Optical Transport Systems for Next-generation Networks

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OVERVIEW: For the transition from existing networks to NGNs, development is continuing in respect to two main pillars: the transport stratum and the service stratum. As for the transport stratum, though both IP networks and optical networks are involved, in the present article, products for optical transport systems only are discussed. In regards to providing a comfortable broadband network environment, optical transport technology plays an important role in whatever network concerned, namely, the core network, metro network, or access network. Hitachi is providing various kinds of optical transport systems aimed at each of these network domains. As for a system in the core network for constructing a large-capacity Ethernet network, the optical transport platform AMN7500—on which an optical cross-connect network or a ROADM can be constructed—is being provided. By using WDM technology, it is possible to set up an easy-to-use, convenient optical core network that can be flexibly reconfigured. Moreover, for construction of a metro network for easily handing large volumes of data, a CWDM system is suitable. Using this system, network providers can construct the most suitable system to meet their service requirements.*

INTRODUCTION

OPTICAL transport technology has mainly been used for transport systems for long-haul transmission of large volumes of data between cities. As a consequence of the continuing conversion of network broadband access, however, optical transport technology is beginning to be applied to transmission within cities and to access systems for users. Optical access systems that perform optical transmission by optical fiber from homes and businesses enable high-speed access faster than ADSL (asymmetric digital subscriber line) and cable modems; therefore, they are considered the ultimate method for broadband access.

As IP (Internet Protocol) conversion of network

* Ethernet is a registered trademark of Xerox Corp.

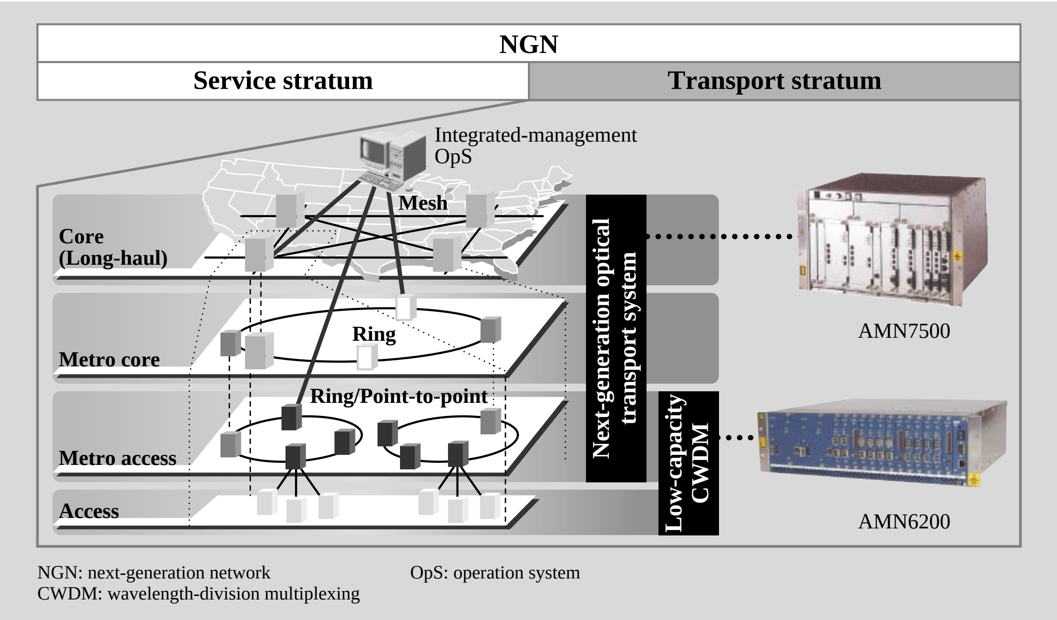

Fig. 1—Example of Optical Transport System Configuration.
In the optical transport system in transport stratum of NGN, the network provider can configure a system for best meeting service requirements for each area (core, metro-core, metro access and access).

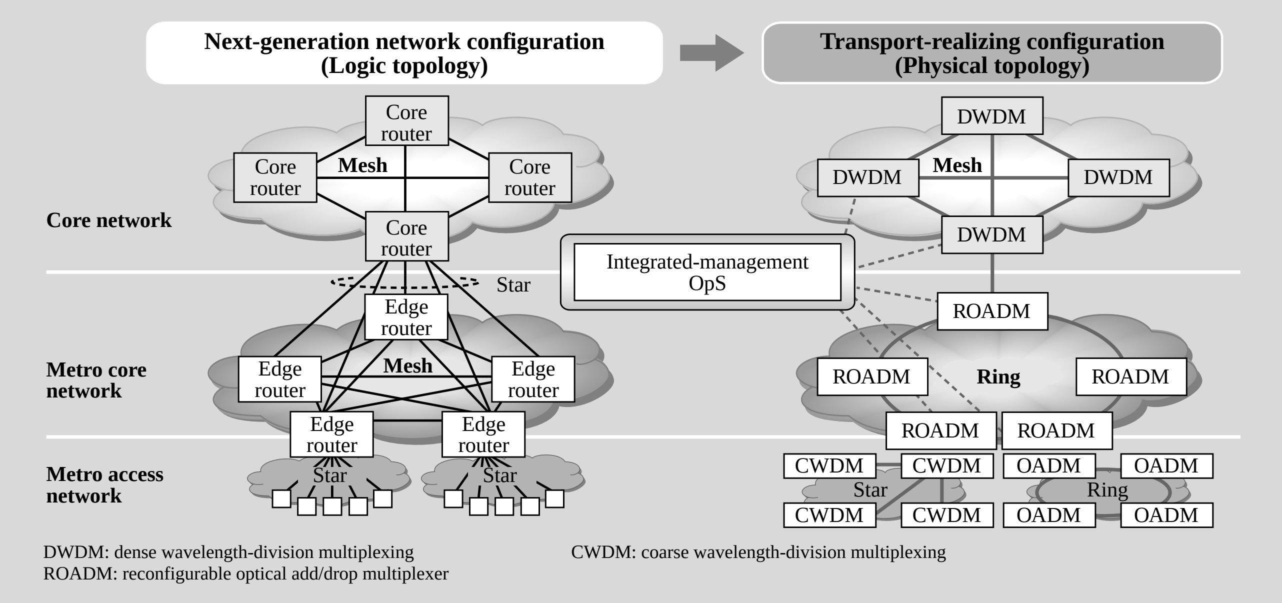

Fig. 2—Configuration of Optical Transport Network.
The physical topology can be thought of as a core network with a mesh configuration, a metro-core network with a ring configuration, and a metro-access network with a star or ring configuration.

services and the above-mentioned "broadbandization" of network access continue, optical transport systems "which support fundamental parts of a network" are required not only to transmit conventional telephony and leased-line data but also to efficiently deliver broadband services in large volumes on IP systems. Moreover, from the viewpoint of network operators employing an optical transport system, ensuring ease of use of the system is becoming a more important challenge. For example, operators require the capability of easily changing the physical topology of an IP network from the control system.

The rest of this article describes two types of easy-to-use high-performance optical transport system—a core-network and a metro-network—aimed at establishing an optical transport network suitable for IP-broadband systems (see Fig. 1).

OPTICAL TRANSPORT NETWORKS

Requirements Regarding Optical Transport Networks

In optical transport networks of the "all-IP" generation, it is necessary to accommodate IP-system interfaces in addition to conventional SDH (synchronous digital hierarchy) international standards. Moreover, with respect to each network area, the following technical requirements must be met.

(1) Core network: all-optical DWDM (dense wavelength-division multiplexing) mesh network for handling ultra-large-capacity traffic over distances of 500 to 1,000 km, OXC (optical cross-connect) function, and 40-Gbit/s interface

(2) Metro-core network: flexibly reconfigurable network for large-capacity transport over 100 to 500 km at high reliability and ROADM (reconfigurable optical add/drop multiplexer) ring

(3) Metro-access network: point-to-point and ring networks for realizing economical installation and operation costs over distances less than 100 km, CWDM (coarse wavelength-division multiplexing), and OADM (optical add/drop multiplexer)

Configuration of Optical Transport Network

The envisioned configuration of a next-generation optical transport network is shown in Fig. 2. As the logic topology, the core network and metro-core network are configured as a mesh type with core routers and edge routers, and the metro-access network, as a star type. In correspondence with that, the physical topology is configured economically as follows: a mesh-type network (conventionally, all-optical OXC) using DWDM technology as the core network; a ROADM ring network for realizing highly reliable and effective utilization of fiber core by DWDM as the metro-core network; and a ring (using OADM) or star (using CWDM) configuration as the metro-access network. Moreover, by integrated management of each network straddling each area, maintenance, operation, and management are made more efficient, and new expansion as "total networks" is expected.

Metro-core-series Optical Transport System

To respond flexibly to changes in traffic of various services carried on optical networks spanning core networks up to metro-core and metro-access networks, we developed the next-generation optical transport platform AMN7500[1]. Fig. 3 is a photograph of the external appearance of the basic shelf of the AMN7500, which is mounted in a 19-inch rack and is one quarter of the size of a comparable standard Hitachi product. The main features of the AMN7500 applied for metro-core networks are as follows:

(1) Under wavelength multiplexing of more than 32 wavelengths, "add/drop/through" set up is possible by means of remote control.

(2) Transmission fiber can configure a system with link lengths of about 500 km by application of normal dispersion fiber (i.e. SMF: single-mode fiber) or DSF (dispersion-shifted fiber).

(3) The user interface accepts GbE (Gigabit Ethernet), 10GbE, STM-16 (synchronous transport module-16), and STM-64 technical standards (and can also handle future STM-256 including electrical multiplex transponder), and the line side performs path control on high-reliability OTNs (optical transport networks) and adopts a full-band wavelength-tunable transponder.

(4) By utilizing universal slots, required packages can be mounted in arbitrary slots and operated in response to demand. And collocation space can be effectively utilized by expansion in terms of units.

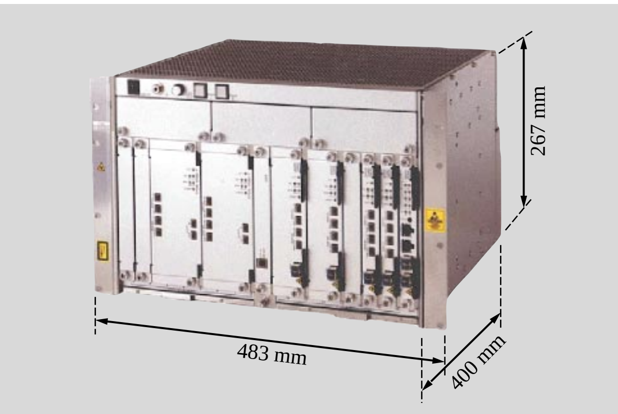

Fig. 3—External View of Optical Transport System "AMN7500." Mounted in a 19-inch rack, this system is shrunk to one quarter of the size of a conventional device (a Hitachi commercial product).

Metro-access-series Optical Transport System

Even in the case of a metro-access network with link lengths of over 100 km, by applying the same AMN7500 platform across the network, the same OADM system as that of the metro-core network can be established, and total integrated administration and high-reliability wavelength-path control straddling the respective optical networks is realized. Since the transmission distance is short, omission of dispersion compensation for 10-Gbit/s interface between offices, reduction of types of optical-amplifier package, etc. allow us to provide even more useful and convenient systems.

CWDM SYSTEM FOR METRO-ACCESS AND INTERNAL ENTERPRISE NETWORKS

Characteristics of AMN6200

With the popularization of broadband services, the demand for economical, large-volume transmission of data on metro-access networks and enterprise networks has grown stronger.

The AMN6200[2] adopts CWDM and thus enables large-volume data transmission. Moreover, long-distance transmission using a forward error correction, but without using optical amplifiers, is possible; thus, an economical network can be set up.

The main characteristics of the AMN6200 are as follows:

(1) By means of CWDM technology, bi-directional signal transmission of eight wavelengths is possible by single-fiber transmission.

(2) A multitude of mixed interfaces [including 10/100BASE-TX, GbE, 10GbE, OC-3 (STM-1), OC-12 (STM-4), and OC-48 (STM-16)] can be accommodated.

(3) Mounting functions for forward error correction and large dispersion tolerance on a 10-GbE signal converter, transmission distances of over 80 km become possible.

(4) By means of local units, a bi-directional star with a single fiber or a linear-path-type system can be established.

Application to Networks

Utilizing wavelength multiplexing of optical signals for metro-access area networks and enterprise networks, the AMN6200 has a CWDM device for transmitting large volumes of data for Ethernet services, database storage, etc., and multi-transmission. The optical signal can be multiply transmitted in a maximum of up to eight wavelengths on a bi-

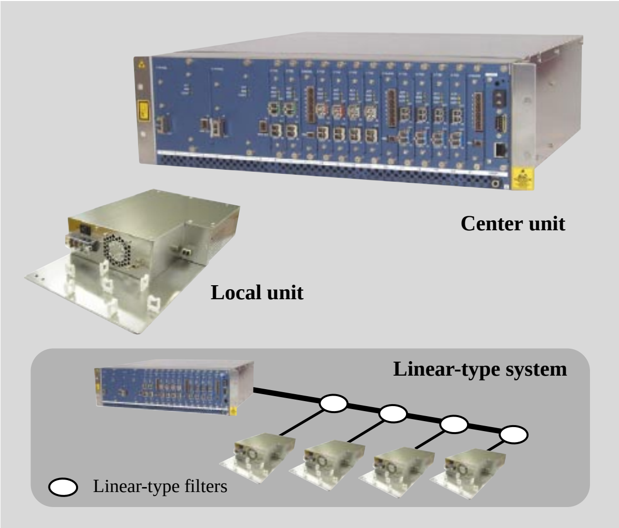

Fig. 4—CWDM System.
Linear-type filters are used, and a linear-type system can be configured with center units and local units.

directional single, and the number of optical fibers and the operation cost can be reduced. The AMN6200 interface covers 10/100BASE-TX, GbE, 10GbE, OC-3 (STM-1), OC-12 (STM-4), and OC-48 (STM-16), and by introducing a pluggable optical module, it is possible to set up a flexible system in compliance with the standards for connection routers, etc. Equipped with a forward-error-correction function for the 10-GbE signal receiver and a large dispersion tolerance, the AMN6200 enables transmission distances of over 80 km on dispersion compensation fiber with the use of optical amplifiers. Applying a “universal slot” system (which can mount interface boards in arbitrary positions), the center unit allows interfaces to be freely combined regardless of their type.

Adding local units and passive filter to the CWDM devices in the point-to-point system makes it possible to provide a point-to-multipoint system. Combining a star-type filter or a linear-type filter makes it possible to construct a single-fiber bi-directional-star system or linear-type system. Furthermore, by applying OTN technology, the local units can perform monitoring at remote distances from the center unit.

CONCLUSIONS

With the arrival of the present era in which broadband services by optical access to homes are spreading, optical transport technologies are becoming ever more important. Straddling all areas of core-, metro-, and access networks, Hitachi’s transport systems will continue to evolve while aiming at expanded functionality and improved convenience. On top of that, they will continue to provide optical-transport solutions making use of the power of our integrated products, thereby contribute to creating the “next-generation network society.”

REFERENCES

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