Application of EOC Technology in Bidirectional Upgrade of Broadcasting Networks: A Postprint

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Abstract

As the "triple-network" convergence trend continues to deepen, market competition is becoming increasingly fierce, and the demands for technological development are becoming more stringent. We cannot remain confined to the traditional cable television business model of broadcasting and television networks; at present, the optimal solution lies in two-way transformation. On this basis, this paper briefly summarizes EOC technology and its application in the two-way transformation of broadcasting and television networks, while proposing corresponding network upgrade strategies, with the aim of positively influencing the development of two-way integrated services and two-way user access across the entire broadcasting and television network. The content is for reference only.

Full Text

Preamble

EOC technology is an access technology based on Ethernet protocols over cable television coaxial cables. The fundamental concept of EOC transmission involves modulating Ethernet data signals onto a specific channel, enabling data signals and cable television signals to be transmitted over the same cable without mutual interference. The primary advantage of introducing EOC technology in the two-way transformation of broadcasting networks lies in its compatibility with other technologies. The optical transmission layer utilizes the EPON system in conjunction with traditional fiber resources of the HFC network for service delivery, ensuring adequate bandwidth for end users.

2.2.3 Quality of Service Control

Quality of Service (QoS) control, which can effectively handle special data types, falls within the category of network security mechanisms. From a network ser-

vices perspective, QoS can be achieved by controlling quantifiable parameters to guarantee service quality and provide users with optimal bandwidth, including metrics such as loss rate control and transmission delay. However, QoS control is not merely about network management; it represents a comprehensive effect. If any component—user terminals, network servers, or applications—experiences issues, the overall QoS control level will inevitably be compromised.

2.2.4 Intelligent Management

EOC systems offer rapid equipment maintenance and management capabilities. Users can directly manage the EOC network by simply accessing the Web interface of the headend device. [Figure 2: see original paper] The most significant benefit of applying EOC technology in two-way broadcasting network transformation is its ability to integrate with other technologies. Employing the EPON system in the transmission layer not only ensures stable and efficient service transmission but also comprehensively enhances security, guaranteeing sufficient bandwidth for end users while resolving quality issues in the television and data optical segments. Numerous regions have already experimented with combining EPON and EOC technologies, substantially improving user experience. However, system design must not overlook the critical factor of user numbers. When the user base is large, module bandwidth must accommodate the actual needs of users at all levels, necessitating careful planning and supplementation of the existing HFC network.

2. EOC Technology Application in Two-Way Cable Network Transformation

Users can directly manage the EOC network by accessing the headend device' s Web interface. The most significant advantage of applying EOC technology in two-way broadcasting network transformation is its compatibility with other technologies. Using the EPON system in the transmission layer ensures stable, efficient service transmission while comprehensively improving security, guaranteeing sufficient bandwidth for end users and resolving quality issues in the television and data optical segments. Many regions have already experimented with EPON-EOC integration, substantially enhancing user experience. However, system design must account for user numbers as a critical factor. With large user populations, module bandwidth must meet the actual needs of users at all levels, requiring careful planning and supplementation of the existing HFC network.

3. EOC Technology Application Cases

According to requirements from China' s State Administration of Radio, Film and Television, the nationwide digital television transition is progressing rapidly, with significant changes occurring in operational models and services within the cable television industry. Traditional broadcast services can no longer satisfy

users' actual needs. Furthermore, the launch of direct broadcast satellites and rapid development of IPTV services have placed tremendous pressure on the cable television industry. This section analyzes the application case of EOC technology in Zhangzhou City, aiming to provide insights for cable operators undertaking two-way access network transformation.

2.1 HFC Network Construction Requirements

When constructing HFC networks, it is essential to consider not only actual optical cable usage but also business development and management as fundamental factors. The bidirectional transmission technology of the basic network must be fault-free. Since this project aims to ensure stable signal transmission, it must neither interfere with basic television signals nor neglect the characteristics of the HFC network for regional construction, dividing users and optical cable access below the sub-headend. Sub-headends connect to optical nodes via optical cables, covering large numbers of network users. Network performance assurance depends primarily on two factors: user scale and optical node quantity.

2.2 EOC Scheme Basic Characteristics

As EOC two-way transformation is based on existing HFC networks, the most critical system component lies in the EOC terminal, enabling optimized utilization of branch distributors and coaxial cables. Currently, EOC technology has matured, with fundamental technical problems resolved. Even in dual-fiber systems, it can separate cable television signal transmission from Ethernet signal transmission to prevent noise interference with signal quality.

2.2.1 Leveraging HFC Network Advantages

As EOC two-way transformation is based on existing HFC networks, the most critical system component lies in the EOC terminal, enabling optimized utilization of branch distributors and coaxial cables. Currently, EOC technology has matured, with fundamental technical problems resolved. Even in dual-fiber systems, it can separate cable television signal transmission from Ethernet signal transmission to prevent noise interference with signal quality.

2.2.2 Stable Access Services in Triple-Play Context

Triple-play services require simultaneous transmission of data, voice, and video over the same network, provided that all user service quality remains normal. Therefore, EOC solutions must encompass all aspects of the system service model, such as business control mechanisms and priority data processing, achieving line-rate scheduling and processing through high-speed data processing engines. Following EOC technology transformation, user experience has significantly improved, and broadcasting operators will inevitably adopt it widely due to its low maintenance costs and exceptional system stability.

3.1 Technical Requirements for Zhangzhou's Two-Way Network Transformation

The equipment selected for this two-way network transformation must possess strong anti-interference capabilities, certain adjustment capacity for severe noise conditions during large-scale line attenuation, and must not affect television signals. Equipment must be stable and efficient, with lightning resistance and voltage fluct tolerance. It must have network management capabilities, enabling remote management and control of all service equipment through the management system, with log recording functionality. The equipment must support remote online batch upgrades, remote information queries, and configuration. It must have high throughput and cover numerous users, meeting concurrent rates for user Internet access and related services. When business expansion requires increased bandwidth, smooth upgrades must be possible without another transformation. It must meet relevant technical requirements and regulations from the State Administration of Radio, Film and Television.

3.2 Design Principles

During Zhangzhou' s cable television two-way network construction, it is necessary to fully understand actual circuit conditions in communities implementing two-way services and users' actual bandwidth requirements. ONU division and selection of high-frequency or low-frequency EOC equipment must be reasonable to ensure subsequent upgrade and expansion capabilities. During the design process, initial user bandwidth allocation follows these requirements: 2M per household for Internet access, 2.5M per household for on-demand services, ensuring concurrent bandwidth demand is not less than 4M. For newly built communities, HFC planning and design must appropriately adjust the overall scheme according to business conditions. The optical cable network requires long-term planning to avoid repeated cabling. For downstream TV signals, the 1550nm combined with EDFA model is used, with EDFA installed at subheadends or community equipment rooms as appropriate. Community equipment rooms are laid out in a star configuration with 4 fibers per optical node as the main standard. Coaxial network construction must emphasize optical receiver selection, using domestic broadband receivers that meet other indicators with power acceptance below 4dB, ensuring output levels above 98dB with stable attenuation, 220V power supply, and AGC functionality. The principle is to use optical receivers without amplification equipment, with one equipment room per residential community, and network equipment must be housed in equipment boxes with reliable grounding for active devices. For old communities (those built according to previous designs, accounting for over 95% of the total and representing the key area for two-way network transformation), EOC product performance must be reasonably designed based on community cable television network conditions and user distribution. Considering network quality and future business upgrades requiring extension to user premises, optical receivers should be appropriately increased, and EOC local installation positions

of optical receivers should reach buildings directly.

3.3 Actual Application

EOC technology is an access technology based on Ethernet protocols over cable television coaxial cables. The fundamental concept is to modulate Ethernet data signals onto a specific channel, enabling data signals and cable television signals to be transmitted over the same cable without mutual interference, distributed to user terminals through cable television networks. At the user end, a splitter separates television signals from data signals for connection to corresponding devices. Currently, China' s EOC technology includes baseband EOC and modulated EOC. Modulated EOC technologies mainly include MOCA, BIOC, HINOC, and PNA. Although no unified standard currently exists for EOC technology, within the two-way technology system of cable television networks, EOC technology solutions remain a viable choice before fiber-to-the-home is fully realized. EOC technology maximizes utilization of existing cable television network resources and structures, preventing large-scale modifications. After comparative analysis of EOC technology products, low-frequency HOME and high-frequency MOCA are selected for modulation based on network status and upgrade requirements. EPCN products can use low frequencies, which allow greater line attenuation values and longer transmission distances. For initial users, maintenance coverage can be achieved by placing EPCN headend equipment near optical receivers. Data signals can use cross-connection mode through amplification equipment, utilizing the 7-30MHz low-frequency band with strong network adaptability, supporting branch distributors in the current network' s frequency range, but the product' s anti-electromagnetic interference capability is poor. Currently, Zhangzhou' s optical network nodes cover over 300 households, with amplifiers not exceeding two levels and cable lengths under 300 meters, predominantly using a small number of optical nodes to cover users. After preliminary estimation of transformation workload and construction difficulty, EOC headends are placed at optical node locations, covering fewer than 300 households. If user numbers increase later, only headends need to be added to ensure coverage quality meets expectations per headend. Therefore, after considering user network environment and stability conditions, HomePlug AV products are selected for transformation, but the goal is not large-scale network modification—only minor adjustments to partial cable networks and optical nodes are required. HomePlug AV headends connect to the EPON system, mixing with television signals in the DATA/TV combiner for input to the cable network. Since HomePlug AV data signals cannot pass through amplifiers, separate cross-connection must be set up, preferably using high-low frequency split amplifiers to reduce network structure complexity, though amplifiers still need replacement with specific modes adjusted according to actual conditions. Additionally, although some of Zhangzhou' s network two-way transformation has been completed, many issues remain, such as messy cable television networks in some users' premises and damaged HFC network structures, resulting in high communication interruption rates even within short transmission ranges.

Therefore, later line planning must focus on testing data signal link loss to avoid poor experience for newly added users. Currently, the EOC solution system is relatively mature, with existing standard differences, but as long as it meets the EOC two-way transformation model, it will connect with the community' s existing network resources. China' s cable television coaxial cable network coverage serves as the most basic line coverage model. With such a large user scale, its inherent quality characteristics deserve recognition. At this stage, EOC technology frequently appears in broadband network development and transmission processes in China, and the increasing demands of the Chinese people will make requirements for EOC technology more stringent. In the transformation and construction of two-way television networks, the unique characteristics of EOC solutions are the key success factors.

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