Application of Multi-Service Platform (MSP) for Submarine Line Terminal Equipment (SLTE)

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Abstract

Following the expansion of IP networks led by a rapid increase in recent data traffic, the needs of SLTE (Submarine Line Terminal Equipment) used in optical submarine cable systems are being diversified. In order to meet this trend, NEC has developed the integrated optical terminal equipment based on MSP (Multi-Service Platform) and is applying this solution to various systems. This paper introduces the features and achievements of the integrated optical terminal equipment and its future development prospects together with trends in the market environment that surrounds it.

Keywords

optical submarine cable system, DWDM, NPE, SONET/SDH, MSP, integrated optical terminal equipment

1. Introduction

In general, the transmission equipment used for the optical submarine cable system is composed of SLTE (Submarine Line Terminal Equipment) based on the DWDM (Dense Wavelength Division Multiplexing) technology, and NPE (Network Protection Equipment) with line protection and switching functions (**Fig. 1**).

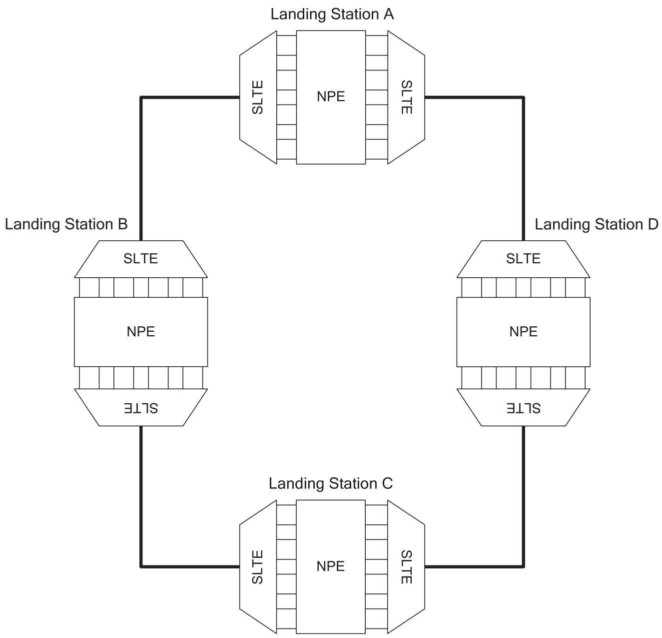

Fig. 1 Example of applications of optical terminal equipment and NPE.

NPE employs the SONET/SDH (Synchronous Optical Network/Synchronous Digital Hierarchy) technology to realize the line protection and switching functions. These functions are contributing greatly to the improved availability and reliability of optical submarine cable system. When a transmission line is disconnected due to a failure in SLTE or a fiber, the line switching function of NPE automatically switches the transmission line to a prepared protection line. The SONET/SDH technology makes it possible to execute such line switching in the very short time of from 50 to 200 ms, thereby minimizing the effects of traffic interruptions.

Following the rapid progress of IP networks in recent years, the NPE products are required to have an increased affinity for Ethernet interfaces. NEC names the advanced NPE products Multi-Service Platform (MSP).

SLTE and NPE have previously been released as separate products. At NEC, however, we have developed the integrated optical terminal equipment by adding the DWDM function in SLTE to the MSP and have introduced it in a number of optical submarine cable systems.

This paper introduces features of the integrated optical terminal equipment together with achievements of the actual introductions.

2. Technical Trends of Optical Submarine Cable Systems and Origin of Integrated Optical Terminal Equipment

While current submarine cable systems perform communications using the SONET/SDH technology, the expansion of IP networks by the rapid increase in recent data traffic has raised the need to optimize the optical submarine cable systems that support the backbone networks for and in conformity with packet transmission.

The NGN (Next Generation Network) also backs up the expansion of IP networks for the reason that it has become imperative to develop ways to integrate the existing networks into the packet based transport networks in order to realize a reduction of OPEX, and provide a quick and flexible way to introduce new applications and services. The optical submarine cable systems are required to accommodate the needs.

On the other hand, the line switching function based on the SONET/SDH technology that serves as the current mainstream technology plays an important role in ensuring the reliability of optical submarine cable systems. Considering the absence of other technologies capable of offering an equivalent switching time it is also essential to retain the SONET/SDH technology.

It was based on a consideration of the above requirements that the integrated optical terminal equipment was developed.

3. Outline and Features of Integrated Optical Terminal Equipment

Previously, SLTE with the DWDM function and NPE were handled separately and the STM-64 interface was used for interconnecting the equipment. The management system was also prepared separately for each equipment, and the operation and maintenance had to be undertaken separately (**Fig. 2**).

The integrated optical terminal equipment is based on the MSP for applying to packet transmission as well as maintaining the line switching functions of the SONET/SDH technology. In order to reduce the maintenance and administration costs the DWDM function in SLTE is integrated into the MSP using special interfaces called colored interfaces. This configuration enables the integrated optical terminal equipment to be monitored by a single management system (**Fig. 3**).

Like the traditional optical terminal equipment, the integrated optical terminal equipment can be applied to various 10-Gbps based optical submarine cable systems, including

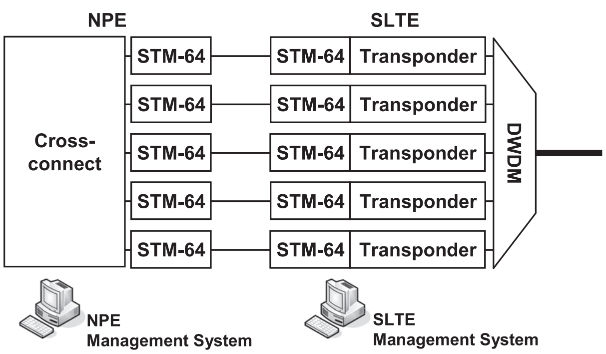

Fig. 2 Connection of SLTE and NPE.

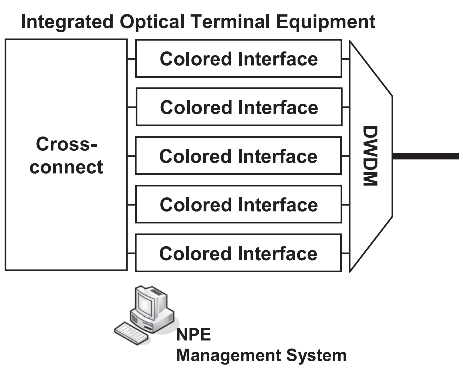

Fig. 3 Configuration of Integrated optical terminal equipment.

non-repeatered systems as well as repeatered systems with submarine repeaters. Applications of the integrated optical terminal equipment are not restricted by the network topology, and it is applicable to any network configuration including ring and mesh architectures.

The implementation of the integrated optical terminal equipment has made it possible to apply not only to packet transmission and to meet network administration requirements but the CAPEX (Capital Expenditure) and OPEX (Operational Expenditure) are also reduced.

Notably, simplification of the connection between the DWDM and MSP using colored interfaces has reduced the overall system costs. In addition, simplification of the equipment configuration has drastically reduced the overall system failure rate and improved system reliability. The improvement of the equipment power consumption and the floor space requirement has also enabled a further reduction of the OPEX.

The advantages brought about by the integrated optical terminal equipment are summarized as follows;

- Application to packet transmission
- Simplification of operation and maintenance
- Reduction of equipment costs
- Improvement of system reliability due to a reduced equipment failure rate
- Reduction of power consumption and floor space

4. Introduction of Integrated Optical Terminal Equipment and Its Effects

The integrated optical terminal equipment has been applied to various optical submarine cable systems since 2005 and the number of countries that have taken delivery already exceeds ten. It was applied not only to newly constructed optical submarine cable systems but also to the capacity upgrade of existing systems. The applications vary greatly and include repeatered and non-repeatered systems, P-to-P systems connecting two landing points and ring systems.

The colored interfaces used in the integrated optical terminal equipment employ two types of modulation scheme, using the NRZ type for short-distance systems and the RZ type for long to middle-distance systems.

According to past achievements, we have calculated that optical terminal equipment can reduce equipment costs by 10% to 20%. With regard to the system reliability, although almost no faults have occurred up to the present, our theoretical calculation has shown that an improvement of about 30% has been achieved. In addition, some systems have also succeeded in achieving a reduced power consumption of 40%.

As shown by the actual achievements described above, the integrated optical terminal equipment has brought about many advantages and its future development is assured.

5. Future Perspectives of Integrated Optical Terminal Equipment

Increases in large-capacity contents in the Internet and data communications, construction of large-scale data centers, transition of networking to NGN and development of cloud computing are expected to promote the transition to packet based network and an increase in the capacity demand for international data communication even further in the future.

As a result of these trends, the integrated optical terminal equipment will also be required to increase its capacity to accommodate the increased data traffic and to further improve its affinity with IP networks.

It is also expected that the path control, line switching and routing functions using the MPLS-TP (Multiprotocol Label Switch-Transport Profile) and GMPLS (Generalized Multiprotocol Label Switch) with a capability of integrating IP and SONET/SDH (the so called legacy transmission technologies) will increase in importance in the future.

In order to increase the transmission distance and capacity, advancements in communication, modulation and error correction methods based on the DWDM technology will also be important.

6. Conclusion

As discribed above and in order to meet recent market requirements, NEC has developed MSP-based integrated optical terminal equipment and has applied it to optical submarine cable systems. As a result of equipment deliveries to more than ten countries worldwide, its effects have been proven in various areas, including a contribution to a reduction of CAPEX and OPEX. In the future, we will tackle the development of solutions for optical submarine cable systems that aim at responding to the new needs that are resulting from progress in optical and IP networks.

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