Carrier Ethernet Technologies for the NGN Era

Satoshi Narikawa, Masahiro Maruyoshi, and Kazuhiro Okura†

Abstract

This article introduces key technologies needed to satisfy the requirements of next-generation Ethernet, i.e., Carrier Ethernet services for the Next Generation Network (NGN) era. They must provide high end-to-end maintainability and operability and high network reliability.

1. Introduction

Compared with conventional leased-circuit services using technologies such as synchronous transfer mode, asynchronous transfer mode, and frame relay, Carrier Ethernet services will be able to provide high-speed circuits at relatively low prices. At the same time, maintenance personal and customers demand that next-generation Ethernet achieve a level of maintainability and reliability on par with that of conventional leased-circuit services.

NTT is developing three main functions to satisfy these demands for next-generation Ethernet: (1) operations, administration, and maintenance (OAM) technology to improve maintenance and operation performance, (2) Ethernet ring protection (ERP) technology in the relay network, and (3) redundancy technology in the access network. The overall objective of developing these technologies is to improve network reliability.

2. Key next-generation Ethernet technologies

2.1 Ethernet OAM technology

Ordinary Carrier Ethernet generally does not include standard maintenance and management functions. Instead, fault troubleshooting and other tasks are performed using the ping command and/or proprietary tools from switch vendors. However, the use of commands on the Internet protocol level (layer 3 (L3)) and higher levels means that normality checking using test frames on the Ethernet level (layer 2 (L2)) is not performed. Furthermore, when a network has been built using switches from multiple vendors, maintenance personnel have no choice but to use the tools provided for each type of switch.

By contrast, next-generation Ethernet will make use of standard management functions provided by Ethernet OAM technology, enabling maintainability and operability to be improved (**Table 1**). Ethernet OAM technology, which was standardized as ITU-T Y.1731 in May 2006 and as IEEE802.1ag in September 2007, features a function set necessary for maintenance and operation work (constant monitoring of each virtual local area network, continuity checking, checking of frame transfer paths, and measurement of transmission delay). Configuration functions at the management level can also be used to provide network security by preventing the transfer paths of OAM frames transmitted from a user terminal from being detected.

2.2 ERP technology

Transmission paths can generally be made redundant by establishing a ring configuration in the relay network (**Fig. 1**). If a fault occurs within a ring network, processing for switching the frame transfer path must be performed while preventing frames from falling into an infinite loop that can put pressure on the transmission-path bandwidth. However, this switching can take several seconds to complete when

† NTT Access Network Service Systems Laboratories
Tsukuba-shi, 305-0805 Japan

Table 1. Comparison of maintenance and operation technologies.

	Conventional technologies	Next-generation Ethernet technologies
Main management functions	Ping command, proprietary tools	Ethernet OAM
Constant monitoring of each user	By pinging	By L2 frames for monitoring use

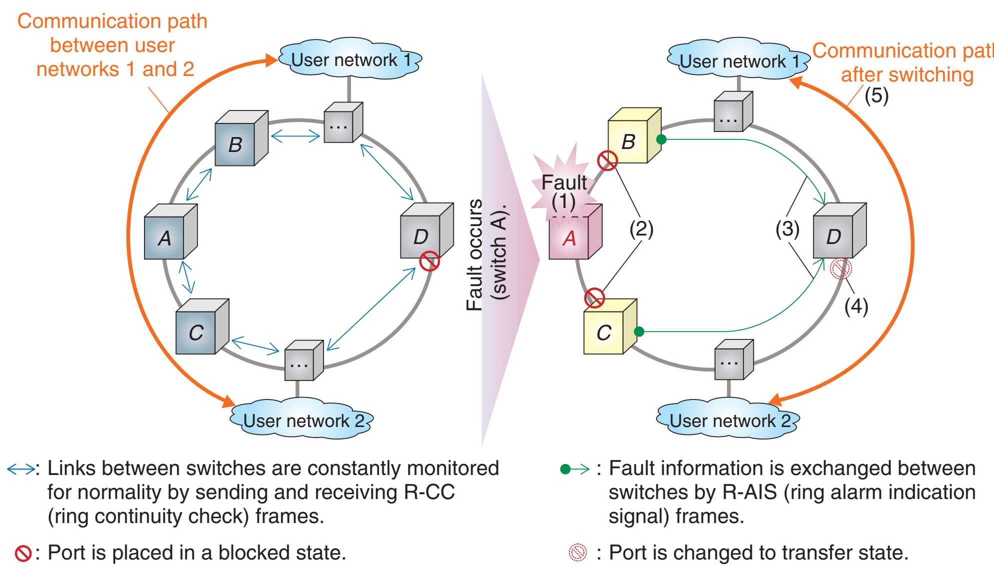


Fig. 1. Example of ERP technology in operation.

using a spanning tree protocol, a general-purpose L2 path control technology, and such a long break in communications presents a technical problem to be solved.

In response to this problem, we have developed ERP technology having the following features toward next-generation Ethernet.

- Loop prevention at the time of path switching
- High-speed path switching

Taking a typical ring configuration (Fig. 1) as an example, we assume that a fault occurs in switch A (1). Then, as adjacent switches B and C detect that fault, the ports on those switches that connect to switch A are blocked (2). Next, other switches are notified of the fault (3), and the port on switch D, which is normally blocked, is now released, thereby constructing a new path for frame transfer (4). Finally, the MAC (media access control) address lookup table is initialized at all switches on the ring, and frame transfer processing on the new path begins (5).

The port-blocking processing of step (2) achieves switch processing without generating loops, and the simple process of blocking and releasing ports in steps (2)–(4) enables a path to be reconstructed and high-speed path switching to be performed.

The development of this technology has prompted standardization efforts in ITU-T SG15 (International Telecommunication Union, Telecommunication Standardization Sector Study Group 15) resulting in the approval of Recommendation G.8032/Y.1344 [1], [2] in June 2008.

2.3 Access-network redundancy technology

Redundancy technology in the access network prepares two systems (active system and backup system) each consisting of an optical network unit and optical subscriber unit in the access network (**Fig. 2**). When a fault is detected, the active and backup systems are switched over, which improves the reliability of the access network.

In this way, ERP technology and access-network redundancy technology combine to achieve a highly reliable network having redundancy functions.

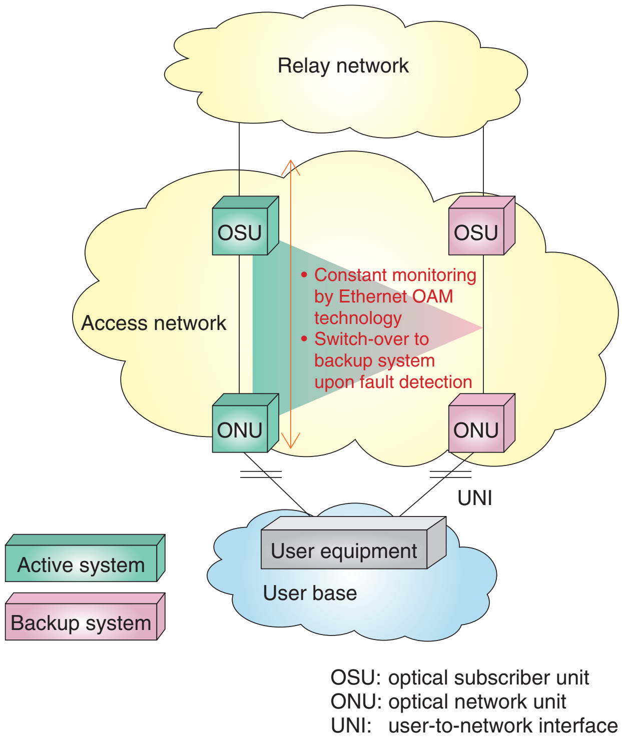


Fig. 2. Network configuration using access-network redundancy technology.

3. Future outlook

This article introduced Ethernet OAM technology, ERP technology, and access-network redundancy technology as examples of key next-generation Ethernet technologies. Looking forward, we plan to develop operation technologies that will enable maintenance personnel and network designers to pursue integrated network management (facility design, accommodation design, and testing) toward next-generation Ethernet.

References

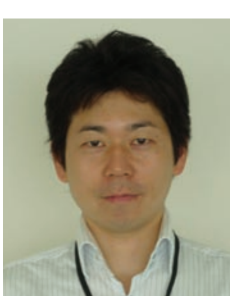
[1] ITU-T Rec. G.8032/Y.1344, "Ethernet Ring Protection Switching," Jun. 2008.

[2] M. Maruyoshi, "Standardization on Ethernet ring protection switching in ITU-T SG15," IEICE Tech. Rep., Vol. 108, No. 394, CS2008-69, pp. 71–76, Jan. 2009 (in Japanese).

Satoshi Narikawa

Member, Fourth Promotion Project, NTT Access Network Service Systems Laboratories.

He received the B.E. and M.E. degrees in electrical and electronic engineering from Tokyo Institute of Technology in 2001 and 2003, respectively. He joined NTT Access Network Service Systems Laboratories in 2003 and engaged in research on innovative optical multiplexing systems for access applications. Since 2007, he has been engaged in R&D of next-generation Ethernet technology.



Masahiro Maruyoshi

Member, Secure Communication Platform Project, NTT Information Sharing Platform Laboratories.

He received the B.E. and M.S. degrees in information engineering from Nagoya University, Aichi, in 2000 and 2002, respectively. He joined NTT Information Sharing Platform Laboratories in 2002 and engaged in R&D of next-generation Ethernet technology. He actively participates in ITU-T SG15 standardization meetings. He is currently one of the editors of ITU-T G.8032 (Ethernet ring protection switching).

Kazuhiro Okura

Senior Research Engineer, Fourth Promotion Project, NTT Access Network Service Systems Laboratories.

He received the B.E. degree in electrical and electronic engineering and the M.E. degree in information processing from Tokyo Institute of Technology in 1994 and 1996, respectively, and the M.B.A. degree from Nanyang Technological University, Republic of Singapore in 2002. He joined NTT in 1996 and engaged in various IT systems development projects for NTT's e-Commerce services. Since 2007, he has led a network architecture design team in R&D of next-generation Ethernet technology.