# Optical Cable Network Deployment for Multi-DwellingUnit

Yukihiro YOKOMACHI*, Hiroshi MIYANO, Kotaro UEDA, Jonathan Bertucci and George A. Mackie

In this paper, we propose a new solution for the optical cable network deployment for a multi-dwelling unit (MDU) by using the Free-Branch Cable. This cable is applicable to the deployment on the floor and the outside wall surface of any scale of MDU and each fiber can be accessed at any point along the span of the cord bundle in order to respond to service order. To test this cabling system, we conducted a field trial at an existing building, and confirmed that the new solution is convenient and effective for the FTTH construction.

Keywords: MDU (multi-dwelling unit), FTTH, ribbon cord, Free-Branch Cable, transition device

## 1. Introduction

In accordance with the spread of high-speed FTTH service, the demand of an optical distribution for a multi-dwelling unit (MDU) is increasing rapidly. **Figure 1** shows an example of the conventional way to deploy the optical cables in MDU. The Fiber Distribution Hub (FDH) with built-in splitter is set to the entrance of the building and a drop cable is installed from FDH to each unit whenever the demand of FTTH is occurred. However, this way leads to the problems of frequent construction works to wire from FDH to each unit with respect to each service order and no more space to deploy the additional cables inside the raceway in accordance with the increase of subscribers.

**Figure 2** shows another conventional way by which optical cables are deployed in MDU. The multi-fiber cable is installed in the vertical direction and each individual drop cable is distributed in the horizontal direction. The multi-fiber cable can be accessed at mid-span and spliced to each individual drop cable in the distribution cabinet installed in every floor. This solution could clear up the problem of distribution space for vertical raceway. However, this solution requires the cabinets, leading to another problem of the construction cost for the installation.

Furthermore, in case of an existing building, especially a small size of MDU, there is no more space to deploy additional cables in the existing pipe line. Thus, the optical cable network spread of MDU has fallen behind as compared with that of Single-Family Unit (SFU).

In this paper, we propose a low-cost optical cabling solution which is able to save the space for deployment and wire to each unit within a short time by using the Free-Branch Cable. Although the deployment is different in each case, the design concept of the cable is common for any scale of MDU.

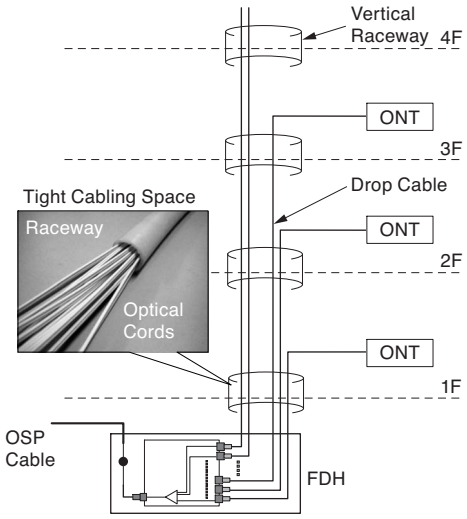


**Fig. 1.** Conventional optical solution (1)

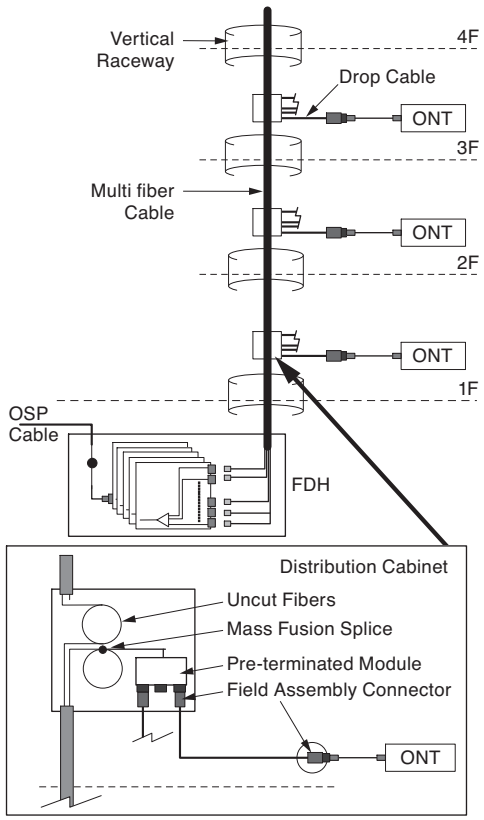


**Fig. 2.** Conventional optical solution (2)

## 2. Cabling System for Large MDU

A large-scale MDU has approximately more than ten to several dozens of units on every floor. A conventional method has been adopted to deploy a drop cable to the optical network terminal (ONT) of each dwelling unit with a vacant space of an existing telephone conduit as an optical service order occurred.

However, the deployment was frequently performed because of distributing the optical cable from FDH to every unit whenever a service order occurred. The cabling space becomes tight and additional cabling cannot be performed as subscriber is increased.

The method using the multi-fiber cable for a vertical distribution cable (**Fig. 2**) could have been solved the space problem. However, a cabinet is needed for splicing a vertical cable with a horizontal cable, and so there have been the difficulties in ensuring an installation space and an installation cost problem.

For the purpose of solving these problems, we propose a new distribution solution using the ribbon cords terminated multi-fiber connectors at both ends for a vertical cable and using a bundle of single fiber cords split from the ribbon cords for a horizontal cable (**Fig. 3**). Vertical ribbon cords are bundled and preliminarily divaricated so as to drop into each floor. The connecting point of a vertical cord and a horizontal one is terminated with a multi-fiber push-on (MPO) connector and protected in a connector sleeve whose size is 140 mm (L) x 25 mm (W) x 18 mm (H). It is so compact that it can break the problems with an installation space.

The horizontal cable has a transition device dividing a ribbon cord into a bundle of 2 mm cords as shown in **Fig. 4**. The ribbon cord is pre-spliced in the factory to the fibers of individual cords inside the transition device. The transition device is 30 mm OD by 250 mm length and so compact as to be free from the limitation of space.

The Free-Branch Cable is a bundle of 2 mm cords and each fiber can be accessed at any point along the span.

At the same time when a vertical cable is deployed, this horizontal Free-Branch Cables are set on the floor in a loop. Therefore, when a service order occurs, the construction work can be finished just by cutting the cord near the dwelling unit and terminating with a field installable connector.

In case the MDU is not so large, the bundle of ribbon cords terminated with MPO connectors is no need as shown in **Fig. 5**. The outline of construction is described below.

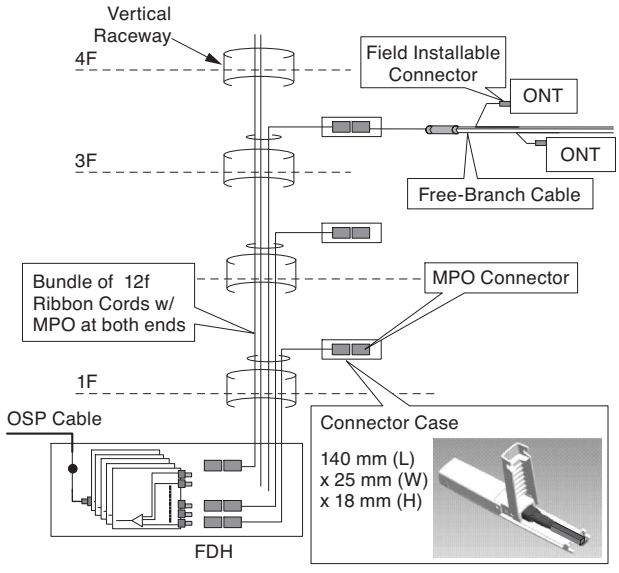


**Fig. 3.** Cabling network for large scale MDU

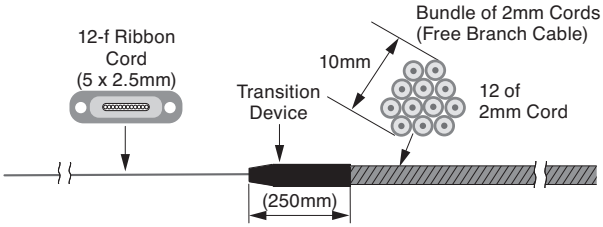


**Fig. 4.** Cable configuration for large MDU

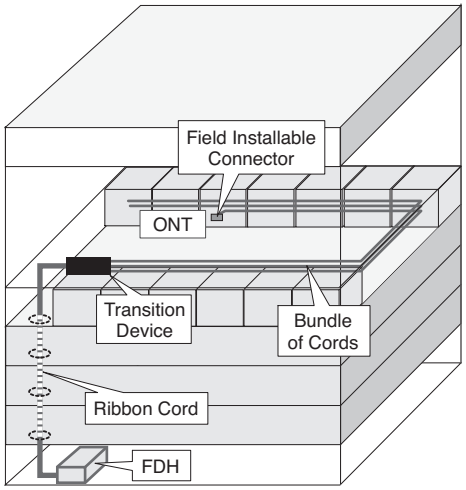


**Fig. 5.** Cabling network for middle scale of MDU

The first step is to set the transition device to the routine floor. The second one is to drop the ribbon cord downstairs and connect into FDH. The last one is to be set to Free-Branch Cable in a loop using a duct on dwelling units. The initial work is done with the three steps.

The field worker cuts and drops a cord within his reach at any position near dwelling unit and terminates a field installable connector to connect the ONT of the dwelling unit when service order occurs. This work does not require any cabinet and can help to eliminate the need for the frequent deployment which requires a large amount of time. As a result, the field worker will finish the work in a very short time.

## 3. Cabling System for Small MDU

Most of the MDU are comparatively small scale from a few houses to several dozens of houses in total. There have been two issues: The existing telephone conduit is so small that it's impossible for additional cables to be deployed and there is no space to set up the cabinet.

We propose a new solution applicable to such a small MDU by distributing the cable on an outer wall surface (**Fig. 6**). The applicable cable configuration is as shown in **Fig. 7**.

The Free-Branch Cable bundled with single fiber cords is designed to finish one construction work. The cable sheath material is applicable to the outdoor environment and the cable has a central strength member (CSM) to secure on a wall. The cable can be divided and terminated with connectors preliminarily in the factory because the vertical pitch of each floor is almost common. Once the Free-Branch Cable is vertically deployed on the outside wall of the building, the construction work for the service order can be finished only by pulling the cable into a dwelling unit and connecting with ONT. This cable is deployed more easily than the conventional ones in the field. In addition, the connector is secured to prevent damage in outdoor environment.

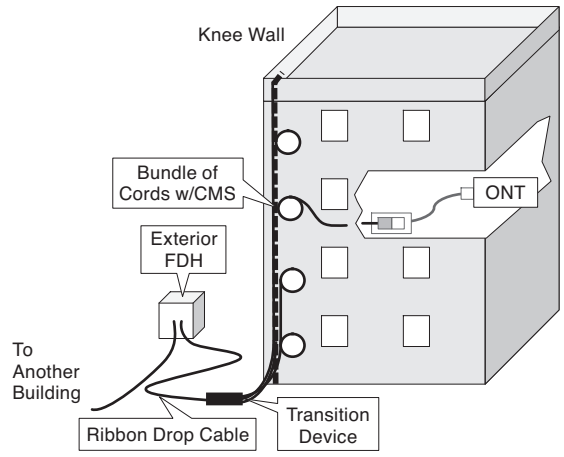


**Fig. 6.** Cable network for small MDU

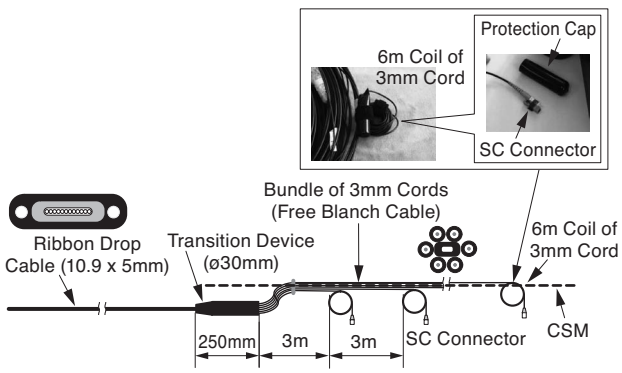


**Fig. 7.** Cable configuration for small MDU

The plural ribbon cords are deployed from the buildings to FDH so as to increase the take rate of splitter involved in FDH and cover plural Multi-Dwelling Units with one FDH. The cable and a bundle of cords are pre-spliced in the factory.

## 4. Field Trial for Small MDU

We have conducted a field trial to verify our solution for small MDU at an existing building. The outline is as follows;

The cables for the field trial were the same configuration as shown in **Fig. 7**.

**Figure 8** shows the deployment procedure and photographs. The installation works were done by two workers (one worker was on the top side and the other was on the ground side). The cable was coiled up in 80 centimeters diameter to go up and down the stairs on worker's shoulder (**Photo 1**).

The first step was to go up to the top. The second step was to drop the ribbon cable to the ground from the top of the building (**Photo 2**). The third step was to secure CSM on the top and ground walls (**Photo 3**, **Photo 4**). The last step was to drop the ribbon cable along the outer wall horizontally and drag the cable into the exterior FDH in the building. The transition device can be secured on the building wall during this deployment work (**Photo 5**). Thus, the cabinet is unnecessary at the connecting point.

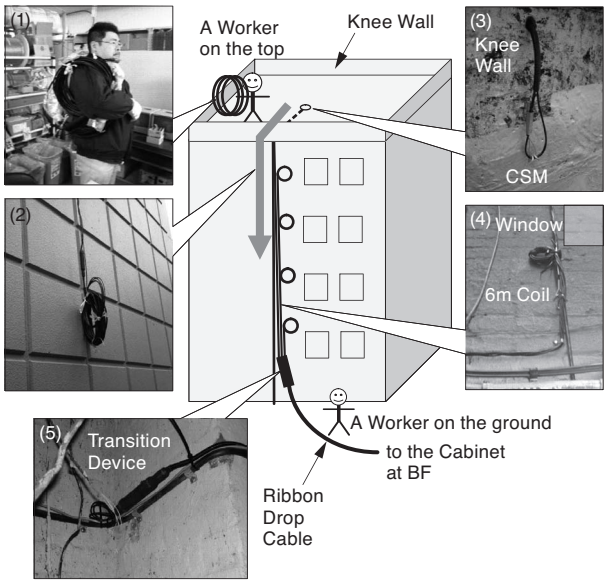


**Fig. 8.** Cabling network of field trial for small MDU

## 5. Characteristics and Performance

**Table 1** shows the typical characteristics and performance of the cable on outdoor wall used in this field trial.

**Table 1.** Characteristics and performance

| Item | | | Characteristics and performance | |
|---|---|---|---|---|
| Cable | Cord | Fiber | Equivalent to G.657.B | |
| | | Cord diameter | 3 mm | |
| | | sheath | PVC (Black), UV resistance | |
| | | Number of cords | 6 | |
| | Outer diameter | | 10 mm | |
| | CSM | | Dielectric, flat (5 x 11 mm) | |
| | Flammability | | UL1666 riser | |
| | Environmental | Temperature cycling | -40 to 70 deg C (GR-20) | <0.06 dB/km |
| | | Water penetration | 1 m, 24 hours (GR-20) | No water leak |
| | Mechanical | Tensile strength of cable | 1320 N (GR-409) | <0.01 dB No Cracking |
| | | Impact resistance | 5.9 Nm (GR-409) | < 0.01 dB No Cracking |
| | | Cable twist | +/-180 deg 10 cycle, 50 N (GR-409) | < 0.01 dB No Cracking |
| Transition device | Dimension | | 25 mm (D) x 250 mm (L) | |
| | Material | | Plastic covered with UV resistant heat shrinkable tube | |
| | Environmental | Temperature cycling | -40 to 75 deg C (GR-2866) | < 0.10 dB |
| | | Water resistance | 3 m water head (GR-771) | No damage |
| | Mechanical | Tensile | 44.5 N (GR-2866) | < 0.01 dB |
| | | Side pull | 22.3 N (GR-2866) | < 0.05 dB |
| | | Flex | 9.8 N,100 cyc. (GR-2866) | < 0.05dB |

## 6. Conclusions

We proposed a new solution for the optical cable network deployment for MDU by using the Free-Branch Cable with a transition device. The Free-Branch Cable is applicable to the deployment on the floor and the outside wall surface of any scales of the building. We made clear that the new solution is convenient and effective for the FTTH construction.


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