Architecture design of big data analysis platform for smart grid in rural areas

Jinghui Song 1,* and Leitao Su2

1China Southern Power Grid Power Technology Co., LTD., Guangzhou 510600, China
2Electric Power Research Institute, Guangdong Power Grid Co., LTD., Guangzhou 510620, China

*Corresponding author’s e-mail: songjinghui@gddky.csg.cn
*Corresponding author’s ORCID: https://orcid.org/0000-0001-8744-6109

Abstract. The power grid is facing more and more challenges with the development of new energy. Thus, uncoordinated network load and local heavy overload problems always affect the development of rural power grid, especially the impact of voltage quality and power supply reliability on the rural power grid. According to the characteristics of rural power grid, firstly, the work establishes the overall architecture of smart grid big data analysis platform and then analyzes the software functions and hardware configuration of the platform, finally, discusses the deployment mode of rural big data platform and power grid big data analysis platform. Furthermore, it introduces the technical principle and data transmission principle of smart grid big data analysis platform. Finally, the paper emphasizes that we should build a rural intelligent big data analysis platform according to building a green and transparent smart platform area and building an integrated and open intelligent cockpit.

1. Introduction
With the rapid development of new energy, the challenge to the power grid is increasing. In the rural power grid, the source-grid-load incoordination, local heavy overload, voltage quality and power supply reliability issues also restrict the development of the rural economy. From the perspective of power control, there are many distributed power sources in rural areas, and there are also many types. From the perspective of voltage levels, the rural power grid is a rural power grid, which is suitable for the construction of a distribution network with a simple structure and a high level of automation. Therefore, there is an urgent need to build a smart grid big data analysis platform to contribute to various distributed power sources, to assist decision-making in real-time supply and demand balance, to rationally construct and use support for local distribution networks, to build smart station areas, and to improve customer experience.
In response to the above problems, this paper develops a smart grid big data analysis platform, divides the platform into a data source layer, a data integration management layer, and a business application layer, and presents a system software and hardware function scheme. Next, describe the deployment method of the smart grid big data analysis platform. Then, data is transmitted using technologies such as data visualization and data analysis and mining. Finally, the application functions and application interaction of the smartest grid big data analysis platform are introduced.
2. The overall architecture of the smart grid big data analysis platform

2.1. Overall structure
The smart grid big data platform includes a data source layer, a data integration management layer, and a business application layer. The overall architecture is shown in Figure 1.

![Overall architecture of smart grid big data analysis platform](image)

The data source layer includes measurement system, environmental monitoring information system, distribution network automation system, enterprise operation monitoring system, marketing management system, asset management system, distribution network GIS system and other related data. It is the application basis for data management and service interaction. The data at the source layer is the result of the business processing of each business application system. The data integration management layer mainly implements the construction and data storage management of the measurement data and basic information of the archives extracted from the data source layer to ensure the efficiency and data quality of data viewing and application. The data management layer also includes a data integration platform, which enables online extraction and concentration of various data (including current data and historical data). The data integration platform, data storage, and calculation management are finally built on the provincial big data platform and data warehouse. The business application layer mainly realizes the customized monitoring and management of related business functions of the platform. Including the management of homepage, basic functions, basic applications, advanced applications, etc. The business application layer is finally built on the provincial cloud platform and follows the microservice specifications. The customer interaction layer mainly meets the needs of users for information interaction during the use of the platform, and the realization of online recording and service processes, following the microservice specifications.

2.2. Software function scheme
A rural smart grid big data analysis and application construction project, as a monitoring project to improve management quality and service effects, should first consider whether the existing software
and hardware environment of the system can meet the requirements in the implementation and selection of system software and hardware. Based on existing equipment, consider making necessary additions and extensions. The following system software is required:

- **Database**: Oracle 11G;
- **Server operating system**: Windows2008 Server or UNIX
- **Client operating system**: Window 7/8/10, install IE9.0 or above browser
- **Intermediate application server**: WEBLOGIC 10

2.3. **Hardware function scheme**

For the research and application of a rural smart grid big data analysis and application construction project, the hardware configuration is mainly considered from the perspective of ensuring the system WEB service of the front-end application of the smart grid integrated monitoring platform and the storage of system management data. It mainly considers the number of concurrent login system application personnel of a rural smart grid big data analysis and application construction project and the hardware resource occupancy of each login system user. The hardware server is mainly deployed on the system web service middleware WebLogic, and the oracle installation configuration for storing system management data. The configuration meets the following conditions, and it is configured with 4 E5 2.66G 6-core CPUs, 64G memory, 5*1000G 10K Hard disk, realize raid5, redundant power supply. The above system hardware configuration uses the existing resources of Shaoguan Power Supply Bureau in the project transition phase, and uses the provincial cloud platform resources in the final delivery phase, which can be directly applied. For the video and picture preprocessing of drone inspections, image recognition software needs to be deployed on the hardware server. The processed videos and pictures are stored as attachments. The database stores the attachment path and uses FTP for transmission. Due to the relatively large capacity of videos and pictures, it is recommended that the configuration meet the following conditions, and configure 4 E5 2.66G 6-core CPUs, 128G memory, 10*1000G 10K hard disks to achieve redundant power supply. Due to bandwidth limitations, it is impossible to upload large-capacity videos and pictures to the provincial company-side system. Therefore, the video and picture preprocessing server will use the existing resources of the Shaoguan Power Supply Bureau and be deployed locally in the Shaoguan Power Supply Bureau. In addition, this system platform uses a cloud platform server with extended functions. If the configuration requirements are not met in the future, it can be extended to meet the platform requirements in time; at the same time, in order to achieve the 3D function display effect on the client, the client configuration needs to meet 16G memory, 4 core CPU with independent graphics card.

3. **Deployment method of smart grid big data analysis platform**

**Database server**: It is used to deploy access data from various intranet systems, big data platforms, Yueyicong platform, etc., and store calculation results for the application server.

**Application server**: used to deploy application services and realize the visual display of integrated applications.

**Data integration server**: used to integrate and store data calculation results from multiple systems, and store analysis results for intelligent analysis functions.

**Video and picture preprocessing server**: used to preprocess UAV inspection videos and pictures and deploy image recognition software. The deployment method of the intelligent big data platform is shown in Figure 2.
4. Principles of Smart Grid Big Data Analysis Platform

4.1. Technical principle

4.1.1. Realize page adaptation based on data visualization technology. Through the use of data visualization technology, it provides a complete multi-screen application solution, adaptive resolution (including text, charts and pictures), supports multiple displays such as PC, mobile, and LED large-screen displays, and provides multi-screen Interactive solutions.

4.1.2. Realize index analysis and prediction based on data mining technology. Data analysis and mining technology can perform data mining processing in different ways for different business needs according to needs, including: cluster analysis, K score calculation, time series analysis, and mining association rules. Data mining functions need to include: load forecasting, power generation forecasting, equipment health assessment, equipment rotation prompts and other functions.

4.1.3. Application in the integrated monitoring platform of smart grid based on game theory. The research of game theory mainly focuses on the strategic interaction between two or more market members. Use the method of seeking the Bayesian Nash balance in the game theory to analyze the relationship between differentiated services and operation and maintenance information compliance, and compare the best countermeasures between the two parties in various situations, and then find the best solution. Any two-player game with a finite pure strategy has at least one equilibrium pair. This equilibrium is called the Nash equilibrium point. Non-cooperative game is the theoretical basis for studying several standard problems of market manipulation by a few manufacturers, and it is of great significance to the study of the market. The rigorous proof of Nash's theorem requires fixed point theory, which is the main tool for the study of economic equilibrium. Starting from the actual conditions of the grid environment and operation and maintenance monitoring and management, the power supply department should choose the optimal combination of strategies, strengthen power consumption monitoring, and improve inspection efficiency.
4.2. Data transmission principle

Figure 3. Data transmission principle of smart grid big data analysis platform

Provincial centralized operation data is sent from the provincial massive quasi real-time data platform to the provincial big data platform. Prefecture data is collected by the customized data collection program to the database of the three secure access districts, and then exchanged by the data exchange component to the database of the three districts of prefecture management, and extracted by the data extraction component of the provincial big data platform. The data is processed and transformed in the provincial big data platform, as well as business-oriented calculation and analysis. Finally, it will be displayed by the application layer visualization component. The data structure realizes the establishment of data analysis data channels collected from the end of the production control area to the management area, explores the realization of cross-regional data interaction technology that meets the smart grid, and accumulates experience for the smart grid panoramic data analysis. The data structure of the smart grid big data analysis platform is shown in Figure 3.

5. Smart grid big data analysis platform application

Smart grid big data analysis platform application functions mainly include the overall platform function module, green energy theme module, safe operation and maintenance theme module and reliable power transmission and transformation theme module and other module application functions. As shown in Figure 4.
Figure 4. Application functions of smart grid big data analysis platform

The overall function module of the platform displays the graphical interactive display method based on the trend diagram/geographical wiring diagram and the display method of the data list. The display content includes three parts: the overall operation monitoring visualization display, the overall structure display, and the total power status display. An overall display of important data such as new energy (including small hydropower, wind power, photovoltaic), power transmission and transformation facilities, power distribution facilities, and key customers. The green energy theme module display covers an overview of the existing green and clean energy in a certain village, as well as the visual display of its demonstration green energy (including small hydropower, wind power, photovoltaic, energy storage, etc.) operation.

6. Conclusion

The smart grid big data analysis platform is generally divided into data source layer, data integration management layer and business application layer. In terms of hardware configuration, it is mainly considered to ensure the system Web service of the front-end application of the smart grid integrated monitoring platform and the storage of system management data. It shall be configured according to the concurrent number of application personnel logging in the system and the occupation of hardware resources by each logged in system user. Multiple servers such as database server, application server, data integration server and video and picture pre-processing server shall be deployed. The application function of the platform mainly includes the overall function module of the platform, green energy theme module, safe operation and maintenance theme module, reliable power transmission and transformation theme module and other module application functions. The relevant data involved in the platform involves the interactive application of multiple production business systems such as marketing management system, asset management system, distribution network production system, measurement automation system, customer service system and Yueyi charge. We should build an intelligent big data analysis platform in accordance with the idea of improving the safe and reliable grid, building a green and transparent smart platform area, and building an integrated and open intelligent cockpit. Provide technical support for rural construction of smart grids in rural mountainous areas characterized by ecological friendliness, simplicity and practicality, flexibility and compatibility, high quality, and reliability.
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