Research on Optimization Strategy of Power Communication Network for Load Balancing

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Abstract: With the rapid development of communication technology, the power communication network based on power grid construction plays an increasingly important role in improving the information transmission rate. Due to the slow start of China's electric power communication network, the relevant research still needs to be improved. In addition, as the structure of power communication network becomes more complex and the business needs become more abundant, the performance of communication network load needs to be optimized. In this context, based on the development status of power communication network, the author analyzes the complex network theory, topology and static characteristics, robustness and vulnerability performance for the realization of load balancing, in order to provide relevant reference for the realization of load balancing.

1. Introduction

1.1 Literature Review

At this stage, with regard to the diversity demand of power communication network and the development of new technology, the development of power communication network is constantly promoted. The state also vigorously constructs power communication network. As a multi-disciplinary integration of power research field, how to optimize power communication network and reduce resource loss is the main direction of related research (Zhao et al, 2016). Wang Zhan and Fu Xuan scholars hold a positive attitude towards the development of electric power communication network, and put forward solutions for network topology optimization and network self-healing protection in view of problems such as weak transmission network structure and insufficient transmission capacity of trunk lines in electric power communication (Wang and Fu, 2012). Zhang Liwen, a scholar, made an in-depth analysis of the possible failures of the power communication network, and proposed that there are equipment failures, human factors and natural factors that may affect its safety. Moreover, he believed that the safety performance of the power communication network would directly affect the reliable performance of the power system production (Zhang, 2017). Zhao canming and other scholars analyzed the routing protocol in the power communication network based on the shortest path priority protocol, and proposed that load balancing can reduce the overload of bottleneck nodes and improve resource utilization (Huo, 2017). Based on the development of electric power communication network, Lin Chuwu proposed the construction of information management system. Adopt TMN structure system, improve relevant systems, and establish system database (Lin, 2013). Li Jiong ju and other scholars studied the relationship between the power system and the communication system in the smart grid, and proposed that the failure of high importance nodes would affect the safety performance of their own network system, leading to the occurrence of cascading failures (Li, 2019).

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1.2 Purpose of Research

With the development of intelligence, information and interaction of power grid, power communication network has made rapid development in this context. However, the rapid development of power communication network has gradually highlighted many disadvantages, network communication can not meet the needs of diversification, and the research on the complexity of network structure is stagnant. In recent years, the state departments pay more and more attention to the construction of electric power communication network, and issue various policies to promote the construction of electric power communication network in China. Corresponding to the power communication network, the relevant theories and facilities are continuously optimized to achieve load balance, so as to save the related resource loss. However, the development of domestic power communication network is relatively slow, and there are still many problems in how to achieve load balance. The author combs the relevant research literature and finds that most scholars have one-sided research. Based on this, this paper studies the optimization of power load balancing based on complex network theory, hoping to enrich the relevant research theory and promote the construction of power communication network.

2. Development Status of Electric Power Communication Network

Power communication network transmission is a national network, mainly divided into trunk transmission and local network transmission. Electric power communication carries out data exchange, operation management and other businesses through the above two transmission modes. Since the implementation of the scientific development strategy in the 21st century, China is expected to develop smart grid and ultra-high voltage grid in terms of energy, so as to promote the development process of domestic energy science strategy. According to the outline of the 12th Five Year Plan for national economic and social development, the Chinese government will rely on advanced technologies such as long-distance transmission technology, information control, and energy storage to promote the construction of the national electric power communication network. As of 2012, the assumed total investment in China's power communication network accounts for 49.47% of the total investment in power engineering. By 2019, the domestic electric power communication network has been completed and put into operation in Bohai Sea, Yangtze River Delta and Tianjin eco city, and the domestic electric power communication has entered the stage of comprehensive promotion. Traditional electric power communication mainly includes data transmission, processing and dispatching, and administrative work. Among them, data transmission mainly refers to information transmission and exchange of terminal equipment through power communication network. Processing scheduling is to solve the operation instructions, fault processing and other services. In addition, multiple professional processing scheduling channels will be configured in the network to ensure the transmission of services. Administrative work refers to the exchange and transmission of information among administrative departments, including human resources, office system, etc. At present, the country vigorously develops the electric power communication network, emerging many related new businesses, among which GPS, GIS and remote sensing technology are widely used. GPS is the application of engineering survey, positioning and navigation based on power system (Dong, 2017). GIS is to integrate the power network and the real network to a certain extent, to carry out troubleshooting, positioning, network monitoring and other services. The last remote sensing technology is widely used in the field of disaster prevention, mainly to prevent power plant operation, power grid disasters and other situations. However, due to the widespread use of power communication services in recent years, network congestion often occurs. People have paid attention to the load balancing of power communication network.

3. Research on Power Load Balancing Optimization Based on Complex Network Theory

3.1 Complex Network Theory

Complex network is a unit system composed of a large number of subsystems. When studying the complex whole, it is divided into the study of the relationship between nodes and edges. From a simple point of view, the complex power network communication system is studied to understand the nature and function of power network communication. Generally, the study of complex network theory is based on the distribution between node degree and network average degree, the ratio of node degree to network sum up points, and the average value of the shortest path between all nodes in the network. Based on the above research elements, the general complex network system mainly includes the following several kinds. The first complex network system model, regular network. The average path length of regular network is large, and the number of connections between nodes is fixed, so the construction and research of regular network is relatively simple. The second kind of complex network system model is stochastic network. Random network is a network system composed of multiple nodes. Two random nodes are connected with a certain probability. This random property also accords with the real network randomness. The last complex network system model is a relatively typical scale-free network, which means that nodes are not connected according to fixed collocation or fixed rules. The degree of these nodes is power-law distribution, and the complex network composed of these nodes is called scale-free network.

3.2 Topological Structure and Static Characteristics Analysis

Traditional power communication network is based on PDH quasi synchronous technology, including microwave, optical wave, optical fiber and other transmission modes. With the development of energy strategy, the application of communication optical cable is becoming more and more popular at this stage. The power communication network based on the power system framework provides network services for several power plants, substations, and power business halls with different voltage levels. Only serving power related industries is the bottleneck of the development of power communication network at this stage. In addition, after studying the topological structure of the system, most of the nodes in the system are low degree nodes of 1 or 2, and only about 10% of the nodes are higher than 2. This kind of structure has typical local aggregation property and uneven network. The general topology requires that the nodes correspond with the devices in the network system, such as router, wave division and so on. The edge in the network system should be connected with the optical cable route in the power equipment. Because the relevant research started late, the current research does not consider the loss between optical transmission and the difference of transmission rate, that is, non-destructive analysis. The nodes in the key link of the topology can provide a fast channel for the information transmission between nodes in different regions, which is mainly responsible for the transmission of communication services. When analyzing the static characteristics, we should consider the impact of the nodes on the key links on the network transmission performance and efficiency.

3.3 Performance Analysis of Robustness and Vulnerability

Power communication network is built on the basis of power system and provides special network services for power system related industries. Therefore, it has special attributes, robustness and vulnerability different from general network. Robustness refers to the characteristic that the network control system maintains some specific performance under the parameter setting, also known as the system fault tolerance ability. The so-called vulnerability refers to the connection characteristics between the core node and the access point. Based on the theory of complex network, the effect of network node changes on network state is called network elasticity effect, which is the performance analysis of robustness and vulnerability. So as to evaluate the fault tolerance rate of power communication network under power failure and network attack, and find the vulnerable part in the transmission of optical fiber network in time, for example, the optical cable or terminal equipment suffers from force majeure or attack, which leads to network transmission failure and

performance impact, so as to solve the problem and build a more perfect power communication network. Generally, the robustness analysis is based on the random fault simulation of nodes or links, and its specific performance is analyzed according to the results. The vulnerability analysis is based on the static parameter calculation, selecting more than 2 height nodes to fail in the network link, and analyzing the performance analysis of the power communication network topology to the vulnerability according to the results. The analysis methods of the above two properties are random fault simulation and selective fault simulation. In order to get the conclusion that the normal operation of the high number nodes and the corresponding links should be protected in the actual operation.

4. Conclusion

With the development of national smart grid, the electric power communication network also needs to be reformed to adapt to the relevant development. As the main development direction of network information automation, load balancing is the key point to ensure the reliability and transmission security of power communication network. In addition, the business requirements and information transmission requirements of electric power communication network are quite different from those of normal network. However, the previous optimization strategies did not consider its particularity, so it is difficult to achieve results in practical application. Therefore, based on the complex network theory and the particularity of power communication network, this paper studies the optimization of load balancing, in order to enrich the relevant research theory and promote the development of domestic power communication network.

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