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Wide Area IP Network System

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**Abstract**

IP networks of the 21st Century will be required to handle various media communications such as data, voice, and images and respond to a quickly increasing amount of traffic. We expressed our agreement with the next-generation computer network concept1,2,3,4 proposed by NTT and developed a wide area IP network system to build the next-generation IP network. In this article, we would like to provide an overview of this system, describe its features, and mention upcoming developments.

1. Introduction

As the Internet grows quickly, a network society that includes homes as well as businesses is gradually being built up. Businesses are gradually expanding corporate activities by intranets and extranets, and electronic commerce is starting up in the homes as well as electronic mail. In addition, the providing of new services that use networks is accelerating.

Networks are being required to not just communicate various media such as voice, data, and images, but to also have the necessary scale and speed, reliability, and stability to provide various applications that can be used on the networks. Carrier networks that are to become the foundation of any network society must be able to meet these demands.

NTT proposed a next-generation computer network concept as a communications infrastructure that will be able to handle such demands. We expressed our agreement with this concept and developed a wide area IP network system as the core system of a large scale network.

In this article, we would like to describe a wide area IP network system that aims to increase the scale of networks and diversify network services such as high value-added intranet.

2. Network Configuration

Figure 1 illustrates the overall configuration of a network that uses a wide area IP network system. In this figure, an example is explained in which an ATM network is used in the access network. The user network is a general network to which user terminals such as PCs in the home or in the office can connect, and IP packets are converted into ATM cells (IP over ATM) at the access network nodes. Data that were converted into ATM cells are efficiently concentrated and transmitted by ATM cell statistical multiplexing, depending on the access network, then are sent to an edge router. The destination IP address of the IP packet received by the edge router is read, then is sent to the edge router that accommodates the destination terminal.

Here we refer to the wide area network between edge routers as the core network, and refer to the devices that comprise the network as the core system. The core network consists of a two-layer network: a Connection-less Network that provides best effort type service, and a Guaranteed Network that provides guarantee type service. These layers can be used selectively according to the QoS (Quality of Service) the user demands. The Connection-less Network realizes efficient, high-speed data transfer by ATM cell level forwarding and provides the best effort type service that is most appropriate for large scale Internet backbones. The Guaranteed Network provides guarantee type service as high-speed, wide area backbones with built in reliability, quality, and security, by way of quality assurance type high-speed SVC (Switched Virtual Connection) cut-through transfers.

Two issues need consideration when speeding up a wide area IP network system. The first issue is that routing control must be separated from the forwarding process, and an address server must be placed that can distribute and manage the route information within the core network. The second issue is that the network configuration and the address system be kept closely related and must use a core address that is hierarchized within the core network in the same manner as a telephone number. Taking these two issues into account will make fast forwarding processing possible.

In the Guaranteed Network of the core network, an SVC function is used which is mounted in a general ATM switching system that is deployed in the core network, then the connection that is appropriate for the QoS requested by the user is set among the edge routers. However, since standardized ATM signaling is heavy, a connection is not established on-demand in IP packet flow units. Guaranteed on-demand IP private line service is only provided when the user requires the specified contract band.
3. Device Specifications

3.1 Edge router

Edge routers are devices that connect user networks to the core network via the access network, and convert the protocols between the user network and the core network. These devices make it possible for the core network to employ a uniform network architecture that is not dependent on a user network and to upgrade to the newest technology even in a user network.

The KT2000 edge router consists of a fast, large capacity switching engine, large capacity CAM (Contents Addressable Memory) that is independent of the circuit response, and an ASIC (Application Specific Integrated Circuit). This edge router has a high-speed routing retrieval mechanism, fast IP packet forwarding, and a high-speed IP packet transfer engine that executes various traffic/charging control. This optimum combination realizes an edge router system that exhibits large capacity and fast IP transfer capability especially in large scale wide area IP networks.

Photo 1 shows the appearance of the KT2000 edge router. Table 1 indicates the specifications. This edge router has the following features.

**NEED TABLE 1 HERE**

1. Hardware realizes cell-by-cell low latency encapsulating/decapsulating processing.
2. Realizes a highly expandable configuration by employing 6 Gbps - 40 Gbps non-blocking ATM switching.
3. CUG (Communication User Group) functionality makes it possible to provide VPN (Virtual Private Network) to the user.
4. Realizes high reliability due to its seamlessly switchable duplicate configuration.

3.2 Core router

The core router we developed based on technology we jointly researched with NTT is a relay transfer device, located in the connectionless network of the core network, that uses ATM connectionless technology to make connections between edge routers. By using hardware pipeline processing, this device realizes high-speed transfer of IP packets by ATM cell unit high-speed routing and high-speed forwarding processing. In order to quickly forward IP packets on an ATM cell basis, a 1-cell encapsulated header is added to the beginning of the IP packet by the edge router on the call origin side. The core address of the terminating side that was converted from the destination IP address is inserted into the encapsulated header.

The KT2100 core router does more than just perform the high-speed IP packet forwarding mentioned above. This router makes high-speed cell forwarding possible by realizing with its hardware all functions such as a multicast cell copy function, and an address screening function that provides security.

Photo 2 shows the appearance of the KT2100 core router. Table 2 indicates the specifications. This core router has the following features.

1. Realizes low latency IP packet forwarding by hardware pipeline processing
2. Realizes multicast function by hardware processing
3. Realizes QoS by EPD (Early Packet Discard) processing
4. Employs standard MIB (Management Information Base) for maintenance purposes.

3.3 Address server

The address server uses general routing protocols to exchange address information with a user network or with other address servers. A routing table that converts from destination IP addresses to termination side addresses is created and managed on the call origin side edge router.
This routing table assumes the role of providing these addresses to the edge router. In general, it is said that the address resolution process becomes congested and bottlenecks occur when applying a centralized address server to a large network, but in the case of this core network, dividing a sub-network at each address block unit of the core address helps distribute the load of managing addresses within the core network.

The KT2200 address server is an address resolution distributed management server with super multiplexing capability. An independent high-speed routing table retrieval device and address resolution protocol engine is mounted for each ATM circuit accommodated. This server is especially powerful in large scale wide area IP networks since, in the case of communications on Guaranteed networks, it receives address resolution requests from an edge node on the call originating side and has a function for converting addresses into terminating side edge router core addresses that have destination IP addresses, then returning a response.

The KT2200 address server has the following features.
1. Realizes address resolution processing on a general-purpose OS.
2. Can be applied to large-scale networks since it manages routing information that is hierarchical in Sub-AS (Autonomous System) units.

### 4. Future Developments

As networks come to have ever-larger capacity, the functionality of edge routers, which are devices that connect core networks with user networks and other backbone networks, will get stronger in preparation for providing more robust service.

The KT2000 edge router employs a structure that is based on a control processor (PROC), ATM switch (ATM-SW), and demultiplexer (CMDX). Therefore, making the circuit interface and trunk section support new interfaces and new services to appear in the future can easily expand its functionality (Figure 2).

We are planning to mount a WDM (Wavelength division multiplexing) interface that supports faster and higher capacity networks onto the circuit interface section. We will also mount an MPLS (Multi Protocol Label Switching) protocol on the trunk section that takes mutual connectivity with other networks into account, and will also mount a service trunk for supporting various services.
5. Conclusion

In this article, we provided an overview and described future developments of the wide area IP network system that we are currently developing as a core system for configuring next-generation IP networks. We believe that added functionality that takes advantage of the expandability of the edge router will become able to support new services in preparation for supporting next-generation wide area IP networks.

6. References