Design of Monitoring Platform for Communication Operation and Maintenance of Distribution Network Based on Artificial Intelligence Technology

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Abstract. This article proposes a design of a distribution network communication and maintenance monitoring platform based on artificial intelligence technology to improve operational efficiency. The platform adopts a B/S hardware architecture, providing a stable environment for efficient hardware operations; The platform software ensures efficient transmission of data information during platform operation by designing a communication network structure; A centralized monitoring module for the distribution network was designed using the method of dynamic data association; Reasonably allocate monitoring signals based on the insertion loss of communication channels on the artificial intelligence computing platform; Deeply analyze the entity association of operation and maintenance job monitoring data, and design a communication operation and maintenance job monitoring database. Testing has proven that the designed monitoring platform has fast response speed and high accuracy of monitoring results.

Keywords: artificial intelligence · distribution network · communication and operation & maintenance operation · monitoring platform

1 Foreword

With the continuous expansion of the power system scale, the monitoring work of the communication operation and maintenance operation of the distribution network has become more and more complex and difficult. In order to solve this problem, aiming at the wide application of AI technology in power system, this paper proposes a design scheme of distribution network communication operation monitoring platform.

2 Platform Hardware Design

In this paper, B/S hardware architecture is adopted, which has stable operation effect and guarantees the efficient operation of each hardware in the platform.

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The network switch of the platform adopts S series 48 * SFP model, port of 48x 1G/10 GSFP +, 6x 40G QSFP +, and exchange capacity of 1.44 Tbps, which can support the platform BGP and monitoring network functions. The maximum and minimum delay of the switch is 0.635 μs and 0.6 μs, the memory size is 1 GB, the flash memory size is 2 GB, the number of IPv4 routes is 8192, and the packet forwarding rate is 1071.4 Mpps. Using the cross-device link aggregation function, the two switch devices in the monitoring platform form an M-LAG dual-activity system to realize the synchronization of FPSO field communication, operation and maintenance operation data, and at the same time, by improving the link reliability, simplify the platform operation network and configuration. Through the adoption of the above hardware equipment, the monitoring platform designed in this paper can realize the efficient and stable operation.

3 Platform Software Design

3.1 Communication Network Structure Design

In the design of the software for the communication operation and maintenance monitoring platform of the distribution network, firstly, the communication network structure used by the platform is designed in an all-round way to guarantee the efficient transmission of information and data within the monitoring platform. The communication network structure of the communication operation and maintenance operation monitoring platform of the distribution network designed in this paper is shown in Fig. 1.

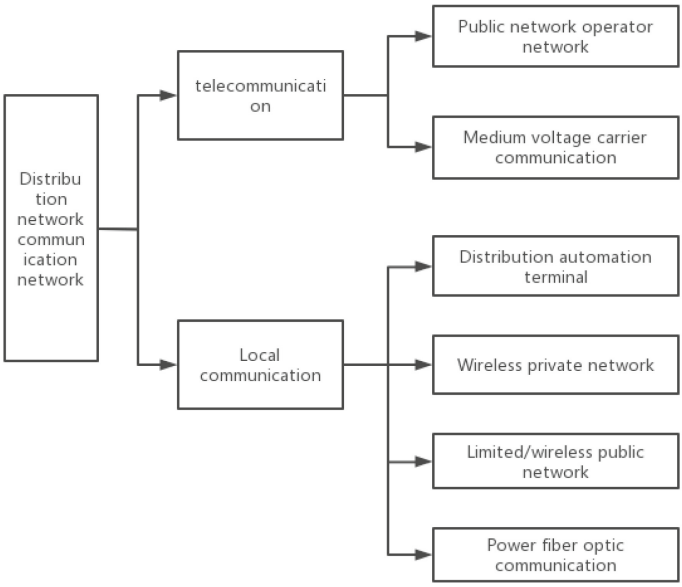

Fig. 1. Communication Network structure of the communication operation and maintenance operation monitoring platform of the distribution network

As shown in Fig. 1, the communication network structure mainly includes two hierarchies: remote communication and local communication. The communication network uploads the monitoring data to the convergence layer site of the platform through the communication channel of the platform, centrally processes the operation data of the distribution network, and uploads it to the core layer of the platform. A certain number of core nodes and convergence nodes are set in the backbone layer of the communication network, and the platform communication network nodes are reasonably configured to promote the efficient transmission of information of the communication operation and maintenance monitoring platform of the distribution network.

3.2 Calculate the Insertion Loss of the Communication Channel Based on the Artificial Intelligence

This paper combines artificial intelligence technology to calculate the insertion loss of communication channel during platform monitoring, so as to provide guarantee for the platform to realize efficient operation and maintenance monitoring of communication. First, before calculating the insertion loss of the communication channel, the operation requirements of each functional module are analyzed during the platform monitoring process, the sum of the channel decay monitored by the platform is calculated, and the platform monitoring EPON communication model is established. Through the operation and characteristics of the communication model, combined with the actual requirements of the communication operation and maintenance operation of the distribution network, based on the computer vision technology and natural language processing technology in artificial intelligence, the link attenuation of the communication channel is calculated. The calculation formula is:

$$\mathcal{W} = \sum_{i=1}^{n} L_a + \sum_{i=1}^{m} R_a + \sum_{i=1}^{t} E_a + \sum_{i=1}^{q} F_a$$

3.3 Monitoring Database Design for Communication Operation and Maintenance Operations

The monitoring data of communication operation and maintenance operations is stored pertinently and logically. In the platform communication operation and maintenance operation monitoring database, the internal and external network firewall is arranged, as shown in Fig. 2.

According to Fig. 2, the monitoring platform designed in this paper adopts the internal and external network firewall, and adopts the platform security access policy to strictly control the access rights of the monitoring data in the platform. This fine and intelligent platform access control can effectively improve the effectiveness of network security in the platform operation.

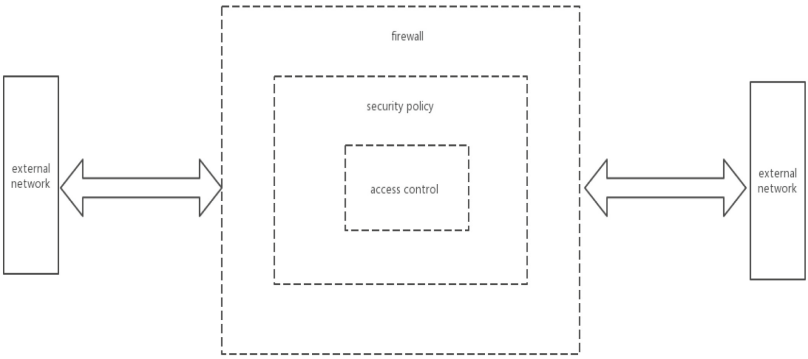

Fig. 2. Network firewall of monitoring database

4 Platform Test

In order to further make an objective analysis of the feasibility of the monitoring platform designed in this paper, the platform test is conducted as shown below. This platform test mainly includes two parts: platform function test and platform performance test.

The integration environment of the platform test is MyEclipse 7.11, the test development framework is SSM components, the platform test language adopts JSP language and JavaScript language, the Web design tool of the platform adopts Dreamweaver 10, the Web service tool of the platform adopts Tomcat 7.0, the Web browser running by the platform adopts Google Chrome browser, and the network environment of the platform test adopts the 100MB enterprise internal data network of a company. According to the technical principle of the white box test, the various functional modules of the distribution network communication operation and maintenance operation monitoring platform designed in this paper are tested in all aspects. The test results are shown in Table 1.

In addition, this paper also uses the test method of comparative analysis to compare the artificial intelligence-based distribution network communication operation and maintenance operation monitoring platform designed in this paper with the traditional distribution network communication operation and maintenance operation monitoring platform based on edge computing. Under the same pressure environment, the response time of the two monitoring platforms is compared to judge their operating efficiency, and the results are shown in Table 2.

According to the analysis of the results in Table 2, the maximum response time of the monitoring platform based on artificial intelligence technology designed in this paper is no more than 1.23 s under different concurrency quantities, which is much faster than the response speed of the traditional monitoring platform. The platform can provide users with relevant information and data in a fast time, and has high operation efficiency.

Table 1. Functional test results of the communication operation and maintenance operation monitoring platform of the distribution network

functional module	test method	expected result	test result
Login module	Based on the interaction design of the platform, the user login identity is verified and the platform is verified to entering the platform.	login successfully	Test success
Operation and maintenance management module	Through this module, the equipment information of the distribution network is added, modified, deleted and inquired.	Operation and maintenance success	Test success
Distribution network status assessment module	The stability of distribution network is evaluated in real time through the change of distribution equipment.	The evaluation is correct	Test success
Operation item reserve module	Create new and audit operations in the module, and safely store the items.	safe storage	Test success
Monitoring module	Intelligent real-time monitoring mode is adopted to monitor the operation situation of various equipment in the distribution network.	Monitoring success	Test success

Table 2. Comparison of the response time of the two communication operation and maintenance operation monitoring platforms

This article monitors the platform			Traditional monitoring platform	
concurrent volume	Maximum response time	Average response time	Maximum response time	Mean response time
100	0.53 s	0.50 s	1.59 s	1.58 s
200	0.68 s	0.67 s	1.87s	1.86s
300	0.74s	0.72 s	2.43 s	2.43 s
400	1.01s	1.00 s	2.96 s	2.95 s
500	1.23 s	1.22 s	3.28 s	3.26 s
600	1.33 s	1.31 s	4.05 s	4.02 s

5 Conclusion

In order to improve the problems of low operating efficiency and poor monitoring accuracy of traditional distribution network communication operation and maintenance job monitoring platforms, this paper proposes a design scheme for distribution network communication operation and maintenance job monitoring platforms based on artificial intelligence technology. Based on the traditional monitoring platform, this scheme introduces advanced technologies such as natural language processing, image recognition, machine learning, etc., which effectively improves the quality and efficiency of the monitoring platform. At the same time, the platform can also conduct in-depth analysis of historical data, providing managers with more accurate and scientific decision-making suggestions, further improving the operational efficiency and stability of the entire system.

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