Application Game Theory in Optimization Telecontrol of Network Reform and Acceptance Technology

Qiangxing Liu[1,2], Jin Wang[1,2], Changzuo Geng[2]

[1]Nari Technology Co, Ltd, Nanjing 211106, China

[2]Nari Group Corporation (State Grid Electric Power Research Institute), Nanjing, China

Keywords: Telecontrol device; Power station; Network transformation

Abstract: Power dispatching automation system is used to monitor the operation status of the whole power grid, so that dispatchers can take a comprehensive view of the overall situation, operate the whole network, and effectively direct the safe and economic operation of the power grid. It is an important means of dispatching modern power grid. Power dispatching automation system plays an indispensable role in the safe and economic operation of power system. Firstly, this paper discusses the necessity of network communication function transformation of remote control device at power plant terminal, then introduces the equipment status of remote control device at power plant terminal, puts forward the transformation scheme and communication mode of remote control device, compares each scheme, and finally expounds the problems that should be paid attention to in the process of transformation. Compared with the traditional front-end system, the network front-end machine has fast network signal transmission, large bandwidth, high reliability, less interference, and is not limited by the number of traditional protocol transmissions. The device has the characteristics of high measurement accuracy, fast data refresh, good anti-interference performance, strong adaptability and high cost performance, certain economic and theoretical value.

1. Introduction

Telecontrol device is an important part of power plant automation. It is an important means to improve the level of dispatching and operation management, reflecting the technical management level and management requirements of a power grid and power plant. Power dispatching automation is responsible for monitoring the operation status of the whole power grid, so that dispatchers can take a comprehensive view of the overall situation, operate the whole network, and effectively direct the safe, sTable and economic operation of the power grid, which is an important means of dispatching modern power grid [1]. Power dispatching automation system plays an indispensable role in the safe and economic operation of power system. With the continuous development of the power grid, the requirements for dispatching automation are also constantly improved. In addition to the new system to meet the ever-increasing automation technology requirements of the Southern Power Grid, it is also required to transform the remote-moving devices at the station and end to improve its automation level [2]. This function is another technical measure provided by the dispatch automation system to the grid management. It is mainly capable of receiving remote operation commands and executing commands [3]. In addition, it can also receive various summoning commands, timing commands, reset commands, and the like delivered by the dispatching end. The telecontrol information transmission of the new substation is basically networked, but some substations still use the old-fashioned line mode due to obsolete equipment.

With the development of national science and technology and the improvement of grid management requirements, the requirements for telecontrol devices are gradually improved, and the telecontrol devices must be updated and updated in time to meet the requirements of the power system. Every upgrade is accompanied by the rapid development of information technology, with the rapid development of computer technology, network and communication technology, database technology, and the requirements of the power market and the maturity of international standards [4]. The station-side telecontrol device is an important part of the power system automation system,

and its automation level will provide accurate real-time information for production command and decision-making. It effectively reduces the fault hazard area, shortens the fault processing time, reduces the outage loss, and also improves the dispatching flexibility [5]. Telecontrol technology has become an indispensable technical means for the safe and economic operation of power system, and also an important technical measure to realize the modernization of power system. In the process of transforming regional substations, it is found that some substations have been transformed by network, and the channels are either on-time or off-line [6]. In order to realize the network communication function of the newly built power grid system, this paper mainly elaborates the principles, schemes and comparisons of the transformation of the network communication function of the plant-station remote control device according to the equipment status quo of the plant-station remote control device.

2. Methodology

Electric power remote control system includes remote monitoring and control technology, which aims to transform the operation conditions of power system plants, stations into signal forms that are convenient for transmission, and to prevent external interference in the transmission process. Through modulation technology, special information channels are transmitted to dispatching stations [7]. Microcomputer protection is the key component of substation automation system. It is not only the measurement and analysis element of primary system operation parameters, but also the data processing element. It is also the control element of primary system switch, which has a set of functions. Power supply is the power source of any device or system. It is a very important part. The power supply includes lightning protection, EMI filter, voltage conversion rectifier filter and so on. The separation of applications from communication systems is one of the main features that support openness. This allows us to construct a physical communication structure, according to the development of current computer network technology, to select network technologies that meet the requirements of the system and meet the requirements of open systems and adapt to future development [8]. When each node uses the bus to send data, it first needs to listen to the busy and idle state of the bus. If a collision is detected during the process of transmitting data, in order to resolve the channel contention conflict, the node stops transmitting data and retransmits after random delay.

The typical structure of the existing power grid is shown in Figure 1. Utilities companies around the world have designed their own grids, clearly defining the main subsystems of the grid: power generation, transmission and distribution systems.
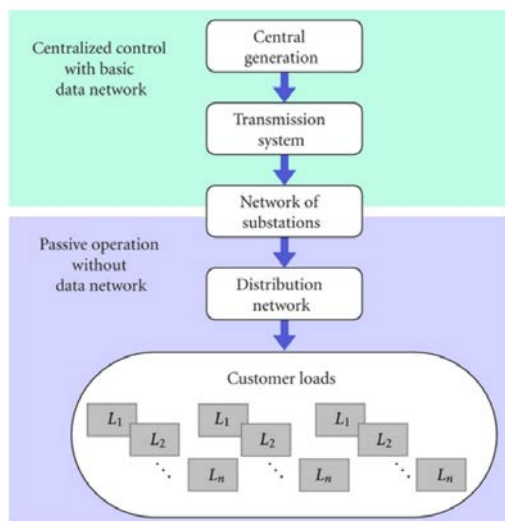

Fig.1. Existing grid structure

In the past, the telecontrol devices of the power grid were all one-to-one discrete component devices. With the rapid development of computer technology, the advent of the 1 to N telecontrol

devices used telecoms to realize telecontrol communication. Each industrial computer is equivalent to a telecontrol terminal. It communicates with each monitoring and control device and protection device in the station separately, and simultaneously exchanges data through modem and scheduling. The success of network design will directly affect the quality of network signal transmission. A good network can better utilize the advantages of network transmission. The existing telecontrol devices should be fully utilized. If the telecontrol devices have reliable performance and can meet the access requirements of the new power grid system after modification, they should not be replaced. The design idea is not to take the whole plant and station as the target of equipment, but to take the interval and components as the basis of design. In the medium and low voltage system, the physical structure and electrical characteristics are completely independent, and the function considers both measurement and control and relay protection. The transformed substation telecontrol protocol remains unchanged. The data of the total control serial port is transformed into network signal through terminal server (serial port to network port equipment), and then served to the main station through network equipment.

The dispatching and monitoring system is to update and display the operation status of plant and station equipment through dispatching and monitoring interface, and present it to dispatchers, such as switch and bit status of circuit breaker, the number of power flow voltage and current, and realize the monitoring operation. After the exchange of voltage transformer (PT) and current transformer (CT), the sampling elements collect the voltage and current signals of primary equipment in power system, and the states of circuit breaker, handcart position and other nodes are collected through auxiliary nodes of primary switch. In a lumped circuit, the current and voltage at different locations at the same time are different, so lumped parameters have no effect at this time, so the theory of distributed parameter transmission line must be used to deal with it. The intelligent sensor and the process control device are connected to the corresponding interval by the interval layer switch, and the data exchange between the internal control and the protection device is separated. In addition, it can also be provided to the office of the director and the real-time operation of the visual grid on the local area network. It can display the real-time picture and the office of the chief engineer, and is mainly used to monitor and provide alarm information. After the installation of the device, the maintenance amount of the device is reduced, and the data receiving and receiving functions are realized, the network adjustment and the provincial adjustment are performed, and the weekly website trial operation ensures the reliable transmission of data.

3. Result Analysis and Discussion

Take safety measures before acceptance, and turn the KK of all running switches of the station from a distant place to the local level. The network pre-communication module accesses the network signal from the network plant communication process module, replaces the original terminal server module, and after processing and interpreting functions, the processing becomes the raw data available to the front-end system. When there is too much information to be processed in the plant station, the CPU load will be increased, the data processing speed will be reduced, and the redundancy of the telecontrol system will not be realized. Therefore, this scheme is mostly used for transmitting plant stations with less data. The hardware of the main unit of the station and the station is centered on high-end industrial-grade modules, equipped with large-capacity memory, flash memory, and electronic solid-state disk and embedded software to form a so-called embedded system. In the process of network transformation of substation, the attribute setting of terminal server should correspond to the specific situation. The centralized remote monitoring is used to monitor and manage the operation status of many stations. Electric power workers can only manage the plant and station equipment through the monitoring system. No matter which link of the remote monitoring system fails, it will have an impact on the monitoring work. By providing operation parameters through the output circuit, the fault current is calculated when the primary system fails and compared with the pre-stored protection settings. When the fault is judged, the fault type is detected and the protection function is started.

Smart grid can be seen as a network, see Figure 2. From the client side, HANN is a network of

communication loads, sensors and devices in the client site. Customers are connected to the energy allocation level through the LAN. LAN identifies the network of smart meters, gateways and components in distribution systems.
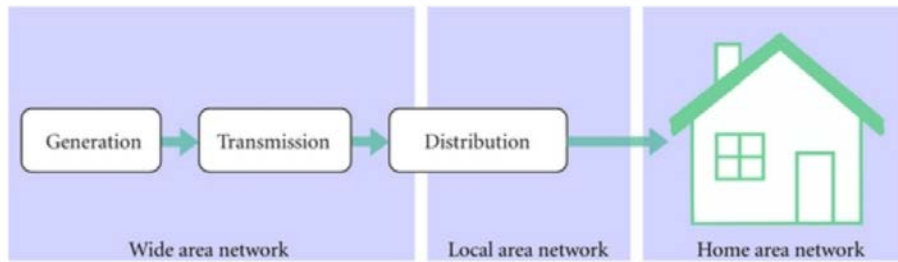

Fig.2. Smart grid network hierarchy

If the impedance of the transmission line and the receiving end do not match, the output current signal and the final steady state of the signal will be different, which causes the signal to reflect at the receiving end, and this reflected signal will be transmitted back to the signal transmitting end and reflected back again. Due to the inconsistent communication protocol of the substation, the incompatibility of the network connection methods adopted by the existing equipment is caused. The substation layer includes a station-wide monitoring host, communication and control host, and an engineering station that implements functions such as management. With the development of computer technology and communication technology, especially the application of network technology. In order to ensure the speed and accuracy of telecontrol, the communication channel must be fast and reliable, so satellite channel is used to adjust. In this way, the remote control capacitor and main transformer can be operated through the protocol channel at the remote main station, because the return of these devices does not affect the normal power consumption of users, but also improves the correctness and reliability of remote control test. It can also be processed as a user-defined data type. Functions that treat members of a class as objects can also act as members of a class, so that data and functions that process these data can be collectively defined.

At present, telecontrol devices in the traditional sense are mostly used in high-voltage and ultra-high-voltage systems with high reliability requirements, which require the separation of measurement, control and protection functions, as well as in agricultural network automation transformation projects with low level of capital shortage and automation. According to the different status of remote control devices (number of devices, number of network ports), the communication modes of remote control devices can be summarized into three modes: single-machine dual-network port mode, double-machine single-network port mode or double-machine dual-network mode. At this time, the master control transmits the data frame according to the set serial port baud rate. According to the size and baud rate of the data frame, the time required for the data frame transmission can be calculated. Therefore, in order to ensure the reliability of the power monitoring system, when one of the devices fails, the normal operation of the monitoring system is maintained by the standby machine, which is generally reliable with dual servers, dual front-end machines, dual networks, and multiple operating machines. The remaining scenarios are configured. The high-order harmonic components in the analog signal are filtered by low-pass filtering, and the continuous signal is discretized by the sample-and-hold link. Then the reflected signal from the receiving end will reach the driving end before the signal changes state. Conversely, the reflected signal will arrive at the drive after the signal changes state. If the reflected signal is strong, the superimposed waveform may change the logic state. Such a structure is very convenient for future system expansion, and there is almost no need to make too many modifications, and the system can be upgraded.

4. Conclusions

The new telecontrol device developed in this paper can be used not only as a conventional telecontrol device with high cost-effective ratio for the automation transformation of rural power

network, but also as a common measurement and control unit for the automation devices of high-voltage or ultra-high-voltage substations, with rich network and communication interfaces. In view of the situation that the substation is interrupted or disconnected after transforming the substation telecontrol network, various factors affecting data transmission are analyzed, and solutions are put forward. The modification of remote control device at plant and station can make it have network communication function. The new EMS system of South China Power Grid can be connected by dispatching data network and special network line, which can improve the real-time performance of remote signal auto-transmission and increase the application scope of remote information. The application results show that the functional design technology of this system is reasonable and can meet the needs of the development of dispatching automation system. It can promote the management level of dispatching automation system and the efficiency of work, and improve the working quality of dispatching system. With the rapid development of science and technology, telecontrol devices will continue to be upgraded. Based on a good experience, we will better enhance the awareness of the device to meet the arrival of new technologies and technologies. Adapt to the development of the power grid and improve the management level.

References

[1] Lu X, Niyato D, Wang P, et al. Wireless charger networking for mobile devices: fundamentals, standards, and applications[J]. IEEE Wireless Communications, 2015, 22(2):126-135.

[2] Chu H C, Yang S W, Ching-Hsien Hsu Digital evidence discovery of networked multimedia smart devices based on social networking activities[J]. Multimedia Tools and Applications, 2014, 71(1):219-234.

[3] Santagati G E, Melodia T. A Software-Defined Ultrasonic Networking Framework for Wearable Devices[J]. IEEE/ACM Transactions on Networking, 2017, 25(2):960-973.

[4] Lee U, Joy J, Noh Y T. Secure Personal Content Networking Over Untrusted Devices[J]. Wireless Personal Communications, 2015, 80(4):1449-1473.

[5] Jo J, Lee S, Kim J. Software-defined home networking devices for multi-home visual sharing[J]. IEEE Transactions on Consumer Electronics, 2014, 60(3):534-539.

[6] Conti S, Corte A L, Nicolosi R, et al. Impact of cyber-physical system vulnerability, telecontrol system availability and islanding on distribution network reliability[J]. Sustainable Energy Grids & Networks, 2016, 6:143-151.

[7] Kuzlu M, Pipattanasomporn M, Rahman S. Communication network requirements for major smart grid applications in HAN, NAN and WAN[J]. Computer Networks, 2014, 67:74-88.

[8] Kumar U, Liu J, Gupta V, et al. Stabilizability Across a Gaussian Product Channel: Necessary and Sufficient Conditions[J]. Automatic Control IEEE Transactions on, 2014, 59(9):2530-2535.