Research and Application of Multi-layer Model for Panoramic Dispatching of Power Grid

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Abstract. In order to realize the data sharing and interoperability among application systems, and build an integrated regional power grid dispatching technical support system, this paper proposes to build a regional power grid dispatching technical support platform, with this platform as the core to provide unified resource services and technical support for professional applications, break through the barriers of professional application systems, build a unified technical support architecture, and take the update of energy management system as an opportunity to build a general information model as the core model. And built-in dispatching technical support platform with panoramic visualization graphics interoperability function, which realizes unified management of power grid model and parameters in A region and sharing of basic resources, and strongly supports the construction and development of smart grid dispatching system in A region.

Keywords: regional power grid; Panoramic scheduling; Multi-layer; General information model; visualization.

1 Introduction

With the continuous development of social economy, the complexity of power grid is getting higher and higher, which puts forward higher requirements for the stability and economic operation of power grid [1]. In order to improve the reliability of power equipment operation and reduce the probability of failure, various types of online monitoring devices for power equipment are constantly emerging, covering almost all the key power transmission and transformation equipment in the power system. At the same time, it is the development trend of safe operation and management of power grid to build an integrated and intelligent remote monitoring and diagnosis system for power equipment in the whole network [2]. In the next 10 years, online monitoring will comprehensively cover about 2,000 substations with voltages of 110kV and above, and the amount of data transmission and processing is extremely huge. The remote monitoring and diagnosis system of power equipment needs to realize a series of functions such as data acquisition, monitoring and early warning, condition evaluation and maintenance decision, so as to effectively support the concrete implementation of condition-based maintenance. Unified panoramic intelligent monitoring information model of power equipment is the foundation of realizing this remote monitoring and diagnosis system, and to solve this problem, we need to start from the aspects of online monitoring information access and model integration. Based on this, this paper builds a dispatching technical support platform with the general information model as the core model and built-in panoramic

ICIDC 2023, June 02-04, Nanchang, People's Republic of China

DOI 10.4108/eai.2-6-2023.2334661

visualization graphics interoperability function, which realizes the unified management of the power grid model and parameters in Area A and the sharing of basic resources, and strongly supports the construction and development of smart grid dispatching system in Area A [3].

2 Construction Objectives

According to the development plan of the dispatching system of State Grid Corporation of China and A Power Supply Company, the dispatching command of regional power grid will be transformed from "manual analysis" to "automatic intelligence" in the future, forming a power grid dispatching control concept with operation risk prevention and control as the core, and finally realizing a highly intelligent integrated dispatching intelligent command and auxiliary decision-making system. At present, the business support systems of regional power dispatching control centers are scattered, and it is difficult to effectively integrate data and applications. Therefore, the construction goal of power dispatching technical support platform is to build a unified technical support platform with CIM as the core, highly integrated with EMS, and integrating various system data and applications by using power information technology. The core business of regional power grid dispatching control institutions is divided into operation planning strategy, real-time operation and operation safety risk control, and each category has thousands of specific business applications. For example, operation planning strategy includes maintenance plan, unit power generation plan, power grid operation mode, stability limit and stability strategy. Due to the limitation of the previous technical conditions, each function is biased towards pure plan management and approval application, and the intelligence level is low. For example, the power grid maintenance plan is essentially a multi-constraint and multi-objective optimization planning work. Constraints include mutually exclusive constraints of maintenance equipment, maintenance time constraints, security risk constraints, etc., and objectives include the shortest power outage time, minimum load loss, etc. [4]. The traditional application system lacks a strong technical support platform, so it is difficult to meet the above requirements. Therefore, the regional power grid dispatching technical support platform is the core technical support of the future dispatching command system of A District Dispatch, and lays a solid foundation for the final realization of intelligent dispatching. For example, Table 1 shows the technical support platform of regional power grid dispatching [5].

Table 1. Contents of each layer of regional power grid dispatching technical support platform

Presentation layer	Application support layer	Panoramic model layer	Data support
SVG visualization platform	Basic algorithm library (core algorithm, application layer algorithm)	Multi-state model service (running state, future state)	Geological survey data center
	Equipment status monitoring (real-time/historical status of primary and secondary equipment)	Bidirectional mapping	
	Distributed data acquisition and	Core model (IEC61970CIM)	

	processing (real-time/quasi-real-time, periodic data)	
Graphic interoperability API library	Application architecture (SOA bus, Web Service, Corba)	Multiple model matching
	-	Model view service
	-	Extended model (prudential, intellectual, water regulation, planning)

3 Design ideas

As a platform system supporting applications, according to the design idea of loose coupling, its design and construction focuses include: the construction of power grid panorama model, the integration of EMS/PAS advanced applications, the distributed data acquisition and processing, the status monitoring of regional power grid equipment, the visualization and interoperable graphic realization based on scalablevectorgraphics (SVG) technology, and the construction of basic general algorithm library. The overall architecture of regional power grid dispatching technical support platform is shown in Figure 1.

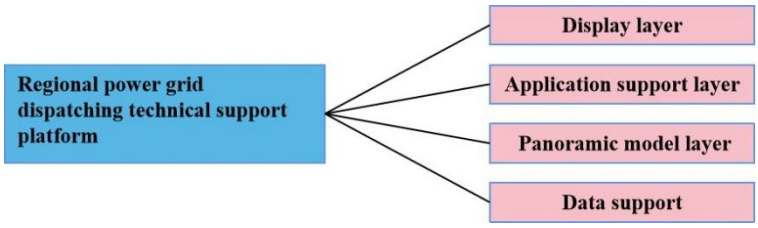

Figure. 1. Application Architecture of Regional Power Grid Dispatching Technology Support Platform

Panoramic model integration architecture of power grid is an architecture that uses CIM model standard to uniformly dispatch proprietary models of different application systems, which is used to realize the integration and interoperability of basic models of different application systems and break the barriers between online and offline models. CIM is an abstract model, which provides a standardized method to express power system resources by object classes, attributes and their relationships. It has become the core standard applied by power dispatching organizations. At present, automation systems such as EMS support interoperability standards based on CIM . On the basis of the unified panoramic model, the integrated application integration architecture adopts different interface protocols such as WebService and Corba to realize the integrated application integration architecture of dispatching. The application integration of local dispatching can be divided into two categories: process integration and function integration. The purpose of process integration is to realize the platform-based process interaction between application systems and other department systems of the company, and adopt bus mode instead of point-to-point interaction mode[6-7]. Application integration is the future development direction of comprehensive dispatching applications, such as safety check of operation instructions, identification and

evaluation of operation risks, etc., which requires business applications and advanced applications such as EMS/PAS to be completed in an interoperable mode.

Data acquisition and processing architecture: The platform needs to be connected with real-time/quasi-real-time measurement data during the operation of the power grid to support applications such as intelligent determination of stable limit, accident identification and rapid auxiliary control, comprehensive intelligent alarm, etc. As the measured data has the characteristics of large amount of data and frequent changes, the platform adopts distributed architecture for data acquisition and processing, and uses independent front-end servers to establish links with various data source systems[8].

Equipment status monitoring center: the correct status of equipment has an important impact on the operation of various applications. Therefore, the platform has built-in status centers of primary and secondary equipment regulated by A power grid, which can ensure the accuracy of equipment status through regular automatic calibration with EMS system and letter guarantee system, and manual intervention. Visualization and interoperability are important features of smart grid. Therefore, the graphics visualization architecture based on SVG technology is built in the platform. This technology is characterized by good interoperability. The device primitives meet the requirements of State Grid Corporation of China. You can directly click on the primitives to perform operations such as changing the running state of the device, setting the monitoring section or the threshold of the monitoring indicators of the device, changing the running mode of the system, etc., and perform automatic inversion display through SVG animation technology.

4 Key technology realization ideas

The platform construction meets the standardization requirements of dispatching business. According to the concept of application and data integration, an enterprise-level service platform is constructed on the premise of meeting the secondary security protection system, so as to realize data integration and function integration, achieve the purpose of consistent data sharing and value-added functions, and improve the efficiency and level of dispatching operation.

4.1 Panoramic data model

Panoramic data model is to solve the problem that there are many heterogeneous application systems in the power dispatching organization, which are difficult to integrate and share. Its goal is to establish a power grid model base with CIM as the core, expand the panoramic models of many professional application systems, such as information guarantee system, operatemanagementsystem (OMS), water dispatching automation system, transient model, etc., and realize the entity data mapping between heterogeneous systems based on panoramic model, and realize the integration of online and offline models. Panorama model realizes the link between CIM-based core model and various professional application extension models through unified coding and standardized semantic encapsulation, and finally forms a distributed storage structure of all models including models, data and graphics, which builds a foundation for analysis, calculation, early warning and auxiliary decision-making of power grid. There is a logical hierarchical relationship between the core model and the models of

various professional application systems [9-10]. Under the clear logical hierarchy design, two-way model and entity mapping association and matching are realized between the professional application models and CIM models, so that the connection between online resources and offline analysis resources is constructed, and various models can be uniformly applied on a brand-new platform architecture. This will provide comprehensive support for advanced applications such as power grid monitoring and real-time warning, operation assistance and accident decision-making, operation and planning in the future. The panoramic model application architecture is shown in Table 2.

Table2. Panoramic Model Application Architecture

EMS/CIM	Planning data model	XML+E	BPA/PSASP
Panoramic model based on CIM core (association, matching, splicing and checking)			
Power Grid Monitoring and Real-time Warning	Operation assistance and accident decision	Operation and Plan arrangement	-

5 Application effect

At present, the technical support platform of regional power grid dispatching has been put into operation in the power dispatching control center of A power supply company, and the panoramic model center of A power grid has been initially constructed. Through the platform application integration mode, the interoperability experiment of power grid dispatching operation instruction and power grid operation and maintenance plan has been carried out, and satisfactory results have been achieved. Therefore, in the next step, the local dispatching plan A will transform and reconstruct the existing application systems with the platform as the core, and gradually transform the basic resource models of the operation order system, the maintenance planning system, the fixed value list and other systems, and finally realize the integrated application.

6 Conclusion

At present, the development of smart grid requires the comprehensive ability of dispatchers to be improved day by day. The successful application of dispatching technical support platform and various application systems needs the cooperation of many specialties and departments, including automation, operation mode, dispatching operation, relay protection, operation monitoring and so on. Through the construction of the technical support platform for regional power grid dispatching, a set of working mechanism has been formed, which brings together multi-disciplines, multi-disciplines to participate in and cooperate with each other. On the basis of the platform, applications such as online comprehensive intelligent alarm, programmed operation control, intelligent auxiliary decision-making of power grid dispatching accident, etc. will be further expanded to realize the intelligent dispatching command of A power grid.

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