

(Press Release)

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“NTT, NEC, Fujitsu Lab, Furukawa Electric, Hitachi and Mitsubishi Electric succeeds in the video transmission experiment using the next-generation photonic network controlled by GMPLS technology”

**Nippon Telegraph and Telephone Corporation
NEC Corporation
Fujitsu Laboratories Ltd.
The Furukawa Electric Co., Ltd.
Hitachi, Ltd.
Mitsubishi Electric Corporation**

Nippon Telegraph and Telephone Corporation (NTT; Head Office: Chiyoda-ku, Tokyo; President: Norio Wada), NEC Corporation (Office: Minato-ku Tokyo; President: Akinobu Kanasugi), **Fujitsu Laboratories Ltd. (Office: Kawasaki-shi; President: Michio Fujisaki)**, The Furukawa Electric Co., Ltd. (Office: Chiyoda-ku; President: Hiroshi Ishihara), Hitachi, Ltd., (Office: Chiyoda-ku; President, Chief Executive Officer & Director: Etsuhiko Shoyama) and Mitsubishi Electric Corporation (President & CEO: Tamotsu Nomakuchi) will conduct the successful demonstration **of controlling Gbit/s- class communication circuit freely by GMPLS (Generalized MultiProtocol Label Switching) technology in our trial photonic network constructed using multi vendor equipments. The photonic network which carried out the maximum use of the high-speed and large-scale optical communication technology have attracts attention considering the next-generation backbone communication network of the which accommodates various communication services, such as IP communication and a leased line. In this experiment, several kinds of GMPLS-supported communication equipments developed in each company was connected mutually, and the photonic backbone network of the form near practical use was built. This GMPLS network supports the**

automatic failure recovery function changed to a backup path at the time of failure of busy communication links or equipments on the working path. In the normal state, this backup path can pass traffic with a low priority, and then can use the backup network resources effectively. Eventually, end-to-end high-speed communication through this network was realized and then the video transmission experiment was conducted.

This technology is for making coexistence of the high reliability and economical efficiency of high-speed and large-scale next-generation network. By this network technology, it can be realized the lower-cost transmission of voice and high-resolution video like digital cinema.

Our technical achievements and demonstration of High-resolution digital video transmission will be introduced from January 26 and to 27, 2004 at the Gigabit Network Symposium 2004 (*1) exhibition booth, in Tokyo, Japan.

- Background

With the spread of broadband communication, the service which transmits voice and video with IP network, like VoIP and streaming, is growing every year. According to this, the required network capacity is also increasing rapidly.

Voice and video are formed into IP packet at a user terminal, and are sent to a network. Present Internet streaming flow required to network capacity of from hundreds of kbit/s to some of Mbit/s. But, it is necessary to treat the data signal of Gbit/s for transmission of high-resolution video such as Hi-Vision and the digital cinema (the movie contents saved in digital form without using film). In the conventional IP network, these packets are multiplexed with packets from other users at the metro and the backbone networks repeatedly. When multiplexing packet, simultaneously arriving packet imposed packet waiting. Then the fluctuation of the arrival time of packet (jitter) arises on the receiver side. Packet jitter causes video application confused (Fig.1). The about several to 10 times transmission bandwidth of which an application needs at minimum might be required for transmission to reduce packet jitter. Therefore, it is necessary to enlarge network capacity more faster than required capacity increase resulted from the Internet population and

improvement of access lines as such service spreads. It is said that network extension by addition of the conventional equipments will lead into cost increases sharply and it will be hard to maintain a cheap communication charge level.

- Technical points

MPLS(*2) and GMPLS(*3) are the key technologies to achieve the broadband and economical network control mechanism. MPLS is a traffic control technology in the IP network. GMPLS is an extension of the MPLS concept to the circuit switching network and the optical fiber network. GMPLS enables unified control management of the network layers (packet / TDM(*4) / wavelength / optical fiber). The use of GMPLS unifies network operations of such as TDM network using by TDM crossconnects and optical wavelength network using optical crossconnects (OXC), which will yield significant network operation cost reductions.

GMPLS is a new control technology designed for the next-generation photonic network. Moreover, GMPLS offers the novel network service of optical wavelength leased-line service in which users can freely change destination and quality.

In network control of MPLS and GMPLS, using the circuit switching concept seen in the telephone network, traffic flows that satisfy different service quality demands can be handled. The traffic of application sensitive to delay or jitter distinguishes from other best-effort traffic and transmits separately in MPLS network. Then, in a GMPLS network, the traffic flow sensitive to delay or jitter is transmitted through TDM network or optical wavelength network. Consequently, the number of packet multiplexing can be held down to minimum because no packet multiplexing occurs in these networks and it becomes possible to suppress the increase in an excessive transmission bandwidth to reduce packet jitter (Fig. 2).

The trial network setup is shown in Figure 3. It corresponds to large-scale backbone network connecting metro networks. The metro network 1 and 2 using MPLS technology was constructed using MPLS routers by Fujitsu Ltd. and Furukawa (GeoStream R920 and FITELnet-G21, respectively). Then, the backbone network using GMPLS

technology was constructed using four kinds of equipments; HIKARI routers(*5) by NTT (IP and wavelength), GMPLS routers of FITELnet-G80 by Furukawa (IP and TDM), TDM crossconnects of SpectralWave U-Node by NEC (TDM and wavelength), optical crossconnects by Mitsubishi Electric, Hitachi, Fujitsu Laboratories, and NTT (wavelength and optical fiber). The above expressions within the brackets represent the function and the layer handled by each company's equipment. GMPLS control software that can handle at least two layers was developed and implemented by each company. These GMPLS equipments are connected using control links (exchange control message like routing information) and data links of over gigabit rate (Gigabit Ether, OC48, and OC192).

Since a wide variety of network equipment (e.g. IP router and a cross connect) will coexist in a GMPLS network, it is essential to verify the interoperability between multi-vendor network equipment.

Until now, interoperability test of GMPLS routing and signaling protocols in control software operation was performed. We succeeded the distribution and collection of the routing information and setup of paths in multi-layer and multi-vendor environment. It is possible to use various communication paths of a packet, TDM, wavelength, and a fiber properly according to the communication quality demanded.

In addition, with this GMPLS backbone network, two functions are supported in this GMPLS backbone network; seamless connection to the Metro network and high reliability. The former is realized by MPLS and GMPLS interworking technology (*6). This interworking technology in multi-vendor environment was succeeded October 2003 for the first time in the world. In this experiment, practicality was verified using the commercial MPLS routers. The latter is network failure recovery technology (restoration) to set up a detour path automatically when failure arises to a certain communication links or equipment on the working path. The backbone network can be robust to network failure. This restoration technology shares a backup path at the time of failure to the several working paths. In addition, this backup path is allowed to use for the lower priority traffic when no failure among these working paths. Consequently, network resource can be used effectively (Fig. 4).

In this experiment, transmission of high-resolution video like digital cinema was achieved through MPLS and GMPLS networks. It was

proved that an economical and high-reliable IP network which can treat high-speed to the grade of which high-resolution video transmission could be realized.

The GMPLS equipments of NEC and Hitachi in this experiment involve a part of result of the research sponsored by TAO (Telecommunications Advancement Organization of Japan).

- Future plan

This experiment was carried out by the Photonic Internet Lab (PIL) (*7). PIL has already conducted interoperability tests of standard GMPLS protocol with a number of global companies at interoperability site of ISOCORE at Washington D.C, USA. PIL will promote to create new control technologies that can be accepted as international standards and to develop novel network services.

<Glossary>

*1) Gigabit Network Symposium 2004

Symposium aiming at announcing the research-and-development results for five years of the Japan Gigabit Network (JGN), and promoting a related researcher, information exchange between areas. JGN is the research network constructed by TAO.

*2) MPLS (Multi Protocol Label Switching)

The abbreviation of Multi-protocol Label Switching. MPLS is a packet transmission control technology for the IP network. MPLS realizes traffic control in the IP network. Using the circuit switching concept seen in the telephone network, it establishes and handles traffic flows that satisfy different service quality demands. At present, MPLS technology is being used to realize traffic management in Internet service providers and to realize IP-VPN services.

*3) GMPLS (Generalized Multi-Protocol Label Switching)

GMPLS is a protocol that establishes generalized MPLS in all layers of the IP network: layer 2, TDM (Time Division Multiplexing), wavelength

(WDM), and the fiber. The basic MPLS is a control mechanism that attaches fixed length labels to IP packets. GMPLS is attracting attention for controlling the next-generation photonic network. Standardization of GMPLS is being advanced mainly by IETF (The Internet Engineering Task Force). The basic function of GMPLS was released as a Proposed Standard in February 2003, with registration number RFC 3471-3473. In order to make it a complete and truly practical protocol, world-wide efforts are needed elaborate the remaining details and develop protocol code that can be directly installed in network equipment.

***4) TDM**

Transmitting technology using time division multiplexing. SDH/SONET is used widely in many networks.

***5) HIKARI router**

A communication equipment of the Terabit (1 trillion bits) -class capacity. It is based on GMPLS concept and controlling MPLS and wavelength paths dynamically and systematically in according to change of IP traffic

***6) GMPLS and MPLS interworking technology**

The interworking between MPLS and GMPLS networks using a newly developed routing interworking function. Because this approach allows the MPLS side to recognize required IP nodes inside the GMPLS domain, GMPLS domain resources can be efficiently managed from the MPLS domain, such as shortest path setup and traffic control.

***7) Photonic Internet Lab**

abbreviation: PIL See <http://www.pilab.org>

PIL, which founded in September 2002, is promoting research into and development of next-generation photonic network technologies. PIL encourages the submission of proposals from its members to global standardization bodies, like ITU-T, IETF, and OIF. PIL also tests the photonic network control programs developed by PIL member companies. This experiment directly supports these goals. At present, PIL consists of seven companies; Oki Electric Industry Co., Ltd. and the six above-mentioned companies. In this experiment, Hitachi Communication

Technologies, Ltd., which is a subsidiary company of Hitachi, Ltd., is also joined in cooperation with Hitachi, Ltd.

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