# Research on Provincial Power Grid Geographic Information System based on Web Network

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**Abstract:** Power grid geographic information system is a geographic information system based on computer network. Based on geospatial data, it can process, manage and analyze the power system in an all-round and multi-level way, so as to provide a series of auxiliary decisions for power production and planning. In this paper, the basic concepts of Web network and GIS system are discussed, and then the provincial power grid GIS system is designed on the basis of Web network, hoping to provide reference help.

**Keywords:** Web network, provincial power grid, geographic information system

## 1. Introduction

With the rapid development of China's electric power industry, the scale of power grid expands rapidly, the task of power grid management is increasingly heavy, and the requirement of power grid management information is getting higher and higher. Therefore, it is urgent to develop a set of efficient, practical and advanced provincial grid geographic information system in order to provide a timely, accurate and reliable power information service platform for power management departments at all levels. Provincial power grid GIS system is a geographic information system facing the whole provincial power grid, which applies GIS technology to provincial power grid management, and is an important aspect of solving power management problems with GIS technology. Therefore, how to develop the system is a concern of people, and it is necessary to carry out related research.

## 2. Basic Concepts of Web and GIS

### 2.1 Basic Concepts of Web networks

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Web network is an important part of Internet, which combines Internet technology and Internet application software. Internet technology appeared in the 1990s, while Web technology is a new network technology that appeared in recent years. Web network technology in the past few years, the development speed is extremely fast, especially in the world, it has become the mainstream of Internet technology development[1].

Web network technology mainly includes two aspects: one is the integration of Internet application software and application server with browser, providing users with a Web-based browser; The other is to integrate Internet services with other network services, that is, to extend Web services to other application areas[2].

A Web application server is a terminal that accesses the Web server on the Internet. It is also a Web server that accepts requests from users and forwards the requests to the corresponding Web application server for processing. The Web application server analyzes the user request and responds accordingly, and then forwards the response to the browser. Once the browser receives the response, it can process it according to its needs and display the appropriate content. Of course, the user can choose to get the required information through other services on the Internet such as FTP, email, address book, etc[3-5].

In a Web network, there are many applications that are managed and controlled by one or more users. Therefore, in order to effectively share and manage resources, there must be a user interface (UI) in the Web network, so that users can easily browse, query and update information. At the same time, it needs to be flexible to communicate with other applications.

In addition, the Web can be compatible with various algorithms, which enables the Web to be used in many fields. For example, in the field of power grid GIS system, the Web can be used to carry Digital Signature Algorithm for Web port identification. See Formula (1) for details.

$$N = P*Q = 3*11 = 33 \tag{1}$$

In the formula, N is the common modulus, i.e. the signature identifier, P and Q are prime numbers, and 3 * 11=33 are parameters (the specific number depends on personal settings).

### 2.2 Basic GIS concepts

GIS is a comprehensive technical system centered on computer technology, integrating electronic maps, geographic information systems, computer networks, databases, multimedia technologies, and analysis and prediction models to collect, store, manage, analyze, and evaluate spatial data, and provide decision support for decision-makers. Its basic function is to provide users with information technology to analyze and process the distribution, interrelationships, and development changes of various geographical phenomena and spatial entities. Compared with general computer systems, GIS has two characteristics: firstly, the integration of spatial data and attribute data. Spatial data and attribute data are interdependent and interrelated. If there is only one geographic information system without corresponding spatial data, effective management of spatial entities cannot be achieved; Secondly, the integration of spatial and non-spatial data. GIS has great advantages in establishing spatial and non-spatial

data models, and can comprehensively manage different types of spatial data, such as conducting geographic location analysis and thematic map production.[6-8].

## 3. System Module Design

### 3.1 Basic Framework

The system is mainly composed of two modules: data management and graph management, as shown in Figure 1.

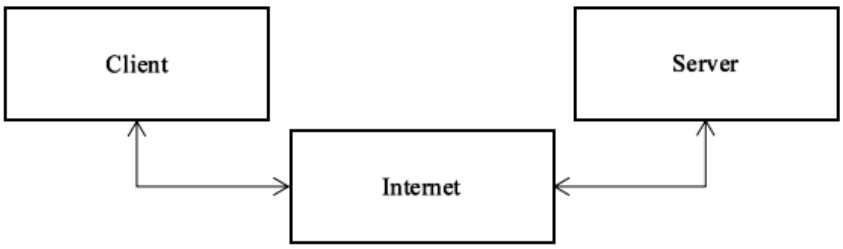


**Fig.1** Basic framework of the system module

Among them, data management module is the core module of the system, including data collection, storage, management and maintenance. The graphic management module is mainly to operate the substation equipment distribution map, transmission line distribution map and other maps.

### 3.2 Module Analysis

First, data management module. The module mainly includes the functions of data collection, storage, management and maintenance. It classifies and codes all types of data in the grid geographic information system, stores them in the database, and processes the data. At the same time, the graphic information and attribute information in the grid GIS are classified and managed according to unified standards, including substation equipment, transmission lines and other objects. In practical application, this module can update all kinds of objects dynamically in real time. Data management module can realize the storage and maintenance of different types of data, and can process each type of data according to business requirements. At the same time, the module can also provide a variety of data query functions, which is convenient for users to quickly find, quickly analyze and quickly locate all kinds of information needed[9].

Second, the graph management module. The graphic management module is mainly to browse, query and analyze the substation equipment distribution map, transmission line distribution map and other maps. Users can query the detailed information of the substation through the module, and also analyze the operating status of the transmission line. The module also provides the transmission line distribution query function, through which the user can query a transmission line, know the substation it passes through, the crossing line it passes through and the name of the substation it passes through[10].

# 4. Overall System Architecture

## 4.1. System Architecture Overview

Provincial power grid GIS adopts B/S (browser/server) mode, and its overall architecture is shown in Figure 2.

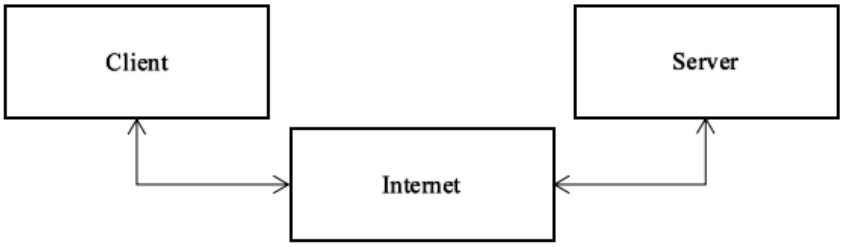


**Fig.2** B/S schema architecture

In this system, B/S mode can greatly simplify the development of application system and reduce the development cost of application system. At the same time, B/S mode enables users to access and manage the information system conveniently. The advantages of this mode are as follows: first, because the system runs on the client side rather than the server side, users do not need to access the server when accessing the information system; Second, because the application software runs on the client side rather than the server side, the system has good flexibility and scalability; Third, because the operation and maintenance of the information system are completed by the client, the system has good stability; Fourth, B/S mode can also solve the problem of data synchronization in Web database and WebGIS. In this system, using B/S mode to manage information can effectively solve the problem of data synchronization on server side; Fifth, B/S mode can also be integrated with other Web applications; Sixth, B/S mode also has good security and stability. In short, B/S model has a good application prospect in provincial power grid GIS.

## 4.2. System Design

### 4.2.1 Basic function design

The design of grid geographic information system adopts B/S mode, that is, browser/server mode. The main functional modules of the system include: spatial analysis module, data management module, statistical analysis module and security control module.

The functional modules of spatial analysis include: according to different needs, different analysis models can be designed, such as linear analysis model, network graph analysis model, etc. Different data can be displayed on the graph, and the query and statistical analysis of the data can be realized through simple operations.

The spatial database stores various attribute data related to the power grid, including equipment name, production date, operation status, geographical location and other information. Graph data management includes: according to different needs,

different types of graph data can be designed, such as line distribution diagram, transmission line distribution diagram, etc. On this basis, the corresponding type of attribute library can be designed, such as substation distribution diagram, transmission line distribution diagram, etc.

The security control function is as follows: To protect the system from damage and virus attacks, you need to add corresponding security control mechanisms to the system, such as password control mechanisms and access control mechanisms.

### 4.2.2 System structure design

This system adopts B/S structure, and in. NET platform development, using a three-layer architecture, the system logic structure is shown in Figure 3.

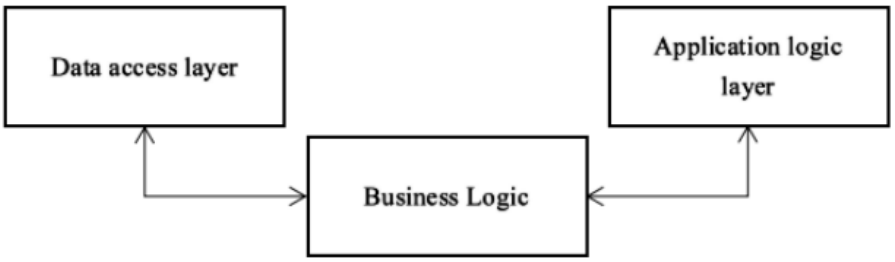


**Fig.3** Logical structure of the system

The first layer is user-oriented data access layer, including equipment and personnel information management, graphic data management, map operation, user management and other functional modules; The second layer is the business logic layer, including power grid analysis module, power grid planning module, etc. The third layer is the application logic layer, including power grid management, query analysis and report making.

The first and second layers are mainly implemented through the server side, and the third layer is mainly implemented through the client side. The client is mainly responsible for graphic display and data operation. Grid geographic information system based on B/S structure, which includes the following functions: 1) basic data maintenance and management; 2) Graphic display; 3) Library maintenance and management; 4) Report making and inquiry. The system adopts the B/S structure and is deployed on the Web server. Users can access the system through the browser, and can also access the system from the client through the network after the system is running. At the same time, due to the use of B/S structure, each server is only responsible for handling their own management tasks, so that the maintenance and management of the entire system is simpler, but also for the future expansion to provide convenience. In addition, because of the B/S structure, the system has high efficiency and flexibility in data maintenance.

### 4.2.3 Implementation of system functions

The system is mainly composed of four modules: basic data management, graphic display, gallery maintenance management, report making and query, as shown in Figure 4.

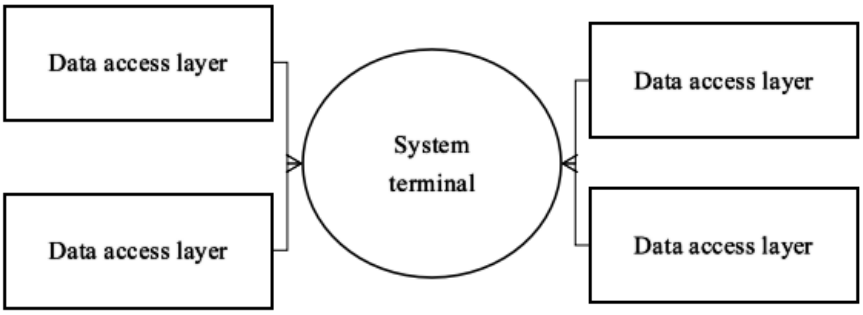


**Fig.4** Composition of system function modules

Among them, the basic data management module is responsible for the management of power grid data, including basic equipment information, equipment information, user information, etc. The graphic display module is responsible for the graphic display of the power grid, including the topology diagram, the circuit diagram and the substation distribution diagram. Library maintenance management module is responsible for adding, deleting and modifying the graphics in the system; Report making and query module is mainly responsible for making various reports, including power grid electricity analysis report, substation switch status table, substation power flow statistics table, etc.

The core part of the system is the Web server, which is mainly responsible for storing the data in the Web server in the database and interacting with the client through the network. On the Web server, the user can access the data in the database directly through the browser. The client is mainly used for data display and operation, its functions include: first, map operation mainly includes map zooming, translation, rotation, etc.; Second, query and statistics: mainly includes the setting of query conditions and the output of query results; Third, statistical reports: mainly including power grid statistical reports, substation statistical reports and electricity analysis reports; Fourth, other functions related to GIS.

## 5. Key Technologies for System Operation

### 5.1. Development Technology

In the first layer of the system, the server side is mainly responsible for data operation and information management, the use of ActiveX controls to convert user requests into corresponding response information, and the data is stored in the database. The second layer is the application logic layer, which receives requests from clients and completes data operations. The third layer is mainly the server side, which needs to accept the request from the client and add new data to the database according to the request from the client. Among them, the Web server is the core part of the entire system, which completes all user requests and handles all data operations. The Web

server communicates with the client browser through the HTTP protocol. It consists of four parts: the Web server, the client browser, the database server, and the application server.

In the data access layer, users can access the system through the browser and obtain the required information. The system uses JavaScript technology to realize the page display. JavaScript is a scripting language that executes on the server side and is mainly used to achieve the dynamic effects of the page. This system adopts. NET platform to develop, using JavaScript as the main programming language, this is because JavaScript not only has the advantages of cross-platform and scalability, but also can run on different operating systems, to achieve efficient, rapid development and maintenance.

The system adopts B/S structure to realize the grid geographic information system, and users can access the system through the browser. It adopts three-layer architecture, that is, user layer, application layer and data layer. The system framework adopts the component development approach, separating data management from business logic. The client is the bridge between the application and data access, and the browser is responsible for data manipulation, graphical display, report making and report printing.

It is one of the key technologies in this system to separate business logic from data access by using component development technology. Component development is a design idea and method that separates the functions and interfaces in an application from the business logic. Component-based development technology can encapsulate most functions of the system in a module, which is easy to maintain and upgrade the application. Component development divides an application into modules, and the individual modules are configured to meet business requirements. These modules are composed of several reusable components, and when a function needs to be changed, only these components can be modified to achieve the change of the function.

### 5.2. Data Interface Design

Grid geographic information system adopts object-oriented method to develop, data interface as the attribute of the object, it is the basis of data exchange between applications. By establishing interfaces, various data sources can be used effectively, duplication of labor can be avoided, and the efficiency and flexibility of the system can be improved. This system uses ODBC interface as the data interface to interact with the database.

ODBC is a very portable database connection technology, which provides an efficient, flexible and easy to manage data access. When using ODBC, you need to provide it with an interface to manage various operations in the database. Two aspects need to be completed here: one is the database connection pool technology, that is, the connection pool is established among multiple applications, and only one application is allowed to connect to the pool; The second is the SQL Server database connection pool technology, which allows users to read and write operations in one SQL Server connection pool.

The data types are dataset, dataset id, and dataset type. You can map ODBC and database based on data types to obtain corresponding operations. The database access interface is a typical database access interface. It defines the logical and physical location of ODBC in the database (that is, the location of ODBC in the database). The

user accesses the database directly through the data interface. Unlike ODBC, SQL Server does not provide specific data manipulation functions, but through a set of data manipulation statements to achieve access to the database. SQL Server encapsulates some common query statements obtained after analyzing and filtering a series of services provided by the SQL Server Server, and then completes operations on the database through these query statements. During the use, the user needs to call the functions provided by SQL Server to query the corresponding field information in the database and display the results on the screen. In the process of use, users also need to maintain and optimize various data operation statements provided by SQL Server.

### 5.3. System Application Function Loading Technology

Because the grid geographic information system needs are different in different regions, other technical support may be required, so loading technology can be used to obtain these functions. Through loading technology, related functions can be directly imported into the system without secondary development. Based on the loading technology, it is suggested to add five functions in the system: first, graphic display function, map display is one of the core functions of GIS system, the system provides a variety of ways of map display. Users can choose different map display methods and layers according to their needs, and can also import and export data in certain formats; Second, the graphic operation function, through the graphic operation function, users can map operation, query, add/delete primitives, attribute editing and other operations; Third, the spatial analysis function, including the analysis of the power network topology structure, the analysis of the line path, the analysis of the equipment attributes; Fourth, database management functions, including spatial data management and attribute data management. Spatial data management provides a variety of query methods, users can query or import all kinds of graph data according to needs; Attribute data management provides users with operations such as adding, deleting and editing graphic elements. Fifth, system setting function, including user login setting, user permission setting, system parameter setting, help information setting, etc.

## 6. Conclusion

To sum up, in the design of provincial power grid GIS system, it is necessary to consider its cross-platform, flexibility and scalability requirements, while fully considering the security and ease of use requirements of the system. With the continuous development of GIS technology in power industry, it is also of great significance to apply it to power grid management.

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