Smart Gird Distribution and Consumption Communication Network Architecture

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Abstract—Smart grid distribution and consumption communication network is one important part of smart gird communication network and the crucial technology field of smart grid. Smart grid distribution and consumption communication network due to its existing features such as large coverage, enormous number and irregular distribution of the network nodes and difficulty of network construction, has been lack of suitable communication technology and network construction mode, and become the negative factors of the development of smart gird communication network and the constraints of the application and development of smart grid distribution and consumption business. This paper makes great efforts on the research about lots of power communication technologies and the existing scheme of power communication network construction, considers the characteristics of business needs, technical prospects and economic cost, and then proposes a widely applicable smart gird distribution and consumption communication network architecture, including smart grid distribution and consumption communication network model, layered network structure, and a series of applicable networking programs.

Index Terms—smart gird, smart grid distribution and consumption communication network, communication technology, network architecture, networking program.

I. Introduction

Smart grid is the direction of development of the existing utility power system in the modern times. It includes six important parts: generation, transmission, transformation, distribution, consumption and dispatching system in China and all of the six parts effectively work together to make sure energy can be intelligently used and information can be efficiently exchanged by using the new technologies of control, information and management. Smart grid communication and information system, an important technical means and a public information platform which supports smart gird construction and operation and exists in all of the six parts, are the key technology field of construction and development of smart grid [1].

Smart grid communication and information system needs to realize the comprehensive collection, smooth transmission and efficient processing of system information to promote the ability to automation of equipment operation and business processing. It includes all the business information and resource information to enhance the modernization management level of business, optimize the allocation configuration of the whole power grid resources and get full control of the risk [2]. It is a powerful business collaboration and interoperability platform which makes information share more transparent and the collection process more standardized to enhance the level of interaction between users and application systems, the grid operators and various stakeholders, among six smart grid parts and various business [3]. We can take full advantage of the potential value of the multi-meta and massive smart grid data to enhance the ability to intelligent analysis and scientific decision-making. We can also connect enormous smart grid supply, consumption and energy equipments as the communication carrier to support IoT (Internet of things), expand the application of IoT and develop the Future Internet [4]. So we should build a powerful smart grid communication network. It must have strong network structure and carrying capacity in the core layer, and have flexible and broad edge access in the access layer [5].

With the increasing development of smart grid technology, smart grid business application systems are gradually developed. The existing power grid communication network meets some new challenges on network structure, coverage, transmission bandwidth, security, reliability, operation and management, especially in the relatively weak power distribution and consumption communication network [2],[6]. The existing power distribution and consumption network is a kind of peripheral network which has the smallest coverage but largest number in the power grid system. And it is a complex network structure of multi-node, multi-branch, multi-crossover and irregular distribution of network nodes. Such a complex network structure characteristics makes the existing power distribution and consumption communication networks be built without an unified network planning by each government department in different areas, and the technical demands and building standards are different in different areas, so the communication infrastructures can not be effectively and efficiently utilized in the whole country. A larger number of business have to rely on the public communication network and be constrained by the technical standards,

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channel security and the operation nature of chasing profits of the public communication network. This results in the low technical standards of the relevant business applications, high risk of information security, and serious constraint of the development of smart grid distribution and consumption business. Therefore, a widely applicable smart gird distribution and consumption communication network architecture is needed.

The rest of this paper is organized as follows. In Section II, a large number of smart grid distribution and consumption communication technologies are analyzed, including wired communications technologies and wireless communication technologies. In Section III a widely applicable smart gird distribution and consumption network architecture including the smart power communication network model, layered network structure, and a series of applicable networking program is proposed. Section IV draws the conclusion.

II. Smart Grid Distribution And Consumption Communicatino Technology Analysis

According to the existing smart grid distribution and consumption communication network construction situation and the trend of the development of smart grid, lots of the existing power communication technologies can be used to build smart grid distribution and consumption communication network. Each of them has its own technical characteristics, we analyze them one by one, study their advantages and disadvantages to finally get the method of how to use them.

A. EPON/GPON

EPON (Ethernet Passive Optical Network) is a broadband access technology which offers a variety of integrated services. The point-to-multipoint network structure enables multiple users to share the bandwidth by TDM (time division multiplexing) technology, i.e., each ONU (optical network unit) may provide maximum 1.25Gbps bandwidth. Only one trunk fiber and OLT (optical line terminal), transmission distance can be up to 20km. The trunk and branch protection mechanism can effectively improve the total reliability of communication [7]. Due to the economic and efficiently high-speed Ethernet platform, EPON becomes one of the most effective communication method of connecting the access equipment and end-user. The emergence of 10Gbps Ethernet backbone will also make EPON become one of the best last-mile solution in the future all-optical-network. The existing power distribution communication network of EPON is shown in Fig. 1.

However, in the upstream of EPON all ONUs belong to the same collision domain, packets from different ONUs which transmit at the same time still may conflict. EPON mainly utilities priority queue combination of the DBA algorithms to guarantee the bandwidth and latency requirements, but both of the bandwidth and latency exist limitation. Only in the light load of network or a small number of ONUs can EPON basically meet the QOS requirements of different business, otherwise it is difficult to ensure the results of optical signal transmission [8].

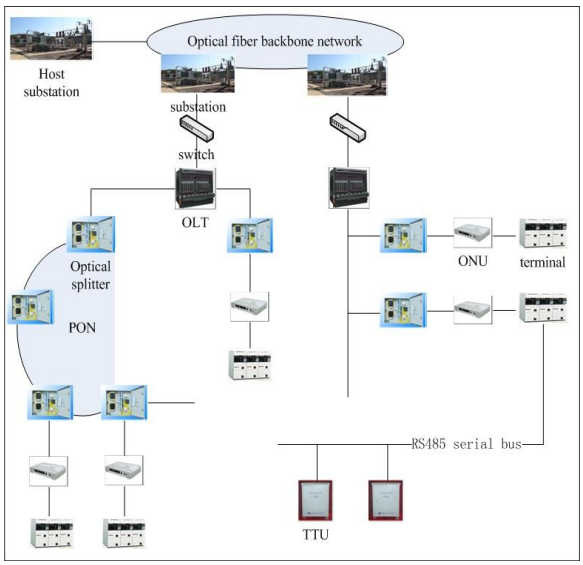

Figure 1. Power distribution communication network of EPON.

GPON (gigabit-capable passive optical network) is the latest generation of broadband passive optical access technology which has more advantages in terms of bandwidth, flexibility, transmission distance and split ratio. GPON provides unprecedented high bandwidth. The downlink bandwidth is up to 2.5Gbps, and its asymmetric characteristics of uplink and downlink bandwidth can meet the demand of broadband data services market more flexibly. Transmission distance is 20km at least and the split ratio is up to 1:64 and even 1:128. GPON also provides the protection mechanism and full business protection of QOS. GPON can precisely adjust the pointer and length of the time slot of each business stream, and adjust the authorized bandwidth and period of ONUs to guarantee the bandwidth and latency requirements of the business [9]. GPON supports full service access and provides good service-level agreement [10]. With a new generic frame procedure GFP based on SDH standards, GPON can transparently and efficiently package various data signal into the existing SDH network, and adapt to any user's signal format and any transmission network standard. These make GPON high efficient, flexible and comprehensive to meet the various requirements of full-service business. Most operators consider that GPON is the ideal technology of achieving broadband access and integrated transmission of network business.

However, PON technologies use broadcast technology in the downstream, so there is a safety hazard. There is not standard about security in EPON series standards. Although GPON uses the advanced encryption standard (AES), the security is still flawed. Therefore, most of the equipment manufacturers adopt their own programs of security. These make the entire safety performance not

very strong, and lead hard to implement device interoperability between different brands. Besides, EPON/GPON will bring high network and equipment costs. But we believe that EPON/GPON will be necessarily the best choice of smart grid for the communication requirements of high flexibility, reliability and transmission bandwidth.

B. PLC

PLC (power line communication) is a communication method which transmits the data signals using the power line. PLC is economic and reliable because we don't afford additional wiring infrastructure investments and daily maintenance costs and the power line is strong and reliable for its physical features. PLC is "plug in and play" and the power line is here and there, so the coverage of PLC communication network is the most extensive [11]. Advanced digital signal processing technology used in new full-digital PLC makes capacity and quality acquire great improvement. People can make call, receive TV signals, access the internet, automatically read the meters, and intelligently manage the home network with PLC in the future [12]. PLC could be one choice for last-mile.

However, the electric characteristic of power line leads to noise interference, impedance changes and attenuation of the signal quality. Moreover, the power line channel is time-varying frequency and selective fading channel, transmission distance and quality of signal have great constraint [13]. Besides, PLC is easily affected by the power equipments it connected. Although we can reduce the harm of these constraints, we can not completely avoid. So, the application prospect of PLC in the future smart grid distribution and consumption communication network is not exciting.

C. Industrial Ethernet

Industrial Ethernet is a strong regional and unit network. It achieves technical compatibility with Ethernet, which improves network speed and reduces Ethernet load by using switch Ethernet, full-duplex communication, flow control and virtual local area network technologies to improve the real-time response speed of the network, at the same time especially considers the usability, real-time interaction and interoperability, reliability, noise immunity and safety in terms of product design and selection of materials to meet the demands of the industrial control field. Industrial Ethernet adopts the high-speed redundant safety network mechanism, very short maximum network reconfiguration time and continuous monitor of network components with simple and efficient signaling devices to guarantee the reliability of network [14]. Besides, it has simple cabinet installation and easily forms a star, linear and ring network topology.

In the field of industrial control real-time performance often refers to the safety of people and equipments. Industrial Ethernet switches improve real-time performance by fast packet forwarding, but this leads the security of data hard to be guaranteed [15]. Moreover, the remote monitoring, control, debug and diagnosis greatly enhance the flexibility of the distributed control, but these applications must ensure the authorized legitimate and bring great cost. Nowadays as is shown in Fig. 2, the optical fiber Industrial Ethernet is used in the access layer of the power distribution and consumption communication network with multiple ring networks constitute double polycyclic structures to guarantee the distribution automation business.

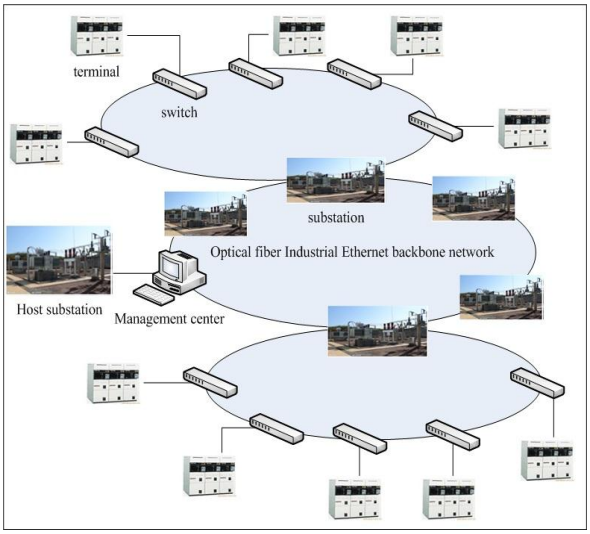

Figure. 2. Power distribution communication network of industrial ethernet.

D. TD-LTE 230M Power Wireless Broadband

TD-LTE 230M (Time Division Long Term Evolution) Power wireless broadband oriented smart grid communication and 230MHz dedicated power frequency band is a new power wireless broadband communication technology in China which integrates advantages of TD-LTE and power communication, greatly improves the peak data rate, spectrum efficiency and network coverage, and reduces the operational and construction costs. It can also adjust the technical parameters according to the characteristics of power communication services to get better performance, such as increase the ratio of uplink and downlink time slot, reduce the control and user plane latency.

TD-LTE 230M power wireless broadband makes use of carrier aggregation technology to improve the utilization of the discrete spectrum resources by integrating the discrete 230MHz band to form a continuous spectrum resources. Besides it makes use of spectrum sensing technology to improve the utilization of the idle spectrum resources by finding idle spectrum and rapidly scheduling the terminal equipment to the available idle spectrum with the rapid dynamic scheduling technology. Thus it can provide high peak transmission rate, frequency choice, multi-service queue joint schedule, conflict avoidance and the aggregation of

different number of adaptive sub-carriers to meet the different business demands and improve the robustness of the system. Moreover, it makes use of interference coordination technology to avoid throughput decrease and co-channel interference on the edge of the cell caused by the same frequency technology and improve the transmission efficiency of the system [16].

TD-LTE 230M power wireless broadband system in China has the following characteristics: the peak rate of single sector reaches 1.76Mbps/0.711Mbps (uplink/ downlink) on the condition that the ratio of uplink and downlink time slot is 3:1; spectrum efficiency is greater than 2.5bps/Hz; the free relay coverage reaches 3km in urban areas and 30km in suburb areas; single base station covers 6000 online terminals. It also supports multimedia transmission for existing narrowband services and meets the demands of real-time scheduling. So, TD-LTE 230M wireless broadband will be a promising solution of smart grid communication.

E. WiMAX

WiMAX technology takes full advantage of the core network of the existing wireless network and the interconnection of the existing wireless network to reduce the WiMAX system core network investment and achieve seamless handover between networks. At the same time, WiMAX system can fully access the users' information of the existing networks and take advantage of the billing, authentication and encryption mechanisms of the exinsting networks. Moreover, it can fully rely on the existing network and business platform to meet the demands of high-speed data transmission and new business services [17]. WiMAX technology enables users to be able to access wireless Internet in the high-speed moving process, and to ensure that the data transmission process is not interrupted, while supporting most of the next-generation network services, such as large-scale point-to-point video communication, large-scale video meeting, high-definition TV, remote control information transmission, the true distance education [18]. WiMAX provides wireless broadband access services for home and business in areas not yet laying optical fiber cable. For smart grid distribution and consumption communication, WiMAX can be used as an adjunct to high-speed data transmission [18], [19].

F. GPRS /3G

The existing GPRS/3G networks have good voice quality, high spectrum efficiency, fast data rates, strong resistance to fading, better resistance to multipath and other technical characteristics. These can ensure the less interference, high efficiency and quality in the data transmission process, the load balance, QoS, no loss of information, and no interrupted communication. GPRS/3G can also take full advantage of the spatial frequency spectrum resources, and simplify the hardware device, reduce costs, and very reasonable in the area without laying optical fiber cable. The advantage of GPRS/3G about communication network construction is very obvious, the communication technology maturity is very high and the commercial mode of operation is also very mature. They have a very full and complete industrial business chain and network construction programs. These make building a wireless communication network very convenient and without pay extra attention on budget, simulation, equipment, and business support. However, for smart grid communication the cost of leasing network bandwidth brings high operation cost, and the performance of security, reliability and real-time can not meet the demand of the control service.

G. ZigBee

TABLE I: SMART GRID DISTRIBUTION AND CONSUMPTION COMMUNICATION TECHNOLOGIES

Technology	Bandwidth	Coverage range	Reliability	Security	Construction cost	Maintenance cost	Limitations
EPON/GPON	1.25/2.5Gbps	20km	high	high	high	low	High cost
Industrial Ethernet	10/100Mbps/1Gbps	Range of switch	high	medium	medium	high	Network structure
PLC	4.5~45Mbps	1~3km	low	medium	low	low	Load and structure of the power grid, harsh, noisy channel environment
TD-LTE 230M Power wireless broadband	Up to 1.76Mbps/0.711Mbps (uplink/downlink)	Up to 3km /30km(urban /suburb)	high	high	low	low	Climate, terrain
WiMAX	Up to 75Mbps	10~50km(LOS),1 ~5km(NLOS)	medium	medium	medium	low	Climate, terrain,not widespread
GPRS/3G	Up to 170Kbps/2.8Mbps (GPRS/ 3G)	1~10km	low	low	very low	high	Costly spectrum fees
ZigBee	20~250Kbps	10~75m,up to 100m	high	medium	low	low	Low data rate, short range

ZigBee mainly used in wireless sensor network and secondary instrument duplex access network is a short-range, low-complexity, low-power, low-data-rate, low-cost, and low-latency, reliable and secure wireless communication technology. It can meet the demands of data output and information and control commands input

of a variety of sensors and play an increasingly important role in the field of industrial control, security, monitoring and home area network [20]. The power consumption of ZigBee system is very low because the signal transceiver time of ZigBee node is very short in work mode, and the ZigBee node becomes sleep mode when it doesn't need to work or wake up periodically [21]. The communication latency and activation latency from a sleep state are very short just about 15ms. The effective coverage and networking program can be flexibly determined according to the actual transmit power and different applications. ZigBee takes advantage of fully acknowledged data transmission collision avoidance mechanism to improve the reliability. ZigBee can effectively protect network security by providing device authentication and data integrity check and flexible determination of its security properties [20]. ZigBee protocol stack is concise; therefore its R&D and production costs are relatively low. However, ZigBee has some constraints such as small memory size, small delay requirements, low processing capability and easy interference with other appliances.

To conclude, wired technologies especially optical fiber such as EPON/GPON and industrial Ethernet are costly for wide area deployments but increase the communications capacity, reliability and security. On the other hand, wireless technologies reduce the installation costs, but bring constraint of bandwidth and security options. Specific technical parameters for smart grid distribution and consumption communication technologies are described in Table I.

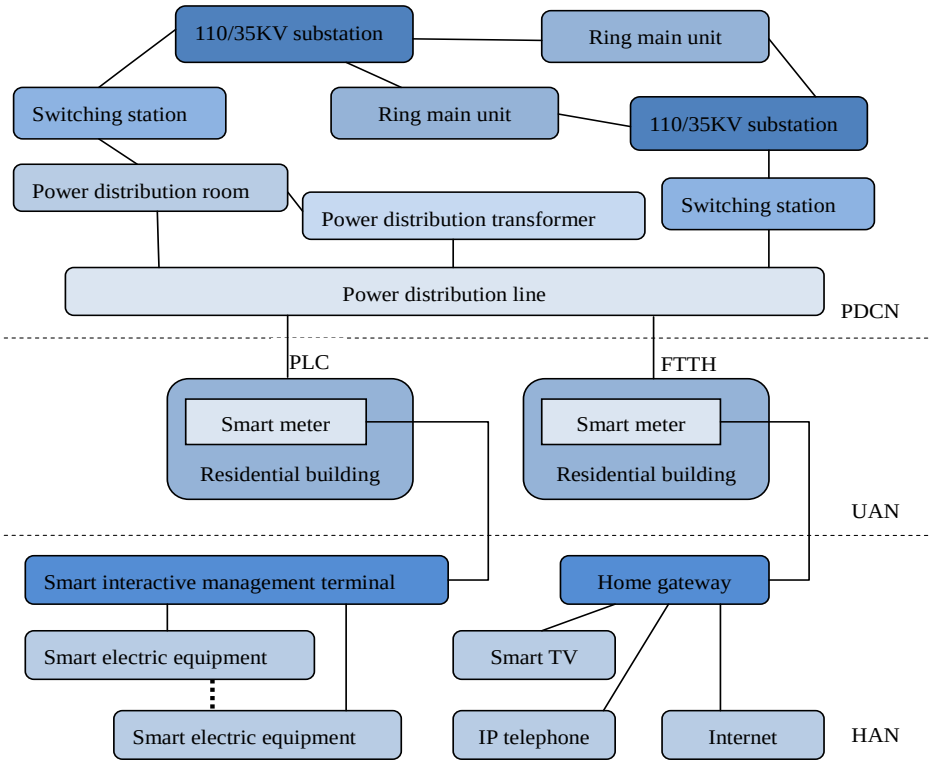

Figure 3. Network model of smart grid distribution and consumption communication network.

III. Smart Grid Distribution and Consumption Communication Network Architecture

Based on the study of the power communication technologies mentioned above, we consider their own technical factors, characteristics of business needs and economic cost, analyze their applicable prospect at the same time, then propose a widely applicable smart gird distribution and consumption network architecture including smart grid distribution and consumption communication network model, layered network structure, and a series of applicable networking program.

A. Network model

Smart grid distribution and consumption communication network connects all of distribution and consumption communication infrastructures and power equipments. We use the end boundary of the distribution network and smart meter as the dividing points, divide smart grid distribution and consumption communication network into three layers, power distribution communication network (PDCN), user access network (UAN) and home area network (HAN). PDCN is the communication network connecting the switching stations, power distribution rooms, ring main units, power distribution transformers, power distribution lines, distributed energy resources (DERs) and so on. UAN is the communication network connecting smart meters, electric vehicle charging stations, data collectors and concentrators and so on. HAN is the home communication network connecting various smart interactive terminals. The network model is shown in Fig. 3.

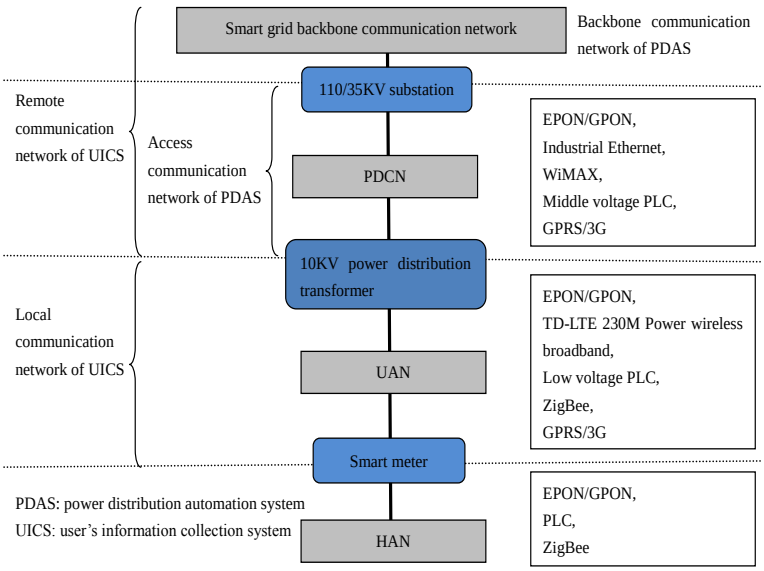

Figure. 4. Network structure of smart grid distribution and consumption communication network.

B. Network Structure

Smart grid distribution and consumption communication network mainly carries distribution automation business, user's information collection business, smart power business, also carries Intelligent Residential District business and Smart Home business to realize data, voice, video integrated service access. From the perspective of business service, the distribution automation system communication network is divided into the backbone communication network and the access communication network which realizes communication between the distribution sub-stations and terminals. The user's information collection system communication network is divided into the remote communication network which realizes communication between host station and concentrators, and the local communication network which realizes communication between concentrators and collectors. HAN realizes communication between smart meters and each smart interactive terminal to achieve smart power business, Intelligent Residential District business and Smart Home business. The network structure is shown in Fig. 4. Meanwhile, we also marked the various communication technologies in Fig. 4. In the next sub-section, the application of these technologies is described in detail.

Some smart grid distribution and consumption applications need continuous availability of communications. However, the public network are shared by customer and market and this may result in network congestion and performance decrease in emergency situations. Thus smart grid distribution and consumption communication needs to build private communication network. EPON/GPON as the networking solution of the power optical fiber private communication network is suitable for almost communication business of smart grid distribution and consumption network. It can support most future smart grid communication business and has the obvious performance advantages compared to other communication technologies. Optical fiber industrial Ethernet is widely used now, but there is security risk. When one industrial Ethernet switch power off, it may lead the optical fiber loop communication to be interrupted, while happen in EPON/GPON, one communication unit can just lead its own communication to be interrupted, not affect the entire optical fiber loop communication. Although lots of the inherent constraints exist, PLC still can not be easily replaced in smart grid communication due to its low cost, simple construction way and private communication characteristic. The communication quality of TD-LTE 230M power wireless broadband/WiMAX is easily influenced by the special terrain and climate, and the constraint of the allocation of spectrum resources also exists, these show that we still have a lot of work to do, but for smart grid distribution and consumption network building power wireless private network should be the best choice. Based on the consideration of private communication network, GPRS/3G just should be used as a supplement.

a) PDCN

The business services of PDCN are mainly include the distribution automation business, the remote communication business of user's information collection system, video communication business and bidirectional interactive marketing business. Thus we should pay more attentions on the control of switching equipments, the operation and monitoring of each distribution network node, the requirements of video and voice monitoring business of each key node. And we also should pay attention on the access requirement of the DERs. PDCN must have high reliability and security, high redundant capacity, fast enough response speed, and high transmission bandwidth. Therefore, EPON/GPON should be adopted as the main networking solution of PDCN, optical fiber industrial Ethernet, power wireless private

network, PLC as the supplement. In some special areas, GPRS/3G may be adopted as a supplement, but should only in the terminal communication which do not need remote control function. Especially, for distribution automation systems, EPON/GPON should be the first choice of information communication access method of distribution automation stations.

b) UAN

The main business services of UAN are user's information collection business, bidirectional interactive marketing business, value-added services, Intelligent Residential District business and Smart Home business. These business services cover a large area, have a large amount of data, and require real-time performance, accuracy and high reliability. The centralized collection of power consumption information of the network nodes happens at a fixed time point of one data collection cycle, and because of the numerous nodes and variety of business, the amount of data is very large, and the data characteristics and communication requirements are different. Image monitoring and video surveillance of some key network node can be effective in preventing and tracing malicious behavior such as stealing and destruction, and rapid tracing and handling communication fault. Therefore, monitoring and management information should be immediately initiative uploaded. The real-time performance is absolutely high required. The power billing data and remote control command information have certain degree randomness need real-time performance, security and high reliability. Interactive power consumption business services such as real-time power price and ladder power price have higher requirements of real-time performance, data accuracy and bidirectional communication. The value-added services for voice, data and video communication require higher bandwidth. Moreover, the customer information and power consumption information are the core data of the power industry, so the collection, transmission, storage and handing of these information should have a high degree of confidentiality, the network information security must be paid on more attentions.

Base on above analysis, we should build a real-time, reliable and effective UAN to establish accurate, flexible, unified and interactive connection between users and smart grid. We should adopt EPON/GPON with the way of FTTH or power wireless private network to people who need to achieve bidirectional interactive marketing business and value-added services, and PLC or ZigBee to people who only need to achieve power consumption collection business. FTTH is shown in Fig. 5. Especially, for the DERs, micro-grid, electric vehicle charging station and energy storage sites which access the middle voltage distribution network, we should adopt EPON/GPON, power wireless private network or PLC according to the choice of PDCN, and for those which access the low voltage consumption network, we should adopt EPON/GPON, PLC or ZigBee according to the choice of UAN.

c) HAN

HAN offers a real-time connection between users and smart electric equipments (smart air conditioners, smart washing machines, smart water heaters, etc.) and form an interactive communication network to achieve interactive power consumption business, intelligent energy management, smart home and other value-added business services. The networking solution of HAN may be chosen from EPON, PLC and ZigBee. The data transmitted in HAN are internet data and control information to achieve internet access and management and interaction between user and home smart terminals. Both of EPON and PLC can meet the demand of HAN communication, EPON wins in the high-speed data rate, PLC wins in the low cost, no additional wiring and no electromagnetic radiation. However, we strong believe that ZigBee will be the promising choice of networking solution of HAN because of its compelling advantages in short-range networking aspects.

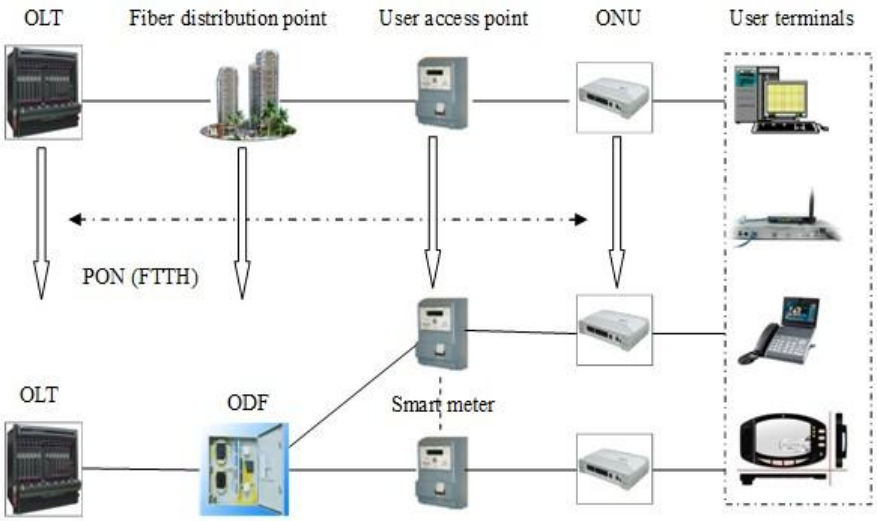

Figure 5. Schematic diagram of FTTH in smart grid.

C. Networking Program of Specific Communication Technology

Based on the above analysis, multiple communication technologies co-exist in the same logical layer and physical area of smart grid distribution and consumption communication network is a long-standing problem. However, from the perspective of the construction management, and development of smart grid, we still hope that we can adopt a single communication technology to build smart grid distribution and consumption communication network in a relatively large area. The following part of paper describes the networking program of several main communication technologies one by one.

a) Networking program of EPON/GPON

Although building smart grid distribution and consumption communication network with EPON/GPON brings high construction cost, long construction period and lots of cable and supporting equipment construction, the advantage is obvious. Once completed, it can easily meet the demands of a variety of business communications and have great adaptability and scalability to satisfy the need of the future smart grid business. As is well known to all, the backbone of smart grid communication network will have been building with optical fiber communication technology, so, EPON/GPON also has inherent advantages. Therefore, EPON/GPON should be the first choice of networking solution of smart grid distribution and consumption communication network.

We can make use of OPPC for the construction of PDCN, and FTTH for UAN. We can install ONU terminal indoor and connect ONU and the user smart interactive terminals (IP phones, computers, smart equipments, etc.) with Ethernet interface to establish HAN. Moreover, we also should deal well with the existing power distribution lines. We can build new communication network with OPPC and OPLC and replace the old lines with ADSS or ordinary optical cables. Reasonable arrangements of spectrophotometric network configuration is another problem we need to concern, ODN network should be unequally split to ensure flexibility and scalability of network due to the characteristic that information point of PDCN is in the linear series distribution along with the lines of power distribution network.

b) Networking program of PLC

Smart grid distribution and consumption network is the middle and low voltage power grid which connects a large number of power equipments, and this brings great difficulties for the construction of smart grid distribution and consumption communication network, but give PLC some advantages compared others. Currently, PLC is still the main solution of power communication, but due to its inherent technical defects, it will mainly play a secondary and complementary role in future smart grid distribution and consumption communication network unless its technical defects will have been solved.

In PDCN, middle voltage PLC can be used for data communication of power distribution, transformation and dispatching information. Broadband carrier can be used to supple a data transmission channel for power distribution automation system and user's information collection system in UAN and meet the demand of high bandwidth and data rate of internet access in HAN. Narrowband carrier can meet the demand of control and monitoring in HAN.

c) Networking program of power wireless private network (WiMAX/TD-LTE 230M power wireless broadband)

Nowadays, the wireless communication technologies which we use to build PDCN are GPRS/3G, but the disadvantages are obvious. The reliability can not meet the demand of confidentiality of power data, and once accessing a large number of users, the communication quality can not be assured. These contradict with the characteristic of power grid communication. Moreover, the operation cost brought by annually leasing bandwidth from the public network operators is relatively high. Therefore, the best choice of wireless communication technology is power wireless private network (WiMAX/TD-LTE 230M Power wireless broadband). The way of power wireless private network has the low-cost and simple construction and a certain degree of scalability, and especially can be used in some occasions that power optical fiber private network can not be implemented or difficult to be implemented. Although the technology maturity, network specification and standard system of power wireless private network still need further improvement and development, the implementation and development of power wireless private network are the key issue to solve smart grid communication. Power wireless private network will account for a considerable proportion of the construction of smart grid distribution and consumption communication network, can serve as a strong complement of power optical fiber private network.

Generally, we can adopt WiMAX in the upper than 10KV substation(PDCN) and TD-LTE 230M Power wireless broadband in the 10KV and lower than 10KV user access station(UAN) to achieve communication among power equipments for data collection and access of control information.

d) Networking program of ZigBee

Adopting ZigBee as the networking solution has no need to consider the positional relationship between the individual devices. It can effectively and accurately finish the data transmission between each home smart device within its communication range, bring promising convenience, applicability and economic value, and be a key communication method of the future smart grid and smart home business.

In UAN, the major application of ZigBee is data collection. Another application of ZigBee exists in HAN. We install smart meter and smart interactive management terminal in the user's family to delivery the information of power consumption and various businesses to the outside of HAN. Inside of HAN, ZigBee can be used in sending state information from smart equipments to smart interactive management terminal and user's control information in the other direction.

IV. Conclusion

This paper analyzes the technical characteristics of variety of communication technologies, and proposes smart grid distribution and consumption communication network architecture. And we draw a conclusion that we can not build smart grid distribution and consumption communication network with only one single communication technology. For a long period, no matter what kind of communication technology has its own advantages and disadvantages. Smart grid distribution and consumption communication network is a complicated communication network which has the coexistence of a variety of communication technologies

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