Photonic Network Systems for Digital Convergence

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OVERVIEW: In regard to the next-generation network society — in which broadcasting and communications will converge — HD video-distribution systems running broadcasting on the communications infrastructure are being anticipated. Accordingly, optical access networks supporting large-capacity data transmission including video services will become an ever more critical infrastructure from now onwards. Playing a key role in such optical access networks, the GPON system "AMN1220" can provide gigabit-class services to homes and offices in a "triple-play" format including voice, video, and data. Moreover, being capable of responding to rapid increases in data traffic on metro-access networks, the 40-Gbit/s extender system "AMN6300" and the CWDM/DWDM system "AMN6200" are available. Hitachi Group is expanding such photonic network systems — which can flexibly respond to the demands of next-generation networks supporting new kinds of services — and proposing "optical transport solutions" that take advantage of its collective manufacturing strength.

INTRODUCTION

IN the coming next-generation network society, the huge variety of new services using IP (Internet protocol) networks will be proposed and appear on the market one after another. Among these services, HD (high definition) video-distribution system — operating on the infrastructure for transmitting broadcasts — is one of the most anticipated services

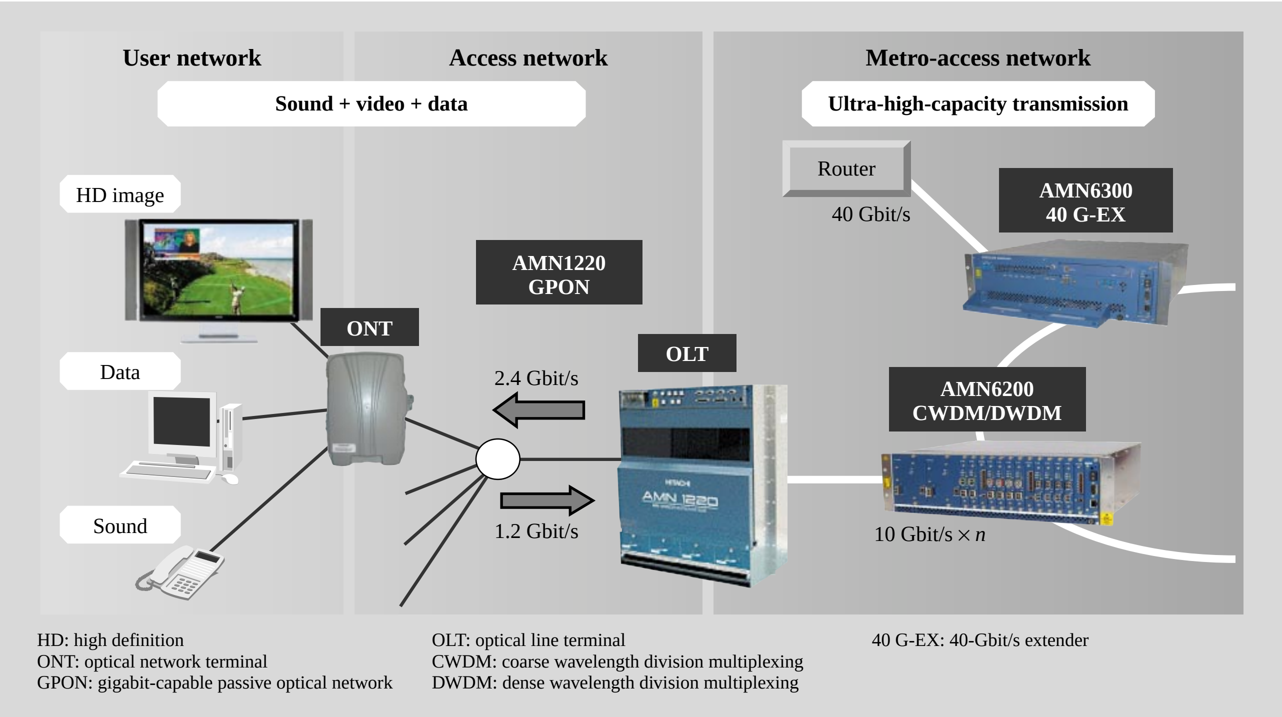

Fig. 1—GPON, 40 G-EX, Bi-directional Transmission with a Single Fiber DWDM System for Accomplishing Key Roles in the Era of Converged Broadcasting and Telecommunications.
In regard to next-generation networks, to provide services using large-volume data like HD images, photonic network systems play an indispensable role in access regions and metro-access regions.

in the era of converged broadcasting and telecommunications. In regard to optical access networks, an important role is played by PONs (passive optical networks) — which provide gigabit-class services for homes and businesses and enable "triple play" services [i.e. providing VoIP (voice over Internet protocol) and existing telephony, analog, and IP video, and data simultaneously]. As PON standards, GE-PON (gigabit Ethernet* PON) of the IEEE and GPON (gigabit-capable PON) of the ITU-T G.984 have been implemented. What's more, as a result of the popularization of video services and the growth in FTTH (fiber-to-the-home) subscribers, the demand for large-data-capacity transmission due to increased IP traffic is continuing to grow, even in metro-access regions. With the introduction of 40-Gbit/s routers by ISPs (Internet service providers), it is necessary to establish 40-Gbit/s optical networks as a replacement for conventional networks with 10-Gbit/s maximum speed. However, since it becomes a problem that transmission length is limited by this "speeding up" of networks, a system that can easily eliminate this limitation is considered indispensable. Moreover, the demand for systems that can efficiently multiplex multiple wavelengths at 10 Gbit/s and create large capacity is growing stronger.

This report presents a GPON system for providing HD video and data transmission and two types of optical transmission systems for a metro access network, a 40-Gbit/s "extender" system and an enhanced system from a CWDM (coarse wavelength division multiplexing) system to a DWDM (dense wavelength division multiplexing) system (see Fig. 1).

* Ethernet is a registered trademark of Xerox Corporation in the U.S.

GPON SYSTEM "AMN1220" FOR PROVIDING "TRIPLE-PLAY" SERVICE

A GPON that is compatible with the ITU-T (International Telecommunication Union–Telecommunication Standardization Sector) is a next-generation access network that can transmit IP data at 2.4 Gbit/s on the downlink and 1.2 Gbit/s on the uplink. In the USA, a "triple service" (i.e. telephony, Internet, and video) using a GPON developed by Hitachi is already available. As one such broadband video-distribution service, downloading of IP video is becoming more popular. In Japan, it is hoped that a value-added broadcasting services aimed at complete transition to terrestrial digital broadcasting by 2011 will be realized. With such services, broadcast data (in the form of HD images) must be transmitted in coexistence with data communication. With conventional technology, however, it is only possible to distribute HD video images on three to four channels. This low channel number is, however, unsuitable for broadcasting services. Moreover, on a "multi-cast network," when broadcast services are provided, it is a problem that the speed of channel switching of programs is slow.

With these points in mind, Hitachi is continuing to develop next-generation GPONs for realizing broadcasting services of HD images to single households on a single optical fiber.

First, a multi-channel video-distribution system that can utilize optical broadcast linkup technology for connecting a GPON and an IP multi-cast network and increase number of broadcasting channels was developed. With this system, 100 channels of HD video

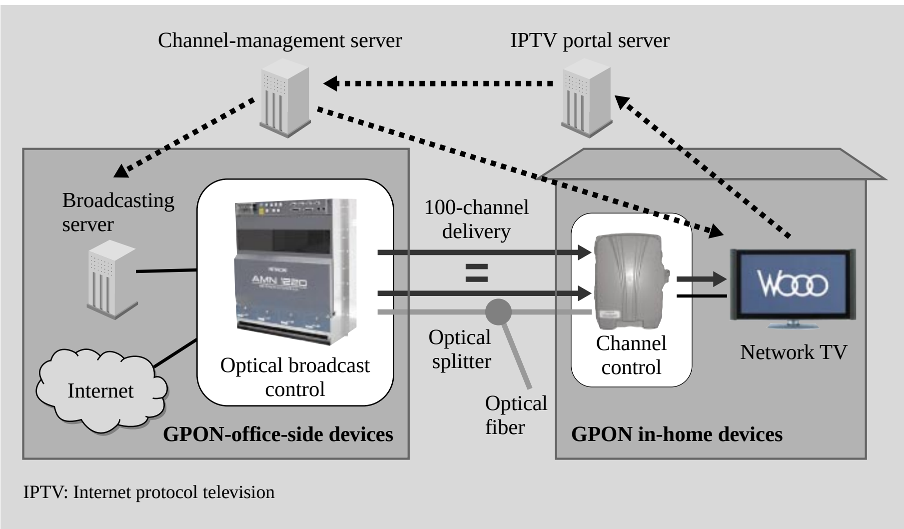

Fig. 2—IP Broadcasting System Using GPON System "AMN1220." By means of optical fiber, it is possible to transmit 100 channels of HD video images to each household.

images can be transmitted to each household simultaneously. In this way, the number of HD programs distributable via CATV (community antenna television) can be surpassed.

Second, a high-speed channel-switching system — which performs channel switching by means of transmitting images on multiple channels from the provider to devices in each home via a GPON in advance — was developed. In this way, channels can be changed within a few milliseconds.

To realize the technology for these two broadcasting services, an IP "multi-cast" function is packaged in the AMN1220. A broadcast service of 100 channels of HD video can be simultaneously accommodated with telephony and Internet services by utilizing this GPON equipment. For example, a telephony service, 1-Gbit/s Internet service, and a 100-channel HD video service can be provided. In that case, H.264-video format at about 8 Mbit/s (which is being recommended for next-generation networks) is used, and a download-type video service is included with the Internet service. By applying a GPON merging communication and broadcasting to an optical access network in the manner described above, an effective video-delivery service is realized (see Fig. 2).

OPTICAL TRANSPORT SYSTEM FOR METRO-ACCESS NETWORK

As access systems containing video services become more popular, traffic in the metro-access region has the potential to grow rapidly.

As optical transport systems aimed at metro-access networks, a 40-Gbit/s-compatible extender system "AMN6300," and a DWDM system — which enhances the functions of CWDM system "AMN6200" — are described in the following sections.

A 40-Gbit/s Extender System "AMN6300"

With the noticeable enhancement of router capacity and introduction of products with data transmission speed of 40 Gbit/s, construction of the critical infrastructure for next-generation networks is being anticipated. At the same time, even if signal processing at 40 Gbit/s becomes possible, to construct a metropolitan network for transmitting these signals, the limitation of transmission length must be overcome. At present, the only standard interface fitted in a router is VSR2000 — with a transmission length of 2 km.

Transmission length is limited by optical SNR (signal-to-noise ratio), chromatic dispersion,

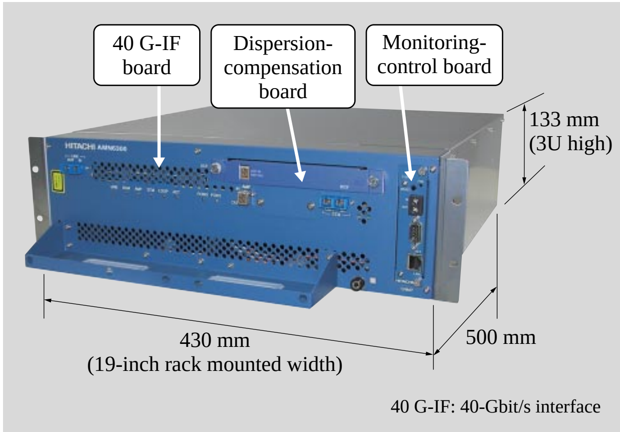

Fig. 3—External View of 40-Gbit/s Extender System "AMN6300."
Various functions (optical amplification, dispersion compensation, and forward error correction) are mounted, and transmission length of 40 km is accomplished.

polarization-mode dispersion, and the fiber nonlinear effect. To deal with these issues, AMN6300 is equipped with various functions such as optical amplification, dispersion compensation, and forward error correction, and attained the transmission length of 40 km.

The AMN6300 — with a height of 3U (133 mm)— can be loaded in a 19-inch rack. An external view of the package of the 40-Gbit/s extender system, AMN6300, is shown in Fig. 3. It is composed of a 40 G-IF board, a dispersion-compensation board, and a monitoring/control board. As well as a 40/43-Gbit/s receiver/transmitter function, an optical amplification funcion, an ITU-T G.709-compatible OTN (optical transport network) interface [with a control function and FEC (forward-error correction) function compatible with the interface] are packaged with the 40 G-IF board.

In addition, the AMN6300 is an "all-in-one" device (that is, high-reliability power supply and fans in a single case with a redundant configuration) which enables set-up space to be saved — a major advantage in the particularly confined spaces in user buildings.

An application example of the 40-Gbit/s extender system is shown schematically in Fig. 4. In this example, three cases are supposed: (1) the case that a network of 40-Gbit/s routers is constructed by users of communication lines such as ISPs; (2) the case that a long-distance network is constructed via WDM (wavelength division multiplexing) lines connecting a user from building α to building A of a communication carrier; and (3) the case that routers of building α are connected to those in a building of

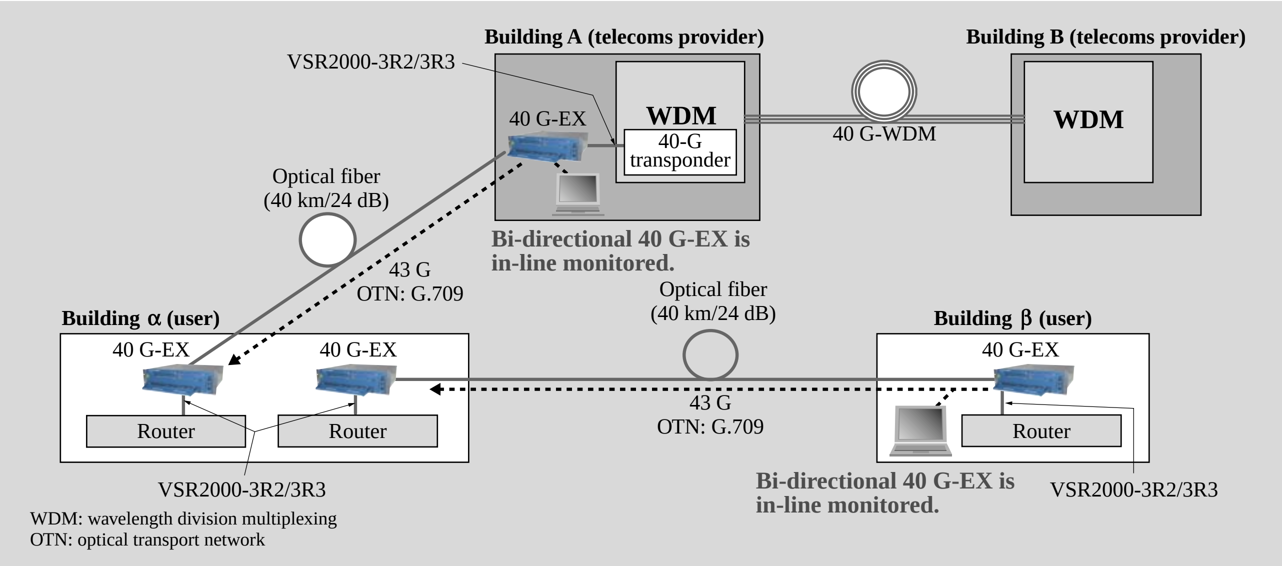

Fig. 4—Application Example of 40-Gbit/s Extender System.
In the metro-access region, necessary devices for a network configuration that ties together user buildings and telecoms carriers as well as connects user buildings are shown.

another user (building β). In regard to the construction of these 40-Gbit/s networks in the metro-access region, an extender system with a transmission length of 40 km is a necessary device.

In regards the 40-Gbit/s extender system, it is often the case that it connects buildings of different companies. As a consequence, it is important that line management and determining failures are possible with no need to visit other premises. Failure determination of lines (which is difficult in networks configured of routers only) is carried out swiftly by device-status-monitoring and loop-back functions under remote control using standard protocols. As regards the device-status-monitoring function, by means of warning signals on opposing devices and remote monitoring of performance data, status of devices can be monitored and controlled without having to go out to other premises. Moreover, the loop-back testing function for the 40-Gbit/s main signal makes it possible to confirm the normality of the transmission between devices.

A DWDM System "AMN6200" for Bi-directional Transmission with a Single Fiber

As a CWDM system that is easy to use in the metro-access region, the AMN6200(1) is provided for bi-directional transmission of eight wavelengths with a single fiber. However, since further capacity increase is demanded in this region, a DWDM system that provides bi-directional transmission of 32 wavelengths with a single fiber while making use of the easy-to-use characteristic of CWDM was developed.

The waveband is supposed as the 1,550-nm bandwidth of an erbium-doped-fiber amplifier. Within this bandwidth, the transmitted wavelength and the received wavelength are separated into the short-wavelength side (blue band) and long-wavelength side (red band), and bi-directional transmission is accomplished. In regard to the transmitter side and receiver side, respectively, a transmitter optical amplifier for amplifying each of 16 wavelengths en bloc and a receiver optical amplifier can be mounted; as a result, a maximum transmission loss of 33 dB [in the case of an SMF (single-mode fiber) transmission] is achieved.

The configuration of the DWDM system that

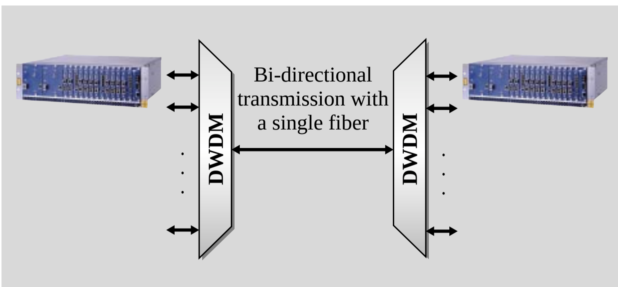

Fig. 5—32-wavelength Bi-directional Transmission with a Single Fiber DWDM System Using AMN6200 CWDM Platform.
A CWDM-system platform is used, and a compact, easy-to-use, large-capacity DWDM system is provided.

provides bi-directional transmission of 32 wavelengths with a single fiber by means of an AMN6200 CWDM platform is shown schematically in Fig. 5. With about the same height as the AMN6300 (i.e. 3U), the AMN6200 is equipped with a wavelength-division-multiplexing unit for bi-directional transmission, a DWDM unit, a transmitter/receiver optical-amplifier unit, and a dispersion compensation unit. The transponder board accommodates client interfaces such as 10 GbE, GbE, STM-64 (OC-192), and STM-16 (OC-48), and by installing it in a shelf form, 16 channels of transponder boards can be housed.

CONCLUSIONS

This report described coexistence of video distribution and IP data transmission by a GPON system on access networks, an “extender system” for extending transmission length at 40 Gbit/s on a metro-access network, and a DWDM system for bi-directional single-fiber transmission that enables large-capacity transmission via various interfaces at 10 Gbit/s. In the midst of the linking-up and convergence of broadcasting and communications brought by next-generation networks, to meet the target of large-capacity transmission including video services, optical networks will become an ever more important infrastructure.

From now onwards, Hitachi Group will strive to expand photonic network systems in such a manner to flexibly respond to the demands of next-generation networks providing new kinds of services. Furthermore, we will propose “optical transport solutions” that make the most of our comprehensive manufacturing strength and contribute to creating next-generation networks for the era of converged communications and broadcasting.

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