Application of Mobile Geographic Information System Platform in High Voltage Grid Planning

Qianmao Zhang, Rui Liu, Xiaoguang Qi, Peng Xi
State Grid Hebei Electric Power Co, Ltd. Institute of Economics and Technologie, Shijiazhuang, Hehei, China

Abstract. Grid planning and pre-project site survey require the support of Geographic Information System (GIS). However, the existing grid GIS platform adopts B/S mode which can only be run and viewed on the computer connected to the company's intranet, thus failing to meet the needs of on-site investigation by the planners. Therefore, the application of mobile GIS platform to pre-grid planning is an inevitable development direction for the future power grid information system, and how to manage more efficiently and use the data collected by mobile GIS terminal will be an urgent problem to be solved. Based on the authors' learning and practical experience, this work first analyzed the potentials of mobile GIS for grid planning, then discussed the problems in high voltage grid planning, and finally proposed the system function and overall architecture design based on mobile GIS platform.

1. Introduction
The traditional method of power grid planning is limited in the current intelligent information age, which is embodied in the lack of coordination between power grid construction planning and urban spatial structure, the lack of coordination of regional power grid planning, and the lack of internal coordination of single regional power grid planning, etc. GIS is a system that can fully integrate and utilize geographic information data, and provide technical support for related personnel, so it is widely used in all important fields in China. The grid lines in GIS have linear geographic characteristics, which can satisfy the visualization and visualization management of GIS. With the continuous development of CIS technology in China, the technology has been popularized in various projects of power grid enterprises and become the most important technology platform in power grid planning information [1]. At present, the application of GIS grid planning method along with various planning processes has become an important research issue in relevant departments. In this work, we designed an auxiliary planning platform based on mobile GIS platform to improve the scientific convenience of grid planning [2].

2. The Potentials of Mobile GIS for Grid Planning
Mobile GIS platform can be divided into hand-held terminal and computer terminal. Among them, hand-held terminal functions include satellite positioning, data acquisition, location query, data transmission, security control; computer terminal functions include data audit and data storage and other functions, as shown in Fig. 1. By studying the interface between the mobile GIS and the original system, the coordinate point information of the grid equipment can be obtained. Then, the power equipment database is set up in the map of mobile equipment, and the power grid elements such as substation and transmission line are superimposed on the map to realize the interactive call between the map software
and the GPS module built in the mobile equipment, thus meeting the functions of grid equipment query, search, location, navigation and so on. According to the actual planning needs of the power grid, the power GIS based on mobile equipment is established to realize the accurate query of the data needed for on-site survey such as coordinate points, latitude and longitude, elevation, and the interactive sharing and synchronous updating of GIS data in the mobile and PC terminals [3]. Therefore, it can solve the practical problem that the existing GIS platform cannot meet the needs of the planners’ on-site investigation. Specific modules to achieve grid planning, pre-grid survey, grid information display, mobile data upload and other functions.

![Figure 1. The structure of mobile GIS platform](image)

3. Problems in High Voltage Grid Planning

3.1. Planners are not familiar with the site
Planning staff in the field survey, on the one hand, do not know the specific location of the equipment, on the other hand do not understand the basic attributes of the equipment. Therefore, in the project survey, it often needs the cooperation of operation inspection, marketing and other professionals, which is too dependent on other business units and too inefficient to work independently.

3.2. There are various links in power grid planning and design
In the stage of plan investigation, it is necessary to carry out the work of locating, taking pictures and recording separately, and after the investigation is completed. The whole process needs to be completed in stages, but the overall work efficiency needs to be improved because of the number of personnel and the quality of the team.

3.3. Information tools for planning are insufficient
As an important professional tool, GIS can only be viewed on the office computer under the LAN. Thus, the use of GIS is limited by time, place, network and other factors, which makes it difficult for the planners to give full play to the role of GIS in the field survey work.
3.4. Post evaluation of grid projects are not yet substantive
Due to the limitation of personnel, time and other factors, it is difficult for the planning managers to realize the on-site verification of each project, and to plan the project more scientifically and reasonably, which often makes the post-project evaluation work a mere formality.

4. System Function and Overall Architecture Design

4.1. System function design
Combined with the above requirements and the relevant theories of grid planning, the main business process of the planning system is designed as shown in Fig. 2. It can be seen in the flow chart that the current situation of power grid application is analyzed in combination with the relevant database of power grid company, including grid voltage level, line loss level, transformer, line load rate, power flow, and line load rate under N-1 mode, etc. In addition, based on the analysis of the current situation of the power grid, the power load of the future area is predicted, and then the planning of substation, power grid line is completed according to the forecast, and the planning report is finally generated to provide the decision basis for the relevant decision makers. Therefore, by synthesizing the above flow, the function of the system is designed as shown in Fig. 3. In this system, load forecasting is the premise and key point of planning, and its accuracy is directly related to the quality of the planning scheme. By dividing the distribution network planning sites, predicting the space load and total load of different blocks, and comparing and balancing the results obtained by various load forecasting methods, it can provide reference and data reference for the subsequent planning. In the process of substation planning, it is necessary to take the future load forecast as the basis, so that the substation can be adjusted reasonably, and the location and capacity of the substation to be built in the standard year and the middle year cannot only fully meet the demand of future load development, but also meet the lowest investment and operation cost.

The placement module of the system has the following functions [4]: (a) The function of automatic placement. The system can calculate the required substation capacity automatically from the results of space load forecasting and the distribution of the existing substation supply area. (b) Manual adjustment of functions. The relevant operators can adjust and modify the automatic wiring results manually, and carry out the automatic placement work under the condition of locking part of the site position and capacity configuration. (c) Grid assessment function. In the process of placement, the whole grid can be evaluated according to the distribution of load, so that the load can be analyzed in real time.

4.2. System architecture design
Based on the requirements of the above system design, this work adopts the data layer, the middle layer and the representation layer to design the overall architecture in the distribution network planning system. Geographic data, grid data and system data are at the bottom of the three-tier architecture, all of which are stored in Oracle 10g. The work of the middle layer is mainly to complete the display of the geographical map and the original electrical appliance to provide strong support for visual distribution planning. The presentation layer is mainly designed according to the different role application and scene planning, which provides the whole system with the results of regional grid planning, residential grid planning and planning, and presents it in the form of images [5-9]. In this work, the overall architecture design of the system mainly adopts the Visual Studio 2010 development environment and the main modules of the B/S system developed by ArcGIS Engineering 9.3. Oracle 10g database is used to store all the data other than spatial data in the system. As for the storage of spatial data, the system uses the middleware ArcSDE spatial data engine to store and access it, while the non-spatial data uses the remote access mechanism in Oracle. The specific physical deployment is shown in Fig. 4.
**Figure 2.** The main business process of the planning system

**Figure 3.** Main functional modules of the system
5. Summary
GIS can carry out the most information integration work which is suitable for the design of grid planning system, thus providing more accurate decision basis for power system decision makers. Based on the system requirements and characteristics of the grid planning platform, a series of systems are designed based on mobile GIS platform. With particular focus on the design of system function and overall architecture considering system requirements and characteristics of grid planning platform, this work can provide support for grid planning regarding the application of mobile GIS platform in high voltage grid planning.

References
[1] Kaijuka E. GIS and rural electricity planning in Uganda[J]. Journal of Cleaner Production, 2007, 15(2): 203-217.
[2] WANG P, JIANG Y. Design and implementation of power grid planning platform based on GIS [J]. Computer Engineering and Design, 2008, 22.
[3] Liu L C, Zhang Y G, Lin R. GIS Construction for Planning and Design of Southern Hebei Power Grid[J]. Electric Power Construction/ Dianli Jianshe, 2010, 31(9): 60-63.
[4] Bullen N, Moon G, Jones K. Defining localities for health planning: a GIS approach[J]. Social Science & Medicine, 1996, 42(6): 801-816.
[5] Stewart T J, Janssen R. A multiobjective GIS-based land use planning algorithm[J]. Computers, environment and urban systems, 2014, 46: 25-34.
[6] Di Chang, Xia Zhang, Qiong Liu, Ge Gao, and Yue Wu. "Location based robust audio watermarking algorithm for social TV system." In Pacific-Rim Conference on Multimedia, pp. 726-738. Springer, Berlin, Heidelberg, 2012.
[7] Di Chang, Xia Zhang, and Yue Wu. "A Multi-Source Steganography for Stereo Audio." Journal of Wuhan University (Natural Science Edition), 2013(3): 277-284.
[8] Xla Zhang, Di Chang, et al. "An Audio Steganography Algorithm Based on Air-Channel Transmitting." Journal of Wuhan University (Natural Science Edition) 57, no. 6 (2011): 499-505.
[9] Xia Zhang, Di Chang, et al. "Tree-like Dimensionality Reduction for Cancer-informatics." In IOP Conference Series: Materials Science and Engineering, vol. 490, no. 4, pp. 042028. IOP Publishing, 2019.