Next-Generation Optical IP Transport

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Abstract

The transport of the next generation network (NGN) is composed of the optical transport, core packet and aggregation networks. While the access methods and services are diversified, the costs can be reduced by integrating the transport networks. The new transport networks will create a dependable social infrastructure and at the same time play the role of a platform for the new services. NEC is continuing to study the transport issue from various angles.

Keywords

optical transport network, packet core network, aggregation network, GMPLS, RPR

1. Introduction

In parallel with the introduction of the NGN, the deployment of open interface and a horizontal division of work for network equipment are also in progress. The materialization of the abstractive functions defined by the NGN standards and the optimization of their physical distribution are being implemented as a part of this process. In access networks, optical fibers are distributed alongside the traditional metallic wires. In the case of wireless access, wireless LAN and wireless MAN will be used in many ways in addition to the generation change of cellular phones. Also, in addition to the communications services, telecom carriers will begin to provide various services that have previously been available only via other media. Consequently, the access methods and services will be effectively diversified in order to increase the number of subscribers, access opportunities, service types and service utilization frequencies. On the other hand, what is required for the transport networks of the next-generation in the context of these trends is to enable sharing through integration.

2. Requirements of Transport Networks in the NGN

Unlike access networks and services the transport networks are not visible from viewpoint of the end user. However, they account for an important share of the costs born by telecom carriers. The following sections will discuss the requirements for transport networks by focusing on those of the NGN.

2.1 Construction of a Large-Capacity Backbone Network

Subsequent to the telephone and dialup connections being replaced by the wider distribution of ADSL, the access bandwidth was widened significantly as a result of the dissemination of FTTH (Fiber To The Home) and the bandwidth of mobile data communications is also being broadened rapidly. Concurrently with these trends, the services using broadband, such as streaming video and video telephone systems and their users are also increasing. Consequent on the multiplier effect of the above, an increase in the backbone capacity is needed more than ever. In addition, the fact that the new services, including the Internet services contain more national/global traffic than the telephone services centered on local traffic tends to promote the need for an increase in the backbone capacity.

2.2 From Per-Service Networks to Integrated Networks

The operational expenditure (OPEX) occupies more than half of the total costs of most telecom carriers, and the key for reducing OPEX lies in decreasing the number of managed/operated networks.

Some communications carriers operate a huge number of networks including best-effort IP networks, leased IP networks, public ATM networks, FR networks, Ethernet networks for VPN, TDM leased-line networks and telephone networks. This is the result of them having built a new network every time they started a new service. The key lies in how to integrate all of these systems without hindering the diversification of the access methods and services.

2.3 Flexible Handling of Diversified Services

The dialup Internet access service, which was started after the traditional telephone and fax services, was used mainly in E-mailing and website browsing and was provided by using the 64kbps channel that was originally intended for the telephone service. Now, new services are being started one after another following the dissemination of AV PCs and the broadening of the accessing bandwidths and mutual linkages through IP protocols.

Since it is not predictable which of the newly provided services will be accepted more widely than the others, the transport network as a common platform should make it possible to start any service quickly and on a small scale and increase its scale smoothly as and when required.

In addition, its use should not be restricted to service delivery exclusively for the telecom carriers. It should be an open platform that is also easy to use for outside service providers such as those businesses that have been using different media or those that want to begin completely new services.

2.4 Migration to Packet Transport

In the future, it is expected that packet-based traffic will become more dominant compared to the time-division multiplexing (TDM)-based traffic. This means that it is important to optimize the transport networks for packet transport.

On the other hand, it is also expected that the network terminals/services currently in use by the end user will continue to be employed for a considerable period of time. As a result, the method for carrying the TDM traffic being emulated by packets via packet-optimized transport is being studied as a replacement for the previous method with which packets were carried being emulated by TDM traffic via the TDM network.

2.5 Functions for Providing Public Services

Emergency calls, wiretapping and priority connection are the functions that are required for a public network but are not able to be provided by a simple IP network. These functions are among the more important factors for the NGN. Traditional telephone systems provide these functions using the signaling systems, and there are many problems to be solved before the same functions can be provided via a packet network. One of the functions required for this purpose is the resource admission control at the time of accepting a session setup in the wider meaning of transport. In addition, the necessity of a session border controller, which incorporates functions such as transcoding, firewall and address conversion for use in connections between different networks or different carriers, is also an important consideration.

3. Configuration of Next-Generation Optical IP Transport

The next-generation optical transport is composed of; 1) optical transport networks; 2) core packet networks; 3) aggregation networks.

Hereafter, we will identify networks 1) and 2) by the generic name of "backbone."

Fig. 1 shows an overview of a next-generation optical IP transport.

3.1 Optical Transport Networks

Optical transport networks have previously included the TDM technology that is represented typically by the SDH (Synchronous Digital Hierarchy). The wavelength division multiplexing (WDM) technology is also used to increase the capacity per fiber . There is even a transpacific optical transport network extending over an ultra-long distance of 9,000 kilometers.

Since the practical implementation of the 2.5Gbps - 8-channel WDM system in 1995, the WDM technology has advanced by increasing the distance and capacity (number of wavelengths and bit rate).

The increase in the line interface rate of the core router has made it a general practice to connect the core router and WDM device directly. Also, the TDM function may continue to be used in backbone networks of a relatively small scale.

The WDM systems processes optical signals based on the

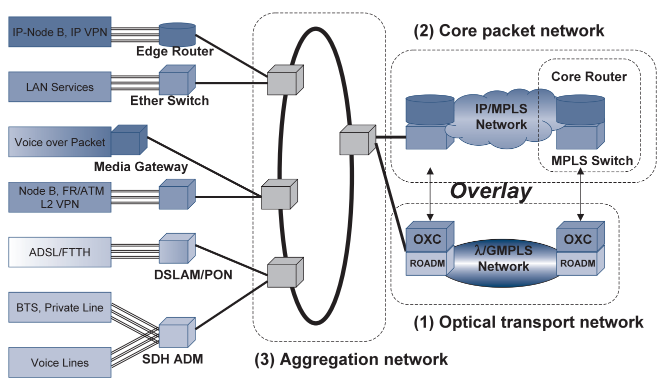

Fig. 1 Overview of next-generation optical IP transport.

all-optical network concept. Namely, it performs multiplexing, demultiplexing and cross-connection of wavelength channels using optical filters and optical switches, without converting optical signals into electrical signals. As this process may result in a change of the length of the optical fiber between the two electrical-optical conversion locations, it is also necessary to prepare an automatic adaptation technology for the fiber characteristics compensation.

3.2 Core Packet Network

The core packet network is composed of the gigabit/terabit-class core nodes and edge nodes. To support the transport in the NGN, the core packet network should be equipped with a highly reliable traffic engineering (TE) function in addition to a pure IP routing function. This is made possible by a group of new protocols and the MPLS (Multi-Protocol Label Switching). Each node in the network is made by integrating an IP router and MPLS switch.

3.3 Aggregation Network

The aggregation network connects the access and backbone, and is also called the metro network.

This network is presently composed of devices in compliance with the SDH standard, and its features include high reliability thanks to fast automatic protection switching and versatile operation management functions including end-to-end path performance management. The SDH standard was originally established for exclusive use with the TDM, but later dealt actively with packet traffic, particularly that for Ethernet traffic. The Ethernet accommodation method has also advanced with the technologies such as GFP (Generic Framing Procedure) ,VCAT (Virtual Concatenation) and LCAS (Link Capacity Adjustment Scheme). These methods are generically called the Ethernet over TDM methods, and are characterized by an emphasis being placed on the dependable multiplexing and transfer capabilities proper to TDM. Following the integration of the backbone network in the future, it is expected that the packet statistic multiplexing and packet switching functions will be incorporated to efficiently accommodate the various packet-based services of other than the Ethernet as well. A migration scenario that traces the change of traffic demand is required for this purpose.

4. Efforts Being Made at NEC

At NEC, we are conducting various R&D programs related to NGN transport. The efforts related to the GMPLS(1), RPR(2) and optical devices(3) are described in the following paragraphs.

(1) GMPLS (Generalized MPLS)

GMPLS is being developed in order to prepare for the integration of the optical transport networks and the core packet networks.

As its name implies, the GMPLS extends the MPLS, which was developed for packets, to include the fields of the TDM and WDM systems. It aims at the integrated control of the networking function of the optical transport network with the packet core network in order to enable a more efficient construction of both the optical transport and core packet networks.

The BoD (Bandwidth on Demand) service is also under study for varying the bandwidth according to the requests from end users. From another viewpoint, this technology is also expected to enable linkages between a centralized control by NMS (Network Management System) of TDM/WDM network and a distributed control of the packet network.

Concurrently with the incorporation and embedding of protocols in the products, we are participating positively in interoperability demonstrations in order to assure interoperability between vendors. **Fig. 2** shows an example of interoperability testing.

(2) RPR (Resilient Packet Ring)

The RPR is a protocol established by the IEEE in June 2004.

Its main features include; 1) high-speed switching with ring protection; 2) efficient packet statistics multiplexing, and; 3)

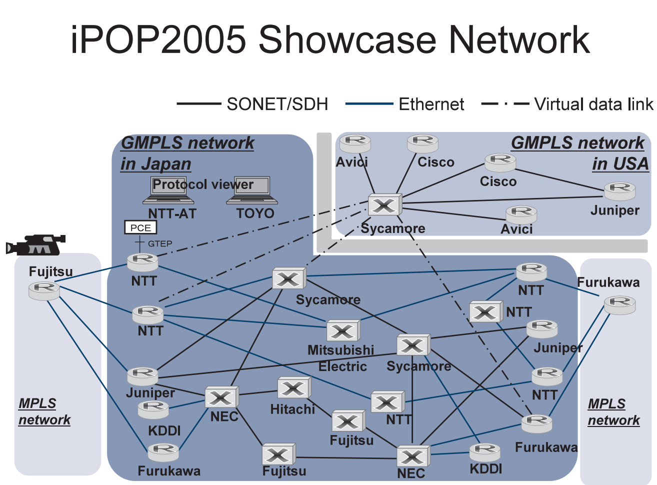

Fig. 2 Example of interconnection test.

efficient point-to-multipoint and multicast multiplexing.

At NEC, we have introduced the RPR technology in the SDH devices to support all of the migration phases from the "100% TDM traffic" to "100% packet traffic." Additionally, we are attempting to expand the limits proper to the ring, including those of capacity and physical topology, by a kind of link aggregation technology.

An example of the RPR network is shown in **Fig. 3**.

(3) Optical Devices

Optical devices are the keys of the optical communications systems supporting the optical transport network. One of the representative examples of optical devices is the optical transceiver for use in mutual conversions between optical and electrical signals, and we at NEC have developed optical transceivers for FTTH and high-speed optical transceivers for the support of the backbone system. Other optical devices include a filter that is the key technology of the WDM system, which is used to multiplex different wavelength channels into a WDM signal or to demultiplex the wavelength channels from the WDM signal and a wavelength-tunable laser offering the capability of providing the desired wavelength (**Fig. 4**).

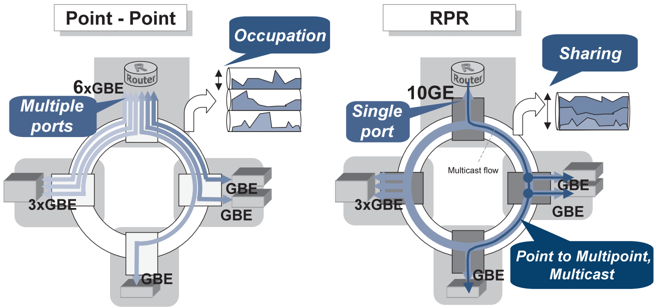

Fig. 3 RPR network.

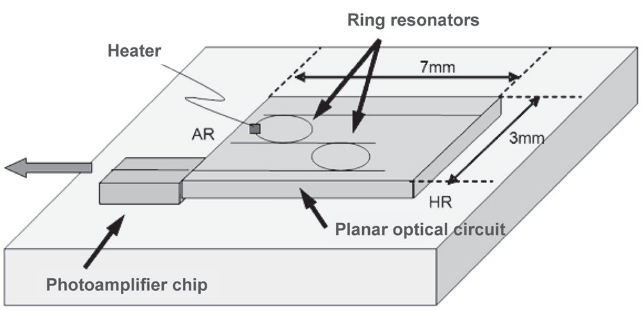

Fig. 4 Wavelength-tunable laser.

5. Conclusion

In this paper, we discussed the anticipated role of NGN transport network, related issues, and the associated efforts being made by NEC.

Here at NEC, we will continue to supply positive proposals and carry out R&D so that NGN transport can evolve as its name implies, as the dependable social infrastructure of the next generation. The NGN also aims to provide a platform to accommodate a large number of services.

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