# 11C3-4 (Invited)

# Development of optical fiber cable and wiring techniques in full-scale FTTH era

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## Abstract

This paper describes the current state of broadband services in Japan and the conditions required for optical wiring techniques in the access network as we approach the full-scale FTTH era. Furthermore, key techniques and recent development examples for mass construction are introduced.

## 1. Trend of broadband services

Recently, the "full-scale FTTH era" has almost arrived in Japan with the commercial introduction and spread of optical services.

As we see from the recent state of broadband services in Japan, the net increase in the number of broadband subscribers per year is approaching 3 million, while ADSL subscribers have started to decrease since the first quarter of 2006. (Figure 1) Therefore, the FTTH service is clearly becoming a leading component of Internet provision.

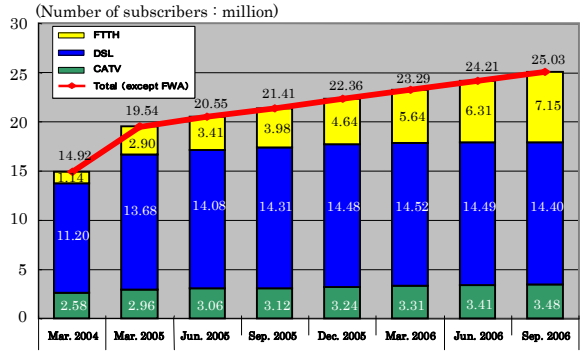


**Figure 1. Transition of broadband subscribers in Japan**

The spread rate of FTTH services to households now exceeds 15% in urban areas. Even in rural areas, the rate is between 2.5% and 5% as efforts are made to eliminate the digital divide. Therefore, it is predicted that the spread rate will continue to grow rapidly not just in urban areas but also throughout the whole of Japan.

When we look at the state of broadband services worldwide, we see that many countries are promoting their introduction. In terms of FTTH services, Japan is the frontrunner as regards service charge and number of subscribers. Therefore our FTTH experiences and technologies could assist other countries.

The "u-Japan" strategy was proposed as a national policy in 2006. The main targets to be achieved by 2010 are shown below.

1. Total broadband coverage
2. More than 90% of households equipped with broadband

And NTT plans for a further acceleration of the expansion of FTTH services and aims to increase the subscriber number to 30 million by fiscal 2010

## 2. Requirements for cable wiring and R&D View

The conditions required for full-scale FTTH service deployment are regulated based on the situation in Japan. Previously, the main target was to reduce the cost of service construction for a fixed level of demand. By contrast, as we move towards the full-scale FTTH era, we need both cost reduction and a quick response to demands for construction. With regard to access network development, we need to construct facilities with long-term durability and develop techniques that enable economical and efficient large-scale construction. Three actual examples are provided below.

(1) Quality assurance

This is the basis of all services. Although problems are commonplace, their affect in large-scale facilities is very serious and we must prepare for many predictable issues at the construction stage. Facilities must offer long-term durability to such environmental factors as wind pressure, vibration, temperature change, the ultraviolet rays of the sun, and the harmful effects of birds and insects. A technique for avoiding human errors in construction is also needed. We have to follow previous specifications and handle new tasks.

(2) Mass construction

Facilities and techniques are required for unprecedented large-scale construction and maintenance. The amount of construction will have doubled by 2010, and the number of service changes and amount of re-construction will increase corresponding to the number of facilities.

It is difficult to achieve the above target with present methods because human resources themselves are limited. Simple and efficient work is needed that reduces the total cost. This will also contribute to a reduction of construction time and improved customer satisfaction.

(3) Flexible network

To correspond to the provision of large-scale services, the total access network from the central office to user equipment must be efficient as regards investment and maintenance. The facilities must provide a flexible response to service demand with the fewest facilities

## 3. Key techniques and recent developments

As specific approaches to meet the above requirements, an easy construction technique that does not require skilled workers, an easy post-construction operation technique, and a flexible response network technique have been developed. The use of connectors and the elimination of bare fiber storage are effective ways to achieve these goals. Some examples are introduced here.

(1) House wiring technique in user houses

With conventional house wiring, a hard indoor optical fiber is installed and bare fiber must be spliced and stored at the lead-in part and connecting part in an ONU. This takes considerable time to accomplish. So, a free bending optical fiber cord has been developed that can be handled like copper cable. Figure 2 shows the application of free bending optical fiber cord. By providing a connector point at an optical rosette, easy connection is achieved and this is effective for mass construction. It is also allows the ONU made smaller by eliminating the need for bare fiber storage, reducing the fiber breakage that sometimes occurs in house wiring, and eliminating unattractive fixed wiring.

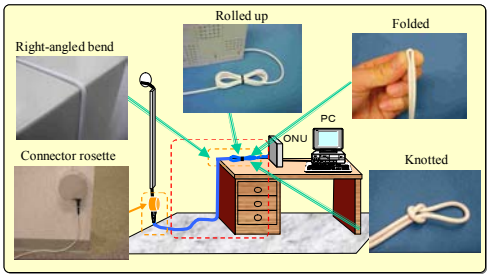


**Figure 2. Application of free bending optical fiber cord**

(2) Aerial optical closure technique

Conventionally, new construction and fiber transfer always required the splicing and storage of bare fiber. This was complicated skilled work that took much time. To simplify this, we have developed stub connectors and a splitter module. This means that fiber storage work is no longer needed, and it is sufficient to assemble connectors and then connect them. The use of a cable sheath holding stub connector facilitates post-construction transfer work in a closure.

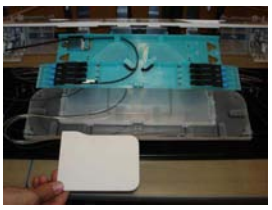

**Figure 3. New aerial optical closure**

(3) Aerial wiring technique

Conventional cable has a simple structure to keep costs low, so optical loss increases when fibers are extracted. As a result, all drop closures must be set up at the same time as the cable is installed. Therefore, an 8-fiber distribution cable and a corresponding aerial optical closure have been developed. This cable enables optical fibers to be easily extracted with less loss change while maintaining a simple structure. Therefore, it is possible to set up a closure according to service demand. Connection work is simplified by using connectors.

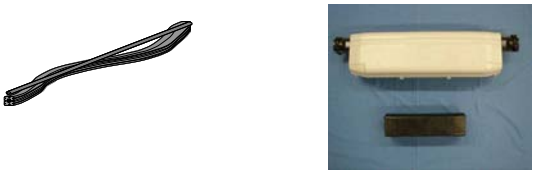

**Figure 4. DF cable and AOF closure**

(4) Underground wiring technique

We are developing a multiple cable installation technique as an effective way of using existing conduits. Conventionally, a maximum of 2000 fibers can be accommodated with a straight-line distance limitation in a $\phi$ 75 mm conduit. Figure 5 shows multiple cable installation in a conduit by using a small diameter inner pipe with a thinner wall. The adoption of a small diameter and a thinner wall is expected to reduce the required pulling force. And this will lead to a relaxation of the distance limitation and the ability to accommodate up to 3000 fibers. This approach controls investment without the need for civil construction and also shortens the construction time.

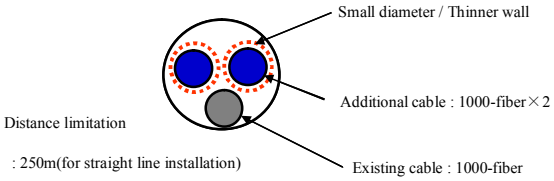


**Figure 5. Multiple cable installation in a conduit**

## 4. Conclusion

The broadband access market for mass users is expanding and starting to shift from ADSL to FTTH. If we are to achieve our targets by 2010, it is very important that we realize prompt installation, and establish easy operating techniques for optical access networks. The keys are efficient construction and cost reduction.