

# IPv6 Broadband Access Network Systems

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*OVERVIEW: To meet the demand for broadband access and enable a smooth transition from IPv4 (Internet protocol version 4) to IPv6 (Internet protocol version 6) networks, Hitachi has developed an optical Ethernet\* converter of the AMN1100 series and broadband access gateway series. The AMN1100 series Ethernet converter supports bi-directional communication via a single optical fiber by using wavelength division multiplexing technology. There are two models that transmit Ethernet frames via optical fiber. One is a PON (passive optical network) converter that shares a single fiber and center equipment with a maximum of 32 users by using an optical splitter installed between the center equipment and the user equipment. The other is an SS (single star) converter that connects center equipment and user equipment piece by piece. Hitachi's broadband access gateway series uses a network processor for packet processing and achieves high throughput performance. It is composed of two elements. One is an IPv4/IPv6 dual stack broadband access server, which accommodates various broadband access technologies such as CATV (cable TV), ADSL (asymmetric digital subscriber line), FTTH (fiber to the home), and so on. Telecommunication carriers using Hitachi's broadband access server can provide a broadband access environment to users. The other element is an address translator, which enables a smooth transition from IPv4 to IPv6 networks.*

## INTRODUCTION

WITH the spread of broadband Internet access technologies like CATV, ADSL, FTTH, etc., the number of users who access the Internet at a speed exceeding 1 Mbit/s has been rapidly increasing.

Telecommunication carriers are now beginning to construct IPv6 networks to provide new services for digital home appliances and mobile terminals.

Telecommunication carriers are creating solutions for access networks to enable broadband Internet access. They are offering various types of access media and high-speed call processing protocols such as PPP (point-to-point protocol) and L2TP (layer-2 tunneling protocol) to connect users to the Internet, and are providing new services, such as contents delivery.

Also, telecommunication carriers must make it possible for both IPv4 and IPv6 networks to coexist in the same environment, in order to enable a smooth transition from IPv4 to IPv6 networks.

To meet these needs for the broadband Internet access and smooth transition to IPv6 networks, Hitachi developed two broadband access systems: an optical Ethernet converter of the AMN1100 series, and broadband access gateway series.

In this paper, we describe Hitachi's broadband access network solutions using these systems (see Fig. 1).

## MAJOR REQUIREMENTS FOR BROADBAND ACCESS NETWORKS

Broadband access networks must have the following functions<sup>1)</sup>:

### (1) Media processing

Media processing is a termination function for access lines that connect users and telecommunication carriers. For example, a media converter has the function of terminating the access via optical lines in FTTH networks.

Devices for media processing have to be supplied in proportion to the increase in the number of users, so telecommunication carriers must reduce the cost of access lines and the space needed to install devices.

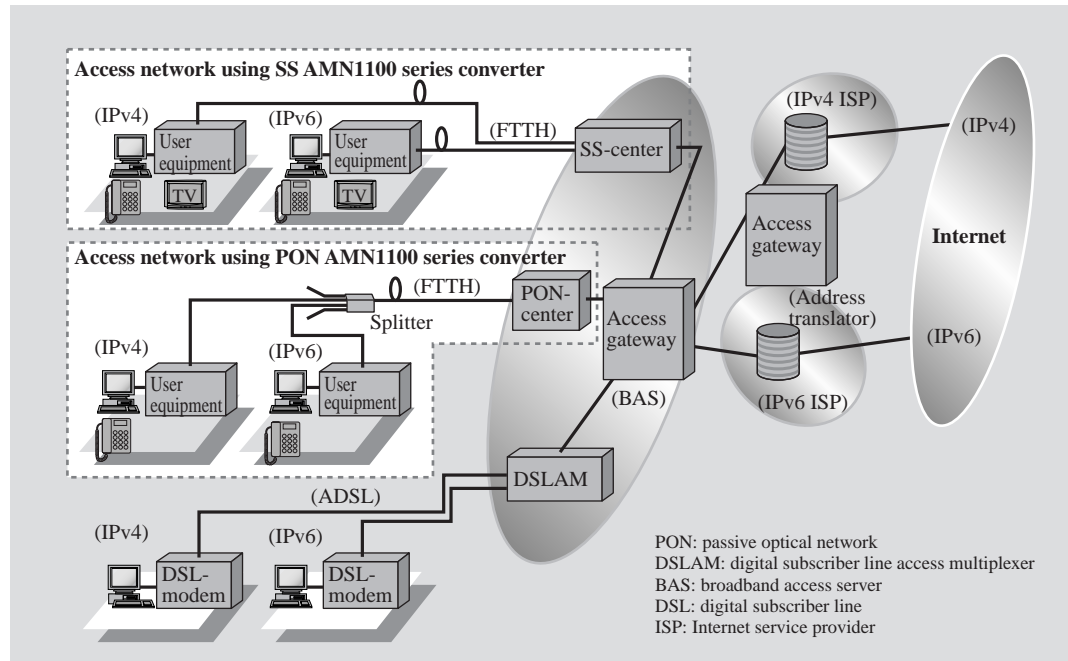
### (2) User management

This is a function whereby telecommunication carriers manage the users of their networks. It enables user authentication and management by using PPP. The

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\*: Ethernet is a trademark of Xerox Corporation, USA.

Fig. 1—IPv6 Broadband Access Network Using AMN1100 Series Converter and Access Gateway Series. AMN1100 series (PON and SS models) enables economical and flexible construction of broadband access networks. The access gateway series (BAS and address translator) can provide solutions for smooth transition from IPv4 to IPv6.



processing of tunneling protocols such as L2TP is also included in this function.

Because users access the Internet at a speed exceeding 1 Mbit/s, high-speed protocol processing is needed for user management.

(3) Network interworking

To forward packets from end to end, it is necessary to make networks operating under different protocols interwork. A special function is needed to convert packet headers at the interworking point. For example, to enable interworking between IPv4 and IPv6 networks, IP header conversion is needed to translate IPv4 (or IPv6) addresses into IPv6 (or IPv4) addresses.

To obtain these functions on access networks, Hitachi developed broadband access network systems. Its optical Ethernet converter of the AMN1100 series enables media processing and access termination via optical lines in FTTH networks. Hitachi's broadband access gateway series provide user management and interworking between IPv4 and IPv6 networks.

**OPTICAL ETHERNET CONVERTER OF THE AMN1100 SERIES**

**Main Features of the AMN1100 Series Converter**

Hitachi developed two types of optical Ethernet converters for access systems that transmit Ethernet frames via optical fiber.

One is a PON converter that splits optical fiber in the middle of the access line by using an optical splitter

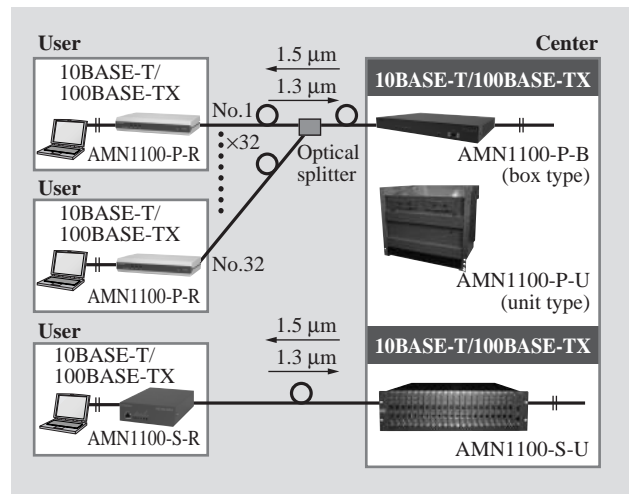


Fig. 2—Configuration of Optical Ethernet Converter of the AMN1100 Series.

AMN1100 series converter can transmit signals bi-directionally via a single fiber-optic cable by using wavelength division multiplexing technology. Both PON and SS models can be provided.

and enables sharing the fiber among several users. As Fig. 2 shows, a single optical fiber between the optical splitter and center equipment can be shared by a maximum of 32 users. This converter reduces operating costs, saves space in device installation, and provides low power consumption.

The other one is an SS converter that connects user equipment and center equipment by a single optical fiber. It features efficient use of optical access bandwidth and simple system configuration.

TABLE 1. Main Characteristics of PON AMN1100-P  
*AMN1100-P shares both optical fiber and center equipment with a maximum of 32 users. Box-type equipment accommodates 32 users, and unit-type equipment accommodates a maximum of 704 users.*

		User	Center	
		AMN1100-P-R	AMN1100-P-B (box type)	AMN1100-P-U (unit type)
Optical access	Transmission method	PON method (based on ITU-T recommendation G.983.1, WDM: single fiber)		
	Transmission rate	156 Mbit/s bi-directional (upstream TDMA, downstream TDM)		
	Number of splits	Maximum: 32-way split		
	Transmission distance	Maximum: 20 km		
LAN	Interface	10BASE-T/100BASE-TX		
	Number of ports	1	1	22
	Frame form	Ethernet II, IEEE802.3, IEEE802.1Q		
Monitoring control		Optical access communication alarm, LAN interface link, equipment failure, power-off notification (AMN1100-P-R)		
Maintenance interface		SNMP (10BASE-T)		

TDMA: time division multiple access  
 TDM: time division multiplex  
 SNMP: simple network management protocol  
 WDM: wavelength division multiplexing

TABLE 2. Main Characteristics of SS AMN1100-S  
*AMN1100-S connects communication cards in the center and user equipment via a single fiber-optic cable. Center equipment accommodates a maximum of 21 optical communication cards per unit.*

		User	Center	
		AMN1100-S-R	AMN1100-S-U	
Optical access	Transmission method	Based on 100BASE-FX (WDM: single fiber)		
	Transmission rate	100 Mbit/s		
	Transmission distance	Maximum: 20 m		
LAN	Interface	10BASE-T/100BASE-TX		
	Number of ports	1	2	
Monitoring control		Optical access communication alarm, LAN interface link, equipment failure, power-off notification (AMN1100-S-R)		
Maintenance interface		SNMP (10BASE-T)		

Both converters enable bi-directional communication via a single optical fiber by using wavelength division multiplexing technology.

**Outline of PON AMN1100-P Converter**

The main specifications of the PON AMN1100-P converter are shown in Table 1. AMN1100-P complies with standard ITU-T recommendation G.983.1. By using bi-directional transmission at 156 Mbit/s, it enables downstream at 100 Mbit/s transmission, and both static and dynamic transmission speed assignment for each user’s equipment in upstream transmission.

There are two types of center equipment, box-type equipment [the height of AMN1100-P-B: 1U (44 mm)] and unit-type equipment [the height of AMN1100-P-U: 9U (400 mm)]. The box-type equipment accommodates 32 users, and the unit-type equipment accommodates 704 users by using a maximum of 22 communication cards with 32 users per card. These two types of center equipment enable flexible system composition.

**Outline of SS AMN1100-S Converter**

The main specifications of the SS AMN1100-S converter are shown in Table 2. AMN1100-S uses

100BASE-FX, which is used in indoor LANs as an optical interface. By using this interface, it converts Ethernet frames into optical signals. The user equipment “alerts” the center equipment that the link is down or that the power is down at the users’ side. The center equipment [the height of AMN1100-S-U: 3U (132 mm)] supports loop-back testing, link-down and failure notification, and the maintenance of remote monitoring/controlling of the user equipment’s status. AMN1100-S accommodates a maximum of 21 optical communication cards, which enables extension/reduction by each user.

The SS converter comes in two versions, and the user can choose which one to use. One is a repeater-type converter that can re-send the output after reshaping the input signal, enabling few delays in transmission. The other is a bridge-type converter that can learn the sender’s address, check received frames, and dispose of unnecessary packets.

**HITACHI’S BROADBAND ACCESS GATEWAY SERIES**

**Main Features of the Access Gateway Series**

- (1) Access server and address translator

The broadband access gateway series is composed

of two elements: a broadband access server and an address translator.

The broadband access server can accommodate various broadband access technologies, such as CATV, ADSL, and FTTH, and it supports IPv4/IPv6 dual stacks.

The address translator enables the interworking of IPv4 and IPv6 networks, as well as multiple IPv4 private networks.

#### (2) High performance and flexibility

Hitachi's access gateway series uses network processors for packet transfer processing. The network processors enable not only high performance in hardware processing, but also flexibility in software processing. The access gateway series achieves high-throughput packet processing on access networks using various high-speed access methods. New functions can be easily added to the access gateway series, which are already installed. As a result, telecommunication carriers can reduce the cost of replacing network devices when they start new services.

#### (3) Compact size and scalability

Hitachi's access gateway series is 2U (89 mm) in height, which means that telecommunication carriers can reduce space costs. Also, it has high scalability and can be used for both very small-scale and very large-scale networks.

Fig. 3 shows the external view of Hitachi's access gateways.

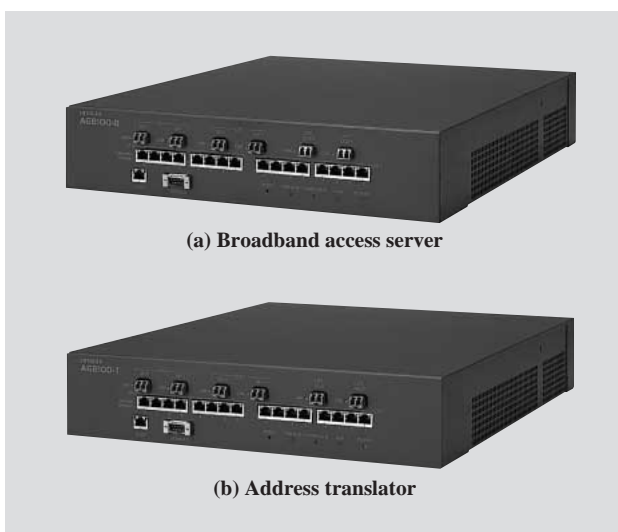


Fig. 3—External View of Hitachi's Broadband Access Server and Address Translator.

The broadband access server and address translator can be provided.

### Outline of Hitachi's Broadband Access Server

Hitachi's broadband access server accommodates various broadband access technologies, such as CATV, ADSL, and FTTH, and it supports IPv4/IPv6 dual stacks. When an access request from a user is received, it authenticates the user, allocates an IP address, and connects the user to the appropriate Internet service provider by using L2TP. Fig. 4 shows a broadband access network using the broadband access server.

The maximum number of users (PPP sessions) the server can accommodate is 16,384 per unit. The maximum throughput of the server is 4 Gbit/s. The main functions of this model are as follows:

#### (1) IPv4/IPv6 dual stacks

Because Hitachi's broadband access server has IPv4/IPv6 dual stacks, telecommunication carriers using it can provide new services based on IPv6 and current services based on IPv4 on the same network.

#### (2) Server redirection function

The broadband access server can redirect packets from servers on the Internet to content servers or cache servers located at the L2TP access concentrator (LAC) side of L2TP tunnels.

Because the volume of traffic in access networks is reduced, it becomes easy for telecommunication carriers to control the bandwidth for streaming communication by using this function.

### Outline of Hitachi's Address Translator

Hitachi's address translator is an IP header converter that enables the interworking of IPv4 and

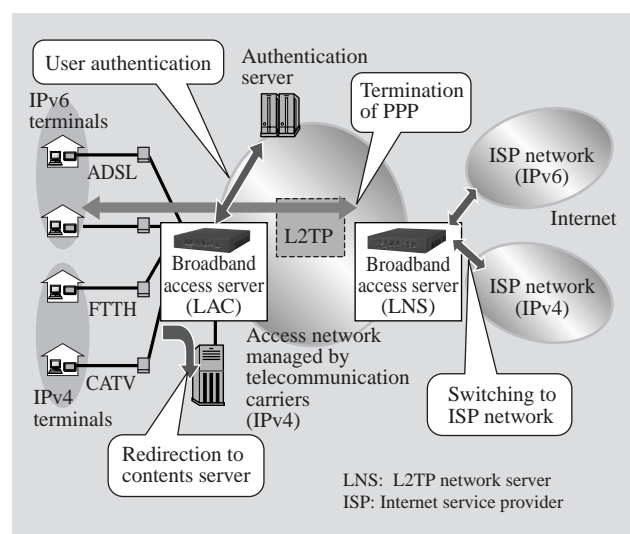


Fig. 4—Broadband Access Network with Hitachi's Server. ISPs can provide IPv6 services by using IPv4 access networks managed by telecommunication carriers.

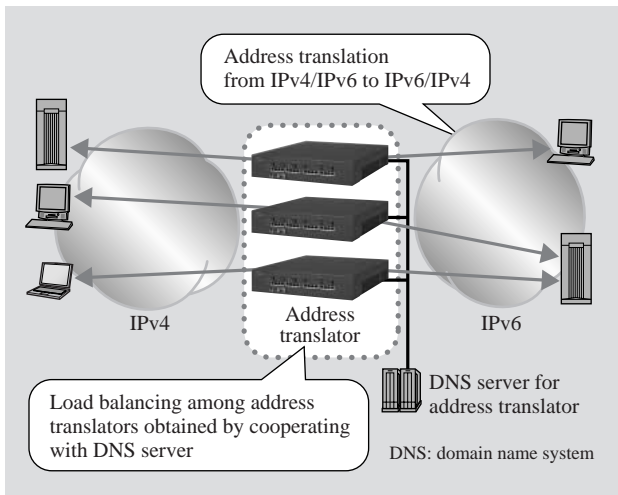


Fig. 5—IPv4/IPv6 Network Interconnection Using Hitachi's Address Translator.

Telecommunication carriers can make IPv4 and IPv6 networks interwork by using the address translator for bi-directional address translation. The processing load is balanced among the translators cooperating with the DNS server.

IPv6 networks managed by telecommunication carriers and private companies, or multiple networks using private addresses that are used for specific organizations.

Fig. 5 shows an example of IPv4 and IPv6 network interworking by using the address translator.

The maximum number of address translation entries of the translator is 16,384. The maximum throughput of the translator is 2 Gbit/s. The main functions of this model are as follows:

(1) IPv4/IPv6 bi-directional address translation

Hitachi's address translator can translate IP addresses to enable IPv4 and IPv6 network interworking. The processing of address translation is bi-directional, i.e., the product can translate IPv4 addresses into IPv6 addresses, and also IPv6 addresses into IPv4 addresses.

(2) Address translation in IPv4 private networks

The translator can translate one IPv4 private address into another IPv4 private address. Using this function, network operators can reduce the cost of network management when they combine several networks in which private IP addresses are assigned.

(3) Automatic generation of address translation tables

When Hitachi's address translator transfers domain name system (DNS) inquiry packets from IPv4 (or IPv6) networks to IPv6 (or IPv4) networks, the translator can relate the IPv6 (or IPv4) address of the device with which the user is communicating to the

IPv4 (or IPv6) address virtually assigned to it for translation. Then an address translation table in the address translator is automatically configured.

(4) Load balancing

Several address translators are arranged in a row between IPv4 and IPv6 networks. The devices cooperate with the DNS server that shows a specific address translator to which the user is connected. The load for processing can then be balanced among the address translator devices.

## CONCLUSIONS

We described Hitachi's broadband access network systems: an optical Ethernet converter of the AMN1100 series, which comes in two models — a PON model and an SS model, and an IPv6 broadband access gateway series, which is composed of a broadband access server and an address translator.

Hitachi will continue to provide broadband access network solutions, for mobile IP communication including voice over IP etc.

## REFERENCE

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