Research on remote test data access method of new energy grid-connected generation based on cloud platform

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Abstract. In view of the trend of the development of power grid information and the characteristics and application requirements of the current new energy grid-connected characteristic test system, the cloud computing service is applied to the remote testing system. The remote testing cloud data platform for new energy grid-connected power generation is designed and constructed. On the basis of this platform, a design scheme of real-time/historical data access and wireless secure transmission is proposed. The feasibility of the high efficient storage of the platform and the reliability and security of the data transmission access are proved by the test of the remote testing system of new energy grid-connected power generation. To some extent, the platform solves the problem of data access in the existing platform. It gives full play to the role of cloud platform data center. The platform provides data support for operation characteristics analysis and grid-connected monitoring and diagnostics of new energy grid-connected generation system.

1. Introduction

With the rapid development of the economy, the demand for power resources is becoming more and more vigorous. Therefore, it is particularly important to build a stable, safe and efficient power network [1]. The status of renewable energy (such as wind energy and solar energy) in the non-fossil energy consumption structure is rising rapidly, under the influence of the transformation of world energy develop to low carbon and carbon free mode. The impact of new energy grid-connected on power network stability is more and more serious, so it is necessary to conduct the characteristic test for the new energy grid-connected generation process. The new energy grid-connected generation system is faced with huge technical challenges in data storage, query and data analysis because of its complex structure and numerous equipment [2]. However, most of the existing data management platforms in the power company only use relational databases[3,4]. And a large number of data that may imply significant value are discarded during the transmission process, causing great waste. It can not adapt well to the real-time processing application requirements of big data. And it can not meet the development requirements of rapid growth of data. This has put forward higher requirements for the design of mass data management platform for new energy grid-connected generation characteristics test.

Wind power and photovoltaic power generation are mainly located in grasslands, barren hills, deserts and seaside areas, which are inaccessible to the environment. Their geographical location is
remote and scattered. At the same time, because the field test device needs to be transferred to the field, the installation position is not fixed. Traditional remote data transmission (such as fiber transmission) is more difficult and costly for wind farm or photovoltaic power plant network detection, operation characteristics test, test point real-time/historical data monitoring and so on. Because the wireless network is convenient for layout, it can be applied to the place where the wiring is difficult. It can meet the data transmission requirements under the condition of scattered testing unit and bad test environment[5]. Wireless data access is an important part of the test system. On the premise of ensuring data security, how to realize remote characteristic test data, mass transfer of real time/historical data and sharing of resources by wireless network has become a problem to be solved urgently.

Cloud computing technology[6-10] can store and process massive and complex data. And it has the characteristics of high reliability, fast efficiency and good expansibility. Therefore, this paper introduces cloud computing service in the design of mass data management platform for the characteristics test of new energy grid-connected power generation. In view of the characteristics of new energy generation, the applications of virtual machine server[11] and client management program, virtual cluster file system and other program suites were applied. The virtual cloud data platform to meet the data management requirements of the new energy grid-connected generation remote test system is constructed. And a scheme of data access interface based on public network communication is designed. It provided a unified and secure data access mode for cloud data center, thus improving the efficiency of data management. The design and application of the platform will vigorously promote the depth of cloud services and Internet of things embedded in the new energy field can realize the development practice of the cloud data platform in the level of data wireless transmission and access management, in order to meet the increasing demand for data transmission and storage in the future.

2. Implementation mode of remote test data access based on cloud platform

2.1. Overall architecture of platform

The design and construction of new energy remote testing cloud data platform for grid-connected generation was composed of field test data acquisition device, gateway/route, database server, WEB server and client personal computer machine and so on [12]. Figure 1 shows the architecture diagram of the design system.

A variety of test equipment was installed in the field of wind farm and photovoltaic power plant, including the testing device of the characteristics of the photovoltaic power plant, the on-line characteristic data acquisition and monitoring device, the portable grid-connected characteristic test device, the wind farm grid-connected test synthesis device and so on. Each distributed test data acquisition device converts the collected data into TCP/IP protocol format through gateway/route. It used 4G wireless communication and LORA wireless network to transmit to the data processing storage part of the cloud platform. The data were counted, analyzed, processed and stored[13,14]. And then the test data and processing results in the storage layer were displayed and released to the client through the WEB server.
2.2. Cloud platform real time / historical data access

**Figure 1.** System architecture diagram of cloud platform.

**Figure 2.** Real-time / historical data access.
With the rapid development of information technology in power grid, higher requirements for massive real-time/historical data access[15,16] of data management platform are put forward. According to the typical design requirements of national power grid, this paper designs a set of data access method based on Webservice technology and OSGI (Open Service Gateway Initiative) framework, aiming at different data sources of wind power SCADA (Supervisory Control and Data Acquisition), wind power forecasting system and boost plant. The whole data access process is shown in figure 2 below. This method mainly includes information format conversion, content check and access interface design. Information format conversion is based on the existing TCP/IP protocol of cloud platform, all of which adopt standard E file format for data access; Content checking was used to ensure the quality of access data, it can carry out repeatability test, integrity check and custom check for data; The access interface adopts the OSGI architecture, the interface module was independent, the data was directly accessed to the Webservice interface through the Karaf container.

In the process of real-time/historical data access of the cloud platform, the real-time/historical monitoring data was obtained through the interface of the wind power SCADA, wind power prediction system and the boost plant to provide the data, and the data was cached to the middle table to ensure data continuity and integrity. Secondly, the real-time data access method was used to get real-time data from the data table and verify the data. If we found that the data of the survey points was missing, we should use historical data complement to recruit historical data from the data tables. Finally, the data was transmitted to the database through Webservice interface in ftp mode.

2.3. Secure design of wireless transmission based on public network communication

With the increasing demand for remote testing in the information age, the application of wireless network technology in the new energy remote testing system has become a trend, but the hidden danger of information security inevitably exists in the process of transmission. Information security is an important condition to ensure the safe and stable operation of the power grid. Therefore, in this paper, the communication network security protection and data security protection of the remote data transmission of the cloud platform were studied and discussed[17]. The new energy remote testing data information security system was built to meet the requirements of the security protection of the power grid (as showed in figure 3), in order to ensure the confidentiality, integrity and availability of the data information [18].

![Figure 3. Topological graph of remote protection system for test data transmission.](image)

3G/4G network has a wide range of coverage, strong network signal stability and low rental cost. Therefore, this system selected 3G/4G public mobile communication network service line and opened the route of entering public mobile communication network by the field data information network. In order to guarantee the strength and reliability of data encryption, the system adopts the encryption algorithm of IPSec VPN technical specification to secure the large amount of data safely. The security system based on the IPSec VPN mode is constructed. IPSec VPN module includes IPSec VPN gateway and data receiving port serial port management software, providing authentication,
authorization, encryption and other functions. In the process of data transmission, it was necessary to exchange the security certificates of the data terminal and the receiver first. After the IKE key exchange protocol and the SM1 encryption algorithm were used for data encryption and key negotiation, a secure VPN communication channel[19] can be established to ensure the communication security between the data terminal and the receiver. Secondly, the data terminal checks the data, transfers the verification results and data to the receiving end. The receiving terminal always verifies the data and its test results during the data transmission. If the two do not match, it was considered that the data have been tampered. After that transmission was cancelled to ensure the transmission safety of the data in the public mobile communication network.

2.4. Performance characteristics of platform
The remote test cloud platform for new energy grid-connected generation has technical advantages in big data set processing, data interface processing, information transmission, data security and so on. The specific introduction is as follows:
  ● Big data set processing: It meets the storage requirements of test data at tens of millions of test points. At the same time, it has the characteristics of unlimited expansion. The data can be processed in a short time within a few hundred thousand increments.
  ● Data interface processing: The interface module was independent. Each component in the interface can be disassembled by itself, which was conducive to design reuse and interface maintenance.
  ● Information transmission: Data exchange over tens of millions of records can be completed in a matter of minutes. At the same time, it can achieve 100 TB to PB level data query and the seconds level response of 100 billion text entries full text retrieval.
  ● Data security: The design of wireless secure transmission meets the requirements of power grid information security protection, ensuring the integrity and security of test data storage. It can effectively improve the accuracy of test results.

3. Test for platform performance
In order to verify the efficiency and security of remote data storage and management of massive data in cloud computing platform, we designed related experiments to test the performance of the platform.

3.1. Experimental analysis on data storage efficiency of cloud platform
The test data of the power quality analysis in the remote testing system of new energy grid-connected generation were selected. And the data storage efficiency of the designed cloud data platform and the existing power quality analysis platform was compared.

The experiment selected 10,100,1000,10000,100000 and 1000000 data to store respectively. The comparison between the cloud platform database and the relational database [20] used in the existing ways to store the time of data consumption is showed in table 1, the memory time-consuming contrast diagram is showed in figure 4 below.

| Table 1. Contrast of time-consuming of storage data. |
|----------------|---|---|---|---|---|---|
| Data number    | 10 | 100| 1000| 10000| 100000| 1000000|
| Approximate amount of data( MB) | 6  | 60 | 600 | 6000 | 60000 | 600000 |
| Cloud platform(S) | 0.07 | 0.2 | 0.9 | 7.5  | 52.1   | 424.8   |
| Existing platform(S) | 0.06 | 0.2 | 1.5 | 14.9 | 127.3 | 1094.78 |

As showed in table 1 and figure 4, when the amount of stored data was relative small, it was almost identical to the time spent on the cloud platform and the existing data platform, indicating that there was little difference in storage efficiency at this time. However, with the increasing amount of storage data, the time gap between the cloud platform and the existing platform was increasing. The storage
efficiency of the cloud platform was accelerated and the advantages were obvious. This showed that the cloud data platform built in this paper can meet the development requirements of the rapid growth of the power grid data.

![Contrast diagram of time-consuming of storage data.](image)

**Figure 4.** Contrast diagram of time-consuming of storage data.

### 3.2. Verification of data access function of cloud platform

The test data of new energy grid-connected generation characteristics were written into cloud data platform through the data transmission access scheme proposed in this paper. Taking the grid-connected point in the control test points of active power as an example, the function of platform data transmission access method was tested by 2h.

The active power data obtained from the remote test system of the new energy grid-connected generation showed that every 5 min has 1 data written to the platform. Using client personal computer to query and place historical data in cloud data platform, 1 new value are collected at every 5min. The historical data collected during the test period were identical with those obtained from the remote test system of the new energy grid-connected generation. Practice has proved that this method can effectively transmit data and protect data security and integrity. It is functionally accord with the requirements of data access.

### 4. Conclusions

The new energy generation system is in the bad working environment for a long time. And the distribution is more scattered. It is a hot issue in the field of remote testing that unified secure and stable transmission and efficient storage processing for the characteristic test data of grid-connected system. In this paper, the cloud computing technology was successfully applied to the remote testing and diagnostics system of new energy grid-connected generation. The scheme of data access and wireless secrecy was designed. Finally, the overall framework of the cloud data platform was constructed. The platform has the functions of information integration, data sharing, big data processing and other functions. It was not limited by the storage calculation capacity of physical equipment. It provides new ideas and advices for the construction of big data platform for power enterprises. Through the experimental analysis of the data storage efficiency and data access function of the platform, the effectiveness of the high efficient storage of the remote testing cloud data platform for new energy grid-connected generation and the security and reliability of the data transmission were verified. It provides us a system platform of remote and comprehensive grasp of the characteristics of new energy grid-connected operation. It also provides technical support for mass data access management and security protection of power grid information.
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