The Design and Implementation of an Electricity Trading Platform

Hu Bo¹, Jin Yukun¹, Jin Xin², Tan Huabin²
¹State Grid Anshan Electric Power Supply Company, China
²Beijing KeDong Electric Power Control System Co., Ltd, China

Abstract — The rapid growth of the electricity market in China causes many problems related to electricity trading and transaction. To solve the problems, we propose an integrated electricity trading platform. In this paper, we conduct the requirement analysis and design process of the platform. Then, the implementation of the platform is detailed. Finally, we test the platform and implement the platform in real situations. The results show a great prospect and stability of the trading platform.

Keywords - Electricity trading, platform design and implementation, transaction information publishing.

I. INTRODUCTION

As one of the important supporting platforms for the national power grid, the power market trading platform can provide technical support for open and transparent, orderly service and operational coordination. According to the general principle of "unified leadership, unified planning, unified standards, unified organization and implementation", the construction of the China State Grid Corp has achieved its expected goal and has played an important supporting role in electricity trade.

Electricity transaction information involves a wide range of government departments, regulators, market players and the community's attention. As an important window to the company's customers, the electricity trading strengthens market information, pays attention to the openness, transparency and timeliness, provides comprehensive, multi-angle market analysis data, meets regulatory agencies, plays a good trading center "firewall" role, forms a power market system construction and other aspects of understanding and support.

As a part of the information management platform of the electricity trading center, the existing information disclosure platform cannot meet the needs of the current electricity market trading platform, and a new power grid information management system is needed.

In the service area, developed countries use all kinds of information and advanced management concepts. The Advisory Service and so many aspects of the market service have initially constructed the market service system. Electricity trading platform not only shows the company image, external release information, provides a good communication platform for the company, customers and users.

At present, the international advanced technology improves the content of electricity information management. In Anglo American, and the United States PJM (United States of Pennsylvania, New Jersey, Mali and Lanzhou Union Electric Co) and CAISO (California power company), the British ELEXON (British England and Welsh electric company) are representatives.

II. REQUIREMENT ANALYSIS

A. General Requirement

The information collection of electricity trading involves many departments, and the total class is even more. The information publishing platform needs to publish the information. This requires that the power exchange information has strict information release mechanism, so as to effectively avoid the large amount of information released. Power exchange information platform is facing a large number of users, they are different in user's type. Therefore, the power exchange information distribution platform need to have a common and easy user interface. Electricity trading platform requires the audit function. Electricity trading department issued the information distributed to various departments in power grid, each department is equipped with an administrator terminal, the negative collection of information released in the Department for approval, it cannot affect the access of other sectors of the system, but obtain information of the Department management information.

B. Functional Requirement

So the electricity trading platform can be divided into two parts, that is, the external information publishing platform and the internal power management platform.

The main functions of the external information publishing platform are as follows:

1) User registration. User registration feature is the main function to the new user. Users can browse through the registered information, such as the results of transactions of the power exchange information platform.

2) Information browsing. Users can be classified according to the demands to browse the information platform for power exchange information.

3) Information retrieval function. The information retrieval system is provided by the external information distribution platform of power exchange, which includes fuzzy search and precise search.
(4) Transaction reporting function. The main application of this function is to participate in the power generation process of the companies.

(5) Print function. All of the users can print the information they browse.

The main functions of the internal management system of electricity transaction are as follows:

1. Notification of transaction information.
2. Transaction rule constraint function.
3. Transaction calculation function.
4. The result of the transaction information.

C. User Case Model

After determining the functions of the system, the users case model is used to represent the relationship between the functions and the use case. The use case model can be represented by the use case view.

According to the above requirements, this study designed the use case diagram of the power exchange information platform based on UML. The system top-level use case diagram is shown in Figure 1.

III. PLATFORM DESIGN

A. System structure

According to the needs of users, the external power trading information platform is divided into public and media center, operations center, today’s news, quick links.

Its overall structure is shown in figure 2.

B. Logic architecture

According to the main points of the system architecture design, we developed the power exchange information platform using SOA architecture, the logic is dividing to five layers as shown in figure 3. These five layers are the representation layer, service request proxy layer, ESB layer, service layer and data layer.
The logic architecture of the information publishing platform of electricity trading is divided into the following layer function: the user interface, services request delegate and the services response processor, the enterprise service bus, services and database.

C. Database

For large-scale information system, the database is one of the keys to component. At present, the large relational database system has IBM IBMDB2, SQL server and Oracle. Power transactions need to handle large amounts of data in real time. Database is the heart of the application system, which is the basis of the development and utilization of information resources. The structure and performance of the database directly affect the safe, reliable and continuous operation of the application system. To ensure the database has the above performance, the database system design is proposed in the following principles:

(1) The database must handle large amount of data, and reliable to the electricity trading platform.
(2) The database of electricity trading platform requires structured data. Therefore, the database should be a relational database structure, and the database must support the logical formula and calculation.
(3) The requirements of data security are strict, therefore, the database should be able to perform fast data backup.
(4) The information processing may exist in the process of duplication, therefore, the database should support the fast data structure of replication.
(5) Power trading information publishing platform features a wide range of users, and a wide variety of information processing business, therefore, the database should be based on business needs of different business data encoding.

Oracle is obviously the advanced technology, with perfect function, support of distributed application, concurrency, compatibility, security, reliability. So we use the Oracle of the Oracle Corp as the database system.

D. Business Processing Module

The main function of the business processing module in the power exchange information publishing platform is to classify the business information. The business processing module receives the request of the business processing, and then analyzes the business process of the request, different business calls are targeted to the business of the request.

Power exchange information publishing function is an important part of the power exchange information platform, power trading information publishing function can be a composite method, or a series of composite method. It's work flow as follows: business processing module receives a series of composite method, call industry service processor for processing business requests. The final business processing module calls the result of the synthetic processor to get the value of the call, and then returns to the business request terminal.

IV. IMPLEMENTATION OF THE PLATFORM

The home page of the electricity trading platform uses JSP and FLEX language.

The main interface of the electricity trading is the dialog window for the user of the platform, it can actively cooperate with the user to do a good job for power transactions. The overall structure of the electricity trading platform is the B/S structure; the power transaction platform is opened by the browser. In view of the type of power exchange information platform, users need to correspond to different types of interface style, so the power exchange information platform designed a special interface style library, using Stmts model view of the design method, the entire interface style library can load data from the XML and use the standardized XSL layout interface

Because the power exchange information platform has a special interface library, the platform has good interface and basic interface style template.

A. Data declaration

Figure 4 shows the declaration of the power transaction to users and the transfer price function in first party. Second party shall declare the functions of the power and the price of the electricity the provincial level to the regional users. Flow chart is shown in figure 5.

B. Transaction audit and approval

After the submission of the transaction results submitted, the regional leadership users can view the submission by the transaction name, and then approval the transaction, such as
the approval of non-compliance will be returned to the transaction calculation process to calculate the transaction results. Flow chart is shown in figure 6.

Figure 5 The flowchart of data declaration of second party

V. SYSTEM TEST

For a wide range of applications, it is necessary to test the platform. Through the test of the power exchange information platform in real-time tracking test, bugs in the development and significant errors can be avoid and corrected in time. The test can also assist the development of the future development of the platform, and ensure the quality of the development cycle.

The system test will fill in some of the obvious error data and then submit, if the submission is a success, the test is end. And if the test input error data cannot be submitted, we must give a certain user helpful tips.

The purpose of the test is to find out the error and timely correct them. The test of power exchange information platform including code testing and business logic testing. The coding test is developed to test whether the normal operation will produce BUG, business logic test is the test has been completed in accordance with the original design and get the results of the process, whether the process will have a link with other business functions. In the process of testing, code testing and business logic testing must be carried out at the same time, that is, the system's code testing must be carried out after the system's business logic testing, to ensure the quality of power exchange information publishing platform.

Figure 6 Flowchart of transaction review and approval

The test of this study included module function, performance and data reporting, transaction calculation, information publish. The performance test included response time of the system function to the user's request, and whether the transaction rate meets the design requirements.

A. Business logic function test

The business logic function test of the power exchange information platform is a most important test procedure in the whole platform testing process. Business logic function test mainly consists of the business process, the function of the platform and the output results, if the output results with normal business income, it is proved that the function through the business logic function test, and vice versa.
B. Performance Testing

The test results are shown in Table I.

<table>
<thead>
<tr>
<th>Number of concurrent users</th>
<th>Number of successful execution users</th>
<th>Minimum corresponding time (s)</th>
<th>Average corresponding time (s)</th>
<th>Maximum corresponding time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>50</td>
<td>20.15</td>
<td>21.18</td>
<td>22.21</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
<td>25.16</td>
<td>26.87</td>
<td>28.81</td>
</tr>
</tbody>
</table>

The results in Table I show that the system function meets the requirements of business rules. Through the above test results, we can draw the conclusion: the functional modules have no abnormal situation and error, meet the business needs of power exchange information platform. The performance of the power exchange information platform satisfies the design requirements.

VI. CONCLUSION

This paper mainly implemented the trading platform of the power trading, information exchange and publishing on one platform. Trading subsystem mainly includes three modules: data reporting, transaction calculation and information publishing. Data reporting module mainly realizes the application of the power purchasing and electricity price management, and integration of the former users with other power plant in a provincial level. The transaction module is the core module of the system. Transaction accounting ensures the accuracy of the data, and provides the necessary guarantee for the correct transaction. According to the trading rules of the regional user, trading calculation function can calculate the transaction quantity. The results of the transaction information and approval functions can achieve the results of the transaction submission by regional users. The director can approve the entire transaction process, to ensure the correctness of the transaction. Information publishing module can achieve the function of power plant electricity trading information publishing, the power plant users and provincial users can easily view the transaction results.

The study has following limitations: this paper only implemented the function of the most basic and the most important part of the electricity information management, other functions concerning transaction data analysis, transaction algorithm are not studied in this study. In future work, we will be aiming at those problems, put forward a reasonable and effective solution.

Electricity trading platform has been tested and applied to the actual electricity trading center. As one of the core systems of the electricity trading system, the platform has been applied to the trading center for almost 6 months. The practical results show that the electricity information trading platform achieved the expected function and can be operated safely and stably.

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