IOP Conf. Series: Materials Science and Engineering **242** (2017) 012091 doi:10.1088/1757-899X/242/1/012091

On Study of Construction of New Generation Intelligent Communication Network for Distribution System

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Abstract: many new technological means are integrated in the new network of smart electricity distribution including electric power technology, control technology and information technology, and in this area, people carry out profound research to the construction of communication network and power distribution network. This paper analyzes specific structures of the communication network for distribution system, discusses the development trend of it, explores its technical system in depth, and finally proposes some concrete constructive strategies, hoping to be a valuable reference for related research persons.

1. Introduction

The smart power grid integrates various technological means including information technology, power technology and automation technology, and especially the communication network for intelligent distribution system is a core in this project, besides, the contradiction problem between technical needs and costs must be handled properly in the construction of a new generation intelligent communication network for distribution system. In order to solve such problem properly, we need to carry out a profound research in industrial demands and development trend of the intelligent communication network for distribution system, and carefully analyze strategies of constructing intelligent communication network for distribution system so as to assist the construction of new intelligent communication network for distribution system.

2. Analysis of Network Structures

The structures of communication network for distribution system and grid topology are roughly same as shown in Figure 1 below. They mainly construct a tree or ring network structure through low-voltage communication network and medium voltage communication network, and view many remote terminals like distribution automation and electricity information collection a downlink terminal points or view backbone communication network node of 35kV or 110kV transformer substation as uplink terminal points in order to offer access channel to information system[1]. There are still severe challenges in constructing communication network for distribution system in 10kV section in this regard, therefore this paper emphasizes on analyzing problems in this network segment.

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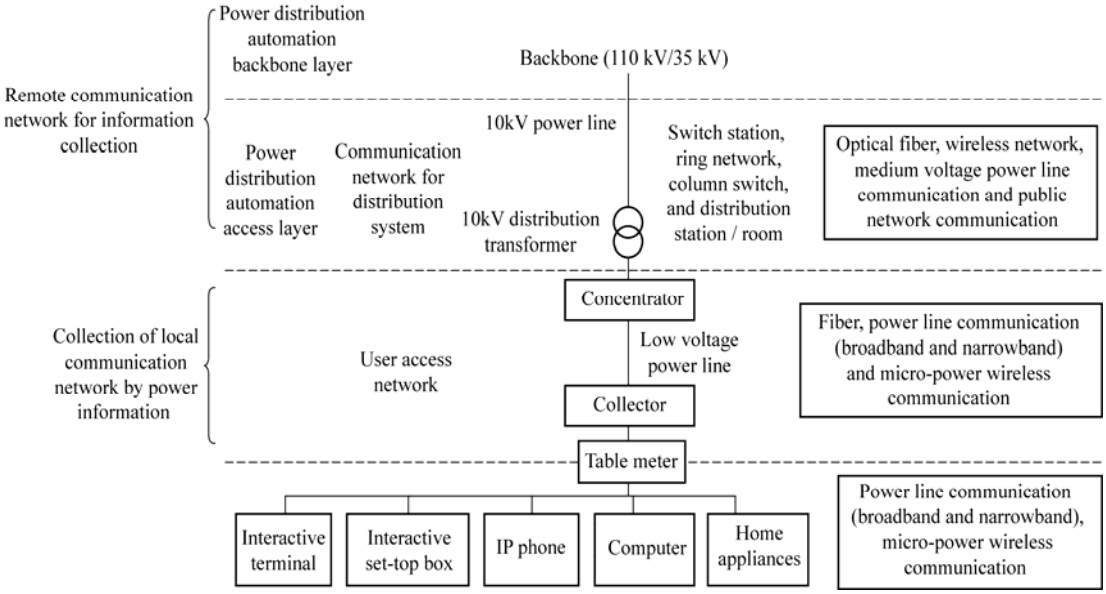

Figure 1: Structures of Communication Network for Distribution System

3. Development Trend of Communication Network for Distribution System

3.1 Business Orientation

The business of smart electricity distribution can be divided into three types according to the level of information application: (1) spot voice, video, data and other ancillary business of communication network for distribution system; (2) remote monitoring and control to distribution network and equipment including distribution transformer control and distribution automation; (3) the interactive operation between electric power enterprise and end users including electricity information collection and expense control, the electric power load supervisory control and power supply access control.

3.2 Communication Network Platform

After realizing platform, the communication network is capable of providing bearer services with high efficiency for integrated business and of improving the overall application rate of network comprehensively. Communication and information platform can be divided into three major levels, namely: (1) application layer, including I, II and III master station systems; (2) platform information layer. It is in the internal partition for centralizing storage; (3) platform communication layer. It is also in the internal partition and responsible for centralized transmission. In terms of specific application, it is mainly responsible for handling information through facing the application layer in business departments directly, which requires that the communication network for distribution system should not only consider the overall carrying capacity of information to distribution business but also realize a unified access, management, backup and expansion in terms of each device interface in the communication layer.

3.3 High Precision Transmission Requirement

The current distribution business is still in the process of integration stage, and communication information in 10kV section also involves in power distribution automation and marketing business processes. The amount of single-point data in monitoring terminal, feeder terminal units, concentrators, collectors and other intelligent terminal systems in distribution transformer is larger than that in 10Mbit/s, and data information collected by transformer substation in sub-granular zone is basically 10Mbit/s, therefore, compared with the public network media data volume, the industrial control information is relatively small in amount which focuses more on real-time and stability requirements. In

the whole business process, the communication part in rigid indicator can be selected according to a higher order of magnitude, which means that communication delay should be less than 100ms and the accuracy rate must be over 99.999%.

3.4 High Security Requirement

Currently, in the whole distribution network system, the distribution business is still in the edge position, and we have to conduct encryption processing to business content involved and user identity information. Besides, we have to ensure the safety of transmission approaches and remote device of communication network, which means that we need to guarantee integrity, availability and confidentiality of data packet and the device itself [2]. Specific measures below can be taken to strengthen the security of communication network for distribution system: (1) encryption processing algorithm can be adopted like Ipsec, WPA, SSL and other transmission pates to avoid the disclosure of communication packets; (2) measures including security authentication, user authentication, packet filtering and others should be taken to avoid illegal communication equipment and data packets to enter into the network environment when the required remote device must be accessed; (3) the exclusive transmission media or logical physical channel can be adopted to effective avoid physical isolation effect in case of encrypted information leak in physical media; (4) measures like network address translation technology and isolation areas as well as others should be taken to hide locations of important information equipments, greatly reducing the chance of direct attacks.

4. Study on Technical System

4.1 Standards of Intelligent Communication Network for Distribution System

When constructing intelligent communication network for distribution system, we must learn to apply many mixed communication technologies and adopt standard system specifications of network control which can be applied in a wider range. The local area networks with relatively small size are mostly from the IEEE802 protocol cluster which is relatively more convenient compared with smaller local area network implementation, but its size and distance will be greatly limited. We have to realize the adoption of telecommunications standards including 3GPP, ITU in order to carry out a relatively large scale network construction with the purpose of properly solving bandwidth loss, network management and business control issues in large-scale terminal equipments and a variety of access network technologies. In terms of Ethernet, the adoption of external passive optical network, global microwave interconnection and multi-carrier wireless information local loop and other information and communication technologies is mainly applied in construction of some relatively small scale networks by virtue of improvement of packet wireless services and network information transmission speed, and this type of carrier-class standard is a main reference basis of large-scale networking technology during the long process of development and evolution. [3]. Figure 2 below refers technology application routes of communication network for distribution system in the wide area of industrial control communications network. Meanwhile, considering the amount of capital investment, operation and maintenance scale and industrial chain development of network access, we think that relatively reasonable technical routes should be based on the current telecommunications wide area network technology system, and industrial customization can be carried out through the real-time characteristic of industrial control communication technology.

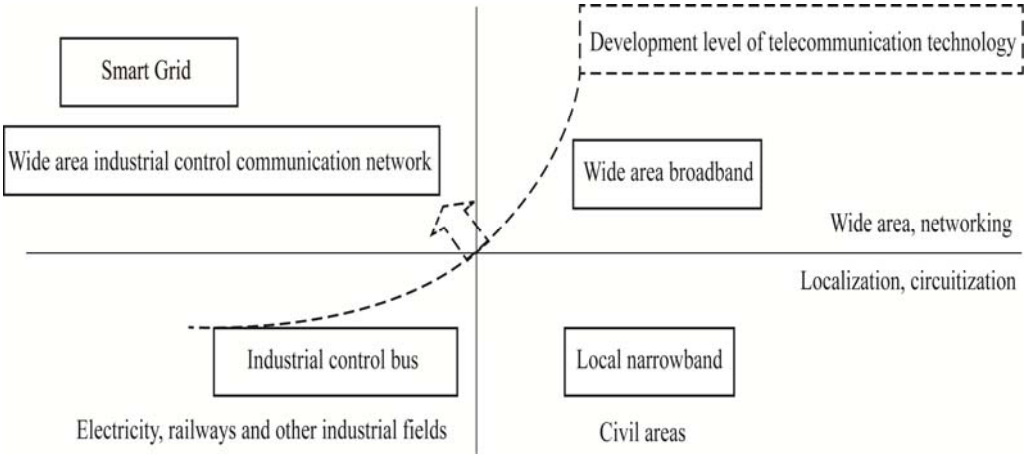

Figure 2: Wide Area Industrial Control Communication Network Technical Route

4.2 Design of Information Transmission Channel

When designing information transmission channels, we have to take bandwidth efficiency, stability, isolation performance and other aspects into consideration and principles of information transmission channel design are summarized as the following:

(1) As for conventional TCP / IP protocol, it can be established on the basic level of statistical multiplexing; as for the transmission of control information, the highly efficient communication resource management technology can be selected to establish a safe and stable circuit channel.

(2) As for various security levels in electricity business, the communication network platform should be adopted to effectively improve practical application of network guided by a design principle that horizontal isolation and longitudinal control. [4].

(3) The distribution electricity network information boasts of a large amount and a single node data volume is relatively small, therefore we had better to avoid over-encapsulation to data packet so as to prevent the communication bandwidth from reducing efficiency.

4.3 Operational Control of Communication Network

The communication network itself is characterized by a certain hierarchy and regionalization and requirements in operation must be taken into consideration by communication network for distribution system.

(1) The scale of network itself also determines that the actual communication network will be divided into multiple levels and a number of logical sub-network systems. When the networks are divided, various problems will occur about stability, application, security and network' bandwidth, therefore, the network division must be implemented according to the actual situations of the entire information in electricity business information.

(2) The communication network for distribution system must take business network address into consideration when passing through the communication network. Address itself can be divided into physical and logical addresses, and IP and MAC may be other network physical addresses.

(3) In order to ensure a safe operation of distribution network, we have to strengthen control to network equipment and business, and prepare network testing, authorization and data statistics servers [5].

5. Constructive Strategies

In the system of communication network for distribution system exists a high integration of technologies and asset attributes, and we should comprehensively consider network structures and industrial control details features when carrying out engineering projects; the following constructive strategies and methods are proposed in terms of construction of a new generation intelligent

communication network for distribution system:

5.1 Mixed Public and Private Network

Viewing of the investment scale and industry division existed naturally, the smart electricity distribution network is bound to adopting mixing application of leased telecommunications public network and self-built dedicated network. While the latter is mainly responsible for production control and other major core businesses, and as for some ancillary businesses, the leased public network can be adopted to make compensation so as to achieve excellent cost performance. When carrying out self-construction of special network, we must meet the practical application of objectives and requirements, and ensure the safety to compliance with the standard specifications. Meanwhile, we have to realize that there is still unreliability for self-built special network in technical maturity, scalability, adaptability, operation and maintenance supports and other aspects, and the technical risks and costs of equipment itself are relatively high, therefore we are able to meet the actual development demands in power industry by virtue of public network communications industry customization with relatively mature technologies. Demands about division of labor and cost will occur when the power industry rents public network, but the management is still weak in this field. Therefore, it requires telecommunications enterprises to fully take communications services demanded by industrial environment development into consideration and turn the target of "private network operators" into one which provides industrial control style industry customized services for many industrial sectors including power sector.

5.2 Separation and Coupling of Communication Network Functions

The continuously development and evolution process of intelligent communication for distribution system should realize the modularity of function itself at the same time so as to avoid serious impact on systems due to improvement of the single functions. For instance the new generation network is divided into network management control layer, information application layer, core transport layer and access layer, and the definition is re-defined to information service interfaces and communication access network interfaces [6].

The telecom network has a large scale and carries out a fixed network individual construction and mobile network construction, effective reducing difficulty in operation and maintenance. However, this also leads to multiple access and acquisition of communication access network management resources, control and management equipments. In terms of power communication network with a relatively small scale, it is capable of avoiding equipment and line resource consumption in the construction process by virtue of coupling of equipment itself on the basis of effectively ensuring that the functions can be separated. For instance, the application of wired or wireless network coupling can improve the overall stability of communication network, greatly reduce cost investment of the entire project or coordinate and apply stability of cable channel and the flexibility of wireless channel, allowing them to display functions respectively.

5.3 Evolution Strategies of Communication Network Engineering of Distribution System

One evolution strategy for intelligent communication network for distribution system refers gradual evolution which highly utilizes the existing network infrastructure in order to fully protect existing assets, to comprehensively upgrade network and to expand capacity. The intelligent communication network for distribution system is characterized by a significant "industrial control" and "wide area broadband"[7], and particularly, a core principle should be fully implemented in the construction process is "private network technology and public network management network. The guarantee layer, a core business in electricity distribution grid should take it into consideration and determine principles with application of private network as the main body and that of the public network as the assistance; consideration should be given to equipment technologies and supplement means include fiber technology and wireless technology. However, you still can select a route transition mode with private network covering and public network compensating covering, and other regions should choose starting and ending points suitable for construction according to actual conditions.

6. Conclusions

In a word, with the rapid development of current information technology, the power grid system develops toward automation and intelligent orientation, and in order to promote the construction of intelligent power grid, we must build a new generation of intelligent communication network for distribution system, which is also an essential way tackling with flaws in construction of traditional intelligent communication network for distribution system. The construction of intelligent communication network for distribution system can not only effectively satisfy control requirements of industrial communication network in wider regions, but also indicate directions and propose goals for the development in power and communication industries.

Reference

[1] Wang Qiang, Zhu Yanzhang and Ge Guangsheng. Application Discussion of Packet Transfer Technology for Smart Power Distribution and Utilization Networks[J]. Power System Protection and Control, 2014, (9).
[2] Zhen Chong, Huang Hui And Zheng Bao. Study on Intelligent Communication Network[J]. Electrical Measurement & Instrumentation, 2017, 54 (4).
[3] Tao Yongjian. Prediction Analysis of Power Communication Network in Distribution Network Construction[J]. Commodities and Quality, 2016, (30).
[4] Hu Cheng and Shen Hanyang. Discussion on Channel Coding Technology in Intelligent Power Distribution Communication Network[J]. Information & Communications, 2015, (5).
[5] He Shisi. Research on Communication Network Construction in Intelligent Distribution Network[J]. China New Telecommunications, 2015, (5).
[6] Dai Yuping. Discussion on Key Problems of Distribution Communication Network in Smart Grid[J]. Architectural Engineering Technology and Design, 2016, (17).
[7] Zhang Yu, Gang Jianxun and Du Qian. On Study of Measures for Constructing a New Generation Intelligent Communication Network for Distribution System[J]. Digital Communication World, 2015, (6).