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# Power Fiber to the Home Opens Up a New Approach of Integration of Three Networks

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**Abstract**

This thesis analyzes the development trend of power fiber to the home (PFTTH) and the current domestic situation of the integration of three networks. It develops its research about the integration system constitution of three networks based on power fiber to the home and proposes the research, development and implementation of power fiber to the home, which not only establishes new "information highway" based on the smart power grid, but also guarantees the realization of the state's planning objective of the integration of three networks to enable the rapid development of information industry in China



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## 1. Introduction

With the development of the world economy, there has been the upsurge of the large scale of construction of fiber to the home (FTTH) in countries and regions like Japan, North America and Europe, etc, which has achieved enormous success. However, the promotion of commercial FTTH in China is still in the beginning and the selection of FTTH technology appropriate to China's national situation is of vital importance in promoting the popularization of FTTH in China [1]. The adoption of FTTH technology to realize the "integration of three networks" boasts realistic significance [2-3]. The integration of three networks refers to the integration of telecommunication network, internet, as well as radio and television network. It realizes the technological integration, interconnection and interworking and mutual compatibility, which gradually integrate a nationally unified information communication network. In simple words, a single optical fiber in the family or unit (FTTH) could realize the diversified and personalized service of multimedia like data, voice, as well as radio and television [4].

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Although it has been several years since the proposition of the integration of three networks in China with frequent policies and continuous actions, trade monopoly, separated supervision, and hard integration of few effects have influenced the information progress and national economy development [5]. The successful research and development of optical fiber composite low-voltage cable (OPLC) in 2009 not only realizes the integration of three networks of power fiber to the home (PFTTH), but also realizes smart consumption of electricity and promotes the development of smart home [6-7].

## 2. Development Trend of Fiber to the Home

Fiber to the home (FTTH) means the connection of a single fiber to the home. Specifically, FTTH is the type that installs optical network unit (ONU) in home users or enterprise users, which is closet to users among the optical access series besides fiber to the desk (FTTD) [8]. Fiber to the home is the higher level anticipated by the communication industry for many years, equaling to access to the global "information highway". Fiber access is an industry of hundred billion yuan, and the development of broadband network with the core of FTTH boasts profound significance beyond communication and economy [9].

### *2.1. The development status status at home and abroad*

Through the development of more than a decade, FTTH has been applied to commerce in a large scale, which has demonstrated a rapid growth during recent years especially. Up until the end of 2009, the amount of users globally has already surpassed 60 million, with an increase of 35% compared with that of 2008. Among them, Asia takes up 81%, North America 11% and Europe 8%. In 2009, the amount of users in China ranks top, but the popularization rate per capita is less than 10%, far from the level of 30%-40% of the developed countries. The major obstructions for the development are the lack of development strategy on the level of the country, the lack of the application of attractive high-broadband, the backward supporting facilities, difficult fiber to the home, and the high constructional cost. The operation and maintenance of FTTH network and technologies need further improvement [10]. .

### *2.2. Development trend of traditional fiber to the home in China*

1) With the comprehensive implementation of telecommunication engineering of "fiber city" [11], it is planed that 30 million households of new fiber users will be added in the urban area in 2011. It is 3 times higher than the "eleventh five-year" period with an accumulative coverage of 40 million families. The southern cities realize an overall coverage of access bandwidth of 8M, and the coverage rate of 20M achieves 70%. a The coverage rate of 20M of developed cities in the east and provincial capitals in central and west regions achieve more than 80%.

2) China Telecom access business consumes more than 80% of network resources and fixed assets of the fixed internet, but the income takes up only 20% of the total income. The development mainly depends on the subsidy from the traditional voice service, but the current subsidy declines at a speed of more than 20%. Since the reorganization of telecommunication in 2008, the effective competition of the market has not been formed, and 5% of the profit of the fixed network is far from 25% of mobile network. The business competition mode of the fixed network is abnormal and the value loss is too fast.

3) With the development of reorganized all-service operation of telecommunication and the promotion of the integration of three networks, the competition in the fixed network industry becomes increasingly fierce. There are repeated network investment and excessive market competition. From 2002 to 2004, the average annual growth of broadband access users is 100%, but during the period from 2007 to 2010, the

average annual growth is below 30%. The growth rate starts to decline, and there are difficulties for the development [12-14].

The 21st century is the era of information, and the occupancy volume of "per capita bandwidth" and "per capita information" has become one of the core indexes evaluating the national economic strength. According to the statistics of International Telecommunication Union, there have already been 82 countries that have issued or plan to issue bandwidth strategy [15] globally including America, Britain, Germany, Japan and Korea. Great importance has been continuously attached to the bandwidth strategy in China, and the era of fiber to the home has come, which has become an irreversible trend.

### *2.3. Development trend of PFTTH*

Power fiber to the home (PFTTH) means to adopt optical fiber composite low-voltage cable (OPLC) in families of power cable access. It lays cable along low-voltage power line, which realizes "to the meter and the home". Coordinated with passive optical network technology, it undertakes the business of electricity information acquisition, smart electricity two-way interaction and "the integration of three networks", etc. OPLC means the composition of fiber in the low-voltage cable and enables the cable to conduct power transmission and have the function of fiber communication [16]. The common structure of optical fiber composite cable is demonstrated in Fig. 1.


Fig. 1. The usual structure of fiber composite cable

Development advantages of power fiber to the home are as follows:

1) Power industry and market: The instant finishing characteristics of the production, supply and selling of power determines that power network must timely realize interaction. Therefore, the information content of end customers will be huge, and to compose fiber in the power network to construct the information of "the last kilometer" will be the most effective scheme.

2) It could integrate resources: the integration of power grid, communication and radio and television network not only enables the power grid resources obtain redevelopment, reuse and re-appreciation but also realizes the strategy of "the integration of three networks".

3) Construction of an economical society: power fiber to the home could realize the co-construction and sharing of network infrastructures, avoid repeated construction of various line paths, solve the problems of security distance, seizing paths and intersected cross, improve the overall utilization efficiency of social resources, greatly reduces the cost of "the integration of three networks", and improve the overall operational efficiency of social resources.

4) New economic growth point: the adoption of PFTTH scheme based on OPLC, compared with the traditional line scheme of electrical cable + optical cable, the overall costs of network construction has decreased by about 40%. It not only harmoniously integrates the functions of power service, information service and community service, but also generates an enormous new industry. Experts predict that the integration of the traditional three networks only will spur the investment and consumption of about 7 hundred billion and increase about 2 million jobs [17].

## 3. Development Trend of the Integration of Three Networks

Currently, China has already boasted the technological condition, network basis and market space of the integration of three networks, accelerating the integration of three networks to enter the critical period [18-19]. Because of the interest distribution between radio and television system and telecommunication system, "two-way access" has always been the bottleneck for the promotion of the integration of three networks. The promotion of the integration of three networks asks for a virtuous and appropriate competition, as well as an open mind of all the participants [20].

### *3.1. Development status of traditional integration of three networks in China*

1) Supervision level: the current segregated supervision of telecommunication and radio and television seriously hinders the integration of three networks and fails to avoid the repeated construction of network resources. It cannot avoid the repeated construction of networks, it restricts the prosperous development of new business and it is unable to guarantee the thorough realization of the integration of three networks.

2) Network architectural level: There are mainly two ways to realize cross connection: ①VolP realizes internal integration through the internet transmission and telecommunication access networks. ②"Cable modem" realizes the broadband access service through the integration of optical fiber metropolitan area network of China Mobile and the cable access network of radio and television. It is only the simple combination of telecommunication transmission network and radio and television access network, which is not the integration of three networks in the real sense.

3) Business level: currently, the new business of the integration of three networks of IPTV, interactive TV and mobile TV has been paid great attention to. The development of business requires to break the separation status of the three networks and to realize "two-way access".

The integration of three networks has made certain breakthrough on the business level, but the development on the level of operation, supervision and network construction needs to be accelerated[21].

### *3.2. New approaches for power fiber to the home to open up the integration of three networks*

1) Power fiber to the home realizes an integration of various networks, the exchange of clean energy and the development of information industry by leaps and bounds. Power fiber to the home avoids the enormous waste of repeated construction. Compared with the mainstream FTTB+LAN, PFTTH scheme adds material cost of less than 10% to reduce the comprehensive cost by about 40%.

2) The formulation of Optical Fiber Composite Low-voltage Cable by Electrical Power Research Institute of China and enterprise standard of power fiber to the home have been accomplished. Product development with independent intellectual property will enable China to get rid of the situation of being disciplined by others for long.

3) State Grid is rapidly promoting the power fiber registration and has selected 10 network provincial companies to initiate the first residence pilots, which plans to cover 47000 families in 2010. It will generate the new market of OPLC and improves the equipment requirement of EPON. A conservative prediction is that new residences along will have a annual average potential requirement of 35 billion yuan (640000 kilometers /year) for OPLC, of which the market scale is predicted to reach 7 billion by 2015 with a composite growth rate of 65%.

4) OPLC of power fiber will become the priority among the schemes of the access end of smart power grid users. Power fiber to the home is the intrinsic requirement of developing smart power grid, which is becoming ntegrated with the traditional three networks.

5) Currently, power system in China has already established the world's largest, advanced and reliable high-voltage cable communication networks specifically for power. Backbone networks above 110kV have realized 100% opticalization. About 50% of the distribution network of 35kV and 10kV has realized opticalization. The 380V and 220V users of the last kilometer of the power grid boast a lower access optical fiber rate. After the realization of power fiber to the home, a new "information highway" based on the smart power grid could be established. Power network management path, telecommunication and adio and television all open their transportation and construct an information network of Chinese characteristics.

6) The trial scope of power fiber to the home of State Grid has already expanded from new unoccupied residence to new occupied residence. State Grid enjoys a good cooperation with local telecommunication operators and local Broadcast and Television Administration, which has initially formed a national promotion idea of "service without competition" [22].

Power fiber to the home is the most ideal way to realize "the integration of three networks". Power fiber to the home will welcome the explosive increase of information industry.

### *3.3. System constitution of the integration of three networks based on power fiber to the home*

1) The system of EPON is composed of OLT (optical line terminal), ONU (optical network unit), ODN (optical distribution network) and various business carriers. Through EPON system, users could adopt a single cable to solve all the communication businesses of family online, telephone and broadcast and television to achieve the goal of the integration of three networks.

2) EPON (Ethernet Passive Optical Network): Since the first commercial FTTH project of Jiangsu Zhenjiang Hengmeijia Garden pilot in 2004, China Telecom and China Netcom have conducted a wide range of pilot study and the project mainly adopts EPON and GEPON technology. GEPON technology [23] boasts a high system cost and fewer pilots as its technology standard is imperfect and manufacturers providing chips are few. Therefore, EPON is generally adopted. EPON technology is a point-to-points passive optical communication technology, and its greatest advantages lie in its flexible topology, the saving of optical fiber resources and high dependence of the system [24]. Its system structure is generally composed of the three parts of OLT, ONU and ODN. It adopts tree and bus topology. The typical structure of EPON is shown in Fig. 2.

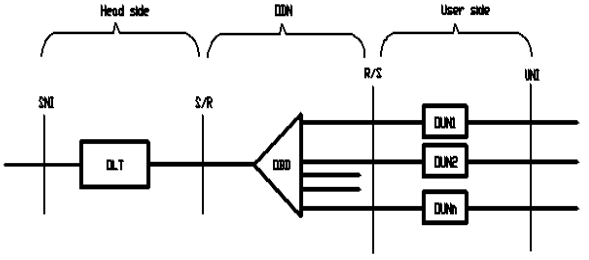


Fig. 2. Typical structure diagram of EPON

3) Network design scheme of power fiber to the home

Network technology scheme design is mainly conducted from the technological advantages of the system, system constitution, network model, installation principle, OLT and selection of ONU [25-26].

The application of EPON technology to construct power high-speed data network platform [27] of PFTTH could realize the unified integration of telecommunication network, cable television network and internet through power channels. The typical network scheme is shown in Fig. 3.

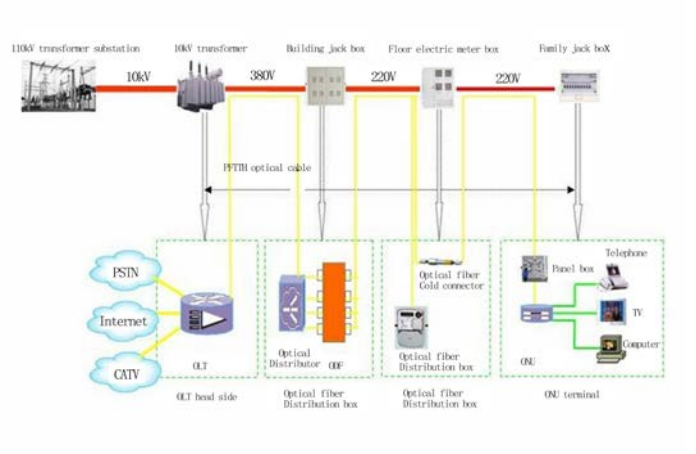


Fig. 3. PFTTH network scheme diagram

## 4. Smart Home Based on Power Fiber to the Home

According to the unified deployment of State Grid, the first pilot project of power fiber to the home in China selects Shumen residential block of Sanmenxia of Henan and Zhongshi junjing residential block of Nanyang as the pilots. On March 23rd of 2011, the pilot project was accomplished. All the 1852 families from two residential blocks realize the common network transmission of telephone, television and internet business through a single power optical fiber for the first time. Outside the pilot sample room, part of the function of adopting the mobile phone to remote control smart household appliances, entrance guard and lighting control have been realized. Then, users could enjoy value-added businesses at home through television and computer, such as remote reservation, supermarket advertisement issuing, etc. The bandwidth in the home of residents could achieve 100M, which is 25 times higher than that of 4M which is commonly used by residents now. “Integration of three networks” becomes a reality and the smart home has been realized initially [28].

### *4.1. Constitution of smart home system*

According to the practical situation, the smart home system mainly includes the following functional subsystems: new energy display, smart appliance use, business display of “integration of three networks”, smart lighting control, visual talking, smart security protection and smart electric appliance control. The typical structure of smart home system is shown in Fig. 4.

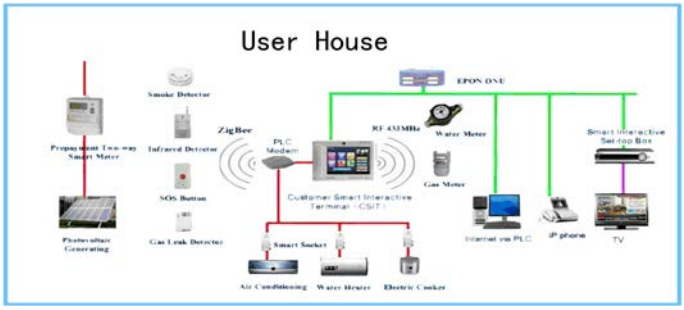


Fig. 4 Structural chart of smart home system

### *4.2. Key equipment of smart home system*

Customer smart interactive terminal [29]; customer smart interactive set-top box; smart socket and home electric appliance control; smart security protection system; information service system

### *4.3. Development of Smart Home*

As early as a decade ago, there were about 40000 families in America that installed “family smart system”. In Singapore, there are about 5000 families in about 30 residence blocks that have installed it. The smart construction in China is just at the beginning. After an exploration for a decade, the area of smart residence now achieves 40 billion square meters. It is predicted that until 2020, there will be another 30 billion square meters added, and thousands of smart residence blocks will be constructed in China in the next decade.

Smart home is the inevitable result of social information and economic development. The smart future architecture is the necessary trend for the development of the society [30].

## 5. Conclusion

The successful research and development of optical fiber composite low-voltage cable (OPLC) makes it possible for the power fiber to the home (PFTTH). The adoption of PFTTH solves the problems existing in the integration of three networks and establishes new “information highway” based on the smart power grid. While guaranteeing the realization of the state integration plan of three networks, it promotes the construction of smart home, drives the national economy to convert to information and to rapidly catch up with the development level of developed countries. Promoted by power fiber to the home, it is certain that there will be a new climax of smart home construction in China.

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