"GMPLS Signaling Protocol Interoperability Test in Multilayer Network"—Toward a Global Standard for the Next-generation Photonic Network

NTT, NEC Corporation, Fujitsu Laboratories Ltd., The Furukawa Electric Co., Ltd., and Mitsubishi Electric Corporation are pleased to announce the successful conclusion to the world's first GMPLS[*1] signaling[*2] interoperability test using a multilayer network consisting of packet, TDM[*3], wavelength, and fiber layers. Given the quality requirements set by the application or traffic state, it is possible to select the optimal communication path from among all possible paths that can be established on the multilayer network.

The results of this experiment were reported on May 22, 2003 in the Workshop held in Kagoshima University organized by the Technical Group on the Photonic-Network-based Internet and the Technical Group of Photonic Switching in the Institute of Electronics, Information and Communication Engineers of Japan.

Background and achievements

GMPLS enables unified control management of the network layers. In the conventional network, each layer network is constructed independently. Conventional technology demands that each is independently controlled by operators specializing in that layer. For example, in conventional electrical or optical cross-connects, the network operator uses a terminal of a centralized control device. This device issues instructions to control cross-connect equipment and hence the setup of TDM or wavelength paths. If the cross-connect equipment supports GMPLS control, then a path is set up by exchanging control packets between these control devices as well as MPLS routers. Therefore, a network operator who has MPLS expertise can manage cross-connects. However, current equipment that supports GMPLS control simply offers a unified management approach. Each layer network must still be managed separately as before. It is impossible to handle all layers in the whole network systematically, if, for example, one side uses TDM routing and the other side uses wavelength routing.

To avoid this problem, control software programs for setting up and releasing paths in the multilayer network were newly developed and installed in the network control devices of each company. The fact that these control devices can be mutually interconnected is a key factor in the success of the interoperability test that examined path setup of multilayer signaling: a world first. These control devices exchange signals based on the protocol RSVP-TE[*4], extended to GMPLS, to set up and release multilayer paths on the multilayer network.

The test setup is shown in Fig. 1. It was designed to replicate a multilayer network with various kinds of network equipment including packet routers, electrical connections, optical cross-connects, and optical switches for fiber port switching. It provides control

*1 GMPLS (Generalized Multi-Protocol Label Switching): GMPLS is a protocol that establishes generalized MPLS in all layers of the IP network. The basic MPLS is a control mechanism that attaches fixed-length labels to IP packets. The basic functions of GMPLS were released as a Proposed Standard in February 2003, with registration number RFC 3471-3473. To make it complete and a truly practical protocol, world-wide efforts are needed to finalize the remaining details and develop protocol code that can be directly installed in network equipment.

*2 Signaling: An exchange of signals between network equipment control devices, such as routers and optical cross-connects to set up and release paths. The format of the control signal and the procedure for exchanging control packets are defined in the signaling protocol.

*3 TDM (Time Division Multiplexing): Transmission technology using time division multiplexing. Many TDM networks use SDH/SONET (Synchronous Digital Hierarchy/Synchronous Optical Network).

*4 RSVP-TE (Resource ReSerVation Protocol with Traffic Extensions): A signaling protocol. An extension of RSVP (a bandwidth reservation protocol) for MPLS.

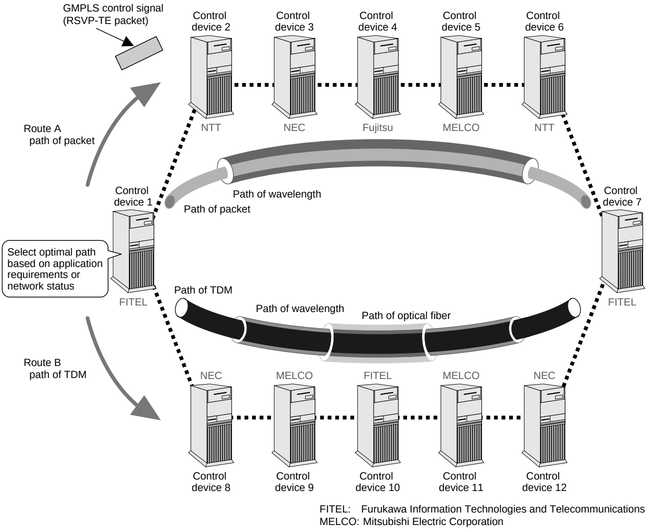

Fig. 1. Setup of GMPLS signaling experiment in multilayer network.

functionality for both packet and TDM paths using control devices 1 and 2. Control device 1 can freely set the packet path of route A and the TDM path of route B. Control device 2 on Route A has path control functions for both packet and wavelength paths. Control devices 2 to 6 are for optical cross-connect control, which sets up the wavelength paths. They newly set up a wavelength path for the packet path from devices 1 to 7. Thus, the setup and release of a multilayer path can be performed by exchanging a control signal among all the control devices handling a particular layer. Given the quality requirements set by the application or traffic state, it is possible to select the optimal communication path from among all possible paths that can be established on the multilayer network.

GMPLS allows network operations to be unified. Significant reductions in network operation costs can be expected because the most economic path can be selected by configuring the optimal configuration of network resource from among all layers of the network. In addition, novel network services can be created, such as a wavelength-dedicated line that changes wavelength path connection points according to user demand. For this reason, GMPLS has been attracting attention as the base technology of the next-generation broadband IP network. GMPLS is being actively discussed and advanced in international standardization organizations, such as IETF (Internet Engineering Task Force), OIF (Optical Internetworking Forum), and ITU (International Telecommunication Union).

Future plans

This interoperability test was carried out by the Photonic Internet Lab (PIL)[*5]. Further interoperability tests with several global companies are planned.

*5 Photonic Internet Lab: Founded in September 2002 to promote research on and development of the next-generation photonic network[*6] and encourage global standardization activities, PIL currently consists of seven companies: the five mentioned above plus Oki Electric Industry Co., Ltd. and Hitachi, Ltd. PIL has two objectives: i) to create new control technologies that can be accepted as international standards and ii) to rigorously test the protocol software code developed by each company. PIL is promoting R&D on next-generation photonic network technologies (see http://www.jk.ws32.arena.ne.jp). It encourages its members to submit proposals to global standardization bodies, like ITU-T, IETF, and OIF. It also tests the photonic network control programs developed by its member companies. Its activities are supported by the R&D support scheme of the MPHPT (Ministry of Public Management, Home Affairs, Posts and Telecommunications) for funding selected IT activities.

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*6 Next-generation photonic network: A network that more fully reaps the benefits of optical technology, such as optical fiber transmission and wavelength division multiplexing. At present, optical fiber and wavelength multiplexing are mainly used for point-to-point transmission. The next-generation photonic network requires effective optical switching technology. Most switches today are electrical because the few existing optical switches offer insufficient performance. A high-speed, large-scale network could be created with advanced all-optical switching.