Research on Network Communication and Convergent Gateway in Terminal Communication Access Network

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Abstract. Based on the analysis of smart grid features and business requirements and using the existing research results of heterogeneous networks for reference, this paper designs a heterogeneous network model and functional architecture that adapt to the smart grid environment. Based on this, according to different network resource status, the paper analyzes and compares the network discovery, network selection and connection management mechanism in multi-network environment which includes multi-level, heterogeneous network environment to support the transmission diversity common link layer processing technology; and business multi-network collaborative bearer technology to improve the flexibility of access to a variety of services in power communications.

1 Introduction[1]

The power terminal communication access network is an extension of the power system backbone communication network and is an important part of the power communication network. The power terminal communication access network consists of a series of delivery entities (such as line facilities and transmission facilities) between the service node interface (SNI) and the user network interface (UNI), and it provides the connection between power distribution and electricity service terminals with the power backbone communication network, and realizes the information exchange between terminals and systems equipped with electric service. It has the functions of service bearing and information transmission.

In view of the differences of various wireless / wired access technologies in the power terminal communication access network in aspects of network resources, networking modes and service provisioning, and the demand for constructing a centralized control architecture for multiservice communication networks, this paper researches on the terminal communication access network requirements analysis, network collaboration, integration gateway and other fields[1].

2 Demand Analysis of Synergetic and Converged Terminal Access Network Technology

At present, the access network faces many challenges. First of all, the energy Internet drives the new

business of the access network to flourish. For example, new energy access, electric vehicles, and "cloud migration" require the access network to support new services rapidly, flexibly and efficiently. Second, the access network bearer services directly to power users, with "multi-faceted" features, the network boundary of the power grid business system gradually increases with the expansion of the business, and some terminals are deployed in the street, cell and other places easy to be exposed, which puts forward higher requirements for the information security protection of the access network[2]..

Terminal communication access network construction and operation and maintenance model used is that each business department to build a single network by the business system, the formation of multiple networks, all departments to maintain their own, formed a variety of business, multiple networks, coexistence of a variety of communication methods Network status[3].. Considering the safety and real-time demand of related businesses, the distribution automation sites with control functions, intelligent power cells, charging stations for electric vehicles, marketing outlets, distributed power terminals and so on should mainly adopt optical fiber communication; The non-control function of distribution network automation station and power information collection point can choose optical fiber, carrier wave, 230MHz and public communication network according to the conditions[4].

With the development of smart grid, more and more services are carried on the power communication network, including not only the enterprise and production information business, but also the strict control of real-time and reliability requirements. The shortcomings of the previous power terminal communication access network construction mode are also gradually exposed:

(1) The power terminal communication access network has been constructed separately according to business needs. One service accesses a network and communication resources are seriously wasted.

(2) In case of network failure, traffic burst, etc., it is impossible to achieve coordinated communication and redundant backup between networks, and the network reliability is low;

(3) The access network has a large network, small traffic and is sensitive to costs. Each service has a separate network and is heavily duplicated. The high cost of network construction and operation and maintenance is not conducive to the unified operation and maintenance management of the equipment[5].

Therefore, there is an urgent need to solve the access problem of multiple communication modes of the power service terminal, to study the network coordination and convergence gateway technologies of the terminal communication access network so that the service can intelligently select among multiple communication modes or perform multiple communication modes Collaborative communication, improve network resource utilization efficiency, reduce the cost of network construction[6].

## 3 Power Terminal Access Network Multiple Communication Methods of Fusion Technology Research

3.1 Analysis of fusion scenarios for multiple communication modes in Smart Grid

A variety of heterogeneous network integration is the next generation of wireless communications network development direction, but also the continuous evolution of wireless communications technology, the user's communications services and the growing number of types of market demand and other factors driven by the results of multi-network convergence of communications[7]. The system can take advantage of the performance advantages of different networks to make up for their respective deficiencies.

3.2 Research on hybrid network of Optical Fiber and Wireless communication for Power Broadband Flexible Access

Due to the different network bandwidth requirements of the broadband services accessed by the power terminals in the smart grid and the external services, the bandwidth requirements of the service layer need to be analyzed according to the type of the demand of the distribution network. This paper

analyzed the application of optical fiber and wireless convergence technology in power terminal access network. As shown in Figure 1 is a PON-RoF optical fiber wireless networking approach.
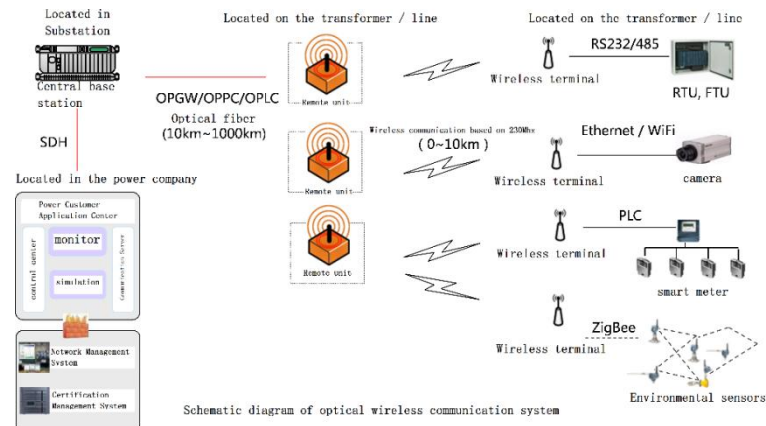

FIGURE1. Hybrid network of PON-RoF fiber and wireless communication

In PON-RoF system, the transmission of radio frequency signal is carried out directly by optical carrier. Information exchange, control and signal regeneration are done at the central station, and the base station just need to achieve the photoelectric conversion, optical amplification and signal transmission, thus complex and expensive equipment will be centralized to the central station, so that multiple remote base stations share these devices, greatly reducing the base station size and power consumption, reducing the base station construction costs and maintenance costs[8]. The radio frequency signal transmitted by the optical fiber increases the transmission bandwidth of the wireless signal.In addition, the use of optical fiber as a transmission link can reduce the loss and prevent electromagnetic interference. Therefore, PON-RoF optical fiber wireless convergence networking can realize large-capacity, low-cost RF signal cable transmission and high-speed ultra-wideband wireless signal access.

3.3 The Architecture Design of Power Line and Wireless Communication Heterogeneous Communication Network

For the smart grid backbone communication network, fiber optic communication is the main means of communication, but for terminal access and some special communication environment, both power line and wireless communication have the advantage of no need to set up a dedicated communication line. However, a single communication mode can not guarantee the reliable transmission of information in the energy Internet. The performance of low-voltage power communication is limited by the power line load, especially the new energy equipment[9]. The performance of wireless communication is affected by topography or obstacles. So power line and wireless combination application can greatly improve the communication performance. Therefore, the fusion of power line and wireless communication can effectively improve the reliability of communication, and can be an effective complement to the high-speed communication technology of optical fiber communication.
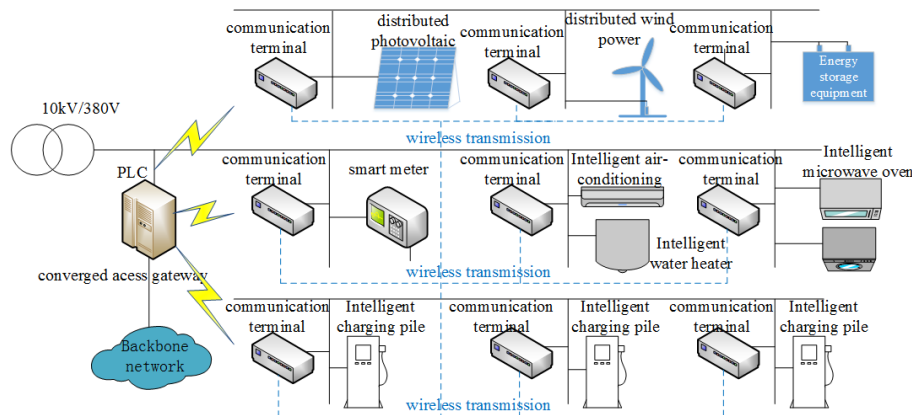
FIGURE 2. Heterogeneous Network Communication Architecture Based on Power Line Carrier and Wireless Communication

As shown in FIG. 2, for the terminal access of the smart grid, the communication architecture combining power line carrier and wireless communication can fully exert their respective advantages and effectively solve the problem of terminal access. In view of the communication demand of the terminal node of the smart grid, the research on heterogeneous fusion technology of power line and wireless communication will effectively promote the development of information communication system[10]. The technologies involved in the integration of power line carrier communication and wireless communication include QoS guarantee mechanism, load balancing, protocol conversion, hybrid path relay, and network switching. Heterogeneous network switching technology of wireless and power line carrier communication relates to how to accomplish the switching of heterogeneous networks efficiently and accurately, which is the key to accomplish the heterogeneous network convergence.

4 Research on link layer processing and network collaborative loading technology in multi level and heterogeneous network environment of smart grid

4.1 Architecture design of intelligent power communication terminal access network based on SDN Technology

This paper designs the communication network system of intelligent power architecture based on SDN technology, the architecture integrates the centralized control of network resources, the flexible configuration of power business virtual network and so on. It provides the basis for the real-time It provides the basis for the real-time bidirectional interaction between the power grid and the user's energy flow, business flow and information flow. The architecture is a power business plane that contains power business data forwarding planes, power SDN control systems and software.

The power data forwarding plane mainly includes 10KV access network such as PON, industrial Ethernet, wireless WLAN, and network equipment related to the backbone network. SDN technology is used to improve the network equipment such as OLT, ONU and switch in each access network so that it supports the unified control protocol of OpenFlow and OF-CONFIG equipment, and moves the complicated functions such as route finding and path calculation of the equipment to the power SDN Control System.

The power SDN control system is the core of the entire intelligent power communication network. It consists of the Flow Visor physical network virtualization platform, multiple access network controllers, and the master total controller. The control system mainly completes the link discovery, topology management (logical topology and physical topology), flow table generation and management, link bandwidth setting, link utilization monitoring, node traffic monitoring, global network resource control and scheduling, virtualization network creation and configuration management functions of the power communication network.

The software-based power service plane is a unified plane based on the physical network and the power SDN control system, which realizes the power communication network function and the power service function through software programming. The plane includes communication network application platform and intelligent power service platform. In the communication network application platform, different power grid operation departments can call the basic network function API of the power control system to develop the characteristic network application according to their own business needs. In the smart power business plane, users can call the network function application interface to develop various types of intelligent electricity business platform.

4.2 The heterogeneous network collaborative bearer solution based on SDN technology
Based on the idea of software-defined network, a gateway-based loosely-coupled mode is adopted without changing the network structure of various terminal access networks. A converged communication scheme based on dual-communication proxy gateway is proposed, which realizes the decoupling of terminal services and communications networks.

Heterogeneous network collaborative load bearing technology and power service visualization: The SDN intelligent power communication network can acquire the whole network resources in real time with the help of the power SDN control system. Based on the real-time status of the whole network and the detailed information of the network link, the visual monitoring of the network and the power distribution service is carried out. The main station network visualization platform can dynamically acquire and refresh the current network resources by dynamically calling the power SDN control system, and realize the network visual monitoring. Network visualization mainly includes topology information, link information and network node information visualization. The visualization of network topology information is to display the global physical topology and virtual logic networking information of power communication network in the main station network visualization platform, so that network managers can grasp the network structure integrally, and accurately determine the location of each node. The network link information visualization is to integrate and process the link resource information obtained by the master controller, and display the network link characteristic information of the link's bandwidth, packet loss rate, utilization rate, delay, connection quality and so on, and real-time feedback the network link quality. Network node information visualization is a detailed display of each node information in the network topology, which can display the details of the working state, MAC address, port situation and real-time traffic curve of the node equipment.

Centralized control of power business based on software programming and unified protocol: The intelligent power device realized by software programming replaces the proprietary power distribution device, flexibly completes the deployment of power distribution service, and unified data transmission and communication protocol for centralized control, which is the key to the intelligent power distribution business. Intelligent power device support OpenFlow unified communication protocol and OF-CNOF device configuration protocol,it can realize the data interaction with the power communication network, the unified configuration of the equipment, and has the standard electrical interface and drive control interface, which can complete the unified access and control of the new power distribution business such as distributed energy and controllable load. The deployment of new business using the software program to complete the new business function model, and then through the main station network resources and business platform to determine the location of the smart appliances of the new business, after that the master controller determines the corresponding domain controller, and the domain controller sends the software function model to the smart power device by the OF-CNOF device configuration protocol to achieve rapid deployment of new services. At the same time, when the power business in a certain area changes, it is only necessary to quickly positioning the exact position of the smart power device on the network resource and business visualization platform of the main station, rewriting the business function model in the power business functional software model development platform and re-issuing the model to overwrite the original strategy.

5 Conclusion

This article mainly studies and analyzes the realization technology of architecture of multi-service bearer access network. Firstly, based on user strategy and operation strategy of different services, combined with different network resource status,this artical analyzes and compares the fusion technologies of EPON, industrial Ethernet, wireless private network and wireless public network;and network discovery technology in dynamic network environment; and network intelligence selection technology. This paper analyzes multi-level and heterogeneous network environment to support the sending of common link layer processing technology to study the business of multi-network collaborative bearer technology to further refine the granularity of network resource allocation and improve business access flexibility.At last, the article also discusses the design of heterogeneous network collaborative bearer scheme based on SDN technology to support multi-service integrated access, and realizes the decoupling between the terminal service and communication network. Through the design of control strategy, virtualization strategy and programmable strategy, Multi-level, heterogeneous network environment, multi-network collaborative bearer.

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