Research of Key Techniques of Grid Dispatching and Control System in the Environment of Dispatching and Control Cloud

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Abstract. The dispatching and control cloud (DCC) is a new technology based on technology like cloud technology, big data, and internet technology, which aims to improve the integrated operation quality of bulk power systems. The application of cloud technology to grid dispatching and control (GDC) system is significant to the management level of dispatching operation of the grid, but will also bring new challenges. Taking the maintenance of data information, the security of network and the control of operation and maintain into consideration, this paper explores the key techniques of GDCS in the environment of DCC, and focus on the scheme to enhance the ability of operation and management of GDC system.

1. Introduction
With the development of extra-voltage AC and DC interconnected power grid and the access of the new energy, the integrated characteristic of the power grid is increasingly obvious [1]. To accommodate the requirement of global monitor, global protection, and centralized decision-making in the power grid, the State Grid Company put forward the comprehensive construction of dispatching and control cloud platform based on the advanced IT technology like cloud computing and big data [2-3]. The realization of the effective management of essential data and the improvement of the online-analysis ability in power grid needs the technical support system of dispatching and control with the characteristic of resource virtualization, data standardization and application servitization [4].

The application of DCC is significant to the improvement of cooperative disposal ability, information support ability and global-source-sharing ability of multilevel GDC system [5-7]. However, it can not be ignored that the DCC also bring new challenge to the maintenance of data information, the security of system and network and the control of operation and maintain. In the context of DCC, the data information of the grid is integrated in the cloud system in the form of big data. Hence, the higher integration of graphic and model, standardization of data information and intelligent of maintenance is required. The power grid is always threatened by the attack from network [8]. The DCC breaks down the barriers between multilevel GDC system and various majors, meanwhile set a higher demand on the security of network. The access permission mechanism of the traditional GDC system is not perfect. The management of the permission assignment to different personnel is not precision, and the operation
on the key servers and business lack authorization mechanism. The users can use a general account to operate the whole system. Therefore, if there is no improved management of operation and maintenance, the GDC system will be threatened by the faulty operation or malicious damage of the internal staff, and the stable operation of the power grid can not be guaranteed.

According to the problem above, the GDC system in the environment of DCC is introduced in this paper. Then to provide the technical support to the improvement of the stable operation of the grid, the key techniques of the GDC system are discussed in consideration of the maintenance of data information, the security of system and network and the control of operation and maintain.

2. Brief introduction of DCC and GDC

2.1. DCC Platform
The principle of DCC is centralized dispatch and level-to-level administration. The DCC system consists of a pilot node and several collaborative nodes. The structure of a collaborative DCC platform is shown in Fig. 1. As can be seen, the DCC platform is composed of Infrastructure as a Service (IaaS) layer, Platform as a Service (PaaS) layer, and Software as a Service (SaaS) layer [9-11]. IaaS serves for the users through the network and computing resources. The users could control the operating system, and manage the storage space, and control the components in network. IaaS also provides the virtualization data service. PaaS serves for the application developer and the operation and maintenance staffs. The construction goal of this layer is to provide services like running environment configuration, business platform upgrade, and technical support for DCC modules. Besides, PaaS provides the platform for the data maintenance, storage and transmission, and provides data support to SaaS. The design objective of SaaS layer is to respond to business requirements and to improve the extensibility of software. The main applications of SaaS include data consulting, grid monitoring, grid analysis, big data analysis and so on. The resource virtualization of IaaS, the model and data platform of PaaS, and the application service of SaaS are due to be completed in the next five years. By the time, a unified service of core resources such as the model and data of power network will be formed, and provide powerful support for the construction of new GDC system.

![Diagram of Dispatching and Control Cloud](image)

**Figure 1.** The structure of dispatching and control cloud.

2.2. GDC system
The GDC system is a resource-sharing and openness technical support system based on network communication technology, computer technology and automation technology, which is responsible for general data information collection, real-time monitoring and dispatching management in power grid.
The superstructure of the system is divided into three safe areas, and the underlying structure is a integration platform across the three safe areas, as shown in Fig. 2. The majority of safe I area is real-time monitoring and warning application. The safe II area mainly serves for dispatching plan and security check. The dispatching management application is located in safe III area.

![Scheme diagram of grid dispatching and control system](image)

**Figure 2.** The scheme diagram of grid dispatching and control system.

### 2.3. GDC system in the environment of DCC

Aiming at the request in the integrative operation of the new power grid, the DCC platform is applied to GDC system by building a sharing channel through the safe III area, as shown in Fig. 3. The data sources involves the systems located in safe III area like Outage Management System (OMS), the Energy Management System (EMS) and the Smart Grid Dispatching Control System (D5000).

With the support of DCC platform, the GDC systems in different areas and levels could share the data information of the whole grid network. Meanwhile, the operation and control ability of the GDC systems can be improved significantly taking advantage of the virtual storage and computing source of DCC platform.

![GDC system connected with DCC](image)

**Figure 3.** The GDC system connected with DCC.

### 3. Discussion of the key techniques of GDC system in the environment of DCC

#### 3.1. Integration of Data Information

The traditional GDC system has the characteristic of regional feature. There could be great difference between the systems from different department in respect of data format and naming conventions. Besides, the lack of effective channels between different systems makes it difficult to share the data and information with each other. The DCC technology provides a sharing platform for the GDC system. The data interaction between the main node, the collaborative nodes and the data sources will be very tightly.
The GDC system should leverage the advantage of DCC in distributed storage and computing, and reduce the coupling between different systems, majors and levels.

Firstly, the unified standard of data information should be built to realize the wide-area query and intelligent analysis across different systems and majors. The data information mainly include primitive, graphics, device parameter, attribute relationship and operation data [12]. Due to the normalized database, the data information of the grid is maintained in the source-end of various GDC systems, and is integrated to the DCC platform in forms of uniform standards. Secondly, the new technology such as speech interaction, intelligent identification [13], and face recognition should be efficiently utilized. The business like voice input of large text and the push of relevant data could promote the convenience of the operation in data query, sharing and analysis.

3.2. Network Security
In the field of network security in power control system, there is no advanced international experience for reference. After a series of severe network security incidents, an integrated network-security theory system was established in the domestic power grid. The National Development and Reform Commission enacted a regulation named as the fourteenth rule, which was an important milestone. It represents the security means based on immunity mechanism and trusted computing technology. The security system involves technical security, emergency plan and safety management.

On basis of the concept of DCC, the security defense of GDC should follow the principle of layered and depth method. A strong and solidity security-protection boundary should be built. The security of the physical infrastructures can be guaranteed by means of setting the entrance guard, monitoring the operating environment and daily audit. The perimeter security framework of the system can be reinforced by adding the preventive device such as firewalls, longitudinal encryption device [14]. The sensitive data in power grid should be necessarily isolated from social public and enterprise information network, and the isolation can be improved by means of high-level security control mechanism.

The intelligent analysis level of security monitoring in the network should be enhanced. The security monitoring methods can be enriched by the advanced technology such as traffic acquisition and analysis, correlation analysis, and panorama perception [15]. Besides, the automatic identification and push of the warning information based on multidimensional data analysis is also a field deserves research.

Figure 4. The security methods of the GDC system under the environment of DCC.
The DCC platform is connected with the GDC system through safe III area. Thus the security structure of safe III area should be reinforced through strengthening the perimeter security deployment and policy mechanisms. To realize the overall and real-time monitoring of the host, virtual machine, and the cloud software, the security methods in the future should focus on the fields such as virtual security protection, cloud platform interface security and virtual machine isolation, as shown in Fig. 4.

3.3. Control of operation and maintenance
In the environment of DCC, the GDC system of the whole power grid is global shared and longitudinal interconnected. Any faulty operation or malicious damage in the collaborative node may cause serious consequence. To improve the operation and maintenance management mechanism, the State Grid Company put forward a series of measures to enhance the control of operation and maintenance.

A typical measure is deploying the operation and maintenance control module besides the core switch which is located in Safe II area, and the module can connect the safe I area through the firewall. The servers, database, security device are connected through a secure encrypted channel with the module, and should only be accessible by the users through the ports in the module. The main highlight characteristics of the module are described below. Firstly, the operation and maintenance personnel can access various target device only through one verification, and they will not need to memory a large of names and keywords. Secondly, the access is licensed by the module based on centralized and unified control and fine-grained authorization policy. Every operation and maintenance personnel is guaranteed with the most reasonable authority. Thirdly, the identity of the users will be verified through various authentication methods such as static password, USB-key, dynamic password, message certification, RADIUS identify and so on. Moreover, the module has the function of security audit on multiple operations like characters, graphics, files, WEB-page and database.

![Diagram of Operational and Maintenance Platform](image)

**Figure 5** The application of operational and maintenance platform in GDC system.

4. Conclusion
The constantly advancing of the DCC construction brings new challenges to the GDC system. This paper addresses the key technique of the GDC in the environment of DCC from the perspective of the maintenance of data information, the security of system and network and the control of operation and maintain. Some new techniques and management mechanisms are also discussed, which are significant to the security and stability of the GDC system.

References
[1] Q. B. Yang, Z. Y. Chen, and D. Liu, “Design and implementation of dispatching and control cloud PaaS platform based on container,” Power System Technology, 2020.
[2] K. F. Wu, L. Liu, Y. T. Wan, “Analytical techniques and application using power big data based
on cloud computing,” Electric Power, 2015.

[3] M. Chen, “Research and implementation of key technologies of dispatching cloud in power system,” Guangxi University, 2013.

[4] L. Zhang, L. Y. Que, X. Han, “Application of grid graphics integrated maintenance technology based on dispatching and control cloud,” Automation of Electric Power Systems, 43(22), 2019, pp. 151-156.

[5] W. K. Wei, “Exploration of key technical points of power system “dispatching cloud,”” Telecom Power Technology, 36(12), 2019, pp. 230-231.

[6] X. M. Zhou, L. Tao, D. P. Li, “Architecture of data access based on power dispatch control cloud,” International Conference on Computer Sciences & Automation Engineering, January, 2015, pp. 353-357.

[7] Y. Chao, Z. Y. Gao, S. C. Yang, “Application of cloud computing in power dispatching systems,” Electrical Power, 45(6), 2012, pp. 14-17.

[8] M. Li, “Research on security protection technology and development of smart grid dispatching control system,” Telecom Power Technology, 35(11), 2018, pp. 76-77.

[9] Q. Zhang, H. J. Liu, N. Li, “Research on the System Architecture and Key Technology of Shandong Provincial and Land Integration Dispatching and Control Cloud,” Shandong Electric Power, 45(5), 2018, pp. 48-53.

[10] Y. D. Yang, Y. J. Zhang, W. L. Liu, “The province dispatching and control cloud system architecture based on cloud computing,” Telecom Power Technology, 36(12), 2019, pp. 38-39.

[11] L. Y. Que, Z. W. Jiang, Y. W. Xiao, “Research and prospects of key technologies for dispatching and control cloud,” Zhejiang Electrical Power, 38(8), 2019, pp. 1-7.

[12] H. Q. Xu, “Structured Design and Application of Power Dispatching Universal Data Object for Dispatching and Control Cloud,” Power System Technology, 42(7), 2018, pp. 2248-2254.

[13] H. Z. Tao, M. Y. Zhai, H. Q. Xu, “Architecture and key technologies of artificial intelligence platform oriented for power grid dispatching and control application scenarios,” Power System Technology, 44(2), 2020, pp. 412-419.

[14] Y. Liang, J. Wang, L. Zhang, “Research of access control system based on attribute encryption technology that suitable for dispatching and control cloud,” IEEE 4th International Conference on Cloud and Big Data Analysis, April, 2019.

[15] S. C. Yang, B. Q. Tang, J. G. Yao, “Architecture and key technologies for situational awareness based automatic intelligent dispatching of power grid,” Power System Technology, 38(1), 2014, pp. 33-39.