Development of the New ADM Ring System

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Abstract

We are developing a new add-drop multiplexer (ADM) ring system that utilizes the functions of our existing 2.4-/10-Gbit/s ADM ring systems. It has i) some new interfaces, so it can handle various kinds of traffic such as SDH, SONET, and GbE, ii) an extension of the offered CoS (class of service) domain based on advanced standard technologies such as a 10-Gbit/s STM (synchronous transmission mode) interface, and iii) improved functions for control and supervision by the network element operating system. These features support flexible and economical networks. (SDH: synchronous digital hierarchy, SONET: synchronous optical network, GbE: gigabit Ethernet)

1. Introduction

With the hardware of the DMS-10 switching system[*1] becoming old, we intend to replace DMS-10 switching modules by new switching modules called RSBMs (remote subscriber modules), ASMs (architectual STM modules), and SBMs (subscriber modules). However, if we simply replaced them, we would need an optical fiber cable for each set of line cross connect modules (LXMs) and RSBMs. This would cause a shortage of optical fibers and thus require a lot of investment for new optical cables. One solution is to use an ADM ring system, but our existing one, which provides basic functions for transporting data at 10 or 2.4 Gbit/s, was introduced six years ago, so it has become obsolete. For this level of performance, it is too big and too expensive. Therefore, we are developing a new ADM ring system that can multiplex several signals transported by multiple optical fiber cables onto one cable. **Figure 1** shows an example of replacing a DMS-10 switching module with an RSBM in local branch networks.

2. Specifications of the new ADM ring system

Figure 2 shows an example of constructing a new ADM ring system. Any equipment can be connected to the network element operating system (NE-OpS) through a data communication network (DCN). We control and supervise it via a human-machine interface (HMI). This ADM ring system has a capacity of either 2.4 or 10 Gbit/s on a single ring. **Table 1** shows the main specifications of this system, which has several superior functions compared with the existing one.

2.1 Various kinds of interfaces

The existing ADM 2.4-/10-Gbit/s ring system can transport only SDH (synchronous digital hierarchy) signals. We have developed some new tributary interfaces, such as ones for GbE (gigabit Ethernet) to handle various traffic signals, so we can provide various network services.

(1) SDH/SONET interface

As STM (synchronous transmission mode) interfaces, we developed SONET (synchronous optical network) interfaces, which are mainly used in North America. We are also developing SDH interfaces, which are used in existing transmission systems. These SONET and SDH interfaces use the same hardware and are distinguished by software settings.

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*1 The DMS-10 switching system from Northern Telecom (Nortel) is a carrier class central office switching platform offering dial tone service. NTT first began using it in 1989, but has decided to phase out this low-capacity digital switching system.

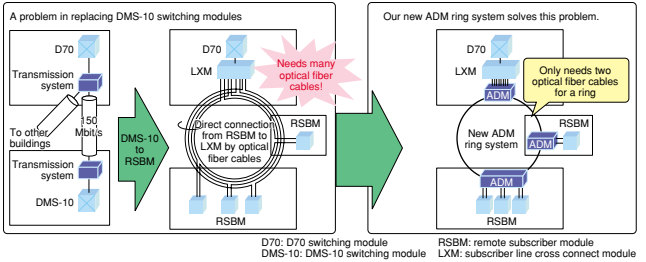

Fig. 1. Effect of introducing the new ADM ring system.

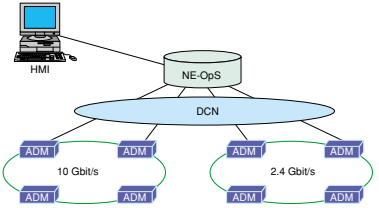

Fig. 2. Example of a network configuration based on the new ADM ring system.

Table 1. Main specifications of new ADM ring system.

		Functions of new ADM	Existing ADM
Aggregate interfaces		2.4 Gbit/s, 10 Gbit/s	Yes
Tributary interfaces		STM: 50 Mbit/s, 150 Mbit/s, 600 Mbit/s, 2.4 Gbit/s	Yes
		SONET 150 Mbit/s, 600 Mbit/s, 2.4 Gbit/s	—
		GbE 1000Base-SX/LX	—
Path switching		Unprotected	Yes
		Hitless switching	Yes
		Switching in 50 ms	Yes
Setting	Path	Virtual concatenation	—
	Ring	Multi-ring, hairpin	—
	Others	Add node in the ring with uninterrupted service Upgrade capacity of the ring (from 2.4 to 10 Gbit/s) with uninterrupted service	—
NE-OpS	Registration	Ring, NE, tributary interface, VC path (through some rings), section in the ring	Yes
	Alarm supervision	NE in the ring, VC path (through some rings)	Yes
	Search	Constitution of path, path contained in a section	—
	Others	Multi-server	—

(2) GbE interface

The new ADM ring system can also transmit Ethernet traffic using 1000Base-LX and 1000Base-SX for IP network services. The 1000Base-LX/SX interface uses one common GbE package for both long-distance and short-distance transmission to reduce the expense of using multiple package types. The GbE package includes an appropriate SFP (small form-factor pluggable module) for each. In the new ADM ring system, we used "virtual concatenation", which maps a GbE signal into the payloads of STM signals and transmits their STM paths as if they were a single path. This technology makes effective use of bandwidth without being limited by the existing hierarchy.

2.2 Small size and high density

We made packages much smaller, so adding or dropping 10 Gbit/s requires only one shelf of equipment in the new system compared with two or three cabinets in the existing system. And the new system shelf fits popular cabinets such as DS1 or DS2. Thus, we achieved a small size and high density. Furthermore, we achieved these functions at a more economical price than before.

2.3 Extension of the offered CoS domain

Like the existing ADM ring system, the new system can transmit STM signal paths such as VC-3, VC-4, and VC4-4c (VC: virtual container), but it extends the offered CoS (class of service) domain by introducing the capability to add or drop paths for VC4-16c (2.4 Gbit/s). We have three kinds of protection: hitless switching protection, switching in 50-ms protection (called normal protection), and unprotected traffic. For GbE paths that use virtual concatenation, we have normal protection and unprotected traffic. **Figure 3** shows the CoS domain offered by the new ADM ring system.

2.4 NE-OpS

We also improved the functions of the operations system for the new ADM ring system (NE-OpS). The main functions are described below.

(1) Improved control of NEs and HMIs

The new ADM ring system can control more NEs per server (i.e., 256) than the existing system (60). It can also handle more HMIs (up to 16) per server. This was made possible by the improved performance of computer and software architectures.

(2) Functions for single-vendor network operation

In the past, when we operated a path through some rings, we used to have to operate the path separately for each ring. In the new ADM ring system, however, we can operate the entire path through several rings just like a single path. At each HMI, we can select whether or not alarms sent from NEs are displayed on the operator's screen and whether they are displayed separately for each ring or in overall order of importance. So we can effectively supervise many NEs in a wide area. Furthermore, we can comprehend the route of a path by graphically displaying it, so we can immediately resolve any trouble. In this way, we

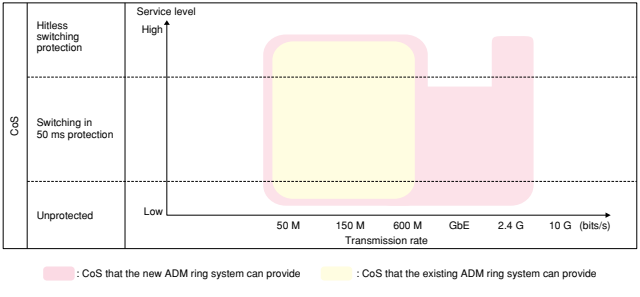

Fig. 3. CoS domain offered by the new ADM ring system.

improved the functions of NE-OpS, so we can supervise and control one vendor's NEs as effectively as when we use a network operating system (NW-OpS).

3. Flexible network

The new ADM ring system lets us construct ADM ring networks flexibly and economically in response to changes in demands, using the four functions shown below. We show network examples in **Fig. 4**.

3.1 Multi-ring network

A multi-ring network has an NE connected to several rings at the same time. We can set a path through some rings without passing through tributary interfaces except for a path added or dropped at our own NE. Using this function, we can construct ring networks more effectively and economically than before.

3.2 Hairpin cross-connection

A hairpin means a path from one tributary interface to another tributary interface that does not go through any aggregate interface. In other words, a hairpin is a path that doubles back on itself. This function also lets us convert interfaces when the NE is connected to another system.

3.3 Upgrading the capacity of the ring with uninterrupted service

In the new ADM ring system, we can upgrade the capacity of the ring from 2.4 Gbit/s to 10 Gbit/s without interrupting service. This function is useful if we initially construct a 2.4-Gbit/s ring network and later want to upgrade its capacity. Even during the upgrading process, a path having hitless switching protection is available for service. This function enables us to take immediate action in response to sudden changes in demand.

3.4 Multi-server

A multi-server means an HMI connected to several servers at the same time. It means that we do not have to prepare an HMI for each server. We can supervise and control NEs in several servers via one HMI. We can set HMIs in various patterns for this function. For example, we can supervise NEs from one centralized HMI. **Figure 5** shows the concept. Usually, each branch has an HMI for path setting, and servers are set for each area. When we supervise NEs in one place, we do not have to prepare an HMI for each server in the new ADM NE-OpS. This reduces the cost of the HMIs.

4. Conclusion and future work

We believe that this new ADM ring system will be introduced as an economical infrastructure. We are continuing to develop more convenient functions and more useful interfaces, such as 10-GbE.

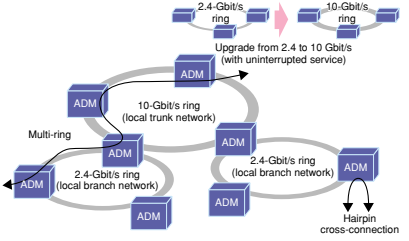

Fig. 4. Making a flexible network.

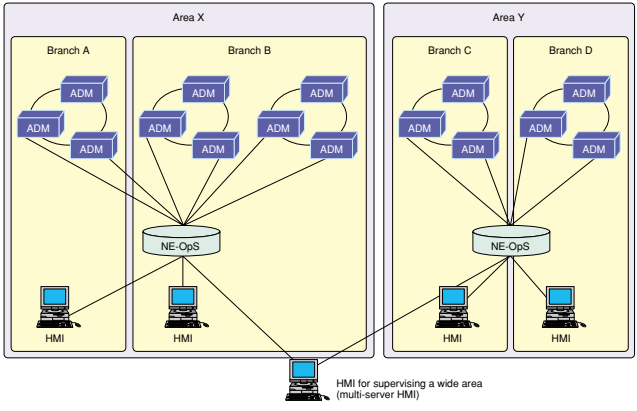

Fig. 5. Concept of multi-server function.

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