Research on Design and Implementation of Power Dispatching Automation System Based on Big Data Analysis

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Abstract: With the development of economy, people's demand for electric power is also increasing. In order to meet people's demand, electric power enterprises are using more and more automatic control systems. Aiming at the problems of low integration and poor accuracy of current power grid data management and information planning, the design of power grid power dispatching automation system based on big data analysis is proposed. This paper analyzes and studies the principles, standards and specifications of the design and implementation of the power grid dispatching automation system; at the same time, it analyzes the requirements of the power grid dispatching automation system in detail according to the current application situation, and constructs the system framework; finally, based on this research, it designs and realizes the power grid dispatching automation system. The system has clear structure, friendly interface and high promotion value.

1. Introduction

Power grid dispatching automation system, also known as energy management system, is a modern power integrated automation system based on computer technology, which is mainly used in regional power grid and provincial and municipal power grid dispatching centers, mainly providing power grid dispatching managers with various real-time information [1]. Compared with traditional transactional applications, scheduling automation system has different characteristics. On the one hand, it needs to maintain a large number of shared data and control data; on the other hand, the completion of each real-time task in the scheduling system has a strict time limit, while the data used for analysis and processing is changing. On the other hand, due to the increasing dependence of modern production and people's life on the reliability of power supply, the production of some enterprises has not been allowed to cut off power, which will cause disastrous consequences, and power has been closely related to people's life [2]. On the basis of traditional evaluation methods, the concept of big data for state evaluation is proposed, aiming at introducing new concepts and algorithms into traditional large power grid industry, but how to apply them is not clearly proposed. Because in general, the larger the amount of data, the longer it takes to process and analyze the data [3]. However, the traditional power big data storage scheme is only designed for power big data with a certain amount of data. Analyzing power data exceeding this amount of data puts great pressure on the traditional analysis and processing method. Aiming at the problems of low integration level and poor accuracy of current power grid data management and information planning, the design of power grid power dispatching automation system based on big data analysis is proposed, and its effectiveness is tested through an example.

2. Design of Power Grid Dispatching Automation System

2.1 System design principles

Principle of progressiveness: system configuration and equipment selection adapt to the rapid development of computers, make full use of advanced technology and experience in the field of computers, and select stable and reliable equipment proved by practice to provide users with products with high performance/price ratio and protect users' investment [4]. Big data analysis technology is adopted to process power grid transmission information. The power grid accurate

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planning information system is built on a general computer platform, and power grid information management and database construction are carried out on different operating systems [5]. In the design of power grid dispatching automation system, the system must have the functions of data collection, monitoring and control. The design phase should rely on the scheduling responsibilities, dispatch automation status and conditions, and follow the low to high, easy to difficult The principle clarifies its main function.

Economic principle: The dispatching system carries out the overall design in accordance with the principles of safety, reliability, economy and practicality. After the whole computer system is put into operation, the substation substation can be realized “unmanned duty” (small person on duty) for functional design and equipment. Configuration. The reason for adopting such a design is that the device channel and communication protocol hierarchy are Abstracted [6]. In order to ensure that the entire acquisition process of the smart grid big data is complete and efficient, it is necessary to select the appropriate strategy according to its data type and characteristics. Data are collected from multiple dimensions, including weather, operating environment temperature, time, etc. in the environmental dimension, and current, voltage, current, etc. in the equipment operating condition dimension. To ensure the system's advancement, stability, reliability, security, network openness, system function practicability, system function expansion and upgrade adaptability; To meet the requirements of system function stratification [7].

Principle of reliability and openness: the system shall be highly reliable and open. The hardware and software shall adopt modular and structured design. The expansion or partial failure of hardware equipment shall not affect the normal operation of the whole system. All performance indexes of the system shall meet the requirements of the “County-level Power Grid Dispatching Automation Functional Specification” of the power industry of the People's Republic of China, and can ensure the long-term stable operation of the equipment [8]. Comply with general international standards for commercial (database, etc.) interfaces. The soft and hard platforms of the system should meet the needs of the development of the power market and realize seamless network connection with the power market technical support system. The data of the real-time database of the dispatch automation system and its processing have strict time limits. The correctness of the system depends not only on the logical result of the transaction, but also on whether the logical result is completed in a certain time domain. The grid dispatching automation system is interconnected with other systems, and different interface modes must be adopted according to different security levels of the interconnected system [9]. The data acquisition module is mainly responsible for obtaining data information according to the setting and operation of the system, and it is necessary to process the data in advance to ensure the accuracy of collecting information.

Self-maintenance principle: The system has strong self-diagnosis. When the software or hardware device in the system fails, the fault type and fault location are automatically given, and the fault part is automatically exited. According to the implementation of the data acquisition system, the functions of the data module are realized, and the main functions thereof are: the communication function mainly realizes the exchange of data with other control centers and power application systems. Data collection can be configured, including collection source, collection object, object path, collection rule, collection parallelism and data conversion rule. It is suitable for data exchange and integration between relational database and distributed storage of big data platform. The software and hardware of the system are configured to meet the current development. It meets the requirements of seamless network interface between other systems such as electricity billing, dispatching production management (DMIS), MIS and dispatching automation system. On the other hand, the traditional serializable concurrency control is too strict for the dispatching automation system, and new concurrency control concepts and implementation methods need to be proposed.

2.2 The relationship between system functional modules

The tasks of dispatching automation system have time limitation. The system must ensure that tasks with strong time limitation or more urgent tasks are executed earlier, i.e. the execution

sequence of transactions can be controlled. Two-way data communication with the SCADA/EMS system of the central dispatching center is realized through an automatic data network, and information of remote terminals and substation automation systems is collected. Through a specific new concurrent processing system, it can efficiently and flexibly process various heterogeneous data, support storage and distributed processing of big data, and provide auxiliary tools [10]. As the bottom layer of the server software system, the kernel layer is used to establish and manage the TCP connection, as well as to receive and send data. It is the most important layer in the whole server software system. How to achieve high performance in the kernel layer is the key to achieve the high performance of the whole server software system. According to the characteristics of the database model and the inheritance between the supporting classes, the user can use the data types and methods to solve the database design problems through the complex construction model. The program driver module is transplanted to the cloud computing platform, and the clock sampling and filtering of power grid information are performed through a / D information sampling and digital to analog conversion, providing accurate data input for power grid planning information system. The relationship between the functional modules in the system is shown in Figure 1:

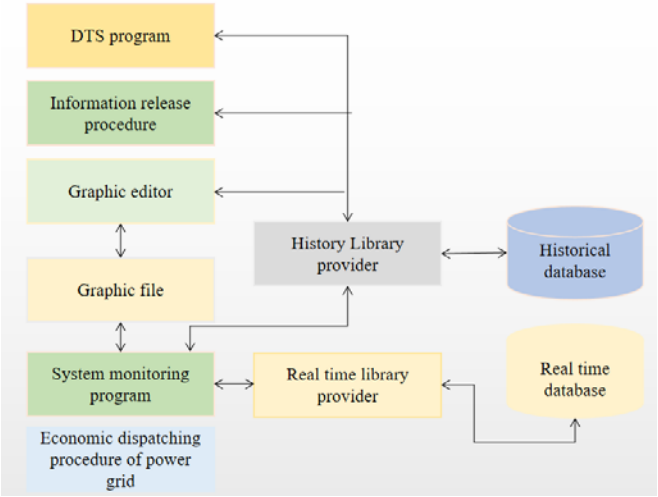

Figure 1 Relationship structure between modules

2.3 Overall design

The hierarchical structure adopted by the system. There are two kinds of power grid dispatching center: centralized redundant control system and distributed control system. We use the distributed control system. Although the centralized redundant control system has rich operation experience, it plays a great role in the actual production. Under the Linux kernel, the modular programming and information loading of the power grid precise planning information system are carried out, the database access and information scheduling model are constructed, and the data access and information planning in the massive power grid data information scheduling process are realized. The central control center automation system adopts the original “soft bus” technology, which not only meets the requirements of real-time, but also ensures the excellent distributed computing performance of the system. Through the topological relationship between the model of the database and the power system, the admission criteria can be achieved without any mapping to meet the needs of different versions of the data model. The development environment creates a series of data files through configuration to generate the data needed for the final operating environment, including real-time database configuration and graphical interface configuration. It is generally completed by the engineering staff based on the specific requirements of different projects.

Scheduling the master station system. The power grid dispatching automation system is an open power dispatching automation system based on computer LAN. It adopts Ethernet that conforms to international standards and follows the IEEE802.3/802.2 protocol. By injecting tasks into the operating system kernel, the operations are responsible for the scheduling and execution of tasks, and notifying the user processes after the operating system completes the tasks. In daily applications,

users need to manage documents effectively, need to be able to share documents (such as scheduled inspection test reports), and be able to quickly retrieve relevant documents when needed. Establishing an unstructured large database system is equivalent to establishing a search engine plus a document collaborative editing and processing platform. The unstructured large database system framework is shown in Figure 2.

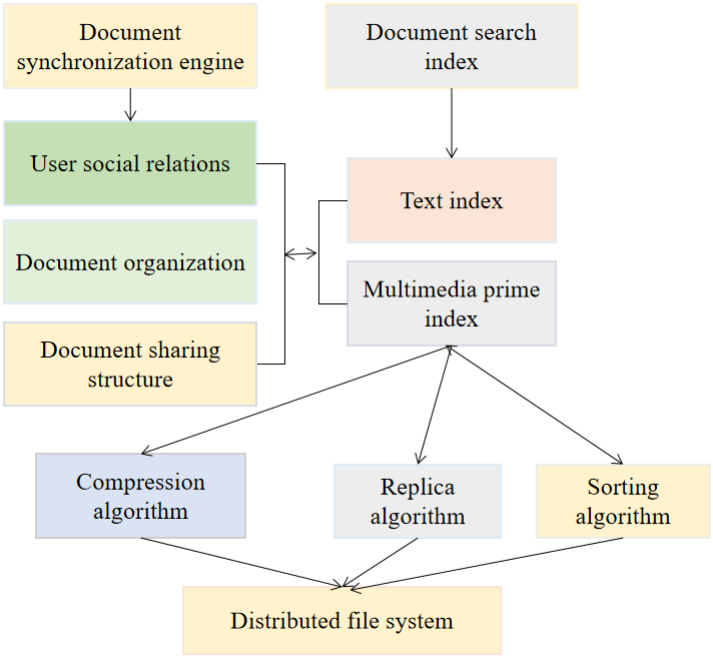

Figure 2 Framework of unstructured large database system

The data acquisition adopts multi-string 13 network communication server (Nport Server), supports TCP/FLP protocol, can be directly connected to the network, and is equivalent to a member of the network group, so as to facilitate the switching of main/standby front-end processors. It completely replaces the previous channel control board and serial channel board. The data acquisition server will be composed of RISC servers with redundant configuration, connected to dual local area networks, and run in a hot standby mode to complete the pretreatment of real-time data. It can monitor the channel status and count the channel availability. When a channel fails, it can complete the channel switching control. In order to protect the user's investment and development continuity, the system must provide cross-platform solutions, the key is to solve the problem of the implementation mechanism of the in-memory database and cross-platform communication.

Remote station. The telecontrol device adopts a completely distributed modular structure. The WJK.31A/LL line microcomputer monitoring device is used as the monitoring unit supplemented by individual independent functional modules, which are completely independent of each other. The module of each line only completes the remote measurement, remote communication and remote control of the voltage, current, power, electricity and switch of this feeder line. Many data in the real-time database are not persistent but changing. Sometimes the impact of data inconsistency and inaccuracy is “transient” and “discontinuous”. Because the amount of data collected is very large, the execution time of the data collection task should be reasonably planned according to the hardware performance and usage time of the source database server, and the peak period should be staggered as far as possible. The device adopts a new hardware design platform and software programming style, integrating monitoring, control and remote motion, including various measurement of line and capacitor, real-time data acquisition, operation condition monitoring, communication, control operation and adjustment, etc. The secondary circuit design can be simplified. The cross-compilation environment is used to output the power grid planning results and human-computer interaction operations, and the interactive system is constructed by using the entry point function of the file system. The user can be proficient in operation through simple training, the

functional interface required for daily operation is simple and clear and has annotated menu, the system design pays attention to the combination of practicality and diversity, the information model description is simple, clear and hierarchical, and the drawing filling is simple, intuitive and convenient.

3. Implementation of Power Grid Dispatching Automation System

3.1 Implementation of monitoring part

SCADA system is a system with real-time multitasking, open interface, flexible use, multiple functions and reliable operation, among which real-time multitasking is its most prominent feature. For example, SCADA system can include data acquisition and output, data processing and algorithm implementation, graphic display and man-machine dialogue, storage of real-time database, retrieval management, real-time communication and other tasks. The design of centralized control center automation system should take into account the diversity of alarms, classification of operation authority and anti-misoperation locking to realize the anti-misoperation performance of centralized control center automation system. When the system is running normally, there is useful data in both networks, and the data traffic is always in a dynamic equilibrium state. In the device pool, each Abstract.device has a data buffer queue that stores the real-time data of the device. These real-time data are used as data resources for the upper-layer application plug-in analysis and utilization, so there is contention for the Abstract.device object pool. In the SCADA system, the real-time database is the core of the system, which can realize the real-time data exchange of each application in the machine, and can extend the real-time data to the whole network through the network communication program. The software structure of the SCADA system is shown in Figure 3.

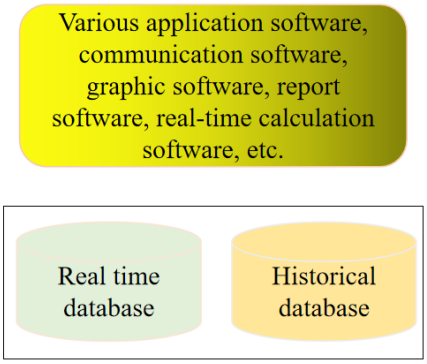

Figure 3 SCADA system software structure

3.2 Real-time database implementation

RTDS uses the core components of the COM/DCOM executable component approach, with its application part as a component client. The RTDS core components provide a variety of data services while managing the integration of field data. Convert real-time data streams such as online monitoring and SCADA into interactive charts, visually display the data on the Web page based on data and time; complete engineering unit conversion and credibility check of real-time data; have a LAN interface; Fault automatic (manual) switching function and complete channel switching of different communication rates, no real-time data should be lost during failover. Obviously, the deductive data object also has a time stamp and an expiration date. The time stamp is the derivation time of the deductive data object, that is, the execution time of the transaction, and the validity period is the time interval between the current export and the next export. The complexity of the core part of RTDS is very high, so its internal and modular design and implementation are extremely important. It not only affects the operation efficiency of the system, but also affects the scalability and maintainability of the system. It should be noted that data collection work is divided into two types. When the system is first online, all historical data in the database need to be imported into HDFS (full import). After the system is online, it is not feasible to update the data

with full import every time, both in time and efficiency, due to the large amount of source data. The local area networks are safely isolated by firewalls or physical isolation devices. All equipment is distributed in different safety zones according to safety protection requirements.

3.3 Implementation of Web information publishing system

Web publishing package mainly realizes the publishing of historical events and real-time events. It is mainly composed of CGI programs and JSP programs, and runs on Microsoft's IIS platform to respond to users' requests. The front server includes an acquisition server connected to a dedicated channel and a communication server connected to a network channel, which can also be combined. The equipment of centralized cabinet includes terminal server (or acquisition router), modem/digital isolation board, channel switching device and network communication router, etc. Each protocol corresponds to a network port number, and TCP protocol (transmission control protocol) or UDP protocol (user data message protocol) is used on the transport layer according to it. In addition to performing various communication tasks, the network communication server will also connect other computer communication servers of real-time / non real time data acquisition system not provided by the seller. After receiving the response from the data service module, the JSP program sends the relevant device description XML file to the requesting user. If the connection cannot be established with the data service module, the user will be sent a prompt message “unable to connect to the data service module, please try again later”, and then the HTTP request will be ended. In the future, other systems can be connected to the dispatching automation system through network switches and gateways. Possible access to computer control systems such as distribution management system, commercial operation system, etc. If necessary, it can also be considered as the access port of network RTU.

4. Conclusion

The power grid dispatching automation system has been widely popularized and applied in our country. As a result of the integration of industrial control technology, computer and network technology, and communication technology, there are many technical and theoretical issues worth studying and discussing. Under the background of power grid data fusion and big data, the design and implementation of power grid power dispatching automation system based on big data technology are studied and designed. Firstly, the paper analyzes and studies the principles, standards and specifications of the design and implementation of the power grid dispatching automation system, and then constructs the overall framework of the system. With the help of task scheduling management layer, the system realizes the automation of data analysis process. Users only need a small amount of configuration, and the system can run automatically according to the configuration cycle. The research shows that the real-time database system based on big data technology can accurately realize the integration of power grid big data information, realize the automation and integrated management of power grid dispatching, and the coverage of power grid information is high, showing good application value.

References

[1] Yan H, Huang B, Hong B, et al. A Hybrid Multilevel Storage Architecture for Electric Power Dispatching Big Data[J]. Journal of Physics Conference Series, 2017, 910.

[2] Yang D, Hua W, Zhu Y, et al. Virtual Private Cloud Based Power Dispatching Automation System - Architecture and Application[J]. IEEE Transactions on Industrial Informatics, 2018:1-1.

[3] Alves W, Martins D, Bezerra U, et al. A Hybrid Approach for Big Data Outlier Detection from Electric Power SCADA System[J]. IEEE Latin America Transactions, 2017, 15(1):57-64.

[4] Zhou Q, Luo J. The Study on Evaluation Method of Urban Network Security in the Big Data Era[J]. Intelligent Automation & Soft Computing, 2017:1-6.

[5] Evans L, Kitchin R. A smart place to work? Big data systems, labour, control and modern retail stores[J]. New Technology, Work and Employment, 2018, 33(1):44-57.

[6] Bruce S, Li Z, Chieh A H, et al. Nonparametric Distributed Learning Architecture for Big Data: Algorithm and Applications[J]. Statistics, 2018, PP(99):1-1.

[7] Xu X, Lei S, Zhe Z, et al. Multiservice Training Simulation System for Multilevel Power Grid Dispatching and Operation Part One System Design and Implementation[J]. Automation of Electric Power Systems, 2017, 41(13):100-105.

[8] Zhenyi L I, Yunfeng S, Yan L I, et al. Fast Query Method of Common Information Model Files in Power Grid Dispatching and Control System[J]. Automation of Electric Power Systems, 2017, 41(9):116-122.

[9] Gu W, Gao Y, Peng H, et al. Architecture and Key Technologies of Distributed Task Management for Power Grid Dispatching and Control Systems[J]. Dianli Xitong Zidonghua/Automation of Electric Power Systems, 2017, 41(9):109-115.

[10] Wang G, Deng C, Xia P, et al. Rolling Optimization Dispatching Method of Power Grid Containing Wind Power with Units Optimal Selection Taken into Account[J]. Automation of Electric Power Systems, 2017, 41(11):55-60.