Highly Reliable Edge Router Type-X40

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Abstract

Type-X40 is a highly functional edge router designed to accommodate various types of user networks. One of the Type-X router family, it features high speed, high reliability, and high quality control. It lets network designers build a sophisticated, large-scale, highly reliable MPLS (Multi-Protocol Label Switching) network.

1. Introduction

As well as fundamental aspects such as quality control and reliability, efficiency and flexible subscriber accommodation are important requirements of edge routers in an MPLS (Multi-Protocol Label Switching) network, especially in a highly reliable and large-scale (so-called "carrier-grade") network. Our Type-X40 router is a sophisticated edge router that has various functions for accommodating diverse user systems in addition to the functions available in Type-X320 and X80, such as wire-speed packet forwarding, advanced quality-of-service (QoS) control, and reliability enhancement functions. The combination of edge routers (Type-X40), core routers (Type-X320/80), and X-OSS (Type-X operations support system) can offer a scalable, highly reliable, and perfectly QoS-guaranteed MPLS network. Type-X40 provides high cost-performance and lets network designers construct highly reliable MPLS networks that are suitable for the required network scale.

2. Features

The Type-X40 router has four main features: i) high speed, high reliability, and superior cost-performance, ii) advanced QoS control function as an edge router, iii) support for various types of network services to users and logical network configuration functions, and iv) maintenance and operation functions for carrier-grade services. Table 1 shows its specifications.

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2.1 High speed, high reliability, and superior cost-performance

Figure 1 shows the hardware configuration of Type-X40. It consists of routing engine blade (REB) cards that control the entire system, input/output controller (IOC) cards each with an interface to a maintenance terminal and relay control signals between line interface (LINF) and REB cards, a switch blade (SWB) that switches packets, and several LINF cards.

It has a switch capacity of 40 Gbit/s (input: 20 Gbit/s, output: 20 Gbit/s), which is the smallest among the routers in the Type-X family. By separating routing control and packet forwarding and by distributing forwarding tasks onto multiple LINF cards and using a hardware-based execution mechanism (similar to Type-X320/80), Type-X40 achieves a high packet processing speed of 48 Mpps (pps: packets per second). Thanks to a content-addressable memory in the forwarding processing part, its packet forwarding performance is never degraded even if complex denial or permission control is executed for each packet forwarding.

To ensure carrier-grade reliability, Type-X40 has two levels of reliability enhancement measures. On the router unit level, Type-X40 has a unique redundancy configuration for its common components (REB, SWB, and IOC), which resulted from our long experience of switching system development. When a running component fails, Type-X40 changes over to

Table 1. Specifications of Type-X40.

System scale	Switch capacity	40 Gbit/s
	Maximum switch throughput	48 Mpps
Line interfaces	Number of line card slots	8
	Line interfaces	POS OC-48c/STM-16, POS OC-3/STM-1, POS OC-12/STM-4*, ATM OC-3/STM-1, Gigabit Ethernet, Fast Ethernet, T1 (by combining with interface unit)
MPLS	LSP setup	Static, RSVP-TE, LDP*
	Types of LSP	L2 (Ethernet/AAL5) over MPLS, L3 over MPLS, MPLS label stack
QoS	ATM QoS	CBR, VBR, UBR, VP/VC shaping
	IP QoS	DiffServ (EF/AF4-AF1/BE, hardware processing), RSVP
Reliability	Redundancy	1+1 configuration (SWB, REB, IOC, LINF*)
		LSP protection switching
	Interruption-free service function	Changeover of common components, software upgrading*
Maintenance operations	Intermission-free service provisioning	Parameter changing (bandwidth, route etc.)
	Fault detection	Audit function of LSP, notification of FCS error
	Fault information gathering	Standby dump, failure data
Protocols	Network	IPv4, IPv6, IPv4/IPv6 dual stack (wire speed)
	Routing	Static, OSPF, RIP, BGP4
IP service		Multicast, virtual router, VPN

*: to be supported in 2003

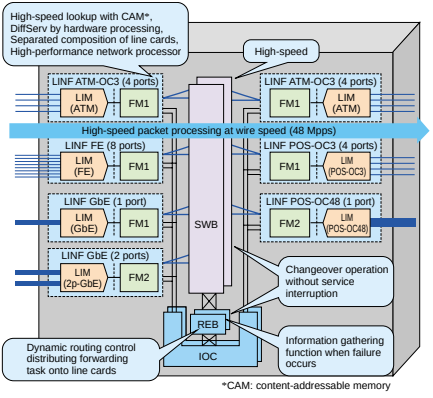


Fig. 1. Hardware configuration of Type-X40.

another component without any service intermission (not ever a small one).

Further reliability enhancement measures will be provided by software upgrades without service intermission and the redundant configuration for LINF (1+1 redundancy). As for path-level redundancy, Type-X40 supports LSP (Label Switched Path) protection switching. When a failure occurs, a failure notification is sent to an ingress router, which quickly switches packet flows from the primary LSP to the secondary LSP.

The hardware composition of Type-X40 is based on the high-density mounting method using highly integrated, high cost-performance devices. This makes Type-X40 so small that two type-X40 systems can be mounted in one cabinet. Its superior cost-performance compared with other routers of the same class derives from such implementation technology.

2.2 Advanced QoS control function at an edge router

An edge router needs to have more finely tunable QoS control functions to meet various user traffic requirements than a core router. For ATM QoS functions, Type-X40 provides a layered shaping function for virtual paths and channels in addition to general QoS functions of ATM. These functions make it possible to design a network that provides well-adjusted QoS capabilities for each user's conditions.

Type-X40, like Type-X320/80, provides a DiffServ (Differentiated Services) function. DiffServ technology in a router consists of six transfer quality classes, with the highest quality class being Expedited Forwarding (EF). This technology achieves fine tuning for various types of traffic, for example VoIP and data communication. To complete DiffServ control, the queuing control of Type-X40 has an outstanding hardware mechanism that simultaneously performs priority read-out control in the Assured Forwarding (AF) class and priority control between classes, which other routers do not do. Furthermore, its DiffServ function can be set not only to a physical circuit but also to each logic interface, such as an ATM virtual channel or virtual LAN. In addition to the DiffServ function, interworking with the QoS servers makes it possible to operate a network where the bandwidth of all LSPs is completely guaranteed.

2.3 Support for various types of network services to users and logical network configuration functions

For a large-scale MPLS network such as a carrier's network, it is important how scalable the network is, how many network services can be provided to users systems, and how flexibly logical network resources can be handled by the network designer. The various network services and logical network configuration examples supported by Type-X40 are shown in Fig. 2. Type-X40 provides various types of circuit interfaces such as POS, ATM, FE, and GbE, so it can deal with the various interface requirements of each user system accommodated. The LINF cards are divided into line interface modules (LIMs) and forwarding modules (FMs) in Type-X40, unlike in the core router Type-X 320/80. This composition, aimed at common use of FM cards, enables the circuit type to be easily

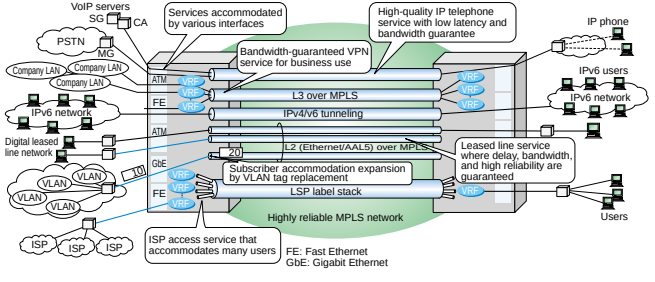


Fig. 2. Various network services and logical network configuration examples supported by Type-X40.

changed by replacing an LIM card with another type of LIM card. This is very useful for coping with not only card failures but also changes in user requirements.

One of the features of Type-X40 as a user accommodation router is its ability to establish data links, such as ATM-AAL5 and Ethernet (including tagged-VLAN), on an IP network with an LSP. Long-distance data links over LSPs give users a free hand in designing their own networks. These LSPs can accommodate many users with various traffic types in the same router by applying QoS control. An MPLS label stack function enables the network to accommodate many data-links in an LSP. Therefore, even when accommodating many users at a low speed, it is possible to establish an efficient MPLS network with the increase in the number of MPLS paths kept to the minimum. Furthermore, to establish many more Ethernet-links in a network, Type-X40 as an MPLS egress router replaces the VLAN-TAG of the Ethernet-frame. This expands the number of VLANs that can be accommodated in the whole network.

Another feature of Type-X40 is abundant service functions which are essential for promising commercial services, such as IPv6 and VPN (Virtual Private Network) function. Type-X40 enables these services without the routers being set up service by service. Of course, such functions can cooperate with the highly reliable and high-quality controlled MPLS edge functions.

2.4 Maintenance and operation functions for carrier-grade services

To minimize service intermissions caused by maintenance operations, not only router reliability functions but also advanced maintenance and operation functions are needed. In particular, the edge router needs a function for performing flexible operations corresponding to various user demands because edge router intermission immediately causes user communication intermission. The maintenance and operation functions provided by Type-X40 are shown in Fig. 3.

Type-X40 has a function for changing various service provisioning data without service intermission. LSP bandwidth and forwarding route are typical examples of such data. For MPLS, it also has intermission-free service provisioning functions that can change an LSP route or QoS parameter without any service intermission. Moreover, Type-X40 can change the ATM bandwidth without service intermission in order to cope with the need to change user bandwidth quickly.

Type-X40 can configure line-card data before mounting and remove or insert a card while operating, so maintenance operations such as adding a new line card can be done efficiently.

Another important element for a carrier-grade network is to avoid or minimize service intermission caused by a network-level failure. For this purpose, it is very important to display latent network disorder and recover from a failure at an early stage. For early

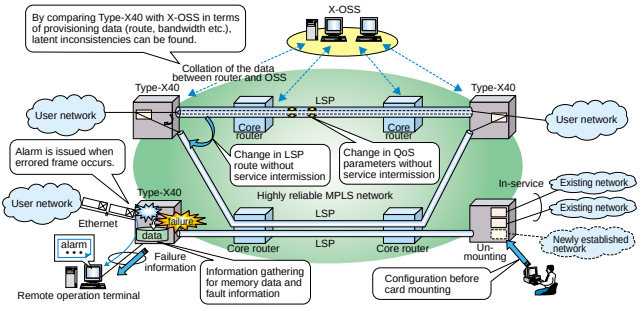


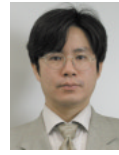
Fig. 3. Maintenance and operation functions of Type-X40.

detection of provisioning data inconsistencies, Type-X40/80 and X-OSS have LSP data audit functions which are achieved by comparing the provisioning data in Type-X40/80 and X-OSS. Surveillance and notification functions for an errored frame on Ethernet are also provided for early detection of failures hidden in an Ethernet segment.

Even when a complicated failure like a software failure occurs, it should not persist for long, and any affect on the whole network must be avoided. Type-X40 has a function for gathering various data, such as memory data and fault information at the instant a failure occurs. Therefore, as in a switching system, the cause of the fault can be identified and the fault can be corrected. Speedy investigation into the cause of failure and complete recovery are possible thanks to these data collecting functions.

3. Conclusion

Development of the basic functions of Type-X40 was completed in the 2nd quarter of 2002, the second step of developing functions dealing with a large-scale network was completed in the 4th quarter of 2002, and Type-X40 is now in a stable operating condition. Demand for a highly reliable service network based on MPLS technology is increasing more and more. We plan further improvements, such as reliability enhancement or high-speed rebooting without hardware initialization, and further development of new service functions, such as IP multicasting.



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