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## The Method Of Preparation Of Individual Support Schemes Of Feeders For The Automatic Formation Of Design Schemes.

Viktor Alekseevich Yarosh<sup>1\*</sup>, Konstantin Aleksandrovich Chebanov<sup>2</sup>,  
Valeriy Georgievich Zhdanov<sup>1</sup>, Vladimir Anatolyevich Kobozev<sup>1</sup>, and  
Evgeny Evgrafovich Privalov<sup>1</sup>.

<sup>1</sup>Stavropol State Agrarian University, Zootekhnicheskiiy lane 12, Stavropol 355017, Russia.

<sup>2</sup>Nevinnomyssk State Humanitarian and Technical Institute, Mira Boulevard, 17, Stavropol Territory, Nevinnomyssk 357108, Russia.

### ABSTRACT

This article considers the issue of integrating the source data for the calculation of the modes of a distribution electric network in geographic information systems and operating-technological software systems. To solve this problem, an improved method of preparing individually supporting feeder schemes has been proposed.

**Keywords:** geographic information system, scheme, integration, source data, electrical network object.

*\*Corresponding author*

## INTRODUCTION

Effective management of the operation of electrical networks is impossible without the use of modern information technology (IT). Geoinformatics is a rapidly developing area of modern IT, which has found wide application in the electric power industry. The basis of geographic information systems (GIS) is graphic and semantic information associated with it. As a semantic information in the power industry used a database (DB) for electrical equipment, and as a graphics card, plans, schemes.

Electrical network diagrams should be submitted to GIS using vector graphics. It is acceptable to use a terrain map as a raster substrate with a vector layer on it containing an electrical network.

The problems solved with the help of or in cooperation with GIS can be divided into three groups: information and reference; calculated and analytical; operational and managerial.

The use of GIS technologies most often boils down to visualizing a network map on a map or a terrain plan and solving information and reference tasks. The next step in the application of GIS is the solution of settlement and analytical tasks, through the integration of GIS with regime-technological software systems (RTSS). The mode calculations are basic in the tasks of design, operation and development of electrical networks.

## MATERIAL AND METHODS

The primary source of information in distribution electrical networks may be supportive schemes of feeders. These schemes contain data on the network topology, types and sections of wires, lengths of sections, numbers of transformer substations, lines, feeders, highways, taps, nominal transformer capacities, the nature of powered consumers, switching devices.

## RESULTS AND DISCUSSION

Initial data for the calculation of the distribution network mode  $D_{RTSS}$  we write in the form [1, 2]:

$$D_{RTSS} = [PD, TI_G, Y, S_{load}], \quad (1)$$

where  $PD$  – passport details of network objects,  $TI_G$  – topological information network connection diagrams,  $S_{load}$  – load vector in nodes,  $Y$  – vector of adjustable mode parameters.

The vector representation of spatial data can be vector-nontopological (object) and vector-topological (nodal, linear-nodal topology) [3, 4].

The advantages of the non-topological model are in the simplicity of the data structure, in the autonomy of the objects, which allows one to go to the object-oriented way of organizing the data. Disadvantages - in an uneconomical use of computer memory, loading a computer processor, organizing topological relations procedurally. The advantages of the topological model are to save computer memory and processor time, in organizing topological relationships in data structures. Disadvantages - in depriving the autonomy of objects [4, 5].

In topological GIS topological information of the network connection scheme in GIS format ( $TI'_G$ ), It is stored in file systems of a graphic DB (GDB). Based on this information it is possible to go to  $TI_G$  in format RTSS

$$TI'_G \rightarrow TI_G, \quad (2)$$

where  $\rightarrow$  – functionally defines the transition from data in GIS format to data in RTSS format.

In non-topological GIS, the following rule is required: each object  $j$  electrical network should be

depicted with a single graphic element. Analysis of the coordinates of the objects of the scheme in a non-topological GIS will allow you to build a graph of the connection scheme of the electrical network  $G_{ob}(x_{ob}, u_{ob})$  in RTSS or semantic database (SBD) GIS, where  $x_{ob}$  and  $u_{ob}$  – vertices (nodes) and edges (links) in the graph of the connection scheme of electrical network objects  $G_{ob}$ . In this case, the coordinates of the objects must be within a certain  $\varepsilon$  - neighborhood

$$\left| (x_j, y_j) - (x_{j+1}, y_{j+1}) \right| \leq \varepsilon, \tag{3}$$

where  $x, y$  – coordinates  $j$  and  $j+1$  electrical circuit objects in GIS.

The equation of integration of the image of objects in non-topological GIS and nodes or links in the graph of the connection scheme of electrical network objects  $G_{ob}(x_{ob}, u_{ob})$ , can be written as:

$$\left. \begin{aligned} V_{ob\ j\ GIS} &\rightarrow x_{ob} \in X_{ob} \\ or \\ V_{ob\ j\ GIS} &\rightarrow u_{ob} \in U_{ob} \end{aligned} \right\}, \tag{4}$$

where  $V_{ob\ j\ GIS}$  – image of an electrical network object  $j$  in non-topological GIS.

Graphing  $G_{ob}$  by object image  $j$  in non-topological GIS can be written as follows:

$$V_{ob\ j\ GIS} \rightarrow TI_{ob\ G}. \tag{5}$$

For the entire network (5), you can write this:

$$V_{GIS} \rightarrow TI_G, \tag{6}$$

where  $V_{GIS}$  – image of the electrical network in a non-topological GIS.

Note that (6) is a more general entry (4). The use of non-topological GIS for the calculation of the electrical network mode is possible when performing the procedure for constructing the electrical network topology according to (6) based on (3).

Passport details of electrical network objects  $PD$  can be stored in the WAN or in the GDB GIS in the form of text on the electrical network diagram. Connection  $PD$ , stored in the WAN, with an element of the electrical network is organized by means of the GIS itself. In the case of elements  $PD$  presented in the form of text on the scheme, you must comply with certain rules. The purpose of these rules is to show the connection between the element of the electrical network and its  $PD$ . To realize this connection, in particular, it is possible by forming a certain type of “tree of objects” or “layers”.

There are two ways of organizing graphic data: layered and object. The layer-by-layer method is based on typing graphic data on thematic community and combining them into layers, effective when considering continuously distributed features in the space. In the object method, the grouping of objects occurs in accordance with the logical interconnections between them, with the construction of hierarchies (a tree of objects) corresponding to their common and particular properties. The object method is effective when it is necessary to emphasize the individual logical relationships of objects [4, 5].

Integration expressions  $PD$  in GIS with  $PD$  в RTSS can be written like this:

$$\left[ V_{PD}^{PTL}, V_{PD}^{TR} \right] \rightarrow \Pi \Pi, \quad (7)$$

$$\left[ PD_{SBD}^{PTL}, PD_{SBD}^{TR} \right] \rightarrow PD, \quad (8)$$

where  $V_{PD}^{PTL}$  – graphic primitive images in the form of text on the electrical network diagram, containing types, wire sections and lengths of power transmission lines;  $V_{PD}^{TR}$  – graphic primitive images in the form of text on the electrical network diagram containing the types and nominal powers of transformers;  $PD_{SBD}^{LTP}$  and  $PD_{SBD}^{TR}$  – passport data of power lines and transformers in the SBD.

Loads in knots  $S_{load}$  can be stored in the sdb gis. In fact, the parameters of the loads in the nodes of the distribution network are not fully known. The easiest and most frequently used method of obtaining in RTSS  $S_{load}$  based on the load distribution of the head section of the feeder in proportion to the nominal capacity of transformers.

In this way:

$$D_{RTSS} = [PD, TI_G, Y, S_{load}] = [D'_{RTSS}, Y, S_{load}], \quad (9)$$

where the source information from the GIS is

$$D'_{RTSS} = [PD, TI_G]. \quad (10)$$

In accordance with expressions (1) - (10), a classification, schemes and expressions were developed in [2] that describe the integration of the source data for the calculation of the modes of distribution electric networks in GIS and RTSS.

We will consider the method of preparation of supporting feeder schemes for automatic generation of computational schemes on the example of integration of vector-nontopological GIS, with the object method of organizing graphic data, with RTSS.

In each of these software systems, feeder schemes are presented in their own form, i.e. in GIS, these are support schemes, and in RTSS, these are replacement schemes. The question of integration is that users prepare one scheme and use it in different programs.

Integration of a GIS using a non-topological model of representing spatial data with RTSS is described by expressions (6) and (7), which implies the observance of certain requirements in the preparation of supportive schemes in GIS.

The main task of the requirements is a description of the rules for the preparation of information about the supportive schemes in the GIS, which make it possible to automate the subsequent formation of network design diagrams, in the database of the software complex for electrical calculations. These requirements allow you to eliminate duplication of information in various services of the enterprise and errors in the formation of design schemes. RTSS users will use operating patterns familiar to their staff as settlement schemes.

An object  $j$  in SIG "Energog-Graf"  $Ob_{jSIG}$  consists of a graphic image of the object  $V_{objSIG}$  and object name  $N_{objSIG}$  in the structure of the "tree of objects" [6]:

$$Ob_{jSIG} = (V_{objSIG}, N_{objSIG}) \tag{11}$$

There are two types of objects on the post scheme: basic objects  $Ob_{jO}$ , involved in the formation of the settlement scheme; additional objects  $Ob_{jadd}$ , denoting rivers, roads, intersections with other high-voltage lines, etc.

The purpose of the preparation of supportive schemes is to transform the main objects in accordance with the requirements for the formation of the design scheme.

$$Ob_{jO} = (V_{objO}, N_{objO}) \rightarrow Ob_{jO}^{tr} = (V_{objO}^{tr}, N_{objO}^{tr}) \tag{12}$$

and additional objects to streamline the "object tree"

$$Ob_{jadd} = (V_{objadd}, N_{objadd}) \rightarrow Ob_{jadd}^{tr} = (V_{objadd}^{tr}, N_{objadd}^{tr}), \tag{13}$$

where  $V_{objO}$ ,  $N_{objO}$ ,  $V_{objO}^{tr}$  and  $N_{objO}^{tr}$  – graphic image and name in the structure of the “tree of objects” of the main object  $j$ , respectively, without taking into account the requirements and taking them into account;  $V_{objadd}$ ,  $N_{objadd}$  and  $N_{objadd}^{tr}$  – graphic image and name in the structure of the “tree of objects” of an additional object  $j$ , respectively, without regard for the requirements and taking them into account.

Graphic representation of the main object  $j$  with the requirements  $V_{objO}^{tr}$  should be represented as a single graphic element (pictograph, text, broken line in accordance with the requirements and satisfy the condition (3):

$$V_{objO}^{tr} = \begin{cases} 1 \text{ graphic element} \\ \left| (x_j, y_j) - (x_{j+1}, y_{j+1}) \right| \leq \varepsilon \end{cases} \tag{14}$$

To reduce labor costs for the preparation of support feeder schemes, a template was developed containing the structure of the "tree of objects" consisting of the names of the main objects  $N_{objO}^{tr}$ , the relevant requirements, and the names of additional objects  $N_{objadd}^{tr}$ , for the possibility of automatically finding an object on the electrical network diagram and giving the "tree of objects" an aesthetic look.

Figure 1 shows the existing algorithm, and Figure 2 shows an improved algorithm for the preparation of support schemes in the GIS for the automatic generation of calculation schemes in the RTSS.



## CONCLUSION

The improved methodology allows to reduce labor costs for the preparation of supportive schemes by automatically adding the required structure of the “tree of objects”  $I_{ob\ SIG}^{tr} = (I_{ob\ O}^{tr}, I_{ob\ add}^{tr})$  from the developed template, using the group transfer capabilities, adjusting and deleting objects.

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