High-Density Optical Cabling Solution for Data Centers

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Global data traffic has been steadily increasing with the spread of the Internet. High-density and high-efficiency cabling between server racks and devices has become more and more important for data centers. We have developed multifiber push-on (MPO) cassettes (PrecisionFlex) and a polarity conversion LC connector (FlexULC). This paper suggests a plug-and-play solution that eliminates the need for fusion splicing by using these new products in combination with round cords and trunk cables that use our MPO connectors (SumiMPO) for improved handling in the field.

Keywords: data center, high-density cabling, plug-and-play, MPO cassette, polarity change

1. Introduction

Global data traffic has been continuously increasing due to the recent proliferation of Internet services. Notably, data centers handle big data and underpin the Internet services. They play a more significant role than previously thought because they offer colocation services (renting server installation space to customers) and hosting services (renting servers owned by data center operators to customers).

According to the White Paper 2016 (Information and Communications in Japan)[1] published by the Japanese Ministry of Internal Affairs and Communications, data traffic handled in the global data center market will further increase. Specifically, such data traffic will more than triple from 3.4 zettabytes*[1] in 2014 to 10.4 zettabytes in 2019.

Under these conditions, we have developed optical communication-related technologies for data centers such as low-power-consumption small optical transceivers[2] and 3456-fiber-count optical cables using pliable ribbons[3] for connecting data centers.

This paper presents our efforts to meet the need for increased density and efficiency of optical fiber cabling in data centers. We will discuss the issues of the current optical fiber cabling technology, and then present optical fiber cabling solutions and relevant new products to overcome these issues.

2. Current Issues in Optical Cabling for Data Centers

In the case of conventional structured cabling such as Fiber to the x (FTTx),*[2] optical fiber cables are installed, and optical fibers in the cables are fusion-spliced with fan-out cords*[3] and stored in panels for termination.

At data centers, optical cabling is performed based on the above method, but there has been a growing need for (1) quick expansion to meet the growing demand, (2) higher density to effectively utilize the space, and (3) higher reliability, among others.

To meet such needs, the plug-and-play system has come into widespread use. This system uses cables and cords with connectors that do not require termination (including fusion-splicing) and cassettes that accommodate fan-out cords with connectors provided at both ends.

The cabling work can be completed only by installing cables with connectors and connecting the connectors to cassettes. This does not involve fusion-splicing and termination that require specific skills. The work can be done quickly with high reliability.

The usage environment and workability must be taken into account when designing products from the viewpoint of high density. At data centers, 19-inch racks are commonly used, and optical fiber cables are consolidated at the top of these racks (Top of Rack) in most cases. The products used must offer both high density and workability at height.

3. Optical Cabling Solutions to These Issues

We have developed high-density optical cabling solutions for data centers to achieve plug-and-play interoperability while taking into account the expected usage environment and workability at data centers.

Figure 1 shows the products that have been developed: (1) a multifiber push-on (MPO) cassette (PrecisionFlex) that can accommodate up to 144 fibers (LC connectors) for 1 U

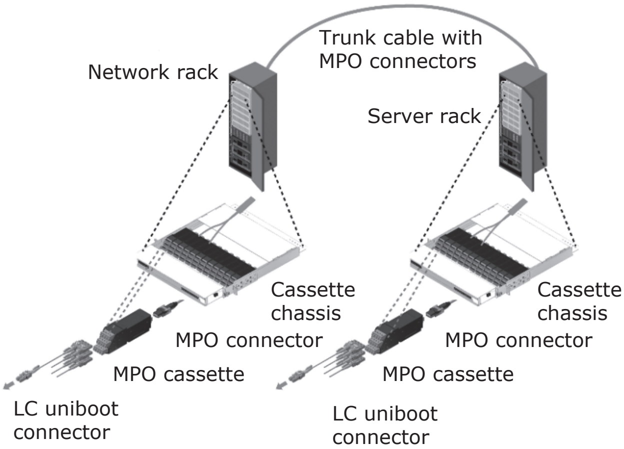

Fig. 1. High-density optical cabling solutions for data centers

and features excellent workability (e.g., installability in racks and attachability/detachability of connectors) and (2) an LC uniboot connector (FlexULC) whose polarity can be easily changed on site and its cord diameter has been reduced to easily achieve high density, and cables (round cords and trunk cables) with SumiMPO[4] that make it possible to easily change their polarity (like an LC uniboot connector) and gender*[4] on site.

A high-density and easy-to-use 10G Ethernet connection can be established by combining these products. In addition, it is easy to switch to 40G/100G by using connectors that use only eight channels in total (four channels on both sides of a 12-MPO). The on-site workload can be effectively reduced.

The features, functions, and characteristics of each product are discussed below.

3-1 MPO cassette/chassis (PrecisionFlex)

A conventional MPO cassette can accommodate 96 fibers for 1U, but there has been demand for higher density. We have developed PrecisionFlex that enables high-density accommodation in a chassis without undermining the attachability/detachability of connectors. The appearance of the products is shown in Fig. 2.

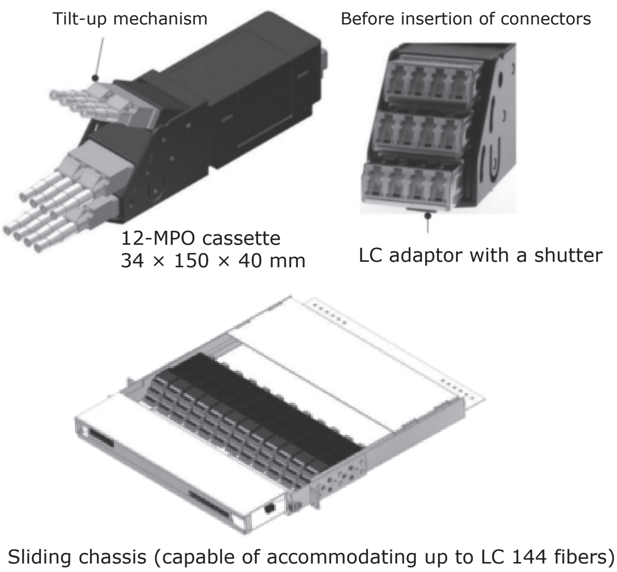

Fig. 2. New 12-MPO cassette (above) and sliding chassis (below)

The characteristics of the cassette and chassis are as follows.

(1) The number of fibers accommodated has increased from 96 to 144 (LC connectors).
(2) Expansion and removal can be achieved simply and quickly.
(3) A tilt-up mechanism has been added to the LC adaptor.
(4) A sliding chassis is used.

Regarding characteristics (1), three quadplex LC adaptors (with high space efficiency) are stacked by offsetting them to the depth direction while taking into account attachability/detachability of connectors. The cross section of the 12-fiber cassette has been minimized. As shown in Fig. 3, the number of fibers that can be accommodated in a 1U chassis has been increased by 1.5 times from 96 fibers (four 24-fiber cassettes) to 144 fibers (12 12-fiber cassettes) to achieve high density.

Regarding characteristics (2), latches (which do not require tools) have been introduced in place of screws to secure cassettes to the chassis. An LC adaptor with a shutter (which does not require a cap) has also been used to improve the installability to the racks and attachability/detachability and safety of connectors, achieving quick and smooth expansion and replacement.

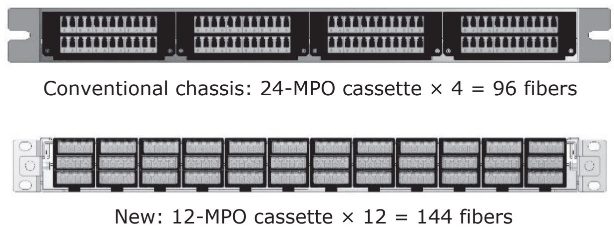

Fig. 3. Increased density of MPO cassettes

Regarding characteristics (3), three quadplex LC adaptors are designed to be tilted up independently to prevent decreased connector insertion/withdrawal performance (attributed to increased density).

Regarding characteristics (4), a chassis can be drawn to tilt up the quadplex adaptors even if other devices are set up on the chassis. This mechanism enables easy insertion and withdrawal of LC connectors. The slide width is 240 mm to secure the workspace necessary for replacing or adding any cassette (depth: 150 mm).

3-2 Polarity change LC uniboot connector (FlexULC)

Another new product is an LC uniboot connector (FlexULC). Conventional duplex LC connectors posed such issues as congestion of duplex cords and the need to specify polarity in advance.

We have developed an LC uniboot connector with a duplex LC connector attached to a two-fiber round cord. Figure 4 shows the cross section of a conventional two-fiber duplex cord (2 mm in diameter) and two-fiber round cord.

The cross section of the new cord is about 70% smaller than that of the conventional cord. The congestion of cords can be reduced, and cabling workability in the racks has been significantly improved.

In most cases, racks in data centers are not deep enough, and little space is provided between the doors and equipment (e.g., servers). For this reason, the length of connectors inserted into servers needs to be reduced. We reviewed the boot material and slit structure to reduce the length, and considered the possibility of using shrinkable tubes.

The dimensions of the new LC uniboot connector are compared with those of a conventional LCF connector in Fig. 5. We achieved a boot (length: 20.6 mm) that is 8.4

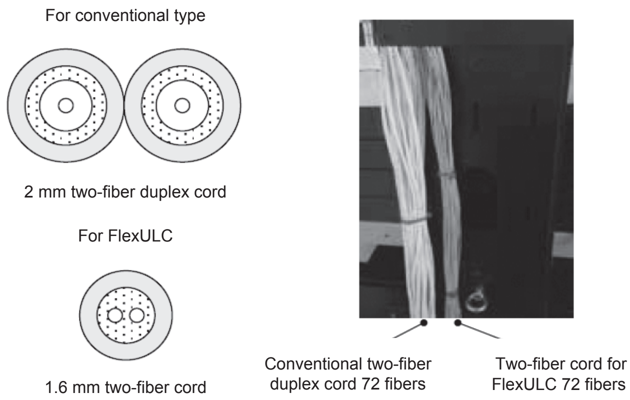

Fig. 4. Comparison between a conventional two-fiber duplex cord and a two-fiber round cord for the LC uniboot connector

mm (28%) shorter than that of the conventional connector without undermining the bending characteristics of the connector.

It should be noted that, in the uniboot structure, a two-fiber optical cable (from a single round cord) must be split in a duplex connector for assembling. Thus, the housing becomes longer than that of conventional LCF connectors.

We have minimized the housing size by optimally arranging the assembling members in the inner housing, and achieved the housing length of 27 mm. The total length is 47.6 mm, which is 1.4 mm shorter than conventional LCF connectors (49 mm) (see Fig. 5).

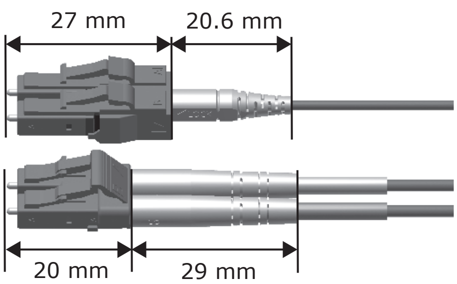

Fig. 5. Comparison of length between the LC uniboot connector (upper) and conventional LCF connector (lower)

Figure 6 shows a push-pull tab that is a standard feature of the LC uniboot connector. The tab enables the cabling workers to easily attach and detach connectors even if it is difficult to hold connectors with fingers for insertion and withdrawal due to the high-density adaptor layout [high-density accommodation panels and MPO cassettes (PrecisionFlex)].

The LC uniboot connector features a function to easily change the polarity (i.e., switching the left and right of the plug) without using jigs. Figure 7 shows how to change the polarity of the connector.

The boot serves as the key to the outer housing. By turning the boot by 90°, the outer housing is unlocked and can be pulled out. To change the polarity, the outer housing

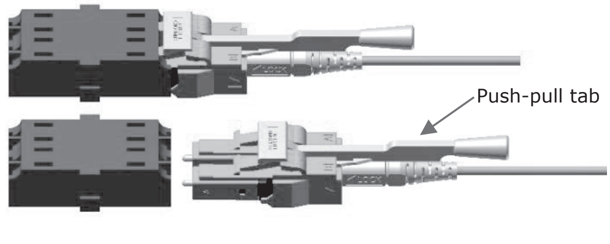

Fig. 6. Withdrawing a connector using a push-pull tab

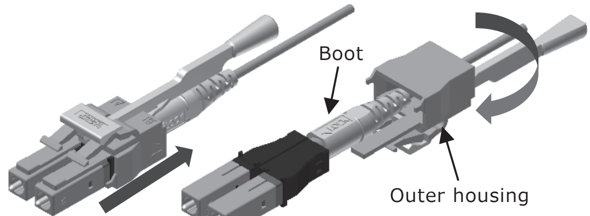

Fig. 7. Changing the polarity of the connector

should be reversed (180°) and reinserted. The boot should be turned 90° backward to lock the outer housing. Thus, the polarity can be changed easily.

This process does not require exposure of optical fibers, and safety can be ensured on site. For example, if a customer notices that polarity of a connector is incorrect after cabling is completed, the customer can take action on the spot without requesting the manufacturer for repair or recabling.

3-3 Cables with SumiMPO (round cords and trunk cables)

Finally, cables with SumiMPO (round cords and trunk cables) are introduced. The appearance of the products is shown in Fig. 8. Conventionally, multiple two-fiber flat cables have been used for installation. However, there has been a growing need for high-density cables due to the limited installation space at data centers.

Under these conditions, we have developed multi-fiber round cords and trunk cables of a small diameter. Figure 9 shows the cross section of a 12-fiber round cord as an example. The cross section is about one fifth of that of six conventional two-fiber flat cables.

We have commercialized round cords and trunk cables (for the product lineup, see Table 1). A highly flame-resistant exclusive polyvinyl chloride material is used for the cable jacket. The cables meet the UL1651 plenum grade.

Fig. 8. A round cord with SumiMPO (left) and a trunk cable with SumiMPO (right)

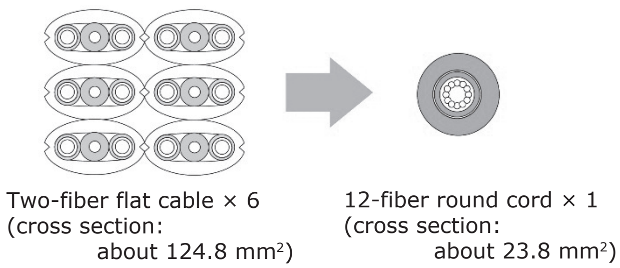

Fig. 9. Comparison of cross section between six conventional two-fiber flat cables (12 fibers) and the new 12-fiber round cord

Table 1. Specifications of the round cords and trunk cables

	Round cord			Trunk cable		
Fiber count	8	12	24	8	12	24
Fiber used	Fiber with enhanced bending characteristics (diameter: 0.25mm) OS2/OM3/OM4					
Jacket material	Flame-resistant PVC					
Outside diameter (mm)	3	3	3.8	5.5	5.5	6.5
Thickness (mm)	0.5	0.5	0.6	1.7	1.7	1.8
Weight (kg/km)	9	9	13	40	40	50
Tensile strength (N)	100			600		
Allowable bending radius (mm)	25		55	55		65
Flame resistance	Compliant with UL 1651 plenum grade					

The round cords suitable for cabling in the racks feature a round structure to achieve high installation flexibility. Eight to 24 fibers with bend insensitive are efficiently bundled. The jacket is 1.2 mm thick to reduce the diameter and attain high mechanical characteristics.

Regarding the trunk cables that are suitable for cabling between racks and underfloor cabling, the lateral pressure characteristics and tensile characteristics have been enhanced by providing another sheath on the round cords.

4. Conclusion

This paper presented new optical fiber cabling solutions and relevant products to meet the need for increased density and efficiency of optical fiber cabling at data centers.

The plug-and-play system using round cords and trunk cables with MPO connectors and MPO cassettes as well as LC uniboot connectors equipped with the polarity change function will be highly useful as cabling technologies and products to cope with ever-increasing traffic at data centers.

• PrecisionFlex and SumiMPO are trademarks or registered trademarks of Sumitomo Electric Industries, Ltd.

Technical Terms

*1 Zettabyte: Zetta represents 10 to the 21st power (10^{21}). The unit symbol is ZB.

*2 Fiber To The x (FTTx): FTTx means to install an optical fiber cable from a central office of a telecommunications carrier to the target point (x) such as a dwelling unit and building. One example is Fiber to the Home (FTTH).

*3 Fan-out cord: Fan-out cord is equipped with a branch for branching one end of a tape fiber or tape cord into multiple single fibers. The end of the branched fiber or cord is terminated by a connector.

*4 Gender change: Gender change refers to changing the status of guide pins (provided or not provided) of an MPO connector.

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