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Framework Design of Power Grid Planning and Design Platform

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Abstract

Power grid planning and design platform is an integration power grid planning and design and technical-support platform system, serving in power grid companies at all levels and the planning and design unit multistage users for collaborative planning design, comprehensively supporting planning and design basis data management, major network planning, distribution network planning, project planning, planning achievements management and project review. Based on the experience of power grid planning and power grid information construction, an overall architecture design scheme of power grid planning and design platform is presented in this paper. The paper emphasizes the data platform design, and expounds the characteristics of the design platform, which provides the reference and basis for the power grid planning and design platform construction.

Keywords: *power grid planning and design platform, general framework, unified data platform, graphics service, cooperative work*

1. Introduction

Power grid planning is a complicated and arduous systematic engineering with such traits as large-scale, broad involved areas andmany participation departments, etc. There exists a large number of research results about grid planning and design platform system, which are mainly studied for some local problems in planning work. So they did not to cover the global application of the whole process about the actual planning business. It is required to conduct a whole design about organization and management mode, system architecture, implementation plan, application running in platform construction. In current domestic power grid planning, there are three prevalent problems as follows: 1) Data consistency is an outstanding issuein planning basic data. Because of scattered data information, the workload of data maintenance is big. And the data management process has not been clearly established, which leads to a lack of corresponding mechanism function, so it is difficult to guarantee data validity. 2) During planning project, the insufficiency of information sharing, coordination between superior and subordinate gird planning, timely and effective communication causes that it is unable to realize integrated optimizing within the whole power grid. 3) The traditional planning software takes CAD (AUTOCAD, 3D aided design software) as the graphic platform.And the limitations of the graphic platform make the software not support huge amounts of data.It is difficult to establish mathematical model and realize objectification design [1-6]. A mature planning GIS platform is also lacked.

As a technical support platform fora multi-level planning system, planning platform takes the application of corresponding modeinto account. The combination of multi-hierarchical distributed application model with professional power system calculation will generate a large number of technical problems. Practice shows that based on the overall design of the platform location, management organization, technical route and application patterns, the platform construction is guaranteed to be scientific and reasonable.

In view of the above questions, the goal of power grid planning and design platform is to construct a service system consists of multiple software systems and service team, which integrates the entire planning including data collection, data analysis, planning and decision-making, result presentation, project evaluation. The platform satisfies multi-level users such as

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the headquarters (branches), provinces, cities and counties with collaborative planning and design, major network planning, distribution network planning and special subject research.

2. Design Principles

Based on the overall architecture guiding principles of state grid corporation "SG-ERP", namely the " centralized platform, integrated application, intelligent decision, safe and practical", the overall technical solution design of power grid planning service system follows the following specific principles:

1)The principle of unity

In accordance with the principle of unified management, convenient maintenance, and low investment, low cost of operation, the same deployment is adopted to form power grid planning and design platform. The construction of the whole system is in accordance with the unified management, unified business processes, unified working standard, unified principle of the integration.

2)The principle of advancement

The design thought, system architecture,adopted technology and platform should have certain advancement, prospective and scalability. On the basis of meet the demand of existing, the platform can adapt to business during a certain period of growth and change in the future.

3)The principle of reliability

The important unit of platformshould use redundant configuration, to ensure availability of the entire platform function is not affected by the influence of a single fault; Cluster technology should be adopted in the system in order to enhance the system reliability of key applications and services;

The failure of system should be able to isolated and removedwhich won't affect the normal operation of all nodes, and garantee quick and smooth recovery process;

4) The principle of safety

All the information in the system are the company's business secrets, it must be ensured that all information in the process of transmission and processing is absolutely reliable.In addition to make full use of network operating system and database system to provide security protection mechanism, security software must be used to ensure the security of data transmission on the communications lines. It is prohibited for illegal users to get access to data in the system. Data access is set according to the level, prohibiting unauthorized users to get access to data in the system.

5) The principle of scalability

In the planning and design of this platformthe link with other application systems is considered. The loose coupling design pattern is used to make the system can realize the integration with other third-party mature products, ensure the system scalability. The system must follow the corresponding specification and standard requirements.

3. The Overall Structure of the Framework Design Platform

The overall architecture of power grid planning and design platform consists of business architecture, data architecture, application architecture, technical architecture, security architecture and other parts. The overall architecture is shown in Figure 1.

The power grid planning and design platform build in this project is developed using J2EE system combined with Hadoop cloud computing architecture. Platform adopts the modular design and development, abstracting platform general function for the component. Characteristic function shall be encapsulated in accordance with different function to form business components. The components can be functional reorganizedalong with the business change. Moreover, the platform provides the function of the component configuration, diagnosis, comparison.

The data model of the platform, based on the theory of unified design, unified storage, unified management, manages integrated data with the uniform access to integrated business system in the "adapter" mode. The underlying developing and running platform adopts SotowerDE. The workflow uses SotowerBPM, and spatial database uses data access interface of GIS. The GIS Web control is introducedto show geographical wiring diagram and complete auxiliary analysis of planning and design. Above the SoTower platform, based on the common

components of program plan management information system, the shoring of foundation components and the basis of planning components of power grid planning and design platform are constructed. And on this basis, the corresponding business components are built to form the core functions of power grid planning and design platform. Through the development of uniform representation entrance, the platform provides users with convenient, unified interface work.

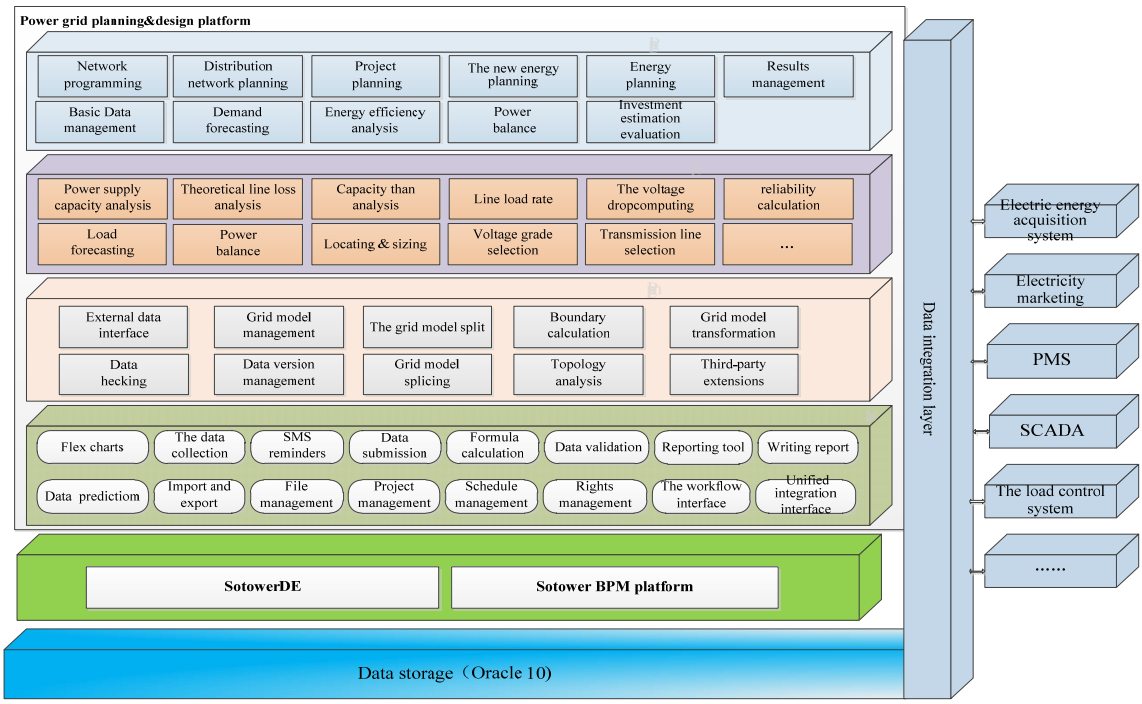

Figure 1. the Overall Framework Design

4. The Design of Data Platform

Power grid planning belongs to data-intensive business, which needs a set of efficient, unified data management tools to support. In consequence, it can provide reliable data sourcesfor planning business and supplement quick and comprehensive analysis tools. And current platforms rely on artificial management data. The existing planning software is relatively closed. The format, source and management, entry mode of data do not meet the actual needs, which not only can not reduce the pressure of management, and even causes problems such as repeated data maintenance, data caliber inconsistent and data error [7]. To solve these problems, the data architecture designed in this paper is shown in Figure 2.

Basic data platform realizes the management of relevant data of the planning, including geographic information data, the data of the national economy, the power load data, energy, etc. These data are mostlyacquired from other planning-related information system, such as production management system, marketing system, GIS system, etc. Therefore the platform should share with information multiple application systems, comprehensively collect planning and design information, support the running each function module in the integrated platform. Now the format interfaces of this platform mainly include CIM, Shape, CAD, SVG, BPA. The system automatically extracts the basic data of the planning from grid information system (such as GIS, SCADA, MIS, etc.) through the CIM interface. Using the file in the Shape or CAD format generates automatically plot (the background is geographical wiring diagram). And the platform can export graphical output, generatespecial subject analysis results chart and GIS thematic map. Since BPA has been successfully applied widely in the stage grid, the system realizes seamless calls with BPA. Flexible open data interface effectively integrate a variety of resources in different grid information system, improving data sharing and enlarging the application range of planning results.

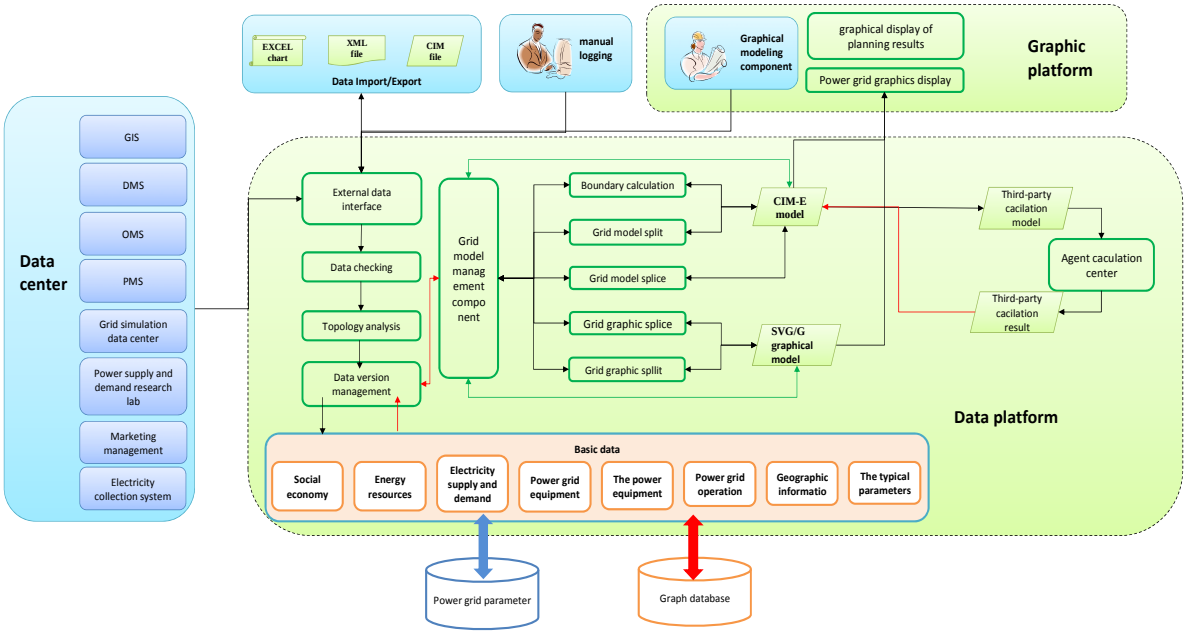

Figure 2. Data Platform Architecture Design

Power grid planning and design platform is an advanced application platform built on the interface systems.The data are numerous and jumbled, and the sources are broad, so categorized management and storage of the information are needed. From the perspective of a longitudinal time section, planning basic data information includes demand for power and resources information in the history, current situation and future [8]. For a single time section (usually a year maximum load moment), planning basic data informationincludes accounting information of grid production, topological information and geographic information [3]. To meet the needs of the planning work, a check repair function forthe above data information should be developed. Calibration includes calibrationof accuracy and consistency, which is able to eliminate redundant data and error data. In addition some advanced data calibrationsare also included, such as topology calibration, electrical calibration, and so on. The calibration finally gives the problems existing in the data. And the problems are manual repaired or auto repaired, which provides data support for the business of planning. On the basis of the completion of data calibration, data version management component is designed to control and manage the basic data version, guaranteeing the unit of data synchronization between the superior and the subordinate, ensuring data version unification in planning and design work between different levels.

In order to solve the problem of the standardization of the data, on the basis of the IEC-61970 standard and the IEC-61968 standard grid model is established combined with the common information model CIM and vector graphics extensible format SVG [8]. And the figure and model integrated technology is used to construct the grid model management component. For the utmost application of existing CIM and SVG model and reducing duplication of modeling, management components need to split/merger this part, forming a complete and accurate grid model, and through the model split/equivalent management components provide the corresponding service model for the specific area. Business model stitching/separation technology is anvery important link to realize the planning information sharing. Grid model can be split and stitched according to time, voltage, project, scenes and other multidimensional. Boundary calculation realizes the boundary calculation for each model in the process of the grid modelsplit. In addition, the data platform also designsa system open computing extension interfaces. By the grid model transformation components we can acquire calculated data model, such as BPA data card. Calculation results are obtained after calculation of third-party extensions component.Finally by the grid model transformation components the grid model is transformed into CIM model.

The construction of planning data platform provides a stable data maintenance and accumulation platform for planning work, ensuring the quality of the planning fundamental data. At the same time it maintains the stability and long-acting of the data, avoiding repeated information collection and error data.

5. The Design of Business Function

According to the overall architecture design idea of power grid planning and design platform, the core of the platform function is divided into eight functions as follows: basic data, demand forecasting, power balance analysis, energy efficiency and energy, network programming, technical analysis, evaluation of investment estimate, achievements management. It meets the distribution network planning, distribution network planning and the application of special subject planning.The functions of power grid planning and design platform are as shown in Figure 3.

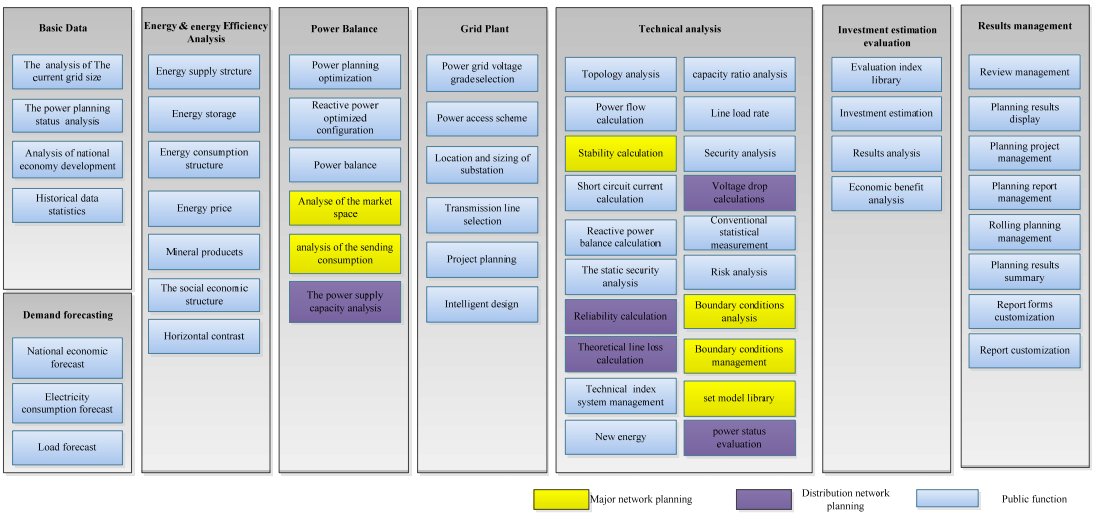

Figure 3. The Frame of System Function

6. The Features of platform

6.1. Graphic Services

The exisiting planning software lacks a better interactive planning platform based on graphics. It just took graphics as a background with a small amount of annotation information. And it almost had no interaction analysis ability. The user experience was poor. Graphical interactive planning platform in this platform is the most important and comprehensive link among planning support. Through the platform experts can intuitively and conveniently use a variety of services, complete the core planning work efficiently with high quality.

Graphics application functions are developed based on the standard J2EE development framework and the Web controls of GIS. The main features include map support, primitive and labeling management, basic graphics operations, graphics drawing and editing, etc. Interactive programming platform takes map as the background. The mapis able to followup scaling and translation. The map can provide latitude and longitude coordinates. The graphics support 2D and 3D display. Three-dimensional display is an integration of GIS, RS, and virtual reality technology. It contains huge amounts of data from multi-source (including image data, DEM, the 3D model data, business data). The power planning area can be simulated on the computer so as to reproduce the natural environment of the area. The platform realizes the 2D and 3D synchronous display, real-time transformation of coordinate system, view the vertical section of transmission linesand other functions.We can plan path for transmission and do all kinds of spatial analysis lines in a virtual 3D scene, so as to make the path more reasonable, shorten the line path, and reduce the cost of investment. The use of this feature can reduce a lot of field

work, reduce adverse effects of the project construction on the lives of the people, and protect the environment.It has obvious advantages compared with the traditional operation.

6.2. Cooperate Work

In the process of power grid planning and design, the same scenario requires people to work together, which reflects power grid planning in real time. With shared pictures and data, it shows the teamwork results. For the same planning scenario, a number of experts not only independently analyze, but also discuss on the BBS in the process of analysis, which is the special requirement of interactive graphic programming platform [9].

The essence of cooperate work is to establish a virtual office for planning experts through the graphics work platform. The platform provides powerful workflow engine to support the sending and transfer of the document. And at the same time it provides a visual interface of maintenance so that the workflow can be maintained. The platform realizesuch functions as document management, document retrievaland statistics, document presentation, instant communication of message and teamwork.On the other hand, the platform provides log management features like system log, application log, user log.Through a variety of ways we can retrieve and inquire the recorded operation log, and generate statistics via further analysis.

6.3. Flexible Integration, Unified Management and Unified Concordance of Grid Application

Power grid planning and design platform provides an open SAAS (Software- as-a-service, Software operation service mode) with a flexible application integration, concordance and unified management, following the basis of service-oriented architecture (SOA). The platform can allocate resources along with the need to build applications. The platform provides the ability ofpower grid planning creation and execution based on basic data and planning business. It is the operating environment of the power grid planning business.

Through an enterprise service bus (ESB), the platform maximizes the flexibility of SOA services. The platform builds outward unified data interactive channel of planning and design business applications in the form of public interface module to strengthen the deep integration with planning program management system. Existing applications and data can be integrated through a variety of grid adapters and business process management (BPM) based on the workflow. It accomplishes disposal and information exchange between different data formats, data types and different business. The platform adopts the concentrated security policy management to realize the centralized management of the system users, unified authentication, authorization and other functions. Through the business process automation, the function of global business flow and interface is linked up with each application system based on the role. By the application integration architecture, the scheme of integration with each application system data and function is provided. And global data and function can be viewed. Therefore, in the system architecture design, considering the integrated information system model frame, from various perspectivethe architecture of planning and designand associated application is comprehensively analyzed and hierarchically decomposed, which reduces the complexity of the IT architecture planning.

Meanwhile, the technical implementation of flexible integration, unified management and unified concordance of grid application depends on integrated particle size and the depth of integration of the power grid planning and design platform [10]. It depends largely on integration level of existing and new systems, applications or services and good software-support tools. On the other hand, application environment of flexible integration, unified management and concordance not only reflects on the technical level of integration of various applications but also vertical integration of power grid development strategy, management and business operation. From the aspect of the main activities and the key elements in the overall planning, the relationship of integration is studieddeep, from the aspect of strategic planning and technology level the implementation approach of the overall integration is analyzed.

7. Conclusion

Power grid planning and design platform, combined with the program planning management platform, expands the development direction of business, which covers the development of business planning and design, project management, planning, statistics,

analysis and other main business stage [11-13]. It builds a complete product line of a business development direction. The planning and design service system based on grid planning and design platform makes the company from product provider to software service provider, which can effectively promote the sustainable development of the company's business.

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