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Research on Online Monitoring Data Storage of Intelligent Substation Based on Hadoop

Allam Maalla*, Xiaohong Ning

Research Institute of Open Data Commercial Application, School of Information Technology and Engineering, Guangzhou College of Commerce, Guangzhou, China.511363

allammaalla@yahoo.com

Abstract. With the development of intelligent substation information integration, power monitoring data has grown exponentially. The characteristics and data monitoring mechanism of intelligent substation monitoring data are studied. Combined with Hadoop cloud computing technology, the reliable storage and online query method of online monitoring data of intelligent substation based on Hadoop is studied. The substation online monitoring and collection of massive power equipment data is redundantly stored in the distributed file system of Hadoop, and the index table structure of the online monitoring data is optimized and stored in a distributed database to realize rapid query of massive monitoring data. A Hadoop- based online monitoring data platform is established to conduct benchmark tests, sequencing tests, and online monitoring data read and write performance tests to meet the reliable storage and high-speed processing needs of large-scale online monitoring data of smart grid substations.

1. Introduction

With the rapid development of computer technology and network communication technology, distributed substation automation systems appeared. The system sets the two-layer distributed control system structure of the whole station control (station control layer, also called substation level) and the local unit control (spacer layer) according to the control level and object of the substation. After more than ten years of development, the substation automation technology has reached a certain level, basically achieving the digitization between the bay level and the station control layer. New substation, regardless of the voltage level, basically adopts substation integrated automation system. Many old substations have also been transformed into substation automation. Many substations have also been unmanned. The safety and reliability indicators and economic indicators of substation operation and management have been greatly improved. However, the conventional substation integrated automation system also has the disadvantages: information is difficult to share, equipment does not have interoperability, system scalability is poor, system reliability is affected by secondary cables, etc., which restricts reliability, real-time and economy of substation. On the other hand, the safe and stable operation of large power grids also puts higher demands on the ability of substations to provide data support for advanced functional applications of the grid. In the mid-1990s, the IEC expected the development of digital substations in the future. The IEC TC57 working group officially released the standard for substation internal communication networks and systems for future substation automation in 2004, namely the IEC61850 series of standards.

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2.Purpose and significance

With the development of intelligent substation information integration, the power state monitoring data has the following characteristics: the data volume is geometrically increasing, the data scale is continuously expanding; the data type structure is complex and diverse, including not only various real-time online monitoring data, but also equipment accounts. Offline information such as information, test data, and defect data; wide-ranging data distribution, including various types of structured and semi-structured data, and the frequency and performance requirements of various types of data query and processing are different; Data communication is difficult, and the interactivity is poor. Most existing data processing solutions for power systems use conventional data storage and management methods. Storage hardware uses disk arrays, and database management software uses relational database systems, resulting in poor system scalability and reliability, and insufficient data processing capabilities. Adapt to the higher requirements of intelligent substation for reliable storage and fast query of condition monitoring data. Cloud computing technology has the advantages of low cost, high reliability and easy expansion, which provides a new solution for the construction of intelligent substation information platform. Cloud computing utilizes distributed computing data storage technology to provide massive storage of fault-free storage; its column-based data management technology can efficiently manage various types of multivariate data; its powerful parallel processing capability enables the power system business logic to The complex details of parallel computing are divided to facilitate fast query and calculation. Cloud computing is currently mainly used in the fields of Internet, business and scientific computing. Pilot research has been carried out in the field of power. Introducing cloud computing technology into intelligent substation condition monitoring system is not only a useful practice, but also has important research value and practical significance. Based on Hadoop cloud computing technology, the key issues of data storage mode, data detection mechanism and index construction method of substation equipment are proposed. The intelligent substation information platform is built based on Hadoop cloud computing technology. The column-oriented distributed structured database Hbase is used in open source. Reliable storage and fast query of online monitoring data in intelligent substation on Hadoop cluster.

3.Digital Substation Technology

With the rapid development of communication technology, information technology, electronic transformer technology, digital protection and measurement and control technology, various manufacturers and research institutes have done a lot of research work in the field of digital substation technology. According to incomplete statistics, since 2005, the State Grid Corporation has successively launched more than 100 digital substations of different degrees, different voltage levels and different modes, and has obtained a large number of digital substation research results and construction experience. From the statistical point of view, the main equipment used in the digital stations that have been invested and under construction can be divided into:

(1) Equipment based on IEC61850 standard is used above the interval layer;

(2) The process layer adopts electronic transformers and conventional transformers; the switchgear adopts intelligent operation box and cable connection;

(3) Process layer device composition may be various combinations of the above device applications;

In general, there are two main modes of digital substations. First, the construction mode of applying IEC61850 standard above the interval layer is mainly to use IEC61850 standard modeling and communication interaction between the interval layer and the station control layer, and adopt the method of mapping to MMS (manufacturing message specification) and apply IEC61850 standard. The second is the construction mode of applying the IEC61850 standard above the process level. Compared with the traditional substation, the digitalization process of information touches the process layer and its primary equipment. As far as the application is concerned, since the switch type equipment does not currently have intelligent conditions, it is often controlled and controlled by the intelligent operation box, and the protection trips; for the transformer, the digital output electronic transformer and the analog output electronic transformer are used. Or traditional transformers. In view

of the above statistical analysis, the main features of the completed digital substation construction are digital substations above 220kV and mainly based on the application of IEC61850 standard above the interval layer, and less involved in the transformation of the process layer; digital substations of 220kV and below involves the application above the process level. The mode of IEC61850 standard, but overall is more prudent; IEC61850-9-1 is the most widely used in process layer data acquisition and transmission standards, IEC60044-8 FT3 is only used by individual manufacturers, and IEC61850-9-2 has just begun to be applied.

In terms of unified modeling and conformance testing, the work is obviously lagging behind; there are few cases of digital substation performance testing and total station testing, especially the whole station dynamic model test; due to the lag of intelligent equipment, no one uses intelligent primary equipment. All adopt the combination mode of intelligent terminal and traditional switch. As the capacity of the substation increases and the complexity increases, the operational letter that needs to be processed is judged.

The interest rate is gradually increasing, so it is necessary to have a system for online monitoring and analysis of the unit operating state and to make a diagnosis in real time. The online condition monitoring and fault diagnosis system refers to the auxiliary operation system which is composed of modern sensing technology, information technology, computer technology and various fields of technology. So far, there is no uniform definition of the size and functional scope of these systems. The main reasons are different objects, different user requirements, and different technical support platforms. It is difficult to propose a unified standard. From a design perspective, online condition monitoring and fault diagnosis systems can be classified in two ways. From the functional point of view, it can be divided into condition monitoring system, monitoring and analysis system and monitoring and diagnosis system. From the perspective of system integration, it can be divided into small machine system, field bus based system, network based distributed system, multi-layer PC bus computer system, single PC bus computer system, single chip system. Although online monitoring has been widely used in modern substation companies, some problems have been discovered in the in-depth development of state maintenance. Since 2003, Tangshan Power Supply Bureau has applied the online monitoring system of domestically produced main transformer oil with mature technology and earlier development. In order to monitor the oxygen content in the main transformer oil, the Tangshan Power Supply Bureau placed a transformer fault online monitor in the north of the llOkV road. During the use process, the industrial computer crashed, the data false alarm caused the alarm and the data reception failure, which caused misleading to the technical monitor. Power supply companies that use such devices have also encountered the following problems:

(1) The stability is not high:

Back-end industrial computer crashes and field component damage are the biggest drawbacks of online monitoring devices. Many of the components in the device are not resistant to harsh environments and power system overvoltage's, short-circuit faults, etc., and are often damaged. In addition, continuous high temperatures and a wide range of temperature changes can also affect the stability and service life of the front-end sensor. The crash caused by the impact load also occurs frequently.

(2) Anti-electromagnetic interference is not strong:

Due to electromagnetic interference, online monitoring devices often lose data or count when uploading data. According to the transmission delay and other phenomena, and electromagnetic interference can also cause the online monitoring device to false alarm. Although the research on the problem of anti-electromagnetic interference has a large proportion in the research and development of online monitoring devices, there is a lot of energy invested. However, at present, the effect is still not good, especially in the strong electromagnetic field interference environment, it is difficult to achieve the same electromagnetic interference resistance as the diagnostic system.

(3) The feature quantity is insufficient:

The lack of sufficient feature quantities has hindered the development of line monitoring technology. Due to monitoring technology, the booming development combined with effective market

competition cannot effectively establish diagnostic thresholds and standardization of online monitoring devices.

4.Monitoring System of Intelligent Substation

Understand the information quantity monitored by the intelligent substation online monitoring system, analyze the data type and data characteristics of the information quantity, and collect the status information of the main high voltage equipment such as transformer, circuit breaker & GIS, current transformer and voltage transformer by intelligent substation online monitoring system. Data acquisition, real-time display, diagnostic analysis, fault alarm, parameter setting, etc., to realize the systematic and intelligent online monitoring of the status of substation electrical equipment, so that it has the function of its own state information management, diagnosis, evaluation and control, through and intelligence The integrated components are combined or integrated to form a unified entity with measurement, control, protection, metering and monitoring functions to realize its intelligence. At the same time, the visual display and transmission to the superior system provide basic data support for the comprehensive life-cycle comprehensive optimization management of the state-based detection equipment for the smart grid, comprehensively improve the intelligent level of the equipment, realize the online safety warning of the grid and intelligent monitoring of the equipment.

According to the characteristics of different structural data in intelligent substation system, the corresponding data storage methods are studied, the advantages and disadvantages of different storage methods are analyzed, and the storage method suitable for a certain characteristic data structure is found.

The intelligent substation online monitoring data processing framework, data index establishment method and data quick query method are studied, and the Hadoop-based online monitoring data processing platform is established. According to the previous research on data types, different data storage methods are adopted in the platform.

5. Hadoop intelligent substation data platform

According to the IEC61850 standard, the intelligent substation data platform is functionally divided into three parts: substation layer, interval layer and process layer, and connected through layered, distributed and open network systems, as shown below:

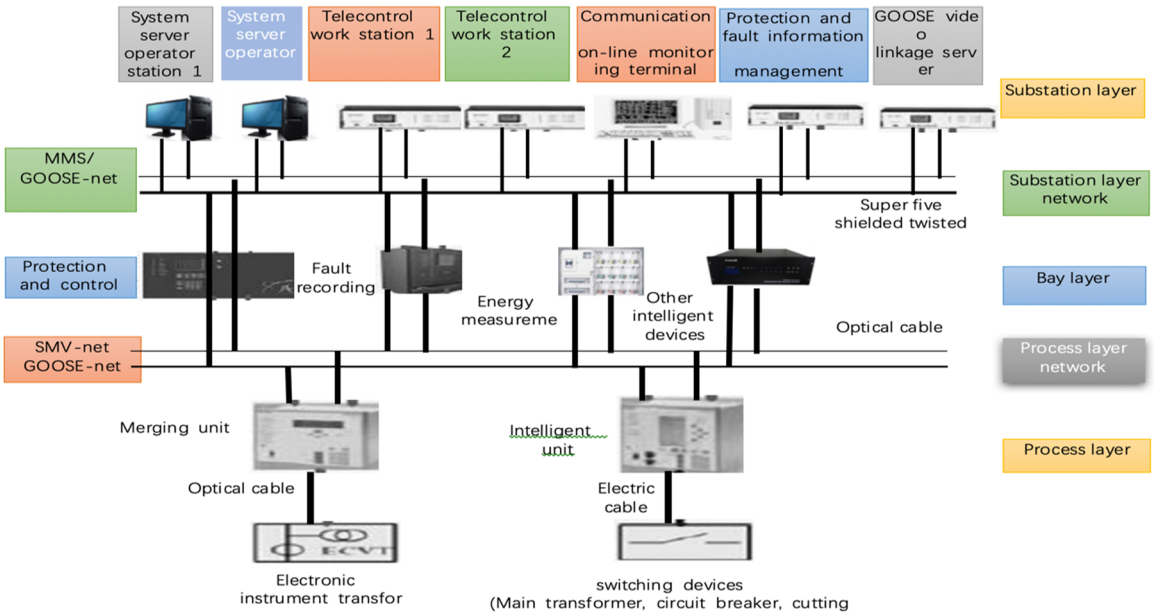

Figure 1. intelligent substation system

(1) Process layer

The layer is directly connected to the sensor signal, the status signal interface and the actuator of the primary device. The layer device can be installed on-site with the primary device, and the working state and device attributes of the primary device are realized by combining the unit MU and the intelligent unit. Digitized, the process layer device is connected to the bay level device through the process layer bus, and generates a system synchronous clock signal through the GPS timing signal.

(2) Spacer

The interval layer device mainly implements protection and monitoring functions, and implements related human-computer interaction functions for controlling blocking and interval level information. The interval layer device can realize mutual dialogue mechanism between devices through the interval layer bus, and the interval layer device can concentrate the group screen or Put it underground.

(3) Substation level

Substation layer equipment includes substation local operation back-end system, external data interaction interface (control center data forwarding, protection information management system data interface, equipment management system) and general function services. The universal function service module realizes the substation level interval control service through the information transmitted by the interval layer device, such as substation anti-missing lock function, voltage reactive power control, and can also receive commands from the control center to realize regional system anti-disoperation and regional security. Stable control and regional voltage reactive power optimization control.

Based on the virtualization platform, the Hadoop online monitoring data processing cluster is built, and the Hadoop Distributed File System (HDFS) and the column-oriented HBase distributed database system are used to provide reliable storage and query services for massive online monitoring data. More advanced data mining and assisted decision making are facilitated. The process is as follows:

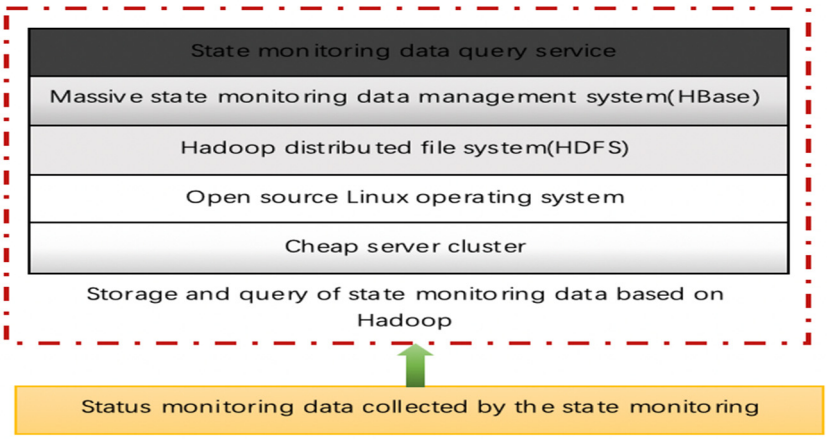

Figure 2. Hadoop Distributed File System process

6.Conclusion

This paper Solves the problem of different online monitoring data storage in intelligent substation, builds a data platform based on Hadoop intelligent substation. The hardware resources of the power system and the data center servers and storage devices of each network are virtualized, upgraded to cloud nodes, and managed in a virtual machine. Virtualized infrastructure can effectively simplify the management and maintenance of data centers and improve service availability and scalability.

Acknowledgments

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