Application of FTTH Access Scheme in Digital Television System

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Abstract. Due to the increase in the demand of users, digital TV network can not only meet watching the digital TV programs, but also meet the fast service of various data upload and download. So, FTTH program is used in an increasing number of digital distribution network transformation projects. According to the characteristics of different types of buildings, the writer discussed three access network schemes in detail for multi-story residential access, high-rise residential access and villa area access.

Introduction

Digital TV system has replaced the cable TV system with its obvious advantages. The establishment of digital TV network is realized based on the transformation of the existing cable TV system. The cable TV network is divided into trunk network and distribution network. The digital process also includes these two parts. In the past ten years, China's digital TV network has developed rapidly. Because of the complexity of the geographical conditions of our country, it makes the digital of the distribution network more difficult.[1] The application scheme of the digital distribution network is also more. Due to the increase in the demand of users, digital TV network can not only meet watching the digital TV programs, but also meet the fast service of various data upload and download. So, FTTH program is used in an increasing number of digital distribution network transformation projects. [2] FTTH (fiber-to-the-home) means fiber reaches the boundary of the living space, such as a box on the outside wall of a home. Passive optical networks and point-to-point Ethernet are architectures that deliver triple-play services over FTTH networks directly from an operator's central office. [3]

At present, the main business of radio and TV operators includes both the broadcast television business and the two-way data business. Therefore, the construction of FTTH network is necessarily related to the construction of FTTH for TV broadcasting and for two-way data business. In combination with the existing resources, there are three main programs to achieve the FTTH network construction. The first one is using coaxial cable to transmit TV broadcasting service and using FTTH network to transmit two-way data business. The second one is using single fiber three-wave scheme to achieve TV service and data service. The third one is using dual-fiber three-wave scheme to achieve TV service and data service. Combined with a variety of factors, dual-fiber three-wave scheme is the most advanced, the highest reliability and the best cost performance FTTH solution.

Application of FTTH Access Scheme

According to the characteristics of different types of buildings, the FTTH access network is divided into multi-story residential access, high-rise residential access and villa area access.

Multi-story Residential Access

The multi-story residential buildings is generally below 10 floors. The number of users is relatively small. Usually, there are two to four households per floor. The total number of households is less than 40 per unit. Each building has several units. In this scheme, we assume that the total number of users is 400, and there are 20 units in the district, 10 floors per unit, 2 users per floor.
**Networking Scheme.** The number of users in this scheme is 400, less than 1000, so it is recommended that the OLT placed in the front machine room, in order to facilitate the later maintenance. And the distance between sub-front machine room to the area is less than 5Km. OLT has 10 PON ports, with each PON port using optical splitting ratio of 1:64 to access the users. The output optical power of optical amplifier is about 22dBm. Each port uses optical splitting ratio of 1:256 to access the user’s points. In this spectral structure of the model, television broadcasting platform and bidirectional data platform are used two-stage optical splitting structure. The signal of television broadcast platform is conducted the first level of 1:16 optical splitting in the junction box, and then the second level of 1:16 optical splitting in the distribution box in the building. And then the signal will enter into the user’s home via fiber links. The two-way data platform signal will complete the first level of 1:4 optical splitting in the junction box, and then after the completion of the second level of 1:16 optical splitting in the distribution box, the signal will achieve the user's home through the fiber access. In line segment, an optic cable junction box of 128 cores capacity will be installed in the district. The trunk fiber from the front end will be conducted optical splitting of 1:4 and 1:16 in transfer box. Then, from the area machine room, a twelve-core optical cable is laid to reach each unit. Four cores of the optical cable are used for TV broadcast platform, and four cores for bidirectional data platform. In the home phase: optical cable is introduced through the first floor. Optical splitting is completed in the distribution box. The television broadcasting platform will complete 1:64 optical splitting by four 1:16 splitters, and then the signal will reach into the user’s home by indoor cable. The bidirectional data platform also uses the same method to enter into user’s home. And in the user's family, using SC optical fiber connector to achieve FTTH access.

**Optical Path Attenuation Calculation.** The loss of 1:4 splitter is 7.5dB, and it of 1:16 splitter is 13.8dB. The connector insertion loss is about 1dB and splice loss is about 0.5dB. The district internal wiring terminal loss is about 0.2dB. The average loss per kilometer of TV programs transmission fiber is 0.2 dB/km, and that of bidirectional data is 0.36 dB/km. Also because the distance from the front room to the village is less than 5km, 1dB margin should be leaved at the time of construction. So, the total bidirectional data signal optical attenuation is 0.36×5+7.5+13.8+1+0.5+0.2+1=25.8dB. This value can meet the design requirement of less than 26dB. And the total attenuation of television broadcasting platform is 0.2×5+13.8+13.8+1+0.5+0.2+1=31.3dB. Which also can meet design requirement of less than 32dB.

![Figure 1. Optical Path Attenuation Calculation of the Multi-Story Residential Access.](image)

**The Advice of Multi-story Residential Access.** Optical splitters are placed in transfer box and the distribution box. The optical splitter output from optical transfer box uses skeleton type optical cable to cover the whole area by the way of directly-buried or pipe laying method. Near each building, Optical cable connector box is used to complete cable branching. The output of the optical splitter in distribution box can use indoor cable to reach the user's home.

**High-rise Residential Access**

The characteristics of high-rise residential is more than 10 layers, with more users in each floor and more total users. The building has the improved shaft and pipeline facilities. This scheme assumes
that the model has a total number of about 1000 households, 10 units, 24 floors per unit, and 4 households per floor.

**Networking Scheme.** In principle, if there are more than 1000 users, the number of PON ports is greater than 15, and there is no access within 1 kilometer, the OLT can be considered to set in the district. In order to reduce the occupancy of core fiber, the OLT position is proposed to move down to the district. The OLT, supplied power by AC or DC, can use cassette and small volume OLT equipment. It has 15 PON ports for output. Each PON port access the user with total 1:64 optical splitting ratio. The optical amplifier outputs power of 22dBm, each port with total 1:256 splitting ratio for user access. Uplink signal will be connected to the three-layer switching devices through the 10GE link ports. The optical amplifier of the broadcasting network also moves down to the district to achieve the access of television business for 1000 users. In this spectral structure of the model, television broadcasting platform and bidirectional data platform are used two-stage optical splitting structure. The total optical splitting ratio is 1:256 in broadcasting channel. The first 1:8 is completed in the district machine room. And then in the building, 1:32 is completed every 8 floors. At last, the broadcasting signal will access the user’s home through indoor cable. The total optical splitting ratio of bidirectional data channel is 1:64. The first 1:2 is completed in the district machine room. Then in the building, 1:32 is completed every 8 floors, At last, the data signal will access the user’s home through indoor cable. In line segment, an optical cable junction box of 96 cores capacity is installed in the district machine room. The signal from OLT and EDFA equipment will be conducted optical splitting of 1:2 and 1:8 by splitters in transfer box. Then, from the area machine room, an eight-core optical cable is laid to reach each unit. Six cores of the optical cable are used for business, including three TV broadcast platform cores and three two-way data platform cores. The other two cores are for backup and test. In the last phase, the cable wiring enters the building through light current cable channel. The cable is divided into vertical wiring by the eight cores fiber splitting box. A 64 cores wall-mounting cable wiring box is used every 8 floors. Optical signals of broadcasting platform and two-way data platform will complete 1:32 optical splitting in the box. Then, the signals enter into the comprehensive information box for each family using indoor cable through the corridor underground pipe. In the comprehensive information box, they access the ONU (optical network unit) and optical receiver with SC terminals.

**Optical Path Attenuation Calculation.** The loss of 1:8 splitter is 10.5dB, and 3.8dB of 1:2 splitter, 17dB of 1:32 splitter. Because the distance from the front room to the village is less than 5km, 1dB margin should be leaved at the time of construction. So, the total bidirectional data signal optical attenuation is 3.8+17+1+0.5+0.2+1=23.5dB. This value can meet the design requirement of less than 26dB. The optical attenuation of television broadcasting platform is 10.5+17+1+0.5+0.2+1=30.2dB. Which also can meet design requirement of less than 32dB.

![Figure 2. Optical Path Attenuation Calculation of the High-rise Residential Access.](image-url)
The Advice of High-rise Residential Access

Optical splitters are placed in transfer or building shaft cable wiring box. Optical cables enter into the building from the underground pipe line. In the building, the cables are placed vertically along the shaft using vertical wiring method. Optical distribution boxes are arranged in a certain interval of floors, with one box for 1-8 floors. Actually, it can be determined according to the number of users per floor. The optical signal enters into the user’s home by indoor cable.

Villa Area Access

Villa area users are scattered. The total number is less, but, with a wide range of coverage. Usually, the building model can be double villa or single family villa. Each building has only 1-2 households. The assumption of this scheme is that the total number of users in a villa area is 100.

Networking Scheme. OLT equipment and optical amplifier are placed in the sub-front machine room, and the distance between sub-front machine room to the area is less than 10Km. OLT has 4 PON ports, with each PON port using optical splitting ratio of 1:32 to access the users. The optical amplifier uses a general frame or rack type with single port output. Output optical power is 22dBm. Each port uses the splitting ratio of 1:128 to access users. Because of the scattered characteristics of villa residential buildings, scattered optical splitting is very difficult to find reasonable placement. It proposes to adopt concentrated splitting method. The optical cable transfer box can be placed in the community center (such as green belt, etc.) and splitters are installed in the transfer box to realize concentrated optical splitting. Television broadcasting platform optical signal will pass through 1:4 and 1:32 splitters placed on the transfer box, and then the signal will be introduced to the user’s family by the introduction optical cable. The two-way data platform signal will be handled by 1:32 splitter in the junction box, then, introduced to the user by the introduction optical cable. In line segment, every 10 households as a wiring area, an optical cable splitting box is set up. 24-core optical cable is laid. In the last phase, 2-core indoor optical cable is laid from the fiber splitting box to each villa to achieve FTTH. In the comprehensive information box, they access the ONU and optical receiver with SC terminals.

Optical Path Attenuation Calculation. The loss of 1:4 splitter is 7.5dB, and 17dB of 1:32 splitter. The average loss per kilometer of TV programs transmission fiber is 0.2 dB/km, and that of bidirectional data is 0.36 dB/km. Also because the distance from the front room to the village is about 10km, 2dB margin should be leaved at the time of construction. So, the total bidirectional data signal optical attenuation is0.36*10+17+1+0.5+0.2+2=24.3dB. This value can meet the design requirement of less than 26dB. The optical attenuation of television broadcasting platform is 0.2*10+7.5+17+1+0.5+0.2+2=30.2dB. Which also can meet design requirement of less than 32dB.

Figure 3. Optical Path Attenuation Calculation of the Villa Area Access.

The Advice of Villa Area Access. Optical splitters are placed centrally in cable transfer box. The output uses skeleton type optical cable to cover the whole villa area by the way of directly-buried or
pipe laying method. Separating fiber box can be placed by underground pipes or rods in the villa area. One separating fiber box can provide 4 to 10 users access. After splitting, the optical cables use of indoor and outdoor self-bearing type or pipe-shaped to introduce into the home. All fiber must be introduced into the integrated information box for better protection. In practical engineering, pigtail connection can be used to realize fiber terminal.

**Conclusion**

FTTH has many advantages. First, it is a passive network. Second, its bandwidth is relatively wide, long distance is in line with the operators. Third, it can support many protocols, suitable for the introduction of a variety of new business. So, it is the most ideal program in digital television system construction.[4] We should take the road of the development of the digital television with Chinese characteristics. The digital of television is not only the upgrading of technical equipment, more important is it will change the service and management. It is an important social system engineering, involving the interests of millions of households. [5] We must start from the national conditions, set up new ways to promote the development of digital television industrial.

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