IP Network Access System

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OVERVIEW: Along with the spread of the Internet society, methods for accessing the Internet have advanced from dialup using existing telephony networks to broadband access using fiber-optics networks. To flexibly provide low-cost and high-speed Internet services to end-users based on their needs, access systems must support various functions, including media processing and user management that match the access method, inter-working of different systems, customizing for individual users, and highly reliable network control. To provide access systems meeting these requirements, Hitachi has been facilitating various technological developments, such as the construction of scalable systems in terms of size and number of features and customization with an open interface.

INTRODUCTION

NETWORKS based on the Internet protocol (IP), i.e., the Internet and intranets, are turning into "extranets," and expanding to provide electronic commerce. The access networks at the entrances of IP networks are being diversified, and transmission speeds are being increased by adopting various types of access media (metal, radio, optics, etc.) The advances in access networks are contributing to the creation of new IP services, such as mobile communication and the distribution of music and movies.

We can thus say that methods for constructing access networks play a vital role in providing lower cost and higher speed IP services.

The introduction of open networks and the deregulation of policies on market entry and of charges in recent years have greatly changed the access-network landscape. The entry of such new telecommunication carriers as targeting the high-speed wireless-service market, has especially activated the IP access market; carriers must now compete fiercely for survival. These are part of the movement to provide timely low-cost and high-speed Internet services.

This paper describes the requirements for IP network access systems and describes the technological developments related to access networks that Hitachi has been undertaking for the future.

TRENDS IN ACCESS NETWORKS

Various technologies are now being developed and provided for establishing new access networks. These technologies use various access media and have various transmission speeds. Based on these features, various services are provided in the access market. Table 1 shows the major access methods and features.

The dialup access method has been the mainstay since the early days of the Internet. The original operation method is to install a remote access server at a subscriber switch, but this is changing to off-loading Internet traffic on to the interface between switches.[1)] Using this same interface, voice over IP (VoIP) service, which carries voice as well as data over an IP network, IP is being provided.

The asymmetric digital subscriber line (ADSL) and

TABLE 1. Features of Major Access Methods
Various access services can be provided based on the features corresponding to the access media and the maximum transmission speed.

Method	Media	Maximum transmission speed (bit/s)	Bandwidth used	Note
Dialup	Metallic	128 k	Dedicated	Uses existing PSTN
ADSL	Metallic	Up: 640 k Down: 6 M	Dedicated	Uses existing PSTN
CATV	Coax	Up: 10 M Down: 40 M	Shared by users	Shared by image services
FTTH	Fiber	10 M	Shared by users	Under demonstration test
Mobile	Wireless	2 M	Shared by users	Under demonstration test

ADSL: asymmetric digital subscriber line
FTTH: fiber to the home
PSTN: public switched telephone network

cable TV (CATV) methods are effective for Internet connections; they are asymmetrical services that prioritize download traffic and are provided over dry copper or cable networks.

The fiber-to-the-home (FTTH) and mobile access methods are now being demonstration tested by several telecommunication carriers in Japan and elsewhere.

REQUIREMENTS FOR ACCESS SYSTEMS

With the growing diversification of access methods and the prevalence of the respective access method, IP access systems have become a major part of our social infrastructure. They must now provide various features, including media processing, user management, inter-working, customization, and reliability.

(1) Media processing

The media to be processed depends on the access method. For telephony network access, there is analog modem termination, ISDN termination, and ADSL termination. Similar to this, cable termination for CATV access, optical termination for FTTH, and wireless termination for mobile/wireless access are needed.

(2) User management

User authentication and its management using point-to-point protocol (PPP) are considered the main features in user management. Furthermore, statistical information must be collected and bills must be processed on a case-by-case basis. As shown in Fig. 1, there are two approaches to user authentication and management. In case (a), they are handled by the access system at the entrance to the IP network. In case (b), users and services are first distributed to the service providers by the access system at the entrance to the carrier network. User authentication and management are then handled by the access systems at the entrances to the service provider networks. In this case, for example, the tunneling is implemented using the layer 2 tunneling protocol (L2TP). There are several other tunneling methods besides L2TP, such as multi-protocol label switching (MPLS) and mobile IP, and the one used depends on the service requirements.

(3) Inter-working

Inter-working can be divided into three major categories: network inter-working, service inter-working, and inter-working for control processing. Their objects and examples are listed in Table 2. For example, a telecommunication carrier wanting to provide VoIP services should select an access system that provides VoIP encapsulation (voice in IP packets) for network inter-working, VoIP media conversion for service inter-working, and VoIP call control for inter-working for control.

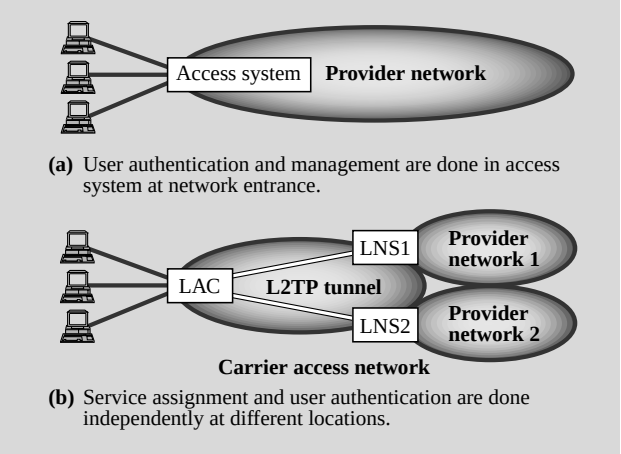


Fig. 1—User Authentication and Management in Access System. In case (b), an L2TP access concentrator (LAC) is placed at the entrance to the carrier network and an L2TP network servers (LNSs) is placed at the entrance to each provider network. L2TP tunneling is used between the LAC and LNSs.

(4) Customization

Customization is necessary when telecommunication carriers provide various services. The main role of network services has been to deliver user data correctly. However, user needs are diversifying with the advancing network society, requiring services with a guaranteed quality of service, a certain level of security, etc.[2)]

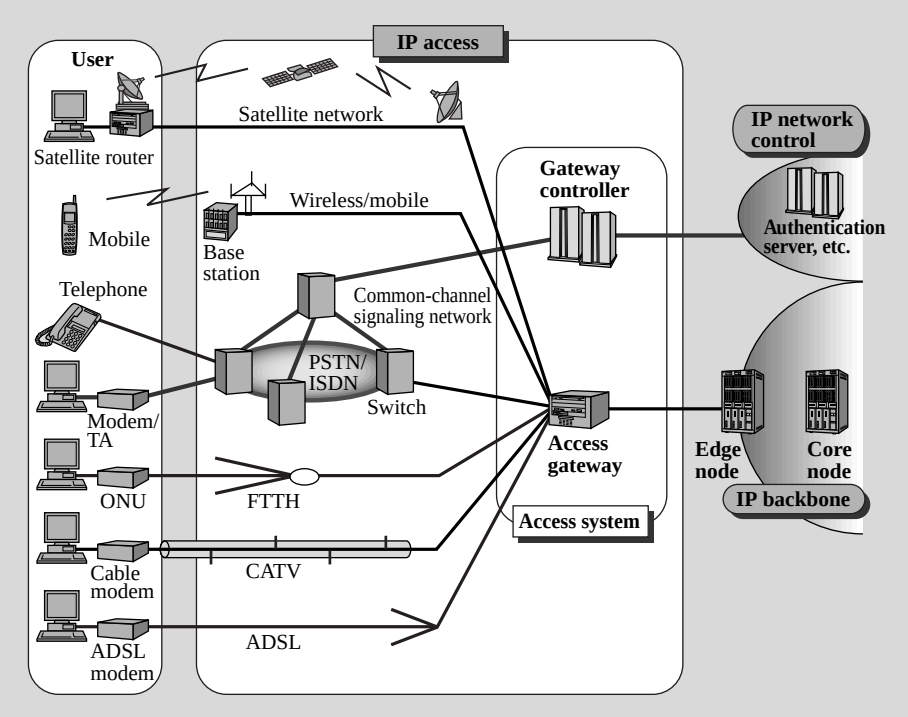
(5) Reliability

Reliability is becoming an essential feature for the IP access system as it becomes a social infrastructure. Telephony networks have functions to control traffic congestion on nodes and to ensure high reliability. We are entering an age in which telecommunication

TABLE 2. Expected Inter-working Features for Access System
Expected inter-working features for access system based on objects for inter-working.

Category	Objects for inter-working	Examples
Network inter-working	Transport method of data	VoIP encapsulation, L2TP, Mobile encapsulation
Service inter-working	Data contents	VoIP media conversion (by compression) IPSec processing (by code)
Inter-working for control	Communication procedure	VoIP call control Mobile IP control

IPSec: IP security protocol



IP: Internet protocol
TA: terminal adapter
ONU: optical network unit
ISDN: integrated services digital network
FTTH: fiber to the home
ADSL: asymmetric digital subscriber line

Fig. 2—Hitachi's Concept of Next-generation IP Network and Its Access System.
The access gateway at the entrance to the IP network accommodates various access systems and forms Hiatchi's IP access system together with the gateway controller that controls the access gateway.

carriers operate IP networks, and the need for congestion control in IP networks as well is growing.

TECHNOLOGIES FOR IP ACCESS SYSTEMS

Fig. 2 shows Hitachi's concept of the next-generation IP network and its access system. This section introduces the technological developments Hitachi is undertaking to respond to the various requirements for the IP access system.

Composing Scalable Systems

The traffic transmitted through IP networks is expanding steadily in volume due to the implementation of broadband access media, such as ADSL and CATV. At the same time, the IP access system is becoming more varied in its service menu and is becoming more advanced in features supporting such as mobile and VoIP. Thus, the access gateway should have a scalable architecture for both capacity and services.

Hitachi's access system provides various IP services by combining basic and advanced features.
(1) Basic access features:

PPP termination, general encapsulation (L2TP, mobile, etc.), header search (Layer 2, Layer 3), switching, etc.
(2) Advanced access features:

Termination of modem, VoIP compression, IPSec (IP security protocol), multiplexing of low-speed interfaces, etc.

By constructing modules providing various combinations of basic and advanced features, we can provide required services [remote access server (RAS), broadband RAS, VoIP, mobile, etc.] in a scalable size based on users' needs.

Multi-layer Switching

For the L2TP configuration mentioned in the preceding page (2), each service provider has to identify the individual user in its access system in order to undertake authentication. This is done by providing a connection-oriented communication path (tunnel) from the L2TP access concentrator (LAC) to the L2TP network servers (LNSs) capable of identifying layers lower than the IP layer.

This will require layer-2-based switching, such as asynchronous transfer mode (ATM) and MPLS. Also needed is IP (layer 3) switching based on special addressing in the network such as L2TP and IP in IP. To provide a virtual private network (VPN) for users, the access system must be able to handle a pair of layer-2 and layer-3 addresses. Thus, by providing these switching features covering multiple layers in the access system, telecommunication carriers will be able to provide various services for end users.

Customization with Open API

To respond to individual user demands, it will be

necessary to incorporate new features in the access system that enable easy introduction of new user services and easy customization.

Specifically, an open application programming interface (API) should be implemented along with a gateway controller to control the access gateway, and then various applications used for providing network services should be installed on the API. By incorporating the following applications on the API, carriers can provide various services:

(1) User authentication
(2) Multimedia/call control among multiple users
(3) Control of voice mail and e-mail
(4) QoS control
(5) User position information

By using the open API conforming to the Parlay specifications now being standardized, carriers can provide network service applications from third parties.

Fig. 3 shows service customization with an open API.

Network Control with High Reliability (Network Congestion Control)

Major cause of traffic congestion in an IP network is a traffic overload in a specific server or node affecting the entire network. An effective way to overcome this problem is to build at the network entrance a gateway system to control the traffic flowing into the server or node where traffic is overloaded.

Specifically, traffic can be controlled by implementing a gateway controller with functions to monitor traffic conditions in the network, such as exchanging traffic information with other gateway controllers and monitoring conditions in combination with the network control/management servers. For example, for VoIP service, traffic control can be done in combination with call control, and for a Web service, in combination with a Web proxy.[3)]

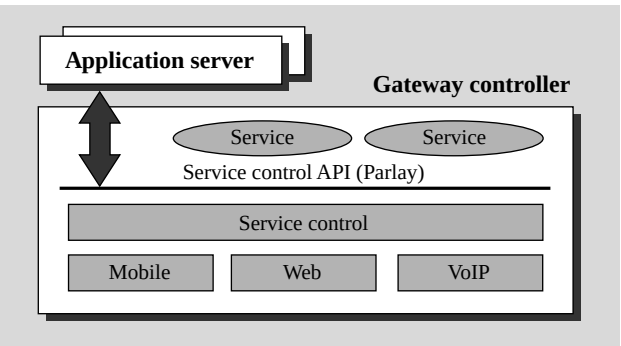


Fig. 3—Service Customization with Open API.
The use of an open API in the gateway controller will enable several kinds of network service applications to be provided.

CONCLUSIONS

We have described the requirements for the IP network access system and technological developments Hitachi is now undertaking to provide solutions for various access methods.

Hitachi intends to establish a scalable access system in terms of both size and number of features for various access networks including ISDN, CATV, ADSL, FTTH, mobile, and VoIP.

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