Planning and Design of FTTH for Cable Television Networks (Postprint)

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Abstract

With the development and advancement of network technology, China' s cable television industry has also achieved rapid growth. However, the fiber-to-the-home (FTTH) penetration rate for cable television remains relatively low. To ensure the implementation of fiber-to-the-home policies, the state has promulgated corresponding laws and regulations, explicitly stipulating that newly constructed residential buildings must guarantee fiber-to-the-home access. Consequently, we must master sophisticated technologies to ensure that cable television networks can achieve fiber-to-the-home deployment. From this perspective and grounded in actual development conditions, this paper presents an in-depth analysis and discussion of the planning and design aspects related to FTTH fiber-to-the-home in cable networks.

Full Text

Media Business Models · Media Technology

Discussion on the Planning and Design of FTTH Fiber-to-the-Home for Cable Television Networks

Abstract: With the development and advancement of network technology, China' s cable television industry has achieved rapid growth. However, the fiber-to-the-home penetration rate for cable television remains relatively low. To ensure implementation of fiber-to-the-home policies, the state has enacted relevant laws and regulations that explicitly require fiber-to-the-home capability in newly constructed residential buildings. Therefore, we must develop proficient technical capabilities to ensure that cable television networks can achieve fiber-to-the-home. From this perspective and based on actual conditions, this paper conducts an in-depth analysis and discussion of planning and design aspects related to FTTH for cable networks.

Keywords: Cable television; FTTH; Fiber-to-the-home; Planning

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Since the beginning of the 21st century, economic and social development has been exceptionally rapid. In this ever-changing landscape, cable television continues to play a vital role. To meet diverse customer needs and ensure compatibility with user bandwidth requirements, fiber access technology must be employed. Current research demonstrates that FTTH technology has excellent application prospects and represents the primary development direction within the industry.

2.1 Advantages Analysis

FTTH technology integrates fiber-to-the-home requirements with users' intrinsic needs to achieve satisfactory outcomes. Analysis of its characteristics reveals several distinct advantages. First, this technology ensures reliable bandwidth guarantees. Second, compared with traditional technologies, it progressively enhances network transparency relative to data formats while imposing lower environmental requirements, particularly regarding power supply conditions. Third, the technology features convenient installation, enabling straightforward deployment for both enterprise and residential customers while accommodating their bandwidth resource needs.

More specifically, current applications demonstrate five primary advantages of FTTH technology. First, FTTH constitutes a passive network, ensuring passivity throughout the entire process from the local area network port to the end user. Second, FTTH technology offers substantially wider bandwidth and longer transmission distances compared to traditional networks, making it highly suitable for large-capacity operators. Third, optical fiber enables lossless information transmission, resulting in minimal issues when transferring large volumes of data. Fourth, the technology' s broad bandwidth provides relatively greater flexibility in supported protocols. Fifth, FTTH technology connects optical fiber directly into user residences, imposing no significant restrictions on transmission technology, wavelength, or bandwidth during installation, thus offering considerable flexibility for widespread practical application.

Furthermore, the most significant highlight of this technology is that the FTTH model enhances the transparency of network data formats and protocols, which necessarily reduces power supply requirements and simplifies maintenance and repair operations in later stages.

2.2 Disadvantages Analysis

First, the technology exhibits certain systemic defects in its institutional development. Many regions in China have encountered considerable resistance in promoting FTTH technology, with numerous issues regarding unclear property rights and insufficient investment, particularly obstacles within the access network system. From the current development perspective, institutional coordination for fiber-to-the-home within the industry remains inadequate, resulting in a fragmented landscape where operators act independently and engage in malicious competition. In today' s rapidly advancing technological environment, the market requires a mechanism with clear property rights and coordination, along with further standardization of supporting products and construction procedures for fiber-to-the-home implementation.

Second, the technology faces significant practical and construction challenges. In FTTH network construction, the ODN (Optical Distribution Network) represents the most critical component, encompassing passive devices such as distribution equipment, splitters, and optical cables that serve as the primary carriers for network signal transmission. From current objective conditions, higher splitter ratios in the ODN result in greater optical attenuation and energy consumption, necessitating substantial financial investment in ODN line construction. However, actual application scenarios reveal severe funding shortages for ODN line construction, with investment accounting for only 50% to 70% of total line investment.

Third, maintenance demands are intensive and fault detection proves relatively difficult. Given FTTH technology' s characteristics, the network' s extensive coverage area creates considerable challenges for subsequent maintenance. At its core, ODN technology employs a point-to-multipoint topology with numerous nodes in the network, further increasing complexity. Moreover, the transmission medium—optical fiber—is more sensitive than traditional copper materials, resulting in higher susceptibility to wear and damage. From the current technological development perspective, fault detection in ODN networks is extremely difficult, making fault localization challenging when failures occur, which severely impacts FTTH network service quality.

Fourth, residential installation represents a major difficulty for this technology. In newly constructed buildings, pre-installed fiber panels are easily damaged by users during subsequent renovation. For already-occupied residences, applying for FTTH network access faces challenges with cable routing. In older buildings, deploying butterfly-shaped optical cables encounters numerous obstacles, while re-cabling often fails to obtain user permission, creating substantial difficulties for FTTH technology implementation.

3. FTTH Technology Planning and Design Analysis

Through the above analysis, we can clearly see that cable television FTTH technology faces various difficulties during installation and promotion, with cost-

performance ratio and technical factors being the primary determinants. In current technological development, we typically employ the "two-fiber three-wave" technology for access, with planning primarily encompassing the following aspects.

From a professional technical perspective, the two-fiber three-wave and EPON technologies represent critical steps in FTTH technology and constitute important foundations for FTTH access systems. Additionally, components such as ODN, ONT, and OLT are indispensable, and planning must strictly adhere to industry requirements. For OLT, we must strictly comply with its formatting specifications, aggregate various signals, and deliver them via ODN transmission to ONT. Then, according to the different requirements of various services, identical signals are consolidated at the ONT signal terminal for unified transmission to respective service networks. On this basis, we must also flexibly utilize ODN to effectively connect OLT and ONT, enabling rapid optical transmission implementation. Essentially, ONT' s primary function is to provide users with accessible language and data information analysis.

During specific planning processes, we must also consider the engineering construction environment, generally conducting comprehensive analysis based on the following factors. First, working wavelengths must be strictly verified. Typically, in practical applications, IG-EPON upstream and downstream wavelengths may select 1310nm and 1490nm. However, in specific applications, IOG-EPON usage presents two common possibilities: symmetric mode and asymmetric mode. The former requires selection of 12700nm and 1577nm, while the latter requires 1310nm and 1577nm.

Second, transmission distance represents another critical factor that must be comprehensively considered during the design process. For example, considering maximum insertion loss, the optical module maximum for 1G-EPON should be 28dB. Additionally, insertion loss values for all connectors should be 0.5dB.

The current technological environment drives continuous development in fiber optics, and FTTH technology demonstrates excellent application prospects as the primary development direction within the industry. Therefore, in future development, we must continuously research this technology' s advantages, apply them in practical implementation, promote the development of fiber network media, and enhance the quality and standards of cable television network development.

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Note: Figure translations are in progress. See original paper for figures.