

Discussion on the Construction of Intelligent Power Production Operation and Maintenance Management and Control Platform for Safety Production Needs

Zhikang Pei ^{*a}, Zhiqin Qiu ^a

^a Yalong River Hydropower Development Company, Ltd., Chengdu 610051, China

^{*}Corresponding author: peizhikang@sdic.com.cn

ABSTRACT

In order to improve the safety management level of power production in power generation enterprises, this paper introduces the operation and maintenance management and control platform of intelligent power production, discusses the overall system architecture, system deployment, network security protection software system architecture of intelligent power production operation and maintenance management and control platform, and provides important reference for the operation and maintenance of intelligent power production in power generation enterprises.

Keywords: electricity production; intelligence; system; security

1. INTRODUCTION

In order to adapt to the upgrading and adjustment of power production mode in power production enterprises, and effectively improve the safety and efficiency of power production operation and maintenance work in power generation enterprises, a set of intelligent power production operation and maintenance integrated management and control platform system must be constructed to realize and ensure the mandatory and completeness of safety measures in the process of two tickets related business operations in power production, ensure the safety of people and equipment in the process of operation, and prevent the occurrence of safety accidents. The intelligent power production operation and maintenance integrated management and control platform system takes the two ticket system as the core. The equipment status library, data interaction system, safety measures comparison system, error prevention and control system, ground wire control system, pressure plate management system, intelligent cloth ball operation safety management and control system, equipment inspection system, regular work management and control system are co-ordinately constructed as the intelligent power production operation and maintenance management and control platform. Through the corresponding intelligent handheld terminal, ground wire, pressure plate, lock, computer key and other hardware, intelligent two ticket control, maintenance

isolation, error prevention locking and other functions are realized ^{[1]-[2]}.

2. INTELLIGENT POWER PRODUCTION OPERATION AND MAINTENANCE MANAGEMENT PLATFORM

As a professional platform of power production operation and maintenance management, the intelligent power production operation and maintenance management and control platform executes the whole process of business processes such as 'two tickets' and inspection on the management and control platform. Through the mutual cooperation with the local subsystems and the data interaction between the cloud and the professional systems, the operation risk is comprehensively controlled and the operation and maintenance operation is standardized from the perspectives of two tickets intelligent filling and approval, risk prompt, safety measures comparison, online error prevention, isolation locking, process tracking and automatic recording.

3. OVERALL SYSTEM ARCHITECTURE

The intelligent power production operation and maintenance management and control platform is based on the ideological construction of the Internet of Things,

including the perception layer, network layer, platform layer and application layer.

The perception layer includes intelligent computer key, anti-mistake lock, door lock, intelligent ground wire, intelligent pressing plate, intelligent safety tool cabinet, lock cabinet, key management cabinet, etc.

The network layer uses Ethernet, Wi-Fi, 4G / 5G, NB-IoT and other communication methods to transmit the device status of the sensing layer to the edge computing gateway. Through the edge computing service, the online sensing of the field equipment is realized with the platform layer.

The platform layer is based on the construction of cloud architecture, which is composed of three layers: infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS), and is the core of the whole system. IaaS services use the company's Yashui cloud platform resources, such as servers, networks, storage resources. Data services in PaaS services should make full use of the database and storage services that enterprise data centers can provide to ensure data reliability while providing conditions for future enterprise big data analysis and reducing software authorization costs. In addition to providing the core services of the management and control platform, SaaS services should provide interface services in the form of Web API to facilitate the integration of third-party systems, and realize the integration with multiple existing systems of enterprises, eliminate information islands, and make data and business interconnection between systems.

The application layer takes App and Web as the core to display applications, and realizes the application display of operation and maintenance control, operation process control and system linkage.

4. OVERALL SYSTEM DEPLOYMENT

The cloud server of the intelligent power production operation and maintenance control platform adopts the virtual server and its storage resources provided by the enterprise management information IV area cloud platform; the equipment information collected on the site of the platform is communicated with the platform server of the cloud platform through the existing intranet channels (telecommunications and power networks), and the network security equipment is shared with the existing hardware firewall and other protective equipment^[3].

The video push gateway server for communication with industrial television system and the reverse physical isolator for one-way communication between IV and III are added in the field production management area III. Because the intelligent power production operation and maintenance control platform is a one-way call to the

industrial television system, the industrial television system has no active request for the event of the intelligent power production operation and maintenance control platform, so there is no need to configure the forward physical isolator^[4].

Power production enterprises provide DNS server internal and external domain name pointing services. When the customized tablet of field operation is connected through Wi-Fi in Zone IV, the domain name points to the IP of the internal network. When the system switches to the 4G / 5G network, it points to the IP of the external network. It ensures that the field operation has two different types of network support, and can achieve seamless switching and improve the robustness of the system.

5. NETWORK SAFETY PROTECTION

The overall principle of power monitoring system security protection is 'security partition, network dedicated, horizontal isolation, vertical authentication' to ensure the security of power monitoring system and power dispatching data network. The intelligent power production operation and maintenance control platform considers setting the following safety protection strategies^[5]:

(1) The intelligent power production operation and maintenance management and control platform is deployed in the private cloud server of the enterprise. Since the intelligent power production operation and maintenance management and control platform needs to unidirectionally call the preset position of the field camera in the production management area III and display it in the terminal bullet window of the industrial TV system in the area III, the reverse physical isolator of communication is added between the production management area III and the management information area IV to ensure the safety of the corresponding system in the production management area III.

(2) The connection between the power plant self-built network (including Wi-Fi network) and the headquarters management information IV area is isolated by hardware firewall.

(3) The connection between public network area and power plant self-built network is isolated by hardware firewall.

(4) Intelligent power production operation and maintenance control platform system configuration network anti-virus system.

(5) The intelligent power production operation and maintenance control platform sets up security measures such as login authentication and authorization, application access rights.

6. SOFTWARE SYSTEM ARCHITECTURE

6.1. Platform layer

The platform layer is mainly constructed by the idea of cloud service, and the hardware infrastructure and software infrastructure are designed by the architecture of cloud service.

6.1.1. Infrastructure service IaaS

Mainly to meet the basin has been put into production and is about to put into production of intelligent power production operation and maintenance control platform construction, and consider the robustness of the overall system. In order to ensure the continuous operation of the overall system, the software and hardware parts of the overall system construction should meet the requirements of gray release.

Gray publishing lets some users continue to use the original product function, and other users gradually enable new functions. In the transition process, the product may be further improved. After the gray release is completed, all users will use new product functions. Gray publishing can ensure the stability of the overall system and minimize the impact of new function publishing.

At the same time, considering multiple power plants in the overall framework, business process unchanged, can provide hardware support for different power plant customized software applications.

6.1.2. Platform service PaaS

The platform architecture is based on SOA architecture design idea, and uses the micro-service architecture to design and build. The system presentation and data are separated to support a variety of front-end display clients. Data is provided by service components and used uniformly through API gateway. The platform separates some basic public functions into basic services, such as service management center, API gateway, event bus, data storage, micro-service architecture, etc.

6.1.3. Application service SaaS

(1) IOT subsystem API gateway: the application layer PaaS services provide unified external access.

(2) IOT service: for the core service of IOT subsystem, the containerized deployment is carried out in the way of server cluster, with the functions of rule engine, cloud edge collaboration, fault alarm, and data

analysis. The IOT service generates different Access Tokens for each device, and provides MQTT over SSL connection. The device uses Access Token to establish an encrypted long connection with the IOT service through MQTT over SSL, ensuring that the communication process is safe and reliable, preventing device identity forgery and data interception and theft.

(3) Equipment management services: for equipment management and equipment parameters configuration.

(4) Edge computing gateway: can be deployed in the cloud server, can also be independently deployed in the local server for device connection and edge computing.

(5) Historical big data: big data analysis and statistics for device and equipment operation.

(6) Bluetooth computer key: it is used to communicate with mobile application App to realize the equipment operation of anti-misoperation locks, door locks, ground wire and other devices.

(7) App application: the real-time operation information of the equipment is interacted with the IOT service through the service of the intelligent power production operation and maintenance management and control platform to realize the linkage of related devices, such as the unlocking of the ground wire in the ground wire cabinet and the push of the industrial TV screen.

6.2. Application layer

The Web end mainly uses technologies such as Vue + ElementUI + Vue Router + Vuex to achieve single-page applications. Compared with traditional Web pages, it has good user experience and reduces the waiting time of integrated loading pages. The MQTT Internet of Things protocol and SVG vector graphics display function are realized, and the latest equipment status information on the site is viewed in real time on the Web side. At the same time, the functions of anti-mistake logic judgment and graphic ticketing are realized combined with the business. Through the way of RESTful API docking with the background service, the front and back ends are completely separated.

The App end mainly adopts the React Native technology, uses the UI component of Native Base, has a unified interface style, and integrates Bluetooth communication, map positioning, scanning code photography, message push, NFC communication, face recognition and other functions. It not only realizes the communication with various hardware, but also provides various humanized and easy-to-use experiences.

On the basis of React Native, the hot update function is integrated. By comparing the differences between JS Bundle and resource files, the difference or full update is carried out. It is convenient to quickly repair BUG

without publishing a new version, and avoid the trouble of downloading App again for each update.

6.3. Network layer

Device communication makes full use of the Wi-Fi network and mobile 4G network built on the site.

Field devices are distributed in the factory area according to the actual situation, and the device information is uploaded to the company Yashui cloud server through Wi-Fi network.

The ground wire connection detection device can use the 4G or NB-IoT network of mobile operators to report the real-time state of the ground wire to the cloud server.

6.4. Perception layer

Mobile perception layer devices, mainly computer keys and mobile handheld terminals. The computer key is connected to the customized tablet through Bluetooth. According to the operation tasks on the customized tablet, the on-site anti-misoperation locking and door lock are operated. The customized tablet communicates with the platform layer in real time through the Wi-Fi or 4G network in the factory, and realizes the whole process perception of equipment operation with the help of Web, mobile App and three-dimensional simulation system.

7. CONCLUSION

Through the data interaction system, the intelligent power production operation and maintenance management and control platform realizes the interconnection with the data and business between the relevant systems, such as basin power production management information system, enterprise data center and three-dimensional visualization intelligent simulation system. At the same time, through the establishment of cloud server, the progress of production site operation and maintenance work, safety risk and pre-control measures, safety measures and lock listing, mechanical and electrical equipment status, lock control status, pressure plate status, ground wire installation and other production information can be understood anytime and anywhere. The safety, standardization and electronization of power station operation and maintenance work control process are realized, which contributes to the safety control of power production and greatly improves the safety production management level of power generation enterprises.

ACKNOWLEDGMENTS

The joint fund of National Natural Science Foundation of China (NSFC) & Yalong River Hydropower Development Company, Ltd. (Abbreviation:

Yalong River Joint Fund; project approval No.: U1965106) is acknowledged.

REFERENCES

- [1] CHEN Yisheng, CAI Zexiang, YIN Liang. "Research on integrative work sheet of substation equipment maintenance and repair management". Proceedings of Electric Power System and Automation. Papers 17(6), 67-70 (2005).
- [2] Wang Xizhao, Liu Shengjun, Wang Dejun. "Intelligent Power Station Framework Research and Information Engineering Practice Practice ". Telecommunications science. Papers (4), 181-185, (2016).
- [3] Li Shaozhuo, Jiao Danguy. "Design and implementation of three-dimensional intelligent security platform for power plants ". Miniature Machine and application. Papers (8), 91-93, (2016).
- [4] GAN Shiyu, CHE Pinjue, YANG Tianshun, et al. "Big data governance system". Computer Applications and Software. Papers 35(6), 1-8, 69, (2018).
- [5] JIANG Bin. "Network security strategy of grid dispatching data network under VPN". Communication World. Papers 26(12): 230-231, (2019).
- [6] GUO Weimin, ZHANG Guangtao, LI Bingnan. "Construction planning and technical route for thermal power plant intelligentization". Electric Power. Papers 51(10), 17-25, (2018).
- [7] ZHAO Zengtao, LUO Yong, LIANG Chenghui. "Research on middle platform construction and large data analysis of power enterprises based on aliyun". Hydropower and Pumped Storage. Papers 5(5), 70-74, (2019).
- [8] LIN Peijie, ZHU Annan, CHENG Shuying. "Performance optimization of android database SQLite". Computer Systems & Applications. Papers 23(4), 193-196, (2014).

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

