Optical Transport Platforms for Supporting Ubiquitous Information Society

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OVERVIEW: As broadband networks continue to spread rapidly, notable "network migration"—that is, shifts towards fiber optics and IPs, integrated fixed and mobile networks, and the ubiquitous information society—is being forecast. Under these circumstances, future optical transport networks, which form the infrastructure that underpins the ubiquitous information society, will require solutions for lowering equipment costs as well as operation and maintenance costs across entire networks, that is, from access networks up to long-haul core networks. As regards handling a multitude of services and data traffic with constantly changing parameters, it is a great challenge to ensure flexibility. To ensure such flexibility in response to varying network traffic on optical transport networks, covering access networks up to long-haul core networks, Hitachi has introduced two optical transport platforms: the AMN7500, providing total integrated management for networks covering different areas and with different topologies, for next-generation optical transport systems; and the AMN6200, emphasizing ease-of-use in access areas, for low-capacity WDM systems.

INTRODUCTION

BROADBAND networks are continuing to spread rapidly. In Japan, notably, the number of broadband subscribers has exceeded 20 million, and the number of subscribers with FTTH (fiber-to-the-home) broadband connections with capacity in the order of 100 Mbit/s has reached four million. Moreover, as the "ubiquitous information society" draws nearer, information exchange between a huge number of terminals (i.e. products) is making the role of data transmission ever more important. Under these circumstances, as part of the information infrastructure,

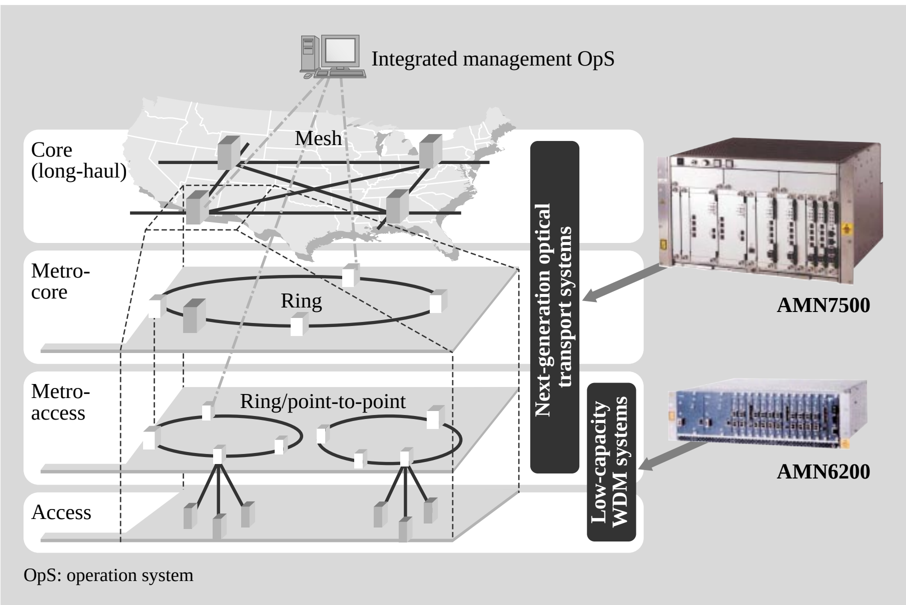

Fig. 1—Entire Layered Configuration of Optical Transport Network, and AMN7500 and AMN6200 Platforms that Create This Configuration.
Covering metro access networks areas of 100 km or lower up to core networks covering over a 1,000 km, thereby enabling integrated management, the AMN7500 is a next-generation optical transport system handling multi-reach and multi-topology domains. The AMN6200 is a low-capacity WDM system in the access and metro-access domains.

optical transport networks are becoming all the more important in response to demands for flexibility and reliability at low cost.

Continuing to look ahead to the challenges concerning the kind of optical transport mentioned above with the aim of proposing solutions for the next generation of optical networks, Hitachi has introduced two optical transport platforms, namely, a next-generation optical transport system, AMN7500 and a low-capacity WDM (wavelength division multiplexing) system, AMN6200 (see Fig. 1).

CONCEPT BEHIND PLATFORM FOR NEXT-GENERATION OPTICAL TRANSPORT SYSTEMS

With its primary purpose of allowing network managers to fully enjoy the economic advantages of reducing maintenance and operating costs, a platform for a next-generation optical transport system is based on the concepts listed below:

(1) Next-generation optical transport system (AMN7500)

(a) Multi-reach transmission

The same platform configuration can span metro-access systems up to core-area (long haul) systems.

(b) Multi-topology compatibility

Flexible configuration on the same platform: the topology can be changed from a point-to-point system to a mesh network using a linear OADM (optical add/drop multiplexing), OADM rings, and even OXC (optical cross connect).

(c) Totally integrated administration

Totally integrated administration and high-reliability, wavelength-path management covering the various above-mentioned optical networks are possible.

(2) Low-capacity WDM system (AMN6200)

(a) Ultra-high-speed interface for access systems up to 10 Gbit/s

The 10GbE (10-gigabit Ethernet*) standard is supported to cope with the rapid conversion of access-area networks to broadband.

(b) Compact unit

Set-up and operation of suitable access-system devices (such as the media converter unit) are extremely easy.

In the following two sections, respectively each system is described in more detail.

NEXT-GENERATION OPTICAL TRANSPORT SYSTEM AMN7500

Succeeding the high reliability and good operability of our large-capacity, long-haul 10-Gbit/s DWDM (dense wavelength division multiplexing) systems AMN6100 and AMN7100[1], which have achieved great success in both Japan and North America, the AMN7500[2] is being offered as a next-generation transport system that realizes compactness with economization.

Multi-reach Transmission

To handle various network demands—spanning metro-access networks up to core area networks—with the same platform, the following platform-type system design was adopted for the AMN7500:

(1) Modular function blocks

(2) Universal slots (a wide variety of function blocks can be freely mounted in any slot.)

The main specification of the AMN7500 is summed up as follows:

(1) Device size (unit height) : 6 U (six units: 267 mm)

By integrating functions of various by means of advanced technologies, the AMN7500 is 1/4 the size of a conventional system, and can be fitted in a multi-purpose 19-inch (about 48 cm) rack (see Fig. 2).

* Ethernet is a registered trademark of Xerox Corp.

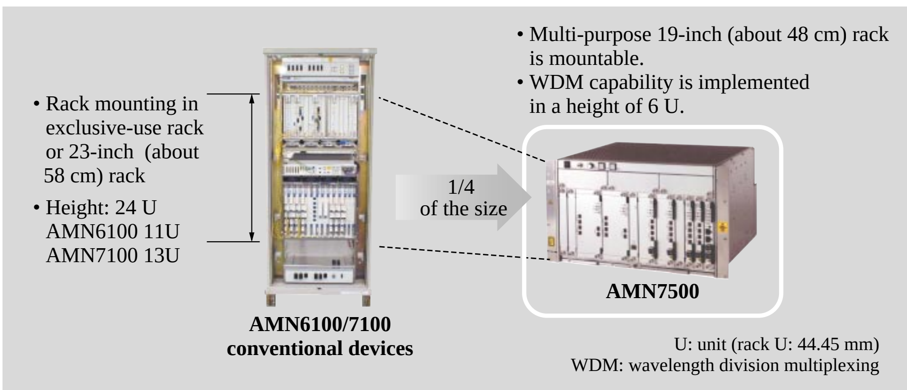

Fig. 2—External Views Comparing Conventional Long-haul DWDM Device and AMN7500.
The AMN7500 is one quarter of the size of a conventional device and thus fits into a 19-inch (about 48 cm) multi-purpose rack. It can handle domains from metro access networks up to long-haul systems of core areas.

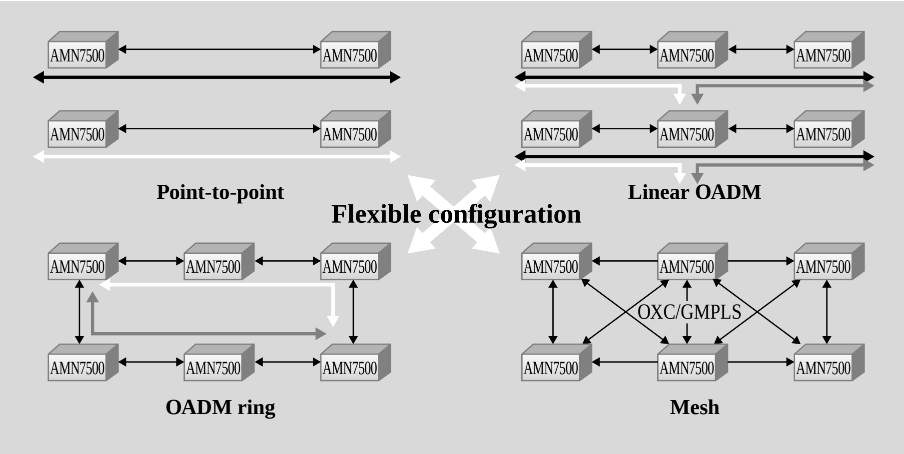

Fig. 3—Multi-topology Concept. AMN7500 can respond flexibly to various network topologies.

(2) Transmittance distance: from 100 km up to 1,000 km

The AMN7500 can be configured to cover metro-access systems up to long-haul systems of core area networks, and in the case of short-haul systems, an economical node configuration without optical amplifiers can be set up.

(3) Applicable optical fiber: SMF (ITU-T G.652: single-mode fiber), NZDSF (G.655: non-zero dispersion-shifted single-mode fiber), and DSF (G.653: dispersion-shifted single-mode fiber)

L band is adopted, and even for DSF, influence of deterioration due to fiber non-linearity is minimized. Maximum number of wavelengths is 32 to 80].

(4) User interface: STM (synchronous transfer mode) system (155 Mbit/s–10 Gbit/s) and Ethernet systems (GbE and 10 GbE)

A GFP (generic framing procedure) enables mixed reception of STM and Ethernet signals. In the future, it is planned to accommodate 40-Gbit/s signals.

Multi-topology Handling

The AMN7500 system can handle low-demand, localized point-to-point WDM systems that are initially introduced, conversion to linear OADM that accompanies node proliferation, expansion to OADM rings consisting of multiple systems, and even the OXC/GMPLS (generalized multi-protocol label switching) of mesh networks (see Fig. 3).

Compatible node types are WDM-ET (end terminal), LA (line amplifier), OADM, and OXC, and the functional components for wavelength multiplexing and demultiplexing, optical amplification, wavelength add and drop, and optical crossconnecting are configured as modules so that a variety of node functions are possible.

Totally Integrated Management

To reduce operation and maintenance costs for the network operator, the following features are adopted:

(1) Vertical integration of layer-1 functions (i.e. integrated management of WDM, OXC, OADM, and TDM (time division multiplexing) functions on the same platform)

(2) GMPLS control (integrated control of layers 1 to 3)

(3) OTN (optical transport network) compliance with ITU-T G.709

As a result of these features, high-reliability WDM wavelength-path control and integrated network administration with multi-reach, multi-topology capability are possible. Accordingly, operation and maintenance costs can be reduced, and new services can thus be developed.

LOW-CAPACITY WDM SYSTEM AMN6200

The AMN6200 is a low-capacity WDM system[3] whose ease-of-use in access areas is particularly noteworthy. Utilizing CWDM (coarse wavelength-division multiplexing; eight wavelengths in the range 1,471-1,611 nm) technology compliant with the ITU-T G694.2 standard, it achieves WDM of an ultra-high-speed signal at low cost without the need for an optical amplifier.

Ultra-high-speed Interface for Access Systems up to 10 Gbit/s

As GbE and 10GbE user interfaces for access systems progress toward full implementation, the AMN6200 can easily handle 10-Gbit/s class ultra-high-speed interfaces that have conventionally only been used on the core-network side. Fig. 4 shows an example configuration of the AMN6200 system. In

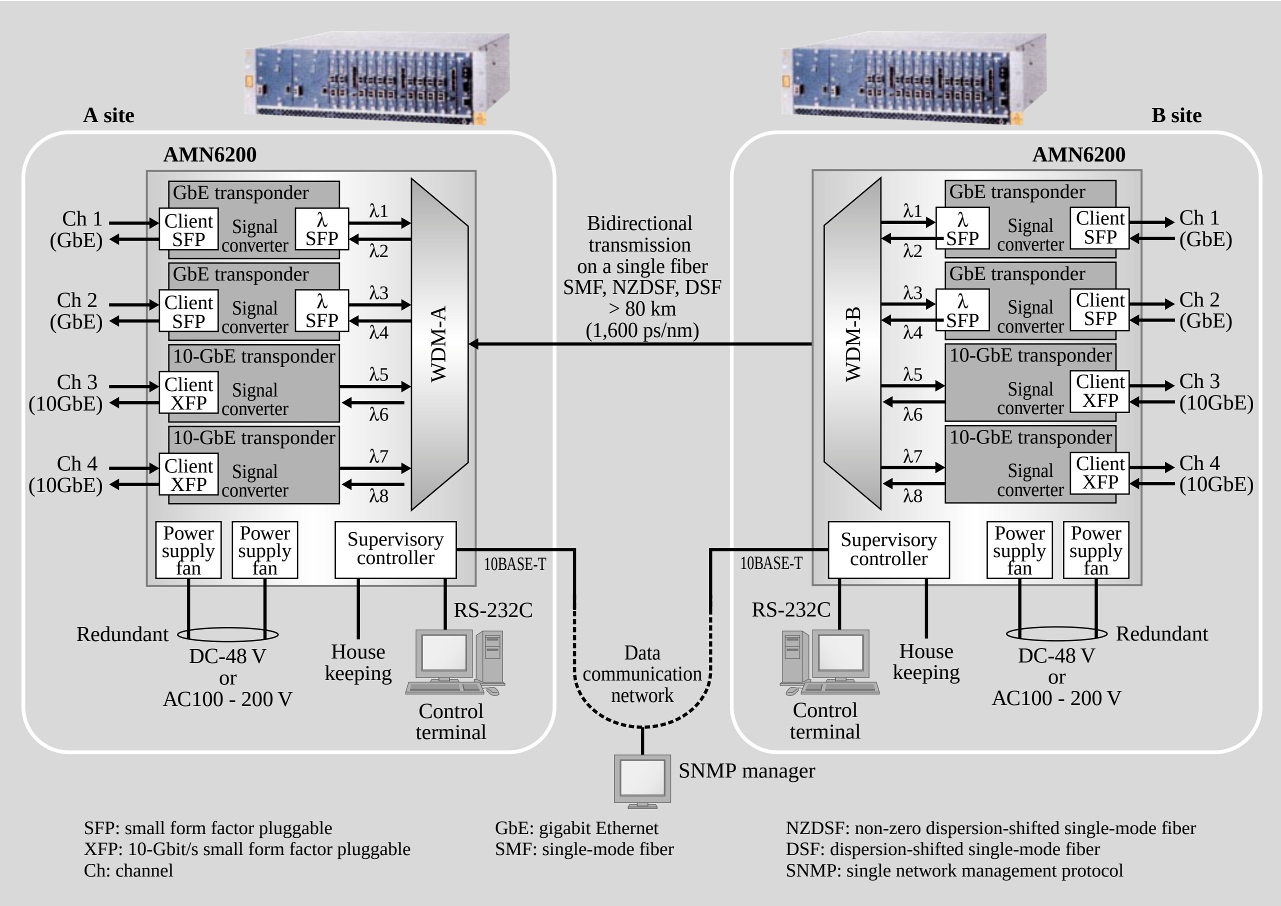

Fig. 4—Basic System Configuration of AMN6200.
GbE and 10-GbE signals can be transmitted in both directions on one fiber by means of eight-wavelength CWDM. As for the transponder, a compact "pluggable" module (which can be connected and disconnected easily) is adopted.

this example, a total of four channels (eight wavelengths) —two for GbE and two for 10GbE— can transmit signals on a single optical fiber bidirectionally. Since the system can be configured with a minimum number of fibers, that is, only one, operating costs can be cut down. Furthermore, owing to a wide wavelength separation (20 nm), signal deterioration due to the fiber nonlinearity under DSF transmission can be avoided.

The main features regarding the ultra-high-speed GbE and 10-GbE interfaces are listed in the following.

(1) Optical amplifier or dispersion compensation fiber unnecessary

Without the need for an optical amplifier or dispersion compensation fiber, a 10-GbE signal can be transmitted with a maximum span loss of 28 dB (on SMF or NZDSF, DSF over 80 km). The 10-GbE signal converter of the AMN6200 is equipped with a FEC (forward error correction) function and a large-dispersion-tolerance (1,600 ps/nm) optical module.

(2) Pluggable optical transceiver

As for the transponder, a compact "pluggable" module (which can be connected and disconnected easily) is adopted. In addition, for conformity with various interfaces on the client side and wavelength selection between offices, quick response and simple handling are made possible. In regards to GbE, an SFP (small form factor pluggable) transceiver compliant with MSA (multi-source agreement) is utilized, and in regards to 10GbE, an XFP (10-Gbit/s small form factor pluggable) transceiver is utilized.

Compact Unit

With a 19-inch width and a height of 3 U (an equivalent size to that of devices used for access systems, such as a media converter unit), the AMN6200 can be installed in a multi-purpose 19-inch rack. And saving set-up space, its installation and operation are simple. Like the AMN7500, the AMN6200 has universal slots, so various kinds of function blocks can be freely plugged into any slot. A supervisory and control interface controls the AMN6200 by means of an SNMP (simple-network management protocol) manager. Moreover, the power supply and fan systems are redundant, thereby assuring reliability.

CONCLUSIONS

As solutions for making economical use of the optical networks forming the infrastructure that underpins the ubiquitous information society, two optical transport platforms were developed: the AMN7500, for next-generation transport systems, and the AMN6200, for low-capacity WDM systems. We consider that the great diversity of shifts toward IPs (Internet Protocols), all-optical networks, etc. and huge increases in data capacity will become all the more prominent from today onwards.

Accordingly, in the future, by responding to this ubiquitous information society in a flexible manner, we will continue to offer solutions with overall merits in regards to entire networks.

REFERENCES

(1) Hitachi Telecom: AMN6100 DWDM, http://www.hitel.com/optical/amn6100.htm

(2) “Advanced Optical Transport Platform for Multi-reach DWDM Networks,” *HITACHI TECHNOLOGY 2005-2006*, p.25 (2005).

(3) “10-Gbit/s CWDM System for Metro Access Networks,” *HITACHI TECHNOLOGY 2005-2006*, p.25 (2005).

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