INNOVATIVE SUBMARINE CABLE SYSTEM APPLICATIONS WITH CONVERGED PACKET OPTICAL TRANSPORT PLATFORM

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Abstract: Along with the rapid popularization of IP/Ethernet based broadband applications and services, the structure of the telecommunications industry infrastructure is shifting toward NGN (Next Generation Networks) with the objectives of reduced TCO (Total Cost Ownership) as well as flexible and rapid service provisioning. In response to this movement, various innovative transport technologies are being developed. The converged packet optical transport platform based on those technologies will provide benefits for the future infrastructure developments, including submarine cable systems. This paper will discuss the application of the converged packet optical transport platform to submarine cable systems.

1. INTRODUCTION

Global increase in diverse large-capacity data contents in the Internet and international data communications accompanied by the globalization of business is driving capacity demands of the international networks, and is accelerating the pace of the submarine cable systems development. The further growth in the global IP traffic and network expansion is expected in the near future, along with migration toward NGN and development of cloud computing.

In accordance with this positive trend, submarine cable systems are enhancing the capabilities of the higher transmission capacity and longer transmission distance, while the bandwidth of the international networks is increasing by the construction of new cable systems and capacity upgrades of the existing cable systems. The construction of new cable systems also creates new network connectivity among countries. While the system reliability is assured by using the SONET/SDH and/or lambda based protection schemes, the functions such as Low Priority Traffic and Shared Protection are additionally utilized in many submarine cable systems as a means of maximizing the available bandwidth. On the other hand, an adaptation to optimum packet transport still remains an important subject. It is also necessary to find a way to coexist with non-packet traffic, taking into consideration that all traffic will not be completely migrated to packet based traffic.

The converged packet optical transport platform is a solution to realize optimum packet transport with a capability of transparently transmitting non-packet traffic. The application of this platform to submarine cable systems will provide benefits in many aspects. This paper will introduce technologies used in the converged packet optical transport platform, and discuss the expected impacts on submarine cable systems.

2. TECHNOLOGIES FOR OPTIMUM PACKET AND NON-PACKET TRAFFIC TRNSPORT

OTN (Optical Transport Network) will be utilized for the future submarine cable systems in place of the SONET/SDH technology in consideration of a capability of high capacity transmission up to 100Gb/s. The OTN is designed so as to efficiently transport IP and Ethernet traffic, and the signal bit rates are adjusted in conformity to Ethernet interfaces. The OTN can transparently transmit Ethernet frames by using the Digital Wrapping technology, and the transparent transport is also applicable for SONET/SDH traffic. This feature enables to integrate the existing SONET/SDH based systems into the OTN based systems without any impact on the existing network configuration or operation. If needed, the existing SONET/SDH paths can be converted to OTN paths by using an OTN switch for the simplification of the path management. Furthermore, DWA (Direct Wavelength Access) services can be diversified with the OTN switch. The interface type will increase, including low speed interfaces with less than 2.5Gb/s, and the application of protection schemes for DWA will become more flexible.

MPLS-TP (Multi Protocol Label Switch - Transport Profile) is a technology enabling integration of the packet and non-packet based networks into a single infrastructure. Many carriers are currently employing and managing a large number of diverse networks, such as IP network, Asynchronous Transfer Mode (ATM) network, Ethernet network, SONET/SDH network, and Telephone network. This is because in the past it was necessary to introduce a new network each time a new service was developed and slated for introduction. Obviously with many different networks in place the operation and maintenance costs of these existing networks have become a source of concern for the carriers. The MPLS-TP is being developed to resolve this issue.

The MPLS-TP is designed based on the IP/MPLS and SONET/SDH technologies and features. The IP/MPLS has advantages of a high flexibility and multiservice capability regarding the system operations and service interfaces, and the SONET/SDH can provide a high reliability, high fault tolerance and excellent OAM (Operation, Administration and Maintenance). Thus, the MPLS-TP with advantages of both technologies can accommodate various service interfaces and protection schemes, while alarm reporting functions and managements of the path connectivity, error rate and transmission delay can be supported. In addition, the traffic engineering capabilities enable flexible control of the network resources, and value-added services such as QoS (Quality of Service) can be introduced.

The converged packet optical transport platform is based on the OTN and MPLS-TP technologies, and is characterized in that both packet and non-packet traffic can be accommodated efficiently, and the design is well-suited to high capacity transmission indispensable for submarine cable systems.

3. PROTECTION SCHEME AND O&M FOR DEPENDABLE NETWORK

High failure tolerance by abundant protection schemes is very important for system operators to maintain sufficient system availability. The SONET/SDH technology realized the protection switching in the very short time of from 50 to 200 ms, thereby minimizing the effects of traffic interruptions. As an alternative to the SONET/SDH based protection schemes, the use of GMPLS (Generalized MPLS) has been considered. However, the switching time realized by the GMPLS protection and restoration functions came a

long way short of the SONET/SDH technology at the current moment. While the performance would be improved in the future, the application of the SONET/SDH based protection schemes to the OTN technology will be an easier way to overcome this issue. Also, the protection schemes of the MPLS-TP that plan to be released in the future will be a key function for the future network development. The converged packet optical transport platform is designed to provide the protection switching functions based on the OTN and MPLS-TP technologies.

Simplifications of the system O&M (Operation and Maintenance) are essential for a reduction of OpEx (Operational Expenditure). For submarine cable systems, a centralized network management system with a single platform that can manage both SLTE (Submarine Line Terminal Equipment) and NPE (Network Protection Equipment) will be able to realize drastic simplifications in the O&M work. Since the converged packet optical transport platform can include NPE function based on the OTN and MPLS-TP technologies, integration of SLTE into the same platform will be ideal for the centralized network management of submarine cable systems.

4. POSSIBLE SOLUTION FOR TRANSMISSION DELAY

Due to the nature of submarine cable systems that provides Ultra long-haul transmission, a transmission delay is a serious problem. In addition, a transmission delay causes significant degradation of traffic throughput. This issue currently becomes concerns not only for system operators, but also for end users. In order to reduce a transmission delay, the shortest path routing is an indispensable factor. However, the upper layer equipment such as MPLS router is generally installed at POP (Point Of Presence) away from the landing station. Depending on the network topology, this equipment allocation deteriorates the efficiency of traffic routing, and the total transmission distance unexpectedly becomes longer due to extra traffic routing between the POPs and landing stations. This inefficiency would be resolved by installing the upper layer equipment at the landing stations. However, since the cost of the upper layer equipment is very high, it will not be a cost-effective solution.

As a practical measure, it would be an optimum solution that necessary functions of the upper layer equipment for the shortest path routing are integrated into SLTE which is installed at the landing station. As most of the current networks are managed with IP/MPLS, a transmission delay can be reduced by incorporating the label switching function of LSR (Label Switching Router) into the converged packet optical transport platform with the SLTE functionality. This solution will also contribute to a drastic reduction in the bandwidth of the backhaul network since all traffic does not need to be routed at POP. Furthermore, interaction between packet and optical networks will be realized by using the converged packet optical transport platform with the label switching function.

5. CONCLUSION

As a high-priority issue, it has become imperative to develop ways to integrate the existing networks into the packet based networks in order to realize a reduction in OpEx, and also to provide a flexible and quick way to introduce new applications and services. For submarine cable systems, provision for optimization of packet and non-packet traffic transport and simplifications of the network management has been required while global IP traffic is steeply increasing. For this reason, several new transport technologies are being developed for accommodating the requirements.

The converged packet optical transport platform based on the OTN and MPLS-TP technologies is presented as an optimum solution for the future submarine cable systems. The technologies employed in the converged packet optical transport platform are ideal not only for high capacity transmission, but also for transport of both packet and non-packet traffic. By incorporating the protection schemes with high fault-tolerance and SLTE functionality, the converged packet optical transport platform will configure a submarine cable system with a single platform. It enables simpler network management, and the simplified network management by a single management system will further contribute to OpEx reductions. The converged packet optical transport platform has a capability of flexibly supporting new functionality according to future needs. For the transmission delay problem due to inefficient traffic routing, it would be effective to add the label switching function to the converged packet optical transport platform.

