Highly Reliable and Managed MPLS Network Using Type-X Products

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Abstract

NTT Network Service Systems Laboratories have developed a series of products called Type-X that incorporate multi-protocol label switching (MPLS) technology. MPLS is a packet transfer method that is highly compatible with Internet protocol (IP) and traffic engineering. An IP network using Type-X products can achieve high reliability by using MPLS path protection, which restores a data transfer process in a few seconds when a network failure occurs. The Type-X OSS (operations support system), which manages network resources, allows a network to handle various services having various requirements simultaneously.

1. Recent IP network trends

Conventional IP networks generally operate on a best-effort basis, sending out as much data as possible and discarding some data if network resources are insufficient. However, best-effort transfer cannot meet the requirements of some recent data communications applications (Fig. 1), which require enough reliability to ensure that not even momentary service interruptions occur. This requires high quality in terms of strict limits on delay and packet loss.

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Constructing separate networks to meet these requirements would be rather inefficient. It would lead to duplication of network equipment costs and network management/maintenance work. Therefore, the network should handle applications with various features and meet all their requirements. Additionally, networks accommodating multiple users simultaneously must be virtual private networks (VPNs) that are secure against data communications between unauthorized users. One solution to these problems is a highly reliable and managed multi protocol label switching (MPLS)[*1] network.

Application type	Reliability		Transfer quality		
	Service interruption time	Unavailability	Packet loss	Delay	
Leased circuit service	Seconds/ minutes	10^{-5}	Disallowed	Relative delay small	▲ Strict
Voice/images	Minutes/day		Disallowed	Small	
Storage data transmission	Hours/day	10^{-4}	Disallowed	Allowable	
E-mail/Web	Day	$<10^{-3}$	Allowable	Allowable	▼ Tolerant

Fig. 1. Features of transfer data for each application.

2. Highly reliable and managed MPLS network

The transfer system necessary for such a network must be highly compatible not only with IP, but also traffic engineering (i.e., technology that can determine the transfer route based on network resources such as transfer capacity and delay). One of the transfer systems that can satisfy these requirements is MPLS [1]. By configuring a highly reliable and managed MPLS network with Type-X products using MPLS technology, we obtain a network that can handle applications with various features and meet their requirements (Fig. 2). Since this network can simultaneously contain a wide range of services, the carrier can provide the network with lower equipment costs for constructing the network itself and lower labor costs for network management/maintenance. Thus, users can get lower-cost services.

*1 MPLS transfers packets according to label information in fixed-length packet headers. Layer 3 over MPLS encapsulates IP packets into MPLS for transfer, and Layer 2 over MPLS transfer encapsulates layer 2 frames, such as Ethernet or AAL5, into MPLS for transfer. Since MPLS enables transfer without using IP header information, it can prevent illegal access due to IP address spoofing, so it is also used for constructing VPNs.

3. Type-X series

The Type-X series consists of the Type-X router and Type-X Operations Support System (X-OSS).

The Type-X router has rich MPLS functions in addition to carrier-grade router features such as the ability to handle a large volume of traffic, a complete range of line interfaces enabling low-speed to high-speed transmission depending upon the required bandwidth, and a wide range of high-reliability functions ensuring stable service operation from every viewpoint. There are three versions, which can be used as appropriate and combined to construct a flexible network (see also Fig. 3).

- Type-X320 (320 Gbit/s): ultrahigh-speed high-capacity core router
- Type-X80 (80 Gbit/s): core/edge router with rich transfer quality control functions
- Type-X40 (40 Gbit/s): edge router with rich edge functions

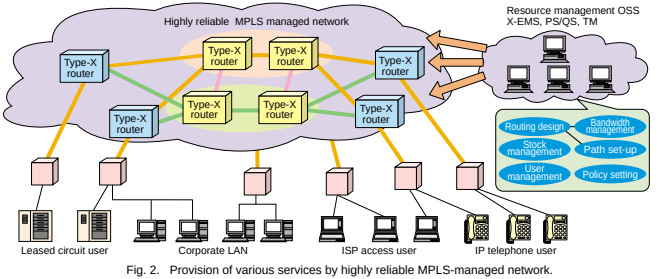


Fig. 2. Provision of various services by highly reliable MPLS-managed network.

Fig. 3. Type-X router line-up.

X-OSS has a number of features that suit various purposes for efficient network construction/operation.

- Element Management System (X-EMS): monitors/manages the equipment/network
- Policy Server (X-PS)/QoS (Quality of Service) Server (X-QS): designs/manages bandwidth and sets up the MPLS path and input traffic
- Traffic Management (X-TM): monitors the actual traffic volume in a network
- Resource management OSS: manages the stock of network equipment and user information

A number of functions for fully utilizing MPLS technology are incorporated in the Type-X router and X-OSS and linked together to enable the construction of a highly reliable and managed MPLS network capable of simultaneously supporting highly reliable traffic of various traffic qualities.

4. Highly reliable network provided by type-X with MPLS

One of the most significant features of a highly reliable network is that data transfer can be restored instantly when equipment in the network fails. It would take a long time to repair the fault and replace faulty equipment with standby equipment.

Therefore, we use a redundantly configured network that always has other paths available, even if some lines are disconnected (Fig. 4).

However, if IP routing protocol is used to switch the transfer path, the routers in a network must recalculate optimum paths based on the failure location and select a new one, so instant-switching of the transfer path is difficult.

The Type-X router has a high-speed MPLS path protection function for switching the transfer path (Fig. 5). This function uses MPLS's ability to set up a designed transfer path in advance. The primary path is set up in the working system and the secondary path is set up in the standby system. Therefore it can continue data transfer over the secondary path by redirecting the traffic in a few seconds when a fault occurs in the working system.

Type-X also enables us to set up a sub-gate path to be used in the redundantly configured user network. As shown in Fig. 6, these technologies and a redundantly configured network enable reliable transfer depending on each application by changing the number of rerouting paths. X-PS/QS also facilitates the design of these complex rerouting paths.

5. Multi-QoS managed network using type-X MPLS solutions

Simultaneous transfer of different quality traffic in a network requires functions for: (1) identifying the quality level of each traffic stream's data and controlling the data at each quality level and (2) managing the network resources used at each quality level.

MPLS can identify the quality level of each MPLS path*2. Different quality traffic can be handled in the

*2 The methods used by MPLS to determine the QoS class are specified in RFC3270, and include L-LSP (Label-Only-Inferred-PSC Label Switched Path) and E-LSP (EXP (Experimental)-Inferred-PSC LSP Label Switched Path) methods. This article treats L-LSP, which determines the QoS class for each MPLS path. E-LSP determines the QoS class based on the Exp bit of the MPLS packet header.
PSC: PHB (Per Hop Behavior) Scheduling Class.

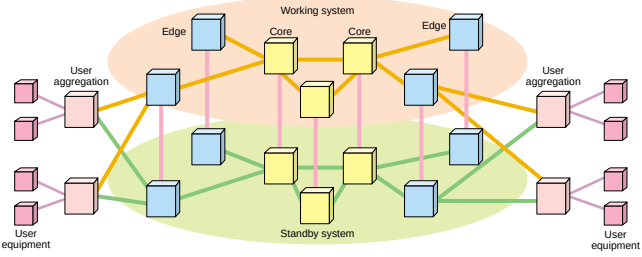


Fig. 4. Configuration of highly reliable MPLS network.

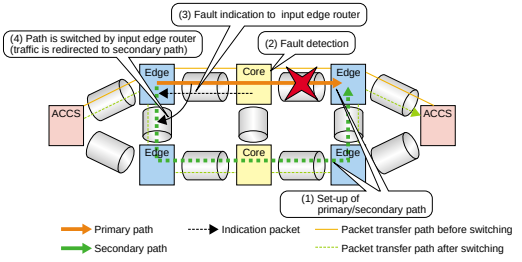


Fig. 5. Outline of MPLS path protection function.

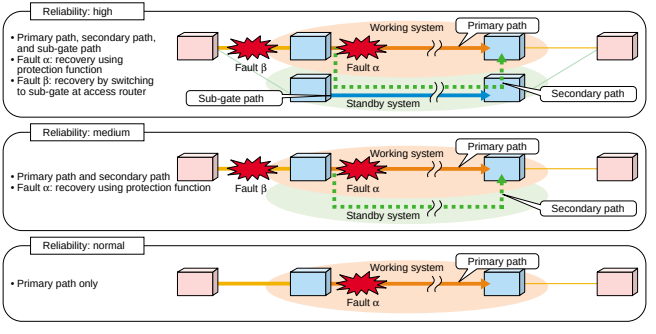


Fig. 6. Variations in transfer reliability provided by changing the number of MPLS paths.

network by aggregating similar traffic in the same path and controlling the quality level corresponding to each path. Since the transfer path can also be explicitly designated, the number and location of resources in a network can also be easily managed.

In the Type-X solutions, the Type-X router QoS function (traffic policing and multi-class queuing) performs function (1) and the MPLS setup/management function of the X-PS/QS performs function (2). This combination makes it possible to construct a (managed) network to manage the input traffic volume and accommodate different quality traffic.

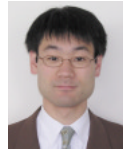
6. Installation status and outlook

NTT EAST has constructed a highly reliable and managed MPLS network for backbone networks in business use. The network currently accommodates thousands of terminals of various types with various operational features. In MPLS technology, the Internet Engineering Task Force (IETF) and independent vendors have enhanced the MPLS path set-up protocol and added a function to link it with VPN applications. To make networks with even more functions in the future, we will also follow standardization trends

and *de facto* standards and enhance Type-X functions as a carrier-grade solution.

Reference

[1] http://www.ietf.org/rfc/rfc3031.txt



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