Light ODN Solution White Paper

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1 Overview

With the development and evolution of access network technologies in the past two decades, FTTx has gradually become the mainstream choice of operators.ODNs are connected to thousands of homes, providing high-bandwidth and high-quality network experience to users. According to the Omdia report, the number of global FTTX users will reach 800 million by the end of 2021. The world has entered a new era of all-fiber access.

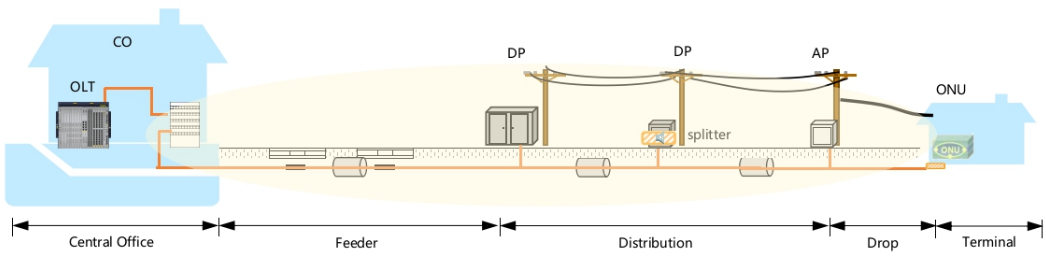
2 ODN Composition and Current Situation

The ODN network devices are located between the OLT and the ONU, and are composed of passive devices and components. The ODN network devices provide the optical fiber interconnection or cross-connection, optical fiber splicing, optical power distribution/wavelength distribution, and optical path protection functions.

2.1 ODN Network Product Composition

Take Fiber-to-the-Home (FTTH) for an example, an ODN network consists of a feeder segment, a distribution segment, and a drop segment. Its main products include optical distribution frames, optical fiber cables, joint closures, cross-connect cabinets, fiber distribution boxes, optical splitters (also referred to as optical splitter), drop cables, fiber jumpers, fiber pigtails, and optical fiber connectors, see Figure below.

Figure 2- 1 ODN Network Architecture



Optical Distribution Frame (ODF)

An ODF is a frame used to provide cable interconnections between an optical cable and an optical communication facility or between communication facilities. It consists of a rack, an optical cable lead-in and grounding unit, an optical fiber termination unit, an optical fiber distribution unit, an optical splitter subrack, and a multiplexer subrack. Its core components include fiber jumpers, fiber pigtails, optical fiber connectors, adapters, optical splitters, and optical multiplexers.

Cross Connect Cabinet (OCC)

An OCC is a device used to connect the outdoor feeder optical cable to the distribution optical cable. Its main components include a protective enclosure, an optical cable lead-in and grounding unit, an optical fiber termination unit, an optical fiber distribution unit, and an optical splitter. Its core components include fiber jumpers, fiber pigtails, fiber connectors, adapters, and optical splitters.

Joint Closure (JC)

A JC is a device that connects optical cables. It mainly consists of a protective enclosure, an optical cable lead-in and grounding unit, an optical fiber termination unit, an optical fiber distribution unit, and an optical splitter. Its core components include fiber jumpers, fiber pigtails, optical fiber connectors, adapters, and optical splitters.

Fiber distribution box

A fiber distribution box is a device used to branch distribution cables indoors or outdoors, and to connect the leading-in optical cables. It mainly consists of a protective enclosure, an optical cable fixing and grounding unit, an optical fiber connection and distribution device, an optical fiber termination device, an optical fiber storage device, and an optical splitter. Its core components include fiber jumpers, fiber pigtails, optical fiber connectors, adapters, and optical splitters.

Optical splitter (SPL)

An optical splitter is a passive optical component that implements optical signal power coupling and splitting functions.

Optical cable, or fiber optic cable (FoC)

An optical cable is a communication cable assembly that utilizes one or more fibers placed in a sheath as the transmission medium and the fibers can be used individually or in a bundle. The basic structure of an optical cable consists of a cable core, a reinforced steel wire, fillers, and a sheath. In addition, it consists of a waterproof layer, a buffer layer, and insulated metal conductors as required.

Optical cables can be divided into outdoor optical cables and indoor optical cables in accordance with application scenarios. Generally, outdoor optical cables have strong mechanical and environmental resistance performance, and indoor optical cables have good fire-retardant performance.

Optical fiber jumper, or fiber jumper

The fiber jumper is also called patch cord. It is an optical cable assembly with fiber connectors at both ends.

Fiber pigtail

A fiber pigtail is a cable assembly with an optical connector at one end.

Optical connector

An optical connector consists of a fiber jumper or a fiber pigtail and an adapter that matches the connector.

Adapter

An adapter is used to join two connectors.

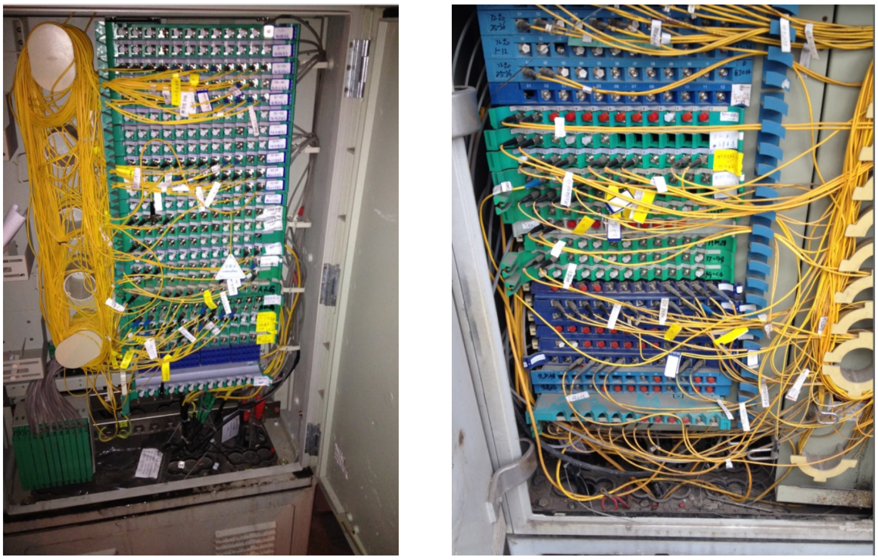
2.2 Current Status of ODN

With deeper and wider FTTH network coverage, the ODN network becomes more and more important as a “neural tip” connecting every home. During the construction of ODN networks, operators are faced with the following problems:

- Onsite splicing is the major mode used in the traditional construction. It has the features of high construction difficulty, low network construction speed, low quality consistency, and strong dependence on professional skills. In addition, the traditional ODN splicing and cabling rely on professional technicians and skills, resulting in low quality consistency.

- Difficult resource management: Because the ODN resources are dumb, it is difficult to perform O&M after the network is built due to the low digital level, which affects network stability as well as resource validity and accuracy. Inaccurate ODN resources lead to the difficulty of port allocation and ODN troubleshooting, resulting in invalid capacity expansion and resource settlement. Traditional ODN resource management depends on manual collection and recording. The real-time performance and accuracy of resources are low, and paper data input wastes manpower and is prone to errors. Fig. below Missing Label or Label Falling Off, Illegible Handwriting, and Recording Errors.

Figure 2- 2 Missing Label or Label Falling Off



- Resource deterioration affects services: Improper use such as exposure to the wind and the sun without closing the door. Resources are aged or degraded due to connection or cabling quality during network construction, and the attenuation is greater than the reserved optical power planned during network construction, affecting services and customer satisfaction.

Figure 2- 3 Resource Deterioration Affects Services

- Long service installation & provisioning cycle: The line side (level-2 split point and upstream) of the traditional ODN network needs to be planned in advance, especially when thin coverage is required under the pressure of port occupancy assessment. When there are actual users, capacity expansion needs to add level-2 distribution points such as fiber distribution boxes and upstream equipment. The long construction cycle affect customer satisfaction.

2.3 Necessity of ODN Solution and Evolution

In the traditional ODN network, fibers are spliced, which requires professional constructors and tools. As a result, the construction cycle of outside plants (OSPs) is long and the cost is high. At the same time, due to the passive feature of optical fibers, there is no effective management method for optical fiber resources, resulting in low resource accuracy.

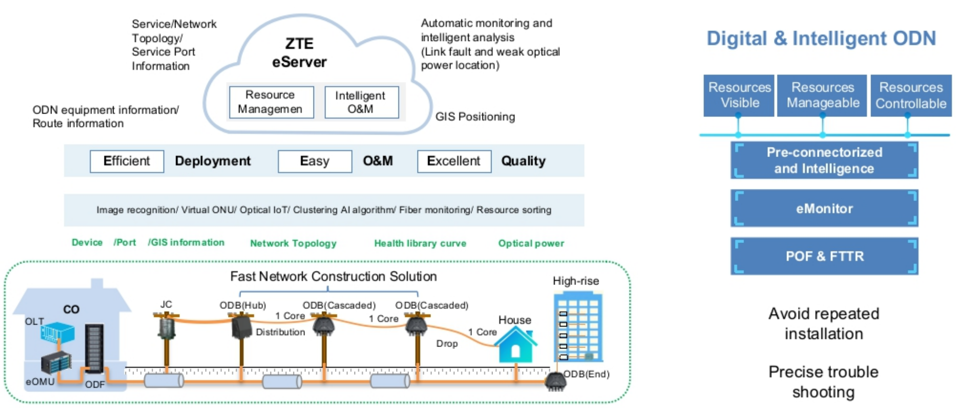
With the rapid development of optical fiber networks, massive optical fiber resources are deployed around the world every year. Therefore, how to construct optical fiber networks efficiently and manage new dark optical fiber resources becomes the key for operators to build competitive optical fiber networks. Thus, how to conveniently and quickly build strong ODNs as well as efficiently and accurately operate and maintain ODNs become the key demands. In addition, because FTTx construction covers and constructs at different proportions around the world, next-generation ODNs should meet and provide solutions based on different user densities, different optical split ratios, and different installation environments. That is, in addition to solving the urgent problems existing in the traditional ODN, the next-generation ODN should also meet the smooth evolution requirements in new construction, expansion, and reconstruction, so that the existing network construction resources of customers/owners can be utilized to the maximum to avoid repeated investments.

3 Composition of the Light ODN Solution

The light ODN solution involves two concepts: First, lightweight network deployment, realizes zero-splicing and plug-and-play of optical networks based on pre-connectorzied products to improve construction efficiency. Second, lighting up the dark passive optical network to ensure the accuracy and visualization of optical link resources.

The Light ODN includes the Feb (Fiber Efficient Box) series products, and intelligent functions. It intelligently identifies and automatically collects optical link resource information, and implements electronic resource data transmission and management. On the platform side, the topology of optical fiber links in the entire network is digitally restored to make dark optical fiber resources visible and improve the accuracy of resource data.

Figure 3- 1 Light ODN Rapidly Builds Premium ODN Networks



Features of the Light ODN solution:

- High reliability and consistency: Robust factory fabricated products with quality consistency.

- 0 skill dependence: Plug and play.
- High construction efficiency: Convenient installation and plug and play. On-demand expansion.
- High timeliness and accuracy of resources: Digital resource collection, one-click upload, and 100% accuracy rate.
- Seamless expansion: Expand the existing available optical path resources of operators to maximize resource utilization and reduce repeated investments.

3.1 Light ODN Pre-connectorized Technologies and Products

Light ODN networking solutions include chain networking and star networking.

Chain networking: The pre-connectorzied optical distribution box is connected with one core of pre-connectorzied cable. Generally, four or five levels of cascading is recommended. In some scenarios, more levels of cascading can be used.

Star networking: Even if the cascading networking pre-connectorzied solution has obvious advantages, the star networking solution is necessary for the expansion and reconstruction of the traditional ODN and the reuse of the existing resources of the original ODN.

3.1.1 Chain Networking Solution and Products

3.1.1.1 Chain Networking Solution for Outdoor Scenarios

For example, in the 1:64 split ratio scenario in Fig. 3-3, the FebH acts as an OCC with no more than four 1:2 even splitters. Each splitter can be connected to two 4-level cascading links. The FebS-E10 has one built-in 1:9 uneven splitter. The 70% optical power occupied by the cascading port is used to cascade the lower-level FebS, and the 30% optical power is evenly distributed to the local output port to connect 8 local users.

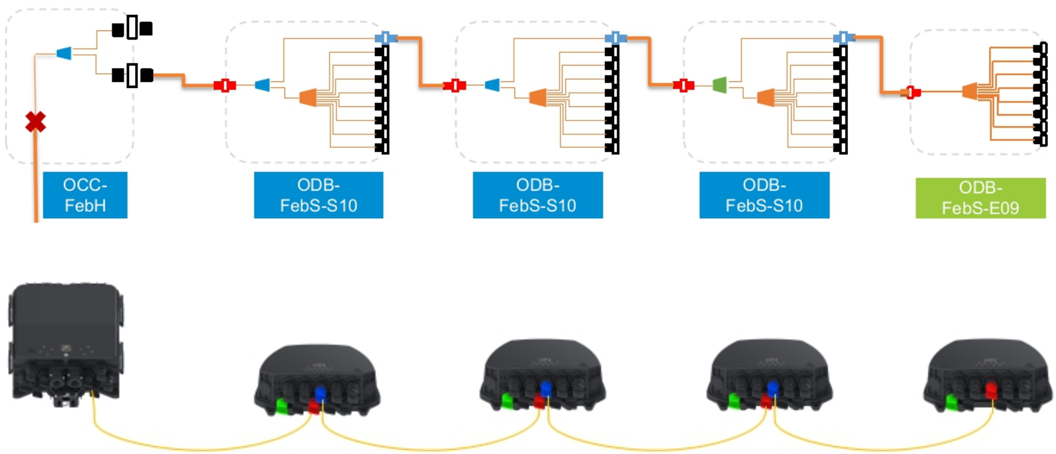
The FebS-09 has one built-in 1:8 even splitter, which is used to connect 8 local users to form a split ratio of 1:64.

Depending on the installation environment, the FebH and FebS may be installed in a man hole, hand hole, wall-mounted, pole-mounted, and suspension wire. The pre-connectorized cables may be used to connect the corresponding FebH to the FebS, between the FebS and the FebS to the information panel/ONT. The Light ODN Solution provides pre-connectorized box and p cables for aerial and duct scenarios.

Pre-connectorized distribution cables, including pre-connectorized cables in aerial scenarios and pre-connectorized cables in duct scenarios, are used between the FebH and the FebS and between the FebS and the lower-level FebS. Pre-connectorized drop cables are used to connect the FebS to the information panel/ONT.

According to requirements of different user density scenarios, different split ratios such as 1:17, 1:5, and 1:2 can also be used.

Figure 3-2 Chain Networking Solution



- **Cable configuration in aerial scenarios**

In aerial scenarios, it is recommended that ADSS all-dielectric cables be used, and the fully-prefabricated (ESCA) connectors be used for interconnection with the pre-connectorized box. For the connection with the SC in capacity expansion or traditional ODN reconstruction, it is recommended to use ESCA on one end and the standard connector matching the existing traditional ODN on the other end. For the connection with the expansion/reconstruction of traditional ODN by splicing, it is recommended to use ESCA on one end and the other end be suspended. Both ends of the cable assembly contain a barcode with the same number, and the barcode of each cable assembly is unique.

Table 3-1 Cable in aerial scenarios

Application Scenario	Product Diagram
It is used in new built aerial scenarios. Both ends has an outdoor pre-fabricated connector (APC) to connect pre-connectorized OCCs, cascade boxes, and end boxes.	
Distribution fiber jumpers are used in the scenarios where traditional ODNs are expanded or reconstructed and installed overhead. One end has an outdoor prefabricated connector, and the other end has an indoor SC/UPC connector, so that it can connect the end box to the level-1 distribution point of the traditional ODN.	
Distribution fiber pigtails are used in the traditional ODN expansion and reconstruction scenarios. One end has an outdoor prefabricated connector, and the other end has an indoor SC/UPC connector to implement splice between the end box and the level-1 split point of the traditional ODN.	

- **Cable configuration in duct scenarios**

It is recommended that one end of the connector that is connected to the pre-connectorized box be ESCA, and the other end be the on-site assembled pre-fabricated ASCA. For the connection with the SC in capacity expansion or traditional ODN reconstruction, it is recommended to use ASCA on one end and the standard connector matching the existing traditional ODN on the other end. For the connection with the expansion/reconstruction of traditional ODN by splicing, it is recommended to use ASCA on one end and the other end be suspended. Both ends of the cable assembly contain a barcode with the same number, and the barcode of each cable assembly is unique.

Table 3-2 Cable in duct scenarios

Scenario Description	Product Diagram
It is used in new built aerial scenarios. Both ends of the cable have an outdoor pre-fabricated connector (APC) to connect pre-connectorized OCCs, cascade boxes, and end boxes.	
It is applicable to the aerial scenarios in ODN expansion and reconstruction. One end has an outdoor prefabricated connector, and the other end has an indoor SC/UPC connector to implement splice between the end box and the level-1 split point of the traditional ODN.	
Distribution fiber pigtails are used in the traditional ODN expansion and reconstruction scenarios. One end has an outdoor prefabricated connector, and the other end has an indoor SC/UPC connector to implement splice between the end box and the level-1 split point of traditional ODN.	

- **Pre-connectorized drop cable**

It is recommended that the ADSS all dielectric cable as the pre-connectorized drop cable be used as the pre-connectorized drop cable, and the fully-connectorized ESCA be used to connect the pre-connectorized box. Both ends of a cable assembly contain a barcode with the same number, and the barcode of each cable assembly is unique.

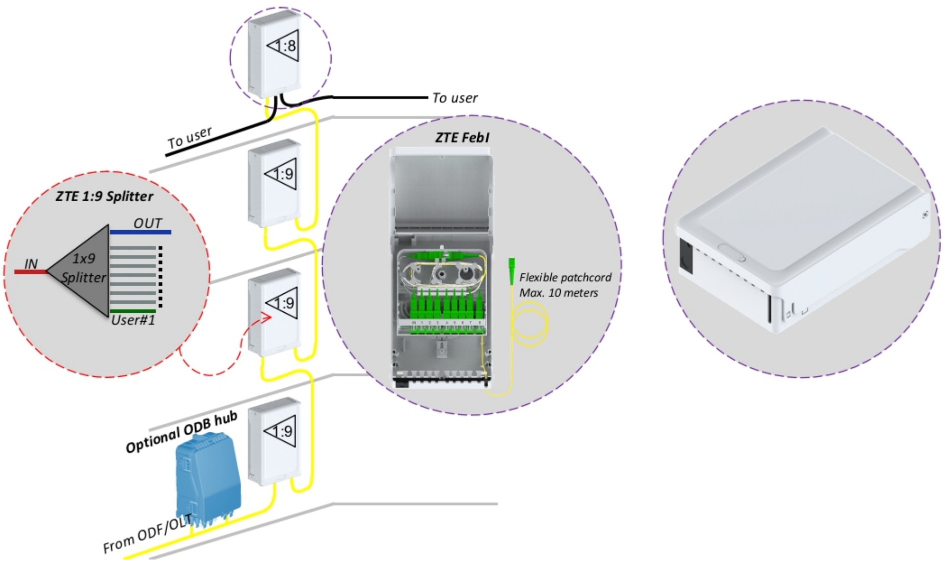
Table 3-3 Pre-connectorized drop cable

Application Scenario	Product Diagram
Pre-connectorized drop cables are used in the new built and capacity expansion of the traditional ODN. One end has an outdoor prefabricated connector, the other end is suspended and form an FAC connector after it is laid inside the home to connect the ONT.	

3.1.1.2 Chain Networking Solution for Indoor Scenarios

In the 1:64 optical split scenarios in high-rise and multi-story buildings, the FebH acts as an OCC with no more than four 1:2 even splitters. Each splitter can be connected to 2 four-level cascading links. The FebI-E10 has one built-in 1:9 uneven splitter. The 70% optical power occupied by the cascading port is used to cascade the lower-level FebI, and the 30% optical power is evenly distributed to the local output port to connect 8 local users. The FebI-09 has one built-in 1:8 even splitter, which is used to connect 8 local users to form a split ratio of 1:64. It is worth mentioning that the FebI can be built in with cascading fiber jumpers, and can be connected to the FebH or the upper-level FebI cascading port as required. The built-in fiber storage function makes cabling more aesthetically pleasing and convenient.

Figure 3-3 Indoor Chain Networking Solution

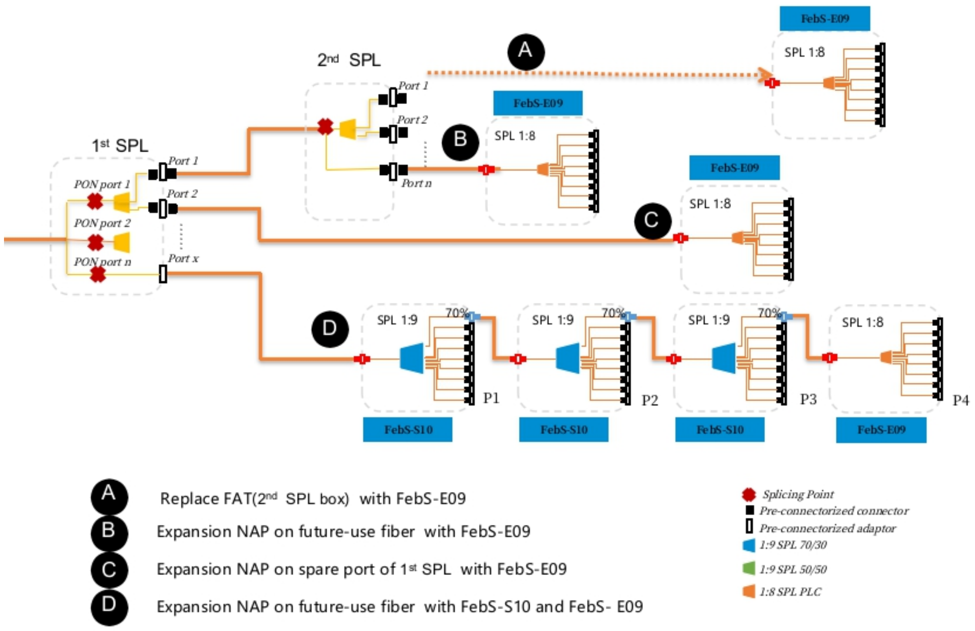


3.1.2 Star Networking Solution and Products

Most traditional ODNs use 1:8+1:8 or 1:4+1:16 or 1:4+1:8 split ratio. Therefore, for the traditional ODN expansion where the level-1 optical splitters have been deployed, the FebS-E09 can be used as the level-2 fiber distribution box with a built-in 1:8 optical splitter, and the FebS-E17 can be used as the level-2 fiber distribution box with a built-in 1:16 splitter.

For the link that can only use the existing fiber core for expansion but the level-1 optical splitter is not constructed, the chain networking solution and products described in 3.1.1 of this document is recommended.

Figure 3-4 Pre-connectorized Solution for Reconstruction/Expansion Scenarios



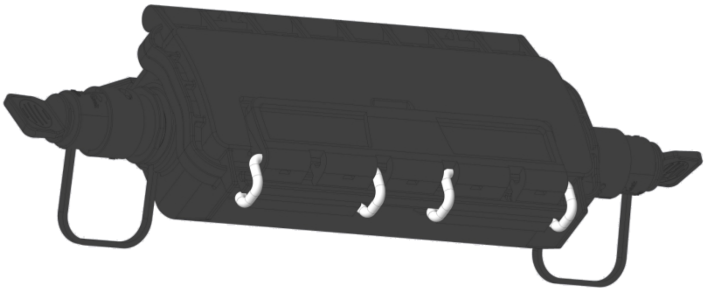
3.1.3 Pre-connectorized Accessories and Peripheral Products

In the process of pre-connectorized ODN construction, acceptance, operation and maintenance, in addition to FebH, FebS, distribution cables, and drop cables, pre-connectorized patching enclosures, pre-connectorized splicing enclosures, reserved cable racks, armour clamps, and test fiber jumpers will also be used.

3.1.3.1 Patching Enclosure

In the pre-connectorized ODN solution, the length range of outdoor MPO optical cable assemblies is generally between 100m and 1000m. When the length is greater than 100m, every 100m is a gradient. The length range of the SC/DLC distribution optical cable assembly is generally between 50m and 500m, and every 50m is a gradient. In an actual project, if a longer cable length is required, the MPO or single-core patching enclosure can be used to extend the connection at most once. The patching enclosure supports pole mount, wall mount, aerial mount, and manhole/handhole mount.

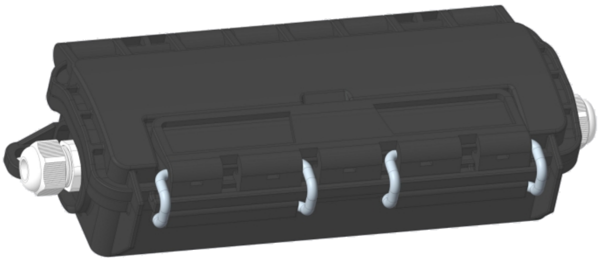
Figure 3-5 Patching Enclosure



3.1.3.2 Splicing Enclosure

The splicing enclosure is used to connect feeder cables or broken distribution fibers. It supports splicing of 1-12 fiber cores, and supports pole mount, wall mount, aerial mount, and manhole/handhole mount.

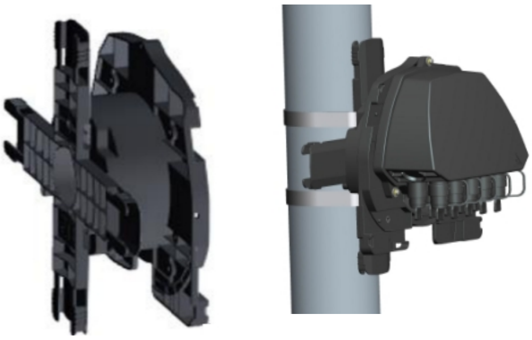
Figure 3-6 Splicing Enclosure



3.1.3.3 Cable Reserved Rack

The cable reserved rack is used for the redundant cable patching and storage. Take the reserved cable rack of the FebS for an example, the reserved rack supports pole mount, wall mount, aerial mount, and manhole/handhole mount.

Figure 3-7 Reserved Cable Rack



3.1.3.4 Armour Clamp

Table 3-4 Armour Clamp

Aerial Cable Anchoring Point	Installing Aerial Optical Cables Across Electricity Poles
 	

1.1.1.1 Pre-connectorized Test Cable

The pre-connectorized test cable is used for pre-connectorized cable acceptance and engineering optical power test acceptance, and can be purchased as consumables.

Figure 3-8 Pre-connectorized Test Cable

3.2 Light ODN Network Resource Visualization

With the large-scale application of FTTX networks, massive fiber resources have been deployed worldwide. The passive feature of the optical network brings about low energy consumption and low failure rate, and also poses challenges to the resource management of the ODN network.

3.2.1 Background of Optical Network Resource Visualization

In the traditional optical network, resources are not managed effectively, and the management of "dumb resources" cannot be closed, resulting in resource waste. In addition, incorrect resource data brings challenges to subsequent O&M. Therefore, the demand for visualized management of optical network resources is very urgent.

Dumb resources cannot be managed in a closed loop

In the traditional optical fiber network construction, constructors perform construction operations based on paper construction drawings, and record and upload the completion information manually. The entire process is performed manually, and is lack of effective and real-time verification and guarantee mechanism. There is no closed loop in resource management, and manual operation errors are easily generated in the construction phase, data recording phase, and data transfer phase.

Resources are wasted seriously

In the resource management of traditional ODN networks, paper labels are used for identification and recording, the paper labels are manually observed and read, and the resource information is recorded and transferred in paper mode. During this process, errors are easy to occur. With accumulated errors, accuracy of network resources gradually decreases with the increase of network operation time, and a large quantity of optical fiber resources are wasted.

Dumb resources cannot support effective O&M

In the O&M phase of the traditional optical network, O&M engineers need to perform operations in accordance with the work orders delivered by the system. However, if the resources are inaccurate, the delivered work orders usually do not match the actual on-site situation. As a result, a large number of rework operations and secondary site visit are necessary, and O&M efficiency is reduced. In addition, inaccurate optical fiber resources may cause inaccurate strategies and operations for resource maintenance and capacity expansion.

3.2.2 Requirements of Optical Network Resource Visualization

Data accuracy

The data of optical network nodes, including site information, device information, network connection relationship, device ID, and port occupation information can be collected, transferred, and recorded accurately.

Route Accuracy

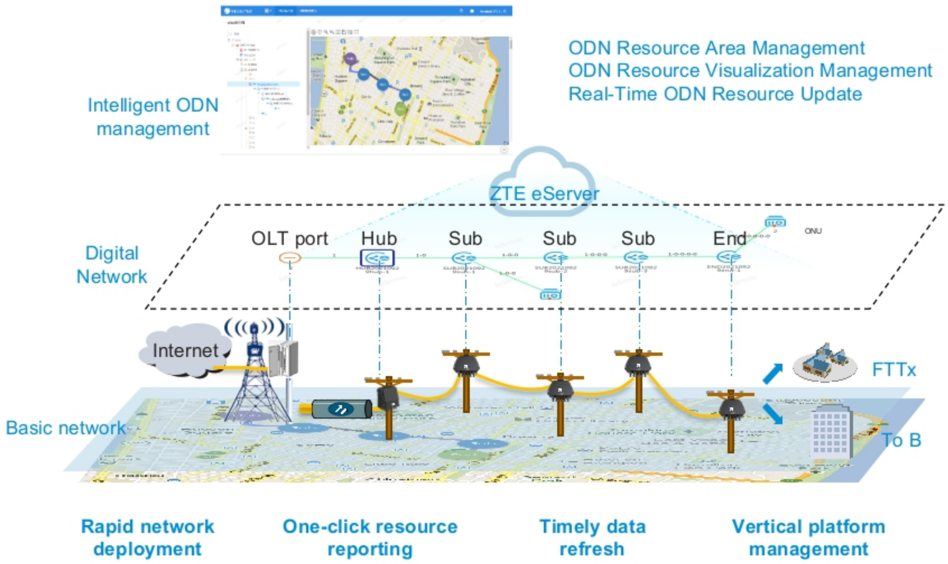
Network routing information, including topology information, same pipe, same cable, and route changes, can be collected, transferred, and recorded accurately.

Accurate prediction

The resource usage and network performance trend can be accurately analyzed and determined, and the network topology optimization policy and network expansion policy can be accurately predicted.

3.2.3 Optical Network Resource Visualization

Figure 3-9 Optical Network Resource Visualization



Physical fiber network

A series of pre-connectorized boxes containing QR codes and pre-connectorized cables containing barcodes are used for the networking of physical fiber networks. Based on the characteristics of pre-connectorized connections outside the boxes and point-to-point single-core connections, it is easy to collect fiber link information.

Digital network

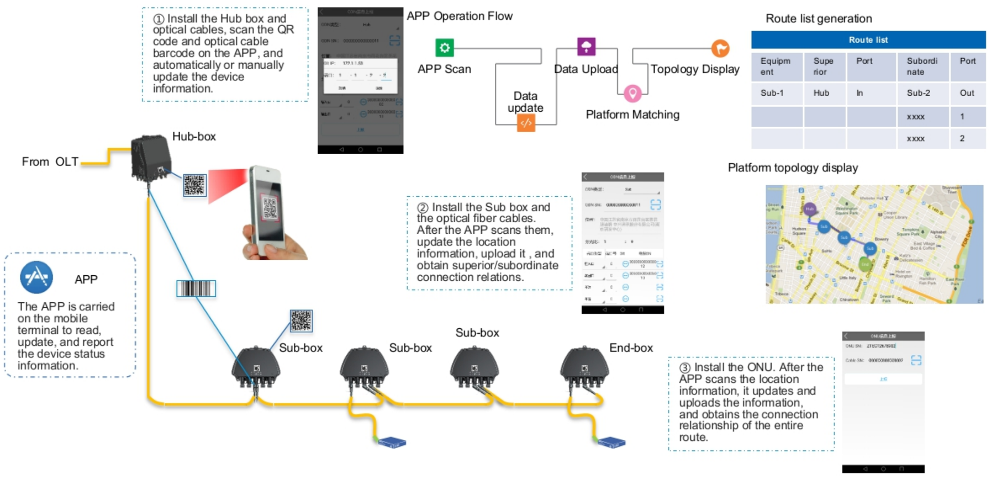
The mobile phone APP is used to scan and identify the connection relationships between the boxes and cables at the network node based on the image recognition technology, and transfer the information to the EMS in real time for electronic collection and input of basic network topology data. Based on the obtained information, the EMS reconstructs a digital network that exactly corresponds to the physical network.

Intelligent Management

Based on the digital network with accurate data, optical link resources can be visually displayed on the platform. With the GIS system, resource information can be displayed on a map to provide visual guidance for O&M. At the same time, the platform can intelligently analyze the use of optical link resources, formulate resource optimization strategies, and guide network O&M and expansion.

3.2.4 Optical Network Resource Visualization Operation Procedure

Figure 3-10 Optical Network Resource Visualization Operation Procedure



3.3 Intelligent O&M of Light ODN

End-to-end optical networks have become a "core base" of information infrastructure for thousands of industries.

3.3.1 Digital Intelligent Physical Fiber Network Is Necessary in the All-fiber Network Era

In the existing network, the dumb optical cable resources cannot support effective O&M. The data is inaccurate, performance is unclear, and maintenance is difficult.

The network construction mode of dumb resources cannot provide real-time valid data including device location, connection ID, and route.

Valid digital and intelligent presentation shall meet the following requirements:

- Accurate data: Site, device, connection, identification, used, and unused.
- Route accuracy: Change, identification, same channel, same cable, etc.

- Fault accuracy: Quantitative, qualitative, and location
- Prediction accuracy: Network performance trend and topology optimization suggestions.

3.3.2 End-to-End Automatic Network Management Solution

Physical data management of the ODN network: Records digital data on site to generate the physical connection topology of the ODN network.

Intelligent platform management: Obtains ODN data to form basic topology data. Obtains real-time OLT data to form basic connection data, forms a correspondence between logic and physical data, analyzes data changes, and reports early warning, or alarms in real time.

OLT logical connection data management: The OLT obtains the logical connection topology of the ONU, obtains a connection characteristic of an ONT by means of clustering analysis, and obtains network feature changes through network performance analysis.

Digital and intelligent network O&M: Network acceptance: Remotely detects and discovers network topology, collects network performance, and digitally records network performance into the ODN management system. Topology recovery: Based on the ODN resource database and the optical network link awareness technology, the existing network topology recovery can automatically display and update the end-to-end network topology connection information. Network monitoring and early warning: Monitors the network/resource status in real time or periodically, locates faults, assumes responsibilities, and monitors the faulty early warning.

3.3.3 Proactive O&M of eMonitor Improves Efficiency

At present, the global telecommunications industry is developing rapidly. In the wireline field, optical fiber-based communication technologies have received unprecedented attention and promotion, and the construction of optical fiber networks has entered a new development era. At the same time, the large-scale deployment of optical networks brings huge challenges and difficulties to the planning, management, and O&M of optical networks. The problem of optical network O&M management is especially serious, which is mainly represented as lack of O&M methods and low efficiency. This problem greatly affects operation efficiency of operators, increases operation costs, and more importantly, reduces the customer satisfaction rate. In the face of this difficulty and challenge, it is very important and urgent to build an intelligent, real-time and accurate optical network monitoring system, which is also a necessary measure to ensure rapid development of optical networks. The existing optical fiber network is complicated. Optical fibers are laid out at one fell swoop and used for many years, and most optical fibers are hidden and invisible. This poses new challenges to real-time monitoring of the operational status of the optical fiber network and troubleshooting of fault points.

The current optical network management method cannot meet the increasing complex optical networks because of the following disadvantages:

- Weak monitoring

Currently, only the operating equipment can be monitored, and the attenuation of the optical signals in the network cannot be monitored or recorded. The optical splitter status, connection point distribution, and operating status cannot not be monitored or recorded. There is a lack of an overall platform to effectively monitor the entire optical network topology and optical path, and there is a lack of performance early warning mechanism. When an optical network fault occurs, troubleshooting is difficult.

- Low efficiency

Currently, there is a relatively large amount of manual intervention when the optical network is monitored, which may affect normal operating network devices. In addition, to manually monitor the operational status of the equipment , multiple persons (teams) may need to cooperate in troubleshooting. In this way, the efficiency is unavoidably low, the fault points cannot be found in a timely manner, and the fault cannot be fixed.

- Manual analysis

There is no valid history record for the running optical network equipment and the running status of the optical path. If statistics and analysis need to be performed on the fault points of these optical paths and equipment, manual analysis and determination is required. The manual analysis and judgment depends on not only personal experience but also personal troubleshooting skills, which is a challenge to the staff.

- Difficult fault location

If the optical path is faulty, the fault point cannot be determined in a timely and accurate manner. When a network fault occurs, it must be determined through manual intervention based on equipment alarms. This is a troubleshooting procedure. The fault location of optical fibers cannot be accurately determined, and the troubleshooting period cannot be effectively shortened.

The core of fiber network monitoring and maintenance is that there is no active maintenance method or process management for fiber line monitoring. The traditional maintenance and troubleshooting method imposes high requirements upon staff, and is time-consuming and laborious. Technical measures are urgently needed to learn about the quality deterioration status of the optical path and fiber core, perform automatic preventive maintenance, and accurately locate fault points, thereby effectively improving work efficiency and reducing maintenance costs.

ZTE actively promotes the in-house developed and advanced intelligent optical fiber monitoring system, and is committed to providing customers with an intelligent, real-time, and accurate optical fiber network monitoring system, thus improving operation and maintenance efficiency of optical networks, reducing operation and maintenance costs, and guaranteeing the healthy and lasting development of optical networks.

The automatic optical cable monitoring system implements remote, real-time, and automatic monitoring of optical cables, monitors the changes in the transmission characteristics of optical cables and analyzes and predicts change trends, raises alarms in a timely manner to locate optical cable faults quickly and accurately, compresses the fault duration, reduces the workload of maintenance staff, and provides reliable guarantee for optical cable network maintenance. In addition, the optical cable monitoring system provides data interfaces for establishing the resource management system and the information customer service system.

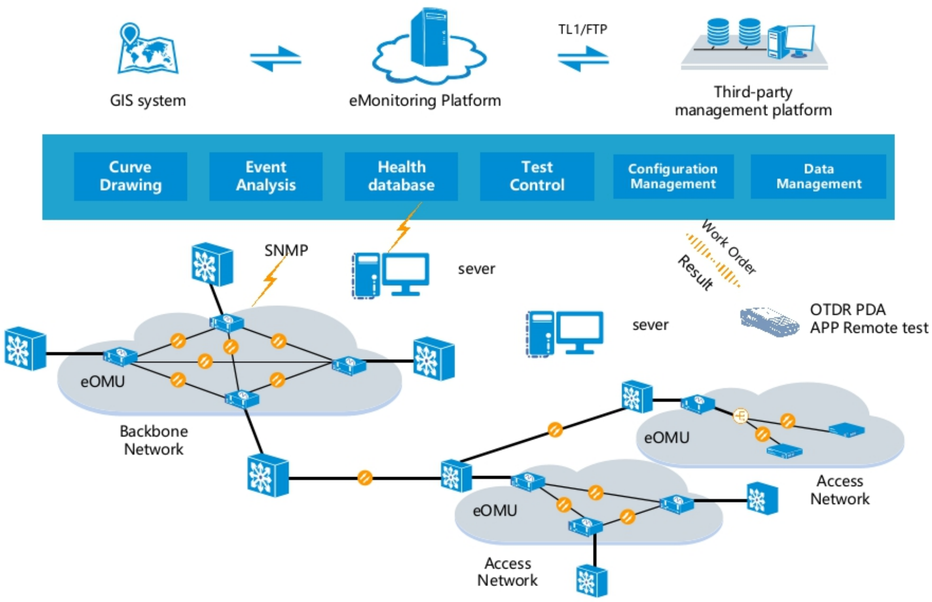
3.3.4 eMonitor Overview

The ZXA10 eMonitor system is an intelligent optical fiber monitoring system that monitors the quality of the fiber core in the entire optical network, including the optical access network, optical mobile backhaul network, optical MAN, optical backbone network, and optical data center.

The ZXA10 eMonitor system includes the eMonitor software platform eServer and the easy Optical Monitor&Survey Unit (eOMU) optical fiber monitoring hardware platform. At the same time, the ZXA10 eMonitor system can be interconnected with the upper-layer system through northbound interfaces, so that the monitoring system and processes can be seamlessly connected.

The positioning of the software and hardware of the ZXA10 eMonitor system in the network is shown in the figure below.

Figure 3-11 Position of the ZXA10 eMonitor System in the Optical Network



The eServer southbound interface of the eMonitor system is interconnected with the eOMU to collect and analyze optical fiber test data, control tests, obtain and display data, and store and compare health databases.The northbound interface is interconnected with the OSS system to transfer work orders, schedule geographical information, query intelligent optical fiber port information, and implement optical fiber monitoring.

The hardware platform eOMU of the eMonitor system includes a cabinet, a chassis, and cards. An indoor cabinet can be used. If ZTE cabinet is not selected, the eOMU chassis can be installed in the existing cabinet in the customer's equipment room. The specific position depends on the actual site survey situation of the equipment room.

3.3.5 Features of the eMonitor Fiber Monitoring Solution

✓ Centralized fiber monitoring system

The ZTE eMonitor system system supports centralized optical fiber monitoring. A single oeMonitor system supports multiple types of optical fiber resources, sharing monitored device resources, improving the utilization of the monitoring system, and reducing operators' CAPEX.

✓ Fast and accurate fault detection and location

As a professional intelligent fiber monitoring system, the ZTE eMonitor system not only can rapidly detect and locate faults, but also can accurately detect and locate faults, including detecting and locating fiber breakpoints and attenuation.

✓ Diversified detection modes

To meet different scenarios and requirements, the ZTE eMonitor system supports different parameter combination detection methods, including the detection pulse width, dynamic range, detection resolution, and detection time. Various detection combinations can meet different application scenarios.

✓ Real-time and online fault monitoring

As required by users, the ZTE eMonitor system supports periodical or real-time fault monitoring. It uses the polling mechanism to report fault alarms in real time when an optical network fault is detected. The ZTE eMonitor system can implement online monitoring without affecting normal services during periodic or real-time monitoring. Therefore, operators can master and troubleshoot faults in a timely manner to improve the response speed of O&M.

✓ Intelligent fiber event identification

Through powerful software algorithms, the ZTE eMonitor system can accurately and intelligently identify optical fiber events, and can intelligently diagnose optical fiber events based on the data in the optical fiber health library.

✓ Visualized fault location

The fault points detected by the system can be displayed in the GIS-based map system in real time, so that the operator can find the actual fault points on the map in real time. In this way, the fault can be rapidly troubleshooted in a visual way through the map, thus improving O&M efficiency.

✓ Abundant system interfaces

The ZTE eMonitor system supports perfect northbound interfaces, southbound interfaces, and report statistics. Through abundant northbound interfaces, it can be seamlessly interconnected with the OSS, improving overall O&M capability and efficiency, and provides more optical network monitoring functions through various southbound interfaces. Abundant report statistics functions can bring more visual monitoring results to operators and facilitate their O&M.

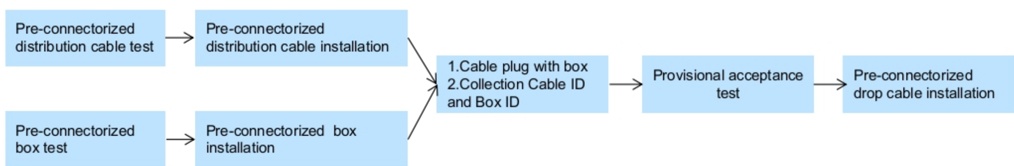
4 ZTE Light ODN Solution Implementation

4.1 Engineering Implementation

Use the HLD and LLD network design as the engineering implementation input, and complete box installation and cable laying in the engineering implementation phase.

For a project using the Light ODN management system, the box and cable information shall be collected and uploaded to the EMS in the engineering implementation phase.

Figure 4- 1 Light ODN Engineering Implementation



4.2 Engineering Acceptance Test

Take the 1:64 split ratio chain networking mode and the 1:8+1:8 star networking mode as an example. For the typical loss of each component, refer to the following table.

Table 4-1 typical loss

ITEM		Loss（dB）
1:2 Even Splitter		4.1
1:8 Even Splitter		10.5
1:9 Uneven Splitter	70%	2.2
	30%	16.3
Splicing Point		0.1
G.652D Fiber @1310nm		0.35/km
G.652D Fiber @1490nm		0.26/km
G.657 Fiber @1310nm		0.36/km
G.657 Fiber @1490nm		0.26/km

4.3 Light ODN Resource Input

Through AI image recognition via the APP, collect the pre-connectorized box, cable ID, and its GIS information (as required), determine the binding relationship among the box, cable, and port, record the ODN resource information, and upload it to the EMS.

4.4 Light ODN Service Provisioning

- Discover available devices and ports: Before service provisioning, find available devices and ports through the Light ODN management system to ensure successful site visit and number allocation.
- After site installation, the installation and maintenance personnel identify the device ID and GIS (pre-connectorized chassis), number allocation port, drop cable, and ONT via the APP, so that the service can be quickly distributed, the data can be accurately recorded, and the data can be uploaded to the Light ODN management system to update resource information and refresh port occupation data.

4.5 Light ODN Network Maintenance

1. Remove the ONT and collect the ONT ID.
2. Remove the pre-connectorized drop cable at the pre-connectorized port, and identify the chassis ID, cable ID, and port occupation relationship through the APP AI. Note: If only the ONT is removed in Step 1, but the drop cable is not removed in Step 2 or the occupation information is not collected and updated via the APP after the cable is removed, the Light ODN management system displays an alarm and urges the installation and maintenance personnel to remove the ONT, remove the cable, and update the resource.

5 ZTE Light ODN Solution Highlights

ZTE Light ODN solution has the following highlights:

- 0-splice in the whole process, improving the construction efficiency.

  ZTE Light ODN solution leverages pre-fabricated connectors to replace traditional fiber splicing, so that no fusion splicing technician or special tool is required during network construction and opening the enclosure is not required during cable splicing. In this way, the deployment of a single site can be implemented by a single person within 10 minutes, improving construction efficiency, reducing network deployment costs, and implementing efficient network construction.

- Connection without opening the enclosure, ensures the network reliability.

Eliminates the performance deterioration caused by the reduction of the protection capability without closing the door. In addition, the industry's first "blind-insertion" and "self-locking" technologies enable stable and reliable plug-and-play of optical fibers, ensuring network reliability.

- "Dummy resource" visualized and manageable intelligent optical network, ensuring resource accuracy.

Based on the image recognition technology, ZTE Light ODN solution intelligently identifies and automatically collects optical fiber port resource information, and implements electronic transmission and management of optical fiber resource information in the entire process. It constructs a network-wide optical fiber link topology on the platform to visualize dark optical fiber resources and improve the accuracy of optical fiber resource data by up to 100%, thus improving the accuracy and efficiency of construction work order dispatch. In addition, based on the large data analysis of optical fiber resources, the system can accurately detect the virtual occupation of ports, solve the virtual occupation of ports, release resources, and protect optical network investment.

ZTE pre-connectorized solution has won the Lightwave Optical Communications Innovation Award, and has been deployed in a number of countries to help operators achieve economical and accurate network resource management in network construction.

6 Light ODN Technology Outlook

China’s "Fourteenth Five Year Plan" clearly proposed the outline of accelerating digital development and building digital China, which requires activating the potential of data elements and promoting the construction of a strong internet nation. As an important new infrastructure, broadband optical fiber network will also enter a new stage of its own development. With the construction of digital China enters into thousands of industries, ODN network construction will also enter a new development period as an important part of broadband optical fiber network, and the Light ODN technology and solution will continue to iterate and evolve.

Based on the achieved pre-connectorization, image recognition, automatic data synchronization and network topology restoration, the next-generation Light ODN technology will integrate the research achievements of the optical fiber sensing, intelligent analysis and prediction technology, combine AI analysis and prediction scenario applications, and make breakthroughs and convergence of key technologies such as optical network full-parameter perception, automatic topology discovery, real-time link monitoring, fault location and delimitation, and risk prediction early warning to form the technical foundation of a communication and perception integrated digital intelligent network.

The Light ODN solution will always be based on the key demands and development trends in the construction of optical fiber networks, and will further expand and enrich the coverage scenarios based on the concept of efficient, fast, secure, reliable and visualized network construction. While satisfying the new network applications of operators, it will explore the transformation and improvement of existing ODN networks and the visualization of dumb resources, promote the application of industrial PON, FTTR and other new fields, form an end-to-end fully visualized PON network through the combination with OLT and ONU, and continue to build a digital intelligent PON network base.