Research on Self-Healing Mode of Communication Channel of Regional Power Grid Stability Control System

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Abstract. Under the new situation of large power grids, security and stability control systems and their communication channels are facing new changes and new requirements. The article proposes a smart grid dispatching control system multi-channel information intelligent comparison method, through the network monitoring method to obtain the main plant station information interactive communication message, using the intelligent comparison algorithm to compare remote signalling, telemetry, sequence of events (SOE), Communication protocol parameters such as remote control and remote adjustment are compared, and alarm events are output in time according to the comparison results. By combining the principle of the stability control device and the principle of communication self-healing, the influence of the stability control channel communication self-healing ability on the operation of the stability control device is analysed, and the influence of whether self-healing is adopted in operation is analysed. Based on the comparison, it is concluded that the communication channel of the regional network stability control system should use self-healing method.

1. Introduction
The power communication system plays an important role in people's life and production. It transmits scene pictures and language to the control base station through communication signals, and provides a reliable basis for management personnel to command and control. Reasonably use power distribution information and communication networks to shape smart power distribution networks, enhance power transmission efficiency, reduce energy consumption, strengthen disaster recovery capabilities, complete two-way interactive energy services and communication between grid companies and grid users, and maximize social benefits [1]. It is a key topic that related scholars need to study, and it has received more and more attention.

Because of the wide distribution of power equipment in China, the complex terrain of the region, and the various types of power terminals, technologies such as excessive transmission of optical fibre communications have not been able to meet the needs of modern smart power distribution services. In the process of increasing requirements for communication technology in the smart distribution network, how to use modern and continuously developing communication technology to improve the transmission capacity of the distribution communication network, to realize the information interaction and transmission of power grid enterprises and users, and improve the social economy Benefit is a problem that modern people need to study and solve [2]. The TS-LTE power wireless private network system uses the new 4G wireless technology and the combination of power wireless resources to meet...
the needs of different power communication services, reduce the cost of network construction and maintenance, and improve the level of power services.

2. Safety automatic device

Safety automatic devices (hereinafter referred to as "safety devices") include safety and stability control systems (hereinafter referred to as "safety control systems"), de-loading devices and steady-state overvoltage devices (hereinafter referred to as "safety devices"). The above three types of devices are important equipment to ensure the safe and stable operation of UHV interconnected power grids and related power transmission systems. In the regional power grid, in accordance with the safety control devices at multiple plants and stations are linked together through communication channels, the stations exchange operation information and transmit control commands, which can implement stable control in a larger range [3]. The regional power grid stability control system generally has one station by station, multiple substations and execution stations. The master station is responsible for summarizing the operating condition information of each station, identifying the operation mode, and transmitting relevant operation control information to each sub-station. With the commissioning of UHV AC and DC transmission lines, the regionalized power grid has gradually transformed into a large power grid structure. The linkage between regional power grid security control systems is getting stronger and stronger, and an interconnected power grid stability control system is derived, which is mainly responsible for emergency control related to tie lines and exchanges important information in the regional power grids. In the actual operation of the power grid, the operation mode, operation management regulations, inspection procedures, etc. of the safety equipment are compiled according to the operation principle and technical parameters of the equipment, and relevant requirements are put forward for the communication transmission channel of the safety control system.

3. System Design

3.1. Overall design

In actual operation, the current mainstream configuration is a dual master control dual plane scheduling data network, as shown in Figure 1. At the same time, the main and backup channels may use different protocols of the same type of channels, or may use different types of channels and different protocols. According to the on-site operation situation, the dispatch automation system has the phenomenon of inconsistent transmission values of the main and backup channels. Due to the lack of effective technical means in operation, timely detection of inconsistent data defects in the main and backup channels will bring hidden dangers to the safe operation of the dispatch automation system, such as main and backup When the channel is switched, the telemetry data jumps and the tele signal is changed, which seriously affects the safe operation of the control production business [4]. These problems are mainly manifested in the inconsistency of the main and backup channel data, which will cause some data abnormalities during the channel switching process. Based on the above risks to the safe operation of dispatch automation, it is urgent to perform intelligent comparison of the information of the main and backup channels, and give an alarm when the data is inconsistent. At the same time, with the popularization and application of the smart grid dispatching control system, the validity and reliability of basic data are essential for the safe operation of the power grid, ensuring the effective operation of SCADA functions and advanced applications in EMS. The intelligent comparison technology of the application data of the main and backup channels proposed in this paper will greatly improve the availability of channel data, discover the abnormality of the channel data in time, make the hot standby state of the backup channel truly available at any time, and ultimately improve the safety of the power dispatch automation system. Stable operation provides a strong guarantee.
3.2. Hardware design

3.2.1. The hardware composition of the emergency communication vehicle. The emergency communication vehicle has mobility flexibility and is used as a signal relay. The emergency communication vehicle is modified from a vehicle with off-road performance. It has high sealing, heat preservation and heat insulation performance. The sealed door and feeder hole must be rain-proof and dust-proof, and the shell must be waterproof, shock-proof and electromagnetic-proof. Interference, lightning protection and other functions [5]. The hardware composition of the emergency command vehicle can be described in Figure 2. The function of each module is as follows: The intermediate frequency processing module is an integrated device that can effectively realize the functions of the LTE network base station equipment and the core network equipment; the radio remote module belongs to the distributed base station The radio frequency module, its installation methods include pole, wall and stand, can also be installed close to the antenna, not only can reduce the length of the feeder and signal loss, but also can enhance the system coverage capacity.

Figure 1. The overall structure of the electric power communication system.

Figure 2. Composition of emergency command vehicle.
3.2.2. Select the main controller. Use AT89C51 single-chip microcomputer to become the overall controller of the system, enabling it to realize the mutual interaction of power and communication system data. The single-chip microcomputer is an eight-bit microprocessor with 4KB memory, which can realize the cyclic filtering of hundreds of read-only memory. The system collection terminal uses AT89C5112 as the main processor and integrates 4KB memory. Figure 3 is the hardware device of the main controller.

![Figure 3. The hardware devices of the main controller.](image)

3.2.3. Distributed channel recorder. The device is mainly connected to the communication cable between the communication interface device and the communication system device by means of high-impedance jumper, to realize the monitoring of the communication channel. It is composed of channel wave recording device and background management software. The wave recording device is installed in the communication room of the factory and station to realize real-time monitoring of the channel and communication message recording; the background management software is usually installed in the background management computer of the network or provincial dispatch [6]. Realize the networking, configuration, and management functions of the distributed channel recorder. The two-exchange data through the Ethernet interface. The basic structure of the wave recorder is shown in Figure 4.

![Figure 4. Structure block diagram of distributed channel recording device.](image)
3.3. Software design
The main part of the design is realized by hardware, and the work of the software part is mainly the display and recognition of hardware initialization and power communication results. The main program flow chart is described with Figure 5.

![Figure 5. System software flow chart.](image)

3.4. Self-healing mode of communication transmission network
The self-healing methods generally used in the power communication transmission network include one-way channel protection and multiplex section protection and their combination. There is no difference in the communication channels provided by the transmission network using different self-healing methods under normal operating conditions. The difference between the different self-healing methods is mainly reflected in the switching delay after a failure and the routing selection after the switching [7]. According to the requirements of the ITU-TG.803 system standard, the switching delay of one-way channel protection is less than 20ms. Due to the dual-transmit selective receiving and single-ended switching, it may happen that the receiving and sending paths are not on the same route after the switching. The switching delay of multiplex section protection is less than 50ms, and the receiving and sending paths are in the same route after switching. The channel unavailability time caused by SF/SD detection before the network switch, because the impact exists regardless of whether self-healing is used or not, and cannot be quantified.

4. Experimental analysis
In order to verify the effectiveness of this system, relevant experimental analysis is needed. The ARM-Linux-toolchains tool chain is used to complete the cross-compilation of the communication program, and the collected information is sent to the hardware platform of the power communication system based on TD-LTE. The text system and the traditional system are used to transmit each group of data 10 times, the average transmission time is calculated, and the average transmission speed is obtained. The test results are described in Table 1. Analysis of Table 1 shows that, compared with the traditional system, the system in this paper works more stably, without data loss, and the maximum transmission speed can reach 702.4KBps, which can meet the general requirements of power communication. Many studies have shown that the relationship between the frequency band utilization rate of the power communication system and the number of orthogonal pulse waveforms conforms to the following formula: \( \eta = \frac{8N}{4N+1} \), that is, when the number of orthogonal pulse waveforms gradually increases, the frequency band utilization rate will infinitely approach the Nyquist rate of 2bit/s·Hz\(^1\).
Table 1. Test results.

| Data number | The average transmission time of the system in this article/ms | The average transmission speed of the system in this article/KBps | Average transmission time of traditional system/ms | Average transmission speed of traditional system/KBps |
|-------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------|---------------------------------------------------|
| 1           | 416                                                           | 508.9                                                         | 463                                               | 521.1                                             |
| 2           | 511                                                           | 484.7                                                         | 572                                               | 496.9                                             |
| 3           | 701                                                           | 534.3                                                         | 749                                               | 551.7                                             |
| 4           | 1102                                                          | 455.6                                                         | 1215                                              | 481.5                                             |
| 5           | 1386                                                          | 641.5                                                         | 1467                                              | 662.4                                             |
| 6           | 1825                                                          | 599.9                                                         | 1982                                              | 619.7                                             |
| 7           | 2333                                                          | 702.4                                                         | 2411                                              | 731.5                                             |

5. Conclusion

The channel recorder will play a key role in correctly evaluating the action behaviour of the security device, determining the cause of the action, analysing, and handling the failure of the security system. Although the channel recorder still has some problems in the early stage of application, such as limited storage of recorder content, inflexible setting of the starting recorder conditions, etc., with the continuous improvement of the manufacturing process of related manufacturers, the channel recorder will stabilize the system Lieutenant will be more widely used.

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