Distributed transmission technology of node status in distribution network

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Abstract. With the rapid development of distribution network automation and the construction of DC distribution network and AC / DC hybrid distribution network, the network operation mode is more flexible. If the distribution network wants to realize rapid load transfer, such as the connection of power supply, upstream and downstream fault isolation signals and other node states need to be quickly identified. At present, the node status identification of distribution automation is basically completed by the master station. However, the master station has poor real-time transmission of status information, which is generally in seconds or minutes, and can not meet the demand of real-time load transfer. In this paper, a distributed real-time transmission method of AC and DC distribution network node status is constructed for distribution automation system. Based on IEC61850 goose communication protocol, the real-time transmission of node status is realized in distribution automation terminal. In this method, the positive direction of each tie switch is defined, which is independent of power flow direction, and the tie switch is distinguished along the user-defined positive direction. When multiple tie switches have the same upstream node, they are each other’s t nodes. Each tie switch needs to be equipped with a distribution automation terminal with goose communication capability. According to different control strategies, the distribution automation terminal can realize millisecond level node state transmission step by step. Node state can be divided into unconditional transmission state and conditional transmission state. The distributed real-time transmission technology of distribution network node status proposed in this paper has been successfully applied to Tongli integrated energy service. The center and Suzhou medium and low voltage DC project lay the foundation for the realization of loop closing, loop breaking control, fast fault isolation and power transfer control strategies.

1. Introduction

According to the requirements of the notice of the National Energy Administration on printing and distributing the action plan for the construction and transformation of distribution network, to ensure the rapid economic and social development of the region and improve the power supply capacity and reliability, by 2020, the average annual outage time of users will not exceed 10 hours. In order to improve the power supply capacity and reliability of the distribution network, the network topology of the distribution network will change from single source radial network to multi source ring network. Network development. In addition, with the rapid development of distribution network automation and the construction of DC distribution network and AC / DC hybrid distribution network, the network
operation mode is more flexible. If the distribution network wants to realize rapid load transfer, such as the connection of power supply, upstream and downstream fault isolation signals and other node states need to be quickly identified. At present, the node status identification of distribution automation is basically completed by the master station. However, the master station has poor real-time transmission of status information, which is generally in seconds or minutes, and can not meet the demand of real-time load transfer. It is mainly reflected in the following three aspects:

- With the construction of distribution network with distributed generation and multi-source AC and DC distribution network, the system power flow direction is changed from one-way to two-way, which lacks a configuration method of user-defined system power flow direction.
- The topology of the existing distribution network is identified by the master station. When the system structure changes, it is necessary to reconfigure and identify the whole network, and the communication delay of the master station is generally second level, so the real-time performance of network identification or operation of some control strategies is poor.
- The existing distributed transmission method of node state adopts the full-time transmission strategy, which consumes a lot of device resources and makes the cost of distribution automation terminal rise sharply, which does not meet the low-cost requirements of distribution automation equipment.

2. Control method

Typical AC/DC distribution network system architecture is shown in Figure 1. In this paper, a distributed real-time transmission method of node state for AC and DC distribution network is constructed.

2.1. Configuration method

Before node status information transmission, it is necessary to define the positive direction of each tie switch in the system, and confirm the upstream node, upstream node and t node of each tie switch. Configure goose communication parameters and association relationship of distribution automation terminal corresponding to each tie switch: mainly including MAC address, appid, dataset reference, status information association, etc. It distinguishes between unconditional and conditional transitive state information. After the configuration is completed, start the flow of line node status information transmission. The configuration process is shown in Figure 2.
Define the positive direction of the system

Confirm the relationship between upstream node, downstream node and t node

Configure GOOSE communication parameters

Distinguish between combined transfer and unconditional transfer of state information

2.2. Formatting author names
In the process of information transmission, if the transmission signal is unconditional transmission status information, if the transmission status information is conditional transmission status information, the connected power supply number and the fault isolation status of adjacent nodes generally belong to conditional transmission status information, if and only if the open position of the node is closed. Judge whether the transmission status information meets the transmission conditions (if the transmission condition is that the switch position of the node is closed). If the transmission condition is met, the upstream node will transmit the status information to the downstream node; the downstream node will transmit the status information to the upper node and t node until all nodes have completed the step-by-step transmission. If the status information changes, it will be transferred again. The implementation process is shown in Figure 3.
3. Technology application and advantages

The distributed real-time transmission technology of distribution network node status proposed in this paper has been successfully applied to Tongli integrated energy service center and Suzhou medium and low voltage DC project. Tongli integrated energy service center is a new type of regional energy Internet, forming a green and low-carbon Park in Jiangnan Water Town integrating energy production, service, exhibition, R & D and office. Taking the four port microgrid router as the center, the main power supply points are 10kV, ±375v, 380V and ±750V ports; "key technology and application demonstration project of medium and low voltage DC power distribution system" as a national key research and development project, with three voltage levels of DC 10kV, 750V and 375v. After completion, it will become the first DC distribution network with multiple voltage levels in China, which can meet the requirements of high reliable power supply, green energy consumption and DC power supply.

This technology does not depend on the master station, defines the positive direction of the system, and is not affected by the direction of the power flow. It meets the construction requirements of the distribution network with distributed generation, multi-source AC and DC distribution network. With the distributed transmission method, when the topology of distribution network changes, it only needs to reconfigure the terminals that change the location to adapt to the change of network structure, and solve the problem of operation and maintenance caused by the frequent expansion and transformation of distribution network. State information transmission is based on goose communication protocol of IEC61850 standard, which has strong real-time performance and reliability. The delay of state information transmission is less than 1ms, and improves the interoperability and standardization level of distribution terminal, and provides good basic conditions for rapid fault location, isolation and transfer.
4. Conclusion
In this paper, a distributed real-time transmission method of node status in AC and DC distribution network is proposed. Based on the goose communication protocol of IEC61850, the step-by-step transmission of node status in millisecond level is realized in distribution automation terminal according to different control strategies, which lays a foundation for the control strategies of fault closing, loop releasing, fast fault isolation and power transfer. This method has been successfully applied to Tongli integrated energy service center and Suzhou medium and low voltage DC project, which can meet the needs of high reliable power supply, green energy consumption and DC power supply of users.

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