (TransformerWinding)" and the corresponding object of the class "Voltage level (VoltageLevet)".
7. Converting the current-carrying equipment of the power supply circuit into the corresponding network elements from the "Network Elements (Wires)" package of the CIM model. Namely, the load break switches are replaced by objects of the class "Breaker", the disconnector - "Disconnector", the bus section - "Busbar Section".
8. Connection of objects derived from the class “Conductive Equipment (ConductingEquipment)” of the CIM model to each other through objects of the class “ConnectivityNode” of the “Topology” package based on information from the power supply scheme about the physical connection of the elements to each other.
9. Adding objects of the "Terminal" class of the "Core" package for each connection between the "ConductingEquipment" and "ConnectivityNode" objects, which will add objects of the "Measurement" class and store meter readings.
10. Fixing the connection between the objects of the class "Measurement" of the package "Measuring (Meas)" with the objects of the class "Terminal" based on the power supply scheme. Namely, measuring transformers of current, voltage, etc. are replaced by a combination of objects of classes "Terminal" and "Measurement" with the corresponding type of measured value. The "Measurement" class is used to represent state variables that take place in technological processes. This class aggregates a set of objects of the "MeasurementValue" class, which allows you to store indicators of the measured value [9-10].

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11. Formation of a list of objects (attributes and belonging to the class and package of the CIM model) of the CIM model to be added to the database in the form

$$OL = \{ol_i | i = 1, \dots, n\}$$

where n is the number of model elements;

$ol_i = (A_{id}, A_1, A_2, \dots, A_m, D_j)$ - i - th model object;

A_{id} - attribute identifier (name) of the object;

A - object attribute;

m - the number of object attributes;

D_j - CIM model class, $j = 1, \dots, k$;

k - number of CIM model classes.

Discussion

The CIM framework is an approach to systems and network management that applies the basic techniques for structuring and conceptualizing the object-oriented paradigm. This approach uses a single modeling formalism that, together with a basic set of object-oriented constructs, supports the collaborative development of an object-oriented schema across multiple organizations. The article describes an object-oriented metamodel based on the Unified Modeling Language (UML). This model includes expressions for common elements that must be clearly represented in control applications (for example, object classes, properties, methods, and associations). This document does not describe specific CIM implementations, APIs, or communication protocols.

Conclusion

The analysis of structural models of information systems for monitoring the parameters of energy complexes for smart grid technologies was carried out based on the CIM model and UML deployment diagrams. One of the most important requirements for the developed information model is the most complete description of the subject area, considering future expansion and the addition of new types and elements of the model. The CIM provides a standard way of representing power system resources as object classes and attributes, and their relationships. The CIM model simplifies the integration of the production and transmission control system. Integration is facilitated by the fact that the CIM defines a common language to enable applications to access or exchange information, regardless of how such information is represented within applications.

The technique for generating a CIM model of objects of the power supply system is a sequence of steps that leads the power supply scheme to an object-oriented CIM model. Through the use of the CIM model, the developed and information models of IS for managing the parameters of energy complexes can be used as a methodological basis for creating larger-scale distributed ISs that combine several energy complexes.

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