OTN Technology Development and Application in Metropolitan Electronic Power Network

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Abstract. Based on the relevant meaning, advantages and characteristics of the OTN technology, the OTN equipment can be applied in man, including the application in the convergence layer, in building circuit scheduling and CPRI interface circuit loading of the access layer. As a transmission network technology in the metropolitan electronic power, the OTN has a broad prospect in development and application in the future.

Keywords: OTN, Metropolitan Area Network, ODUflex, GE

1. Introduction
In recent years, the data services carried by the telecommunication network in the metropolitan electronic power are developing rapidly. The types of services carried by the telecommunication network are changing from TDM to packet traffic. The optical transmission network structure based on SDH with VC-12/VC-4 as scheduling particles cannot meet the requirements of packet services with larger and larger particles [1]. Therefore, a new optical transport network is needed to provide the large package service transmission and cross scheduling, which makes it easier for equipment to achieve large cross connection capacity and reduce equipment cost. For the traditional SDH optical transport network, the transmission bandwidth is limited. So, the early WDM optical transport network and the optical service transmission maintenance and monitoring capabilities are insufficient [2]. In order to overcome the shortcomings of the SDH optical transport network, such as small transmission bandwidth particles. Then the ITU-T began to put forward the concept of the optical transport network (OTN). As a new technology for networking, scheduling and transmission based on large granular service bandwidth [3, 4].

2. OTN Development and Standard
The intelligent optical network based on OTN will provide an ideal solution for the transmission of large package broadband services. The transmission network is mainly composed of the provincial trunk transmission network and the Metro (local) transmission network. The Metro(local) transmission network can be further divided into the core layer, the convergence layer and the access layer. Compared with the SDH, the biggest advantage of OTN technology is to provide scheduling and transmission of large package bandwidth [5, 6]. Therefore, whether OTN technology is adopted in
different network layers depends on the size of bandwidth of the main scheduling services. According to the current situation of the metropolitan electronic power network, the core layer scheduling of the provincial trunk transmission network and the Metro(local) transmission network is generally Gb/s or above. So, these layers can be constructed with OTN technology with better advantages and scalability. For the convergence and access layer of Metro(local) transmission network, when the main dispatching packages reach Gb/s level, OTN technology can be preferred.

With the continuous development of telecommunications networks, the OTN equipment using the ODU0 signal, it can realize the multiple protection methods of GE signal flexible. ODUflex can realize efficient bearing of other kinds of non-standard signals, which makes OTN equipment further popularize in the Metro electronic power transmission network. In addition to the backbone layer, the OTN technology can be applied in the following three aspects: the convergence layer, the building scheduling and the access layer in base station [7].

2.1 Application of OTN in Convergence Layer

With the rapid development of mobile Internet, the demand for base station is increasing, especially in economically developed cities, the 10G bandwidth of convergence layer will be consumed in a short time. The introduction of OTN devices in Metro convergence layer networking can not only meet the rapid growth of wireless services, but also realize the unified and comprehensive base stations, big customers and other services, and realize the certain convergence function. The application of OTN in convergence layer is shown in Figure 1.

![Figure 1. OTN networking application in convergence layer](image)

The core node using the large capacity electric cross matrix to form the multi-directional OTN equipment for the flexible scheduling. The electric cross matrix with smaller cross capacity can be selected in the convergence layer. If the integrated multiple GE is needed, in order to comb the GE circuits at a lower level, the large capacity PTN equipment at the convergence layer node or core node of backbone layer is chosen. In this network mode, through the electrical cross matrix, a variety of protection modes can be flexibly configured to improve network security.

2.2 Application of OTN in Building Circuit Dispatching

In order to prevent the inconvenience of circuit adjustment and network maintenance caused by more optical cables in the business room and transmission room, some machine buildings have built in building circuit dispatching system. In the early stage of SDH network construction, the circuit connection between the service room and the transmission room in most of the buildings is copper cable. With the development of business and telecommunication network, circuit cut over and adjustment are frequent, and the number of cables is huge and lacking of effective maintenance. The use of manual methods will bring a series of problems, such as high error rate, long time-consuming,
waste of copper cable resources, etc. Therefore, gradually develop into and out of the group building system or use large capacity DXC combing and other methods, in order to reduce the manual workload in circuit adjustment and the amount of wiring in the building, to improve efficiency rate [8, 9]. Learn from the experience of SDH development, in the case of rapid growth of data volume, OTN system can be selected to realize in building scheduling, increase business scheduling volume and flexibility, and build a safe, efficient and flexible in building system that can be configured through network management. The specific situation is shown in Figure 2.

Figure 2. OTN networking application diagram

2.3 Application of OTN in Access Layer
In the access layer, because OTN devices with ODUflex function can support any other non-standard rate interface larger than GE, such as CPRI interface, small capacity OTN devices (coarse wavelength division, low cross capacity) can be used to break the distance limit between BBU and RRU for rapid deployment and construction of base station. BBU can even be placed in the core computer room, and CPRI interface scheduling can be used in the whole process from access to convergence. Compared with the traditional PTN/SDH access, the cost of this network construction method is higher. When the optical fiber resources are scarce and many basic resources cannot be obtained, this network construction method can use a small amount of optical fiber resources to carry CPRI interface. Then this network can meet the needs of telecom operators for rapid deployment of base stations, and complete the comprehensive carrying of group customer's special line, PON and other services [10, 11]. The details are as follows the situation is shown in Figure 3.
3 The Future Development of OTN Equipment

Networking is the development trend of the OTN technology. There are many types of networking methods of OTN technology as follows.

3.1 The Operation Mode of OTN Equipment

This networking mode is mainly based on the upgrading of WDM equipment. If the reasonable use conditions are set in WDM equipment, it can be transformed into OTN equipment and networking operation can be carried out [12, 13]. This way of setting up network is not only simple and effective, but also the cost is not high, which is a way to upgrade power communication equipment. However, in the process of upgrading, the equipment cannot be cross connected, and technicians need to pay attention to this problem.

3.2 OTN Optical Domain, Electrical Domain Equipment Networking

In general, if the OTN has cross network, it can meet the basic demand of power communication dispatching. But this method has two disadvantages, one is the high cost of transformation, the other is the small information capacity of the overall scheduling. The multiplexing equipment of optical bifurcation in OTN can be effectively applied in the networking scheme, and the form of organization is relatively flexible, the information capacity after scheduling is relatively large, and in the process of processing, it can work directly for the optical layer [14, 15]. However, there is also a defect, that is, in the long-distance power communication signal transmission, the optical bifurcated complex network will produce relatively large changes, which has a negative impact on the smooth transmission of power communication signal.

3.3 Photoelectric Hybrid Cross Equipment Networking

It is mainly the joint scheduling of the optical domain and the electrical domain, so the scheduling is more flexible, and the transmission of information capacity is relatively large. The information transmission has the considerable reliability, but the disadvantage is exit. In order to achieve the establishment of double-layer cross equipment, the metro electronic power will use the OTN to meet the multiple existing needs in the networking.
4. Conclusion
With the continuous expansion of the communication capacity in the electric field, more and more network services are required to be satisfied at the same time. The OTN technology and equipment have the advantages of large-particle bandwidth scheduling and transmission, and could meet the increasing business needs. This technology realizes safer, more flexible and more efficient networking applications within the metropolitan electronic power network.

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