Implementation of Distribution Network Integrated Blackout Management Platform Based on Business Central Platform

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**Abstract.** With the rapid development of information technology in power grid enterprises, there are many information systems in relevant business departments. It is difficult to avoid the dilemma of duplication of business functions and waste of data resources because of the "chimney" function development model oriented to business lines. Aiming at the decentralized management status of data related to blackout business such as smart grid dispatching technology support system, production management system, distribution automation system and marketing system, based on the system architecture of business center, this paper takes integrated blackout intelligent optimization as the construction goal, and optimizes blackout inspection from the standardisation of data. Repair plan, improve the coordination efficiency of relevant business departments, avoid repeated blackouts, improve the reliability of power supply, and provide decision support for power grid enterprises in blackout management.

1. Introduction

With the continuous improvement of social industrialization, the demand of power supply reliability is also increasing. In order to reduce the impact of power outage caused by users, scientific and effective power outage management is a necessary technical ways. In order to ensure the quality of power supply and the security of power grid, considering the operation mode of power grid, the allocation of operation, maintenance resources and other related factors, it is inevitable to involve the data sharing and business collaboration of multiple departments for power grid enterprises, such as dispatching, equipment, marketing and so on. Literature [1] introduces the research and judgment scheme of distribution network fault based on dispatching management, literature [2] introduces the distribution network production emergency repair technology based on operation and distribution connection, literature [3,4] introduces the on-site power failure diagnosis technology based on power consumption information collection system, literature [5] introduces the equipment fault location technology based on intelligent algorithm, and literature [6,7] introduces the distribution network fault location technology based on big data. It can be seen that at present, the power outage business management of power grid enterprises mostly relies on the internal single management, which mainly has the following problems:
(1) repeated construction leads to waste of resources: independent construction of similar systems by multiple departments, chimney construction mode is easy to cause waste of construction capital;

(2) the separation of services leads to low management efficiency: the artificial separation of the analysis chain of power outage services, especially the centralized management of master distribution network diagram and model data, is easy to lead to low efficiency of power outage services management;

(3) data duplication leads to untrustworthy data: power outage related business data exist in the business system independently constructed by each department. Due to the inconsistency of data collection channels and basic data, the indicators of power outage statistical analysis are contradictory;

(4) data sunk: resulting in the data value can not be mined: in the process of information system construction, different business information is digitized, but with the advancement of time, most of the data only become 0 and 1, the value behind it can not be deeply mined, and it is difficult to realize the data commercialization.

Referring to the construction experience of Internet enterprises, taking Alibaba and didi as examples, table[1] shows the optimization scheme of realizing common business through business Cnteral Pataform.

| Business line      | Present situation                                                                 | Solution                                                                                   |
|--------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Alibaba: Taobao, tmall, Alibaba, Ali’s mother | Each business has its own system and data source, and has done a lot of services on its own system. These systems are not connected | The data center platform completes the storage, calculation and productization process of massive data. The business in the middle platform builds a "big middle platform, small front-end" through "service reuse" to meet the market demand of rapid business distribution |
| Didi car: Express, taxi, special car, hitchhiker, Valet | The essence of all businesses is travel, which has synergistic effect. However, in the case of independent development, there is no synergy between businesses | In the process of building business in Taiwan, we should gradually build up the synergy through service, asynchronization, configuration, plug-in and data. |

In this paper, the integrated power failure management platform of distribution network is set up from the equipment management model, the power grid control model and the power grid marketing model. The unified panoramic model of the power grid is established. Through the key data of the EMS system, the distribution automation system, the power information collection system and so on, based on the topology of the electrical network equipment and the real-time equipment status information, the power failure of distribution network is comprehensively analyzed. At present, the power grid equipment maintenance plan, distribution network outage management and other businesses have changed from passive acceptance to active perception, gradually improving the closed-loop management of outage business, providing power grid enterprises with outage management decision support, and improving the refined management level of power grid enterprises.

2. Business platform overview
The core requirement of business platform is to store the data associated with power grid business in the shared platform, and provide data calculation, business calculation and other data services, so as to solve the problems of data isolation and data inconsistency caused by "chimney" architecture. Through the common design of data storage, data tagging service and business calculation of public model, the basic data service ability of power grid enterprises is improved.

The basic implementation of the business platform depends on the data middle platform. The technical architecture of the data middle platform is shown in Figure 1.
The process of data processing is described as follows:

① access target data from business services, file services, database services and other diversified data sources, including structured data sources and unstructured data sources;

② after obtaining different data sources, standardize and standardize the data, and screen the abnormal data according to the business rules;

③ after the completion of data governance, it is put into the database for management and operation;

④ in order to support the data security in different business scenarios, it is necessary to manage the permissions of different users and scenarios at different levels;

⑤ connect different business systems and drive business scenarios through data.

It can be seen from the above description that the data center realizes cross domain data integration through data tagging processing of primary equipment, secondary equipment, transformer load, switch status, etc., and data encapsulation and development through data services. Based on the data middle platform, the business middle platform realizes the decoupling of data and business in the way of business rule processing interface, and meets the personalized requirements of different business systems to quickly build new business scenarios. Figure 2 shows the business middle platform for comprehensive intelligent power outage analysis.
Taking the topological structure service of power grid as an example, through the results of operation, distribution and commissioning, the emergency repair resource information of PMS system is supplemented, and finally a node service provider of "station line transformer (emergency repair) - Household" is formed to realize the relationship between power grid equipment and topology. The construction of panoramic model of marketing users. Based on the panoramic model, combined with the real-time operation data of switch state, energy meter (metering point), distribution transformer, maintenance plan, switching operation and other grid operation management data, consolidate the data base of intelligent analysis and optimization of power outage.

3. Overall system architecture
Based on the dispatching automation system, distribution automation system, power consumption information collection system, production management system and other systems, the power outage business management of distribution network comprehensively analyzes the real-time information of power grid operation, equipment maintenance information and so on, in order to find out the final optimal power outage scheme.

Figure 3 shows the overall architecture of the integrated power outage management platform of the distribution network, in which the ODS layer of the data center platform realizes the unprocessed storage of data from other systems, the CDM layer is subdivided into the detailed wide surface layer (DWD layer) and the public summary data layer (DWS layer), and the ads layer stores the personalized statistical index data of data products; the data map is a unified query of the data in the whole data center platform Query and management map; data model management, mainly to solve the inconsistency between architecture design and data development; data quality around integrity, accuracy, consistency, timeliness monitoring and analysis of data quality problems, improve the quality of enterprise data [8].
Fig. 3 System functional architecture

It can be seen from Figure 3 that there are many data sources in the integrated power outage management platform of the power grid. The power outage business should be interfaced with energy management system (EMS), power grid operation management system (OMS), production management information system (PMS), distribution automation system (DAS), power consumption information collection system, Power Grid Geographic Information System (GIS) and other systems to realize data collection and status analysis of power outage business. And the intelligent management of fault study and judgment, and later provide data support for equipment maintenance plan optimization through big data analysis technology.

Through the application of data center and business center, the system can meet the data source requirements of power outage business model, realize the decision optimization of power outage plan, support the business requirements of intelligent management of power outage business, and realize the visual management of power outage business through intelligent report and GIS platform.

4. Key business scenarios

4.1. Panoramic model construction

There are many data sources in the integrated outage management platform of power grid, such as the real-time operation control data of power grid from EMS, the operation management data of power grid from OMs, the operation data of power grid equipment from PMS, and the power consumption information data of power supply users from the power consumption information collection system. How to solve the problem of inconsistent description of the same equipment object in each related system is the key to the intelligent analysis of integrated outage. Where. In this paper, we build a panoramic model based on the data in the middle of the data, based on the operation and distribution data, to realize the information from the main network equipment in EMS, OMS, PMS, marketing system and GIS system to the power supply user according to the voltage level. The realization mechanism of the panoramic model is shown in Figure 4. The unique identification of equipment based on panoramic model realizes the association with the real-time operation data model of power grid equipment.
Based on the results of operation, distribution and dispatching data penetration, taking the topological relationship construction of "station line transformer (emergency repair) - Household" as an example [9], the realization mechanism of panoramic model is described.

① Based on PMS system, acquire station line relationship and line transformer relationship;

② Secondly, based on the marketing business system, the relationship between the station and transformer, between the station and user, between the metering point and the station and user is acquired;

③ Based on PMS system, obtain emergency repair resource information and equipment account information;

④ Based on the results of operation, distribution and dispatching data penetration, the core business data based on "station line transformer (emergency repair) - customer" is formed.

Based on CIM model, a power grid panoramic model for distribution network outage management is systematically constructed with the core data of the relationship between station and line, equipment account, drawing model and emergency repair resource information. On the basis of panoramic model, the system of power consumption information collection is connected to obtain the live state of distribution network equipment in real time, and the live state of distribution transformer and meter can be called to support fault diagnosis.

4.2. Optimization of outage maintenance plan

The outage maintenance plan management includes four stages: declaration, optimization, adjustment and release. In the declaration process, it is required to comprehensively consider distribution transformer, new energy and other factors. The lower level dispatching organization shall declare the maintenance plan according to the annual and monthly cycle. The maintenance system shall summarize and analyze the rationality of the maintenance plan, and the maintenance plan shall be balanced and optimized manually by personnel [10 ~ 12].

Distribution network maintenance plan optimization is a multi-objective and multi-constraint optimization process with maintenance time range, maintenance outage range and maintenance resources as control variables. Maintenance time optimization includes operation time balance, maintenance duration balance and other processes. Maintenance outage range includes restoration outage balance, maintenance correlation balance, load transfer and other processes. Maintenance resource optimization includes maintenance Window balance, maintenance density balance and other processes. Based on the principle of comprehensive outage, a decision-making system of intelligent outage plan is established to change the passive outage balance into the active outage balance, push forward the gateway of equipment outage plan arrangement, and realize the automatic balance of outage plan in advance.
According to the priority of each outage plan and the requirements of repeated outage, realize the balance of repeated outage; automatically analyze the topological relationship of power grid through the visual window, realize the balance of Maintenance Association; carry out the balance of maintenance density according to the construction unit and operation team involved in the maintenance plan; carry out the balance of maintenance density according to the seasonal operation characteristics of power grid section, load characteristics change, power maintenance situation and important sensitive user time Requirements, etc., take the initiative to prepare maintenance window period; carry out maintenance period and operation time balance according to historical work time of the same type and typical maintenance standard working hours, and finally give optimization suggestions.

The principle of maintenance plan balance optimization is as follows:

1. according to the principle of "overall planning of overhaul and technical transformation, rural power grid engineering, municipal engineering, industrial expansion engineering, equipment defects, overhaul and pre test", the system achieves the optimized coordination of main distribution network, primary and secondary equipment, power generation, transmission and transformation;
2. give weight to different types of maintenance work (infrastructure construction, industrial expansion, government, rural power grid, etc.) and adjust the maintenance plan time according to the priority;
3. according to the special time periods such as power saving and peak load, no outage maintenance work shall be arranged, and the rationality of maintenance window period shall be judged;
4. judge whether the maintenance period is reasonable according to the rules that the maintenance time of the more difficult power-off equipment is not arranged in the high load period, and the maintenance time of the equipment that cannot be cut off at the same time must be staggered;
5. through the analysis of power outage scope, judge whether it meets the requirements of repeated power outage;
6. judge whether the maintenance density is balanced through the analysis of maintenance resource allocation.

Based on the analysis process of maintenance plan balance model, it can avoid unreasonable arrangement of maintenance plan, provide intelligent service for the planners, improve the rationality and enforceability of planning, and optimize the scope of maintenance outage and maintenance human resource cost.

4.3. Study and judgment of power failure in distribution network
The research and judgment of distribution network outage fault is based on the business service realization of multi system integration. It is an intelligent management and control of outage work order based on the combination of 95598 system, PMS system, distribution network automation system, dispatching operation management system, marketing system, etc.

Based on the panoramic model of power grid, the system realizes the intelligent management of the outage event pool, and analyzes the real-time signals of the power distribution network obtained by combining with the operation, distribution and commissioning through state. The analysis conclusion should include the outage type, outage failure point, outage scope, outage impact on users. On the basis of accurate low-voltage diagram, the low-voltage power failure management and control and fault analysis are based on the intelligent analysis of the collected equipment state operation data, so as to carry out the low-voltage power failure management and control and fault analysis; the medium-voltage fault analysis of the power-off time of distribution transformer is based on the battery shutdown, combined with the intelligent analysis of the supply circuit path, to achieve the research and judgment of the distribution transformer fault source, so as to form a complete distribution network Failure analysis scheme.
4.3.1. Blackout event pool.
Power failure event pool is the data base of power failure analysis of distribution network. The data source of power failure intelligent analysis mainly comes from EMS system, distribution automation system, power consumption information collection system, 95598 and other systems. Power failure of distribution network mainly includes planned power failure and fault power failure. In the outage intelligent analysis platform, the outage event pool is divided according to the outage location.

① main line fault: through the study and judgment of switch displacement and protection action of EMS system, feeder switch trip and main network fault cause feeder voltage loss event, which is synchronized to power failure event pool;

② branch line fault: comprehensively judge the tripping event of feeder automation switch through EMS system and distribution automation system, and synchronize it to power failure event pool;

③ distribution transformer fault: according to the power failure event of the power consumption information collection system, it is judged as distribution transformer fault according to the corresponding relationship between the power failure event and distribution transformer, and it is synchronized to the power failure event pool;

④ low voltage line fault: the real-time operation data of distribution transformer and electric energy meter can be provided by the power consumption information collection system to determine that the low-voltage line fault is synchronized to the power failure event pool.

4.3.2. Study and judgment of power failure
The power supply path represents the topological connection between the power supply point and the load [1], which is one of the core businesses of integrated power outage management. Based on the service of power supply path, the system can identify the relevant equipment and areas affected by power failure, and can count the number of users and repeat power failure households and other key indicators. In order to realize the real-time perception and accurate positioning of faults and improve the efficiency of distribution network fault disposal, the service of power supply path is used to accurately locate the fault area and provide auxiliary decision-making of fault disposal.

According to the 95598 power supply user's repair information, the user's account number and address information are used as the source of information. Based on the power supply path service, the distribution transformer information and power supply points of the power supply user are analyzed, and then the intelligent matching of the equipment repair plan and power failure information of the power failure event pool is realized. The real-time operation of key equipment such as distribution transformer and power meter in the power consumption information collection system and distribution automation system is combined Call test function of information, analyze and locate suspected fault equipment and influence range [13].

The flow of study and judgment of distribution network outage is shown in Figure 5.
According to the repair information of the power supply user, determine the user's ownership, analyze the matching relationship between the fault work order and the power failure event pool through the fault judgment of the distribution network, if there is a corresponding relationship between the fault work order and the power failure event pool, the upper level active repair service has the function of not re dispatching the order, if there is no corresponding relationship, the system has the function of adding power failure events in the power failure event pool according to the power failure location Function.

5. Appendixes
Based on the power grid integrated outage management platform of business middle platform, the multi department data barrier is solved through data middle platform, and the optimal utilization of computer resources is realized. Then, the business functions of power grid topology analysis, power supply path analysis, outage fault analysis and other multi-system reuse are realized by using business middle platform, which meets the requirements of power outage business management of dispatch and control center, equipment department and marketing department. Under the premise of management, the ability of business sharing and collaboration between systems is improved.

Through the business application of the power grid integrated outage management platform and the outage event pool mechanism, the possibility of repeated dispatch is minimized. The fault point range is basically determined by using the medium and low voltage fault research and judgment to improve the efficiency of fault emergency repair, which provides a strong support for the development of active emergency repair service.

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