Promotion of Next-generation Photonic Network Protocol Standardization by Photonic Internet Lab (PIL)

Akira Misawa, Kohei Shiomoto, Satoru Okamoto, and Naoaki Yamanaka

Abstract

Photonic Internet Lab (PIL) aims to achieve global *de facto* standardization for photonic technology and managed network technology as its core competence. This article introduces PIL activities.

1. Standardization of GMPLS

Due to the increase in the number of Internet users and the emergence of various services, the volume of traffic carried on telecommunication networks is doubling every year. NTT has created various service-level IP (Internet protocol) networks that use MPLS (multiprotocol label switching), a key technology for IP managed networks.

GMPLS (generalized MPLS) is the new control technology for the next-generation photonic network. It extends the concept of MPLS in the IP network to the digital-communications network, the optical fiber network. It enables unified control management of the network layers (packet, TDM (time division multiplexing), wavelength, and optical fiber). The standardization of GMPLS protocols is being discussed in the Sub IP Area of IETF (Internet Engineering Task Force). GMPLS standardization was started at the point of SDH/SONET (SDH: synchronous digital hierarchy, SONET: synchronous optical network) path setup. The basic function of GMPLS signaling was released as a Proposed Standard in February 2003, registration numbers RFC 3471–3473. However, many points still remain under discussion, such as an extension for optical wavelength path setup and interworking of IP-SDH/SONET-wavelengths.

In the advancement of communication technology, the role of *de facto* standards is equal to that of *de jure* standards. Protocol software is being implemented even while standardization discussions are underway. For example, in the field of MPLS standardization, protocol testing has been performed in various interoperability bodies, such as ISOCORE [1], in which many global communication vendors participate. In establishing global standards, not only technical proposals but also proof of practicality by implementing and testing software code is important.

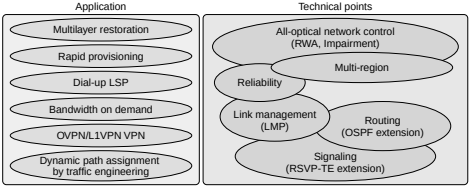
NTT Network Service Systems Laboratories
Musashino-shi, 180-8585 Japan
E-mail: secretariat@pilab.org

2. PIL organization and operation

Photonic Internet Lab (PIL) is a consortium established to promote research on and development of the next-generation photonic network as well as encouraging global standardization activities. Its aim is to publish *de facto* standardization technologies from Japan based on optical technology and network management techniques. PIL was founded in September 2002. At present, it consists of seven companies; NTT, NEC Corporation, The Furukawa Electric Co., Ltd., Mitsubishi Electric Corporation, Fujitsu Ltd. and Oki Electric Industry Co., Ltd., and Hitachi, Ltd. **Figure 1** shows the application target and technical points being discussed in PIL.

PIL activities are assisted by the R&D support scheme of the MPHPT (Ministry of Public Management, Home Affairs, Posts and Telecommunications) for funding selected IT activities.

PIL consists of a steering committee and two working groups: standardization strategy WG and technical test WG. The standardization strategy WG discusses novel network technologies to support ser-



L1: layer 1, LSP: label switched path, LMP: link management protocol, RWA: routing and wavelength assignment problem

Fig. 1. Application targets and technical points for next-generation network.

vices over the photonic network and has proposed extended protocols to global standardization bodies. Internet drafts submitted to IETF by PIL members are being examined while other drafts are receiving co-author support. At present, PIL members are discussing fault recovery functions in the multilayer network like restoration and protection, multi-region framework, and novel service creation like OVPN (optical virtual private network). In the year since IETF55 (Nov. 2002), we have discussed more than 25 Internet drafts proposed by PIL members or hot topics in global standardization bodies such as IETF, OIF (Optical Internetworking Forum), and ITU-T. We submitted two cooperating drafts: requirement for fault recovery in optical network to CCAMP (Common Control and Measurement Plane, IETF55) and requirement for extra service [2] to CCAMP-WG (IETF57).

The other important activity of PIL, besides standardization activities, is protocol code testing. PIL members are implementing software code based on protocol specifications. The technical test WG is conducting interoperability tests of protocol code. The results of these tests are fed back to protocol development. Code so tested includes not only standard protocol code but also leading-edge protocol code, extensions of IETF standard code that have been developed by PIL members for the next-generation protocol standard. From the viewpoint of intellectual property confidentiality, testing is restricted to just the development partners that have a common purpose and a give-and-take relationship. Most standard protocols contain vague or undecided parts and final implementation depends on the developer. This testing clarifies the differences in implementation methods and thus provides important know-how. Initial interoperability tests of GMPLS RSVP-TE (reservation protocol, traffic engineering) and OSPF (open shortest path first) protocols have been performed and an extended protocol test is under way.

The results of technical tests allowed Furukawa Electric, NEC, Fujitsu, Mitsubishi Electric, and NTT to announce their success in establishing multi-layer signaling in a multi-vendor environment [2]. **Figure 2** shows the setup using the network control software implemented on various devices like routers and cross connects. Multi-layer path setup and release by signaling was successfully demonstrated through the selection of multiple routes that offered various speeds and levels of quality.

Moreover, NTT, NEC, Furukawa Electric, and Mitsubishi Electric conducted the world's first successful demonstration of interworking between legacy MPLS for IP network control and GMPLS for next-generation photonic network control, shown in **Fig. 3** [2], [3]. This was demonstrated at MPLS2003 held in Washington D.C. This interworking technology will lead to the smooth introduction of the next-generation high-speed and flexible backbone network without demanding that changes be made to existing IP and MPLS network configurations.

Standardization proposals and insights gained from these experiments have been publicly released on the PIL web site. To enhance the development and standardization of the next-generation photonic network, PIL hopes that its activities will gain global support.

3. Future plans

PIL members will hold discussions with global

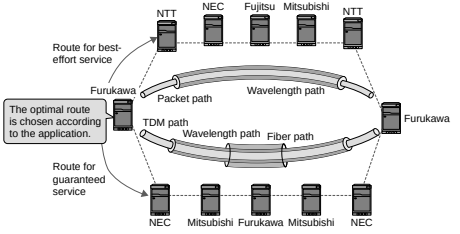


Fig. 2. Test setup for multilayer path setup using GMPLS signaling [2].

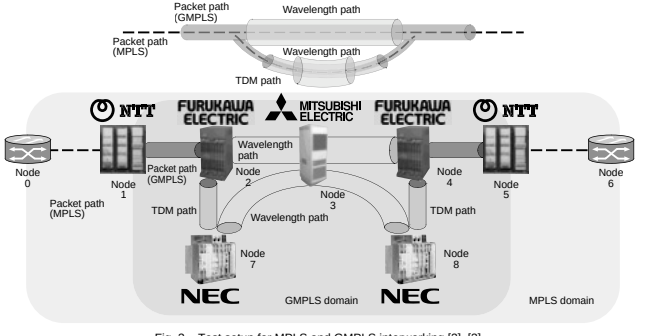


Fig. 3. Test setup for MPLS and GMPLS interworking [2], [3].

vendors and participate in the ISOCORE interoperability test, a US interoperability site. While the first trial involved only the control software developed by PIL member companies, PIL will conduct interoperability tests with a number of global companies. PIL is also planning a nationwide field trial of the next-generation network using the resources of the Keihanna Open Laboratories of Communication Research Laboratories [4].

References

[1] http://www.isocore.com/
[2] http://www.pilab.org/
[3] "NTT, NEC, Furukawa Electric, and Mitsubishi Electric Succeed in the World's First Interworking of GMPLS and MPLS," NTT Technical Review, Vol. 2, No. 1, pp. 102-105, 2004.
[4] http://www2.crl.go.jp/pub/whatsnew/press/030609/030609.html

Akira Misawa
Senior Research Engineer, Supervisor, NTT Network Service Systems Laboratories.
He received the B.E. and M.E. degrees in electronics engineering from Hokkaido University, Hokkaido in 1988 and 1990, respectively. He joined NTT, Tokyo, Japan in 1990, where he was engaged in R&D of photonic packet switching systems. From 1999 to 2001, he was in NTT Department III (R&D Strategy Department). From 2001, he was engaged in research on L1VPN architecture in NTT Network Innovation Laboratories. Since 2003, he has been developing service and system architectures in IP and optical networks. He is a member of the Institute of Electronics, Information and Communication Engineers (IEICE) and IEEE. He received the Young Engineer Award from IEICE in 1997.

Kohei Shiomoto
Senior Research Engineer, Supervisor, NTT Network Innovation Laboratories.
He received the B.E., M.E., and Ph.D. degrees in information science from Osaka University, Osaka in 1987, 1989, and 1998. He joined NTT, Tokyo, Japan in 1989 and engaged in R&D of ATM traffic control and ATM switching system architecture design. From Aug. 1996 to Sep. 1997, he was engaged in research on high-speed networking as a Visiting Scholar at Washington University in St. Louis, MO, U.S.A. From Sep. 1997 to June 2001, he was directing architecture design for the high-speed IP/MPLS label switch router research project at NTT Network Service Systems Laboratories, Tokyo, Japan. Since July 2001 he has been engaged in the research on photonic IP router design, routing algorithms, and GMPLS routing and signaling standardization at NTT Network Innovation Laboratories. He is a member of IEICE, IEEE, and the Association for Computing Machinery. He is a Secretary of International Affairs of the Communications Society of IEICE. He was involved in organizing several international conferences including HPSR 2002, WTC 2002, HPSR 2004, and WTC 2004. He received the Young Engineer Award from IEICE in 1995.

Satoru Okamoto
Senior Research Engineer, Photonic Transport Network Laboratory, NTT Network Innovation Laboratories.
He received the B.E., M.E., and Ph.D. degrees in electronics engineering from Hokkaido University, Hokkaido in 1986, 1988, and 1994 respectively. In 1988, he joined the Transmission Systems Laboratories, NTT, Yokosuka, Japan and engaged in research on ATM cross-connect system architectures. Since 1991, he has been engaged in research on photonic switching systems and optical path network architectures. He is currently developing HIKARI router systems. He received the Young Engineer Award and the Achievement Award in 1995 and 2000, respectively, from IEICE. He also received the IEICE/IEEE HPSR2002 outstanding paper award. He is a member of IEICE and a senior member of the IEEE Communications Society.

Naoaki Yamanaka
Senior Research Engineer, Supervisor, and research group leader, Photonic Transport Network Laboratory, NTT Network Innovation Laboratories.
He received the B.E., M.E., and Ph.D. degrees in electrical engineering from Keio University, Tokyo, Japan in 1981, 1983, and 1991, respectively. In 1983 he joined Nippon Telegraph and Telephone Public Corporation (now NTT) Communication Switching Laboratories, Tokyo, Japan, where he engaged in R&D of high-speed switching systems and high-speed switching technologies for broadband ISDN services. Since 1994 he has been active in the development of ATM-based backbone networks and systems, including Tb/s electrical/optical backbone switching, as an NTT Distinguished Technical Member. He is now researching future optical IP networks and optical MPLS router systems. He received the Best of Conference Awards from the 40th, 44th, and 48th IEEE Electronic Components and Technology Conference in 1990, 1994, and 1998, TELECOM System Technology Prize from the Telecommunications Advancement Foundation in 1994, IEEE CPMT Transactions Part B: Best Transactions Paper Award in 1996 and IEICE Transaction Paper award in 1999. He is Technical Editor of IEEE Communication Magazine, Broadband Network Area Editor of IEEE Communication Surveys, Editor of IEICE Transaction as well as TAC Chair of the Asia Pacific Board at IEEE Communications Society. He is an IEEE Fellow and a member of IEICE.