Analysis of Smart Community Development in Cable Television FTTH Networks (Postprint)

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Abstract

Traditional cable television systems have historically relied on active equipment, frequently encountering lightning strike disturbances, thereby consistently manifesting drawbacks such as compromised safety and excessive maintenance expenditures. In contrast, FTTH network coverage models advocate the deployment of drop optical cables directly to subscriber premises for user access; owing to the large-scale implementation of passive optical networks, this approach concurrently and continuously reduces both equipment failure rates and maintenance costs, warranting comprehensive promotion in the future. Based on this premise, the author endeavors to objectively demonstrate the practical significance of synchronizing intelligent technology with cable television access engineering, expound upon specific construction key points, and explore practical measures for developing intelligent residential communities, with the objective of providing valuable assistance to relevant construction and management personnel.

Full Text

Analysis of Intelligent Community Development via Cable TV FTTH Networks

Abstract: Traditional cable television networks have long relied on active equipment, which frequently suffers from lightning strikes, resulting in persistent issues of low safety and excessive maintenance costs. In contrast, the FTTH (Fiber to the Home) network coverage model advocates direct fiber-to-the-home deployment using drop cables. Due to the large-scale deployment of passive optical networks, both equipment failure rates and maintenance costs are significantly reduced, making it worthy of comprehensive promotion. Based on this, this paper objectively demonstrates the practical significance and specific construction points of synchronizing intelligent technology with cable TV access engineering, and discusses concrete measures for developing intelligent commu-

nities in combination with practical conditions, hoping to provide assistance for relevant construction and management personnel.

Keywords: Cable TV; FTTH Network; Intelligent Community; Development Measures

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1. The Significance of Simultaneous Construction of Cable TV Access Engineering and Intelligent Communities

After the completion and handover of intelligent community construction projects to property management units, technicians specializing in cable TV FTTH network development for intelligent communities generally do not need to make frequent visits to these communities. This is primarily because sufficient staffing ensures both high-efficiency television signal transmission and regular inspection and maintenance of the entire intelligent network environment's security.

Furthermore, cable operators possess considerable broadband advantages that enable them to comprehensively meet the diverse service requirements of property management and residents. These services include providing high-quality broadband and television resources to property management, real-time expansion of wireless coverage within the community, regular delivery of news information to community announcement systems for promotional purposes, rapid connection of community surveillance footage to public security agencies, and embedding these capabilities into set-top boxes for all users, thereby satisfying residents' standardized demands while ensuring community management security and continuously enhancing its preventive capabilities.

Traditional networks primarily rely on coaxial infrastructure. In our local operational reality, rural areas feature dispersed regions with numerous coaxial connectors. Based on our analysis of failure statistics, the main issues include water ingress at connectors, damaged splitters, and cable degradation due to environmental parameter changes—all contributing to high external line failure rates. Complaint rates surge during thunderstorm seasons. Networks typically require replacement after eight years, with costs, particularly labor costs, increasing annually. While the trend in past network upgrades has been moving fiber progressively closer to users, it had not yet reached the ultimate last-mile solution.

Current operators, taking local telecommunications as an example, first promote the concept of "fiber" broadband to differentiate it from "coaxial" broadband, guiding customers to perceive fiber broadband as a premium-quality product. Existing two-way networks contain active equipment; with each optical node consuming an average of 80W, annual electricity costs (at 0.9 yuan per kWh) amount to: $0.08 \times 24 \times 365 \times 0.9 =$ over 630 yuan per node.

The integration of cable TV FTTH networks with intelligent community development offers four primary advantages:

First, high and stable signal transmission efficiency. In these projects, the intelligent central equipment room facilities consistently employ fiber transmission technology when interfacing with other system architectures, resulting in more stable signal transmission.

Second, low resource consumption. After network access, cable television becomes an indispensable supporting facility in urban communities. Particularly under the combined influence of intelligent and fiber-optic network transmission technologies, only a limited quantity of fiber transmission equipment is required—namely ODF frames, optical cross-connect boxes, and fiber distribution boxes—representing significant savings compared to previous approaches in fiber, community pipelines, and even bridge rack resources.

Third, simpler and more transparent structural mechanisms. During the integration of cable TV FTTH networks into community construction systems to achieve intelligent development goals, all construction tasks are undertaken by a single company, while technical equipment requires unified procurement, planning, and installation.

Fourth, convenient maintenance and easy expansion of additional broadcasting value-added services. With networks and transmission systems positioned closer to users, optical resources can be appropriately conserved. Additionally, centralized splitter placement facilitates maintenance while enabling large-scale savings on OLT resources.

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2. Key Points for Interactive Integration of Cable TV FTTH Networks and Intelligent Community Construction

The development of intelligent communities utilizing cable TV FTTH networks specifically employs the FTTH dual-fiber three-wave to-the-home model, supported by full-fiber single-line access to replace traditional outdoor coaxial network coverage. During this process, professional receivers at user ends, ONU terminal equipment, digital television, and broadband data signals must all be carried via different types of fiber, while introducing appropriately scaled optical amplifiers and OLT technical resources within the broadcasting room.

First, the two-level optical splitting mode for cable TV signal processing and transmission. For rural television signals, the first-level 32-way optical splitter and PON signal first-level 8-way optical splitter are placed in village-level equipment rooms or optical cable 交接 boxes, while the second-level 8-way optical splitter for television signals and second-level 8-way optical splitter for PON signals are placed in user-proximate distribution boxes. In communities, the first-level 16-way optical splitter for television signals and first-level 4-way optical splitter for PON signals are placed in community equipment rooms or optical cable 交接 boxes, while second-level 16-way optical splitters for both television and PON signals are placed in user-proximate distribution boxes. It is necessary to lay professional dual-core drop cables from distribution boxes to household low-voltage distribution boxes—one core for 1550nm television signal transmission and the other for data signal transmission.

Second, the promotion of single-level optical splitting for data control and transmission. The total splitting ratio remains 1:64, meaning single-level splitting is integrated into community optical 交接 boxes using 64-way optical splitting, covering 64 ONUs under one PON port. This requires introducing larger quantities of 24-core and 48-core optical cables into the optical 交接 boxes and sequentially connecting them to unit distribution boxes, ensuring that wall-mounted distribution boxes are designed for every 48 households as a basic unit. Direct fusion splicing is employed within these distribution boxes to enable simultaneous processing of optical cable and drop cable laying and splicing.

Amidst the rapid and large-scale development of China's cable TV networks, staff must adopt a combined approach of centralized and distributed optical splitting. Centralized splitting offers greater convenience in both on-site equipment maintenance and construction, making it typically applicable in urban areas with concentrated users. Although fault detection and maintenance are more convenient, the relative concentration of optical cables between OLT and splitters imposes stricter security requirements for broadcasting network transmission. In suburban and rural networks, distributed splitting is recommended. After phased verification and certification, this model proves relatively convenient and flexible, covering sufficiently large user areas while maintaining relatively low comprehensive construction costs. The primary reason is that in this operational environment, splitters can be positioned as close to users as possible, slightly reducing engineering construction costs while achieving backbone savings.

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3. Specific Measures for Developing Intelligent Communities via Cable TV FTTH Networks in the New Era

First, ODN Coverage. ODN (Optical Distribution Network) nodes, given the inherent particularity of cable TV network operations, employ diverse coverage modes. Therefore, high-end users are typically considered the core service target, utilizing cost-effective and high-quality processing methods to ensure the cable TV FTTH network achieves true end-to-end implementation. For newly constructed communities, efforts should ensure high standards while implementing appropriate cost control, laying foundations for comprehensive high-rise building coverage and phased multi-story building construction. In other words, during collective construction phases, line construction activities from CO (Central Office) to DP (Distribution Point) must be properly completed; after handover to the service activation phase, appropriate optical cable laying is performed.

Second, Precise OLT Location Selection. OLT (Optical Line Terminal) primarily interfaces with terminal equipment in fiber trunk lines. According to EPON protocol specifications, the distance between OLT and ONU must not exceed 20 kilometers. EPON's technical characteristics influence OLT positioning, while the number of main optical cable fibers within ODN network construction also affects OLT location. Particularly when main optical cable fiber counts are insufficient to guarantee access for all regional users, construction personnel may consider appropriately downward relocation of OLT positions, such as transferring them into community areas, typically positioned at intermediate locations between main and distribution optical cables. If user numbers in a community exceed standards, dedicated OLT equipment rooms must be additionally established. Practical investigations reveal that when user numbers exceed 1,000, no access room exists within 1 kilometer, and PON quantities exceed 16, community OLT installation becomes necessary. During main optical cable selection, current routing conditions should receive maximum attention; distribution optical cables must meet stricter standards, including high-density assembly, small and easily divisible/spliceable cable diameters; 入户 optical cables must maintain strong tensile, bending, and side-pressure resistance while enabling free pipeline 布置 between buildings and facilitating high-efficiency maintenance.

Third, Rational Splitting Mode Matching. Based on extensive practical experience, cable TV FTTH network construction for intelligent communities—particularly during optical splitting—must adhere to three fundamental principles: first, employ uniform single-level splitting while structurally simplifying existing network architectures to facilitate timely fault identification and elimination; second, ensure centralized splitter placement to facilitate maintenance while enabling large-scale OLT resource savings; and third, adopt a combined centralized-distributed splitting model.

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4. Conclusion

In summary, FTTH fiber access technology, because it can fully overcome the drawbacks of previous last-mile access solutions, has currently achieved comprehensive promotion and application. However, during actual network construction, since different types of construction scenarios vary, more flexible application within the framework of basic principles is necessary. Due to cable TV operators' special market positioning, comprehensive verification and certification must incorporate their own business characteristics—requiring additional economic and stability planning. This ensures sufficient expansion space for future networks and cable TV services while truly accelerating intelligent community construction progress. In the long run, this will inevitably satisfy the comprehensive requirements of various community residents and win deserved recognition within the industry.

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