R&D Spirits

Ahead of the World's Telecom Carriers in Developing a Photonic Network for IP

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In response to the rapid increase in IP traffic volumes, research into photonic networks that dramatically improve the quality and economy of networking has become an arena for fierce competition among the world's large telecom carriers. At NTT, the Photonic Networking Research Group of the Network Innovation Laboratories has played the leading research role in the development of Photonic Multi-Protocol Label Switching (MPLS) routers. The Group's research in this area is now moving toward its final stage. We spoke to Group Leader Yoshihiro Takigawa to clarify the present situation as his group's research heads for commercial application at the end of fiscal 2005 and to talk about the future.

Research Focus Shifts to Experiments with Prototypes. Goal is Practical Business Application from the End of Fiscal 2005

Editor: What are some of your group's current research themes?

Takigawa: Our Group's main research is in the area of photonic networks. Typical products that we are studying are Photonic Multi-Protocol Label Switching (MPLS) routers and optical cross-connect nodes. Our research includes the development of technology for various key system elements, technology for components, network design, and operation and maintenance tools. We are not doing all the development work ourselves, of course, but are collaborating with other organizations in NTT, such as the NTT Photonics Laboratories, the NTT Network Service Systems Laboratories, and software developers outside the NTT Group. Our Group, however, is charged with pulling together the overall research and preparing the final system for a new business opportunity.

E: In what areas will the results of your group's research be applied?

T: The technology will serve as the core for NTT's next-generation network, the Resonant Communication Network Architecture (RENA). As broadband usage and related services expand on the Internet in the future, tremendous volumes of information will flow through networks. It is clear that the present system that involves optical-electrical-optical conversion will soon reach the limits of its capabilities. If information is routed solely through optical technology, the burden on the overall system will be greatly reduced (Fig.1). Based on that thinking, we developed a Photonic MPLS router—the HIKARI router—that uses wavelength as the identifier for transferring IP packets (Fig.2).

E: What are the main technical points of your group's research?

T: One of our main research areas is network restoration by providing minimum redundant capacity for failure recovery of Internet links and nodes. For example, if three locations A, B, and C are each connected by 10 Gbit/s lines, the simplest and safest backup would be to reserve identical capacity for each link. But doing so would mean adding two 10-

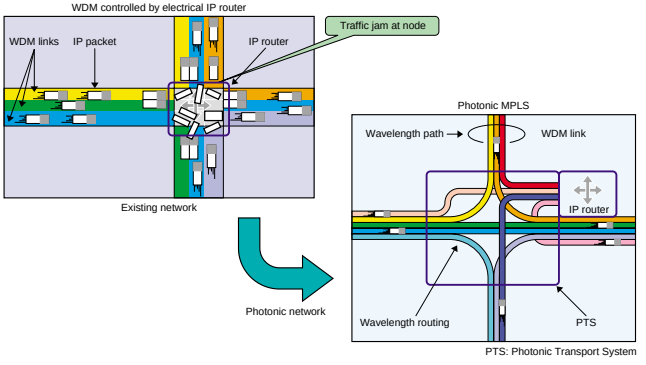

Fig. 1. Wavelength routing on photonic superhighway.

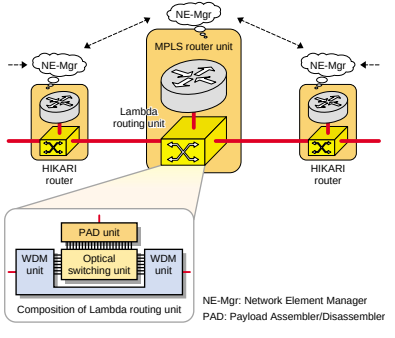

Fig. 2. Functional Components of HIKARI Router.

Gbit/s lines (e.g. a total of 20 Gbit/s) for each link, a completely uneconomical approach. Using the network restoration technology, a single reserve link of 10 Gbit/s could be designed to back up all three locations, with emphasis on dependability and economy.

Another area of interest for us is a signaling method called Generalized MPLS (GMPLS). When a network becomes extremely complicated the management of nodes surpasses human capabilities. GMPLS allows information to be automatically provided

between nodes on a network whitch are installed, reconfigured and removed. Even without centralized management it can make such an arrangement on the network smoothly and efficiently.

E: With such technology, what can we expect to happen in three to five years from now?

T: Usable bandwidth will expand by a full order of magnitude, making it possible to read magazines and newspapers on the Internet, and to relax and watch movies and videos without interruption. And as the Internet becomes more economical, there will be a tremendous increase in the number of Internet users. Once we reach that point, some aspects of society will change. At any rate, our group is moving toward that kind of future, and we plan to introduce our first system with RENA when that service is introduced at the end of fiscal 2005. Service will be provided initially in large cities like Tokyo and Osaka, and will be expanded gradually afterward to eventually cover all of Japan.

E: What is the current status of your group's research?

T: Prototypes of the HIKARI router have already been built, and we are now conducting experiments. We have to verify the equipment with various kinds of checks, including not only fast restoration technology but also size and cost of the equipment. We are also studying ways to guarantee quality and economy for media streaming of large-volume media such as movies and newspapers.

Balance between Competition and Cooperation, and Developing an R&D Strategy

E: What are the main domestic and overseas trends in your group's area of research?

T: The research we are conducting is currently one of the hottest research areas worldwide. The major vendors and telecom carriers around the world are competing in the area of GMPLS research, and moves are progressing toward standardization. Concerning the HIKARI router, meanwhile, there are still almost no organizations using it, mainly because the performance and functions already achieved are not yet felt needed. In a few years, however, it is absolutely certain that other organizations will introduce similar equipment. So we must not be satisfied with what we have accomplished. Actually, until a few years ago something like 10 or 20 U.S. companies—from large corporations to venture businesses—competed intensely in the area of optical crossconnectors. After the IT bubble burst, however, almost all of them halted their work. Essentially, the only other company now conducting research in the same area as us is Calient Networks.

Telecom carriers are the main participants conducting research in the area of restoration, and the competition is intense. Among them, the two most advanced organizations, as viewed from the level of papers being presented at conferences and forums, are NTT and France Telecom. NTT has conducted experiments with fully supported prototypes that permit switching among three nodes within 700 milliseconds. France Telecom's product can switch among four nodes in one second or less. Although there are differences in the experimental conditions, the products of both companies perform at about the same level. Despite not having presented papers at conferences, Deutsche Telekom has probably also reached the same level of research as NTT and France Telecom.

In the U.S., the government has taken the lead in promoting research in this area, keeping it an "all-American" undertaking. It appears that R&D is being powerfully promoted across a wide spectrum of activities in the U.S. Against that backdrop it would seem that worldwide competition will become even stiffer in the future.

E: Given the difficult competitive situation, is your group cooperating with any organizations overseas?

T: Although research in the area of restoration is mutually and totally competitive, both competition and cooperation exist in research in the area of GMPLS. That is quite natural, because the Internet is a connection of networks around the world. The different carriers must be tied together. Also, technological progress in GMPLS is very fast. If research were to be conducted in isolation, a company would not be able to respond to the speed of the advances being made. From the viewpoint of research costs as well, give-and-take relationships have inevitably developed among the major players. Basically, however, it remains a competitive environment, making it difficult to maintain a balance between what to reveal and what to keep hidden. A good sense is needed for that kind of decision. Although companies earn a sort of

batting percentage for how they handle that balance, fortunately nobody knows about most research because it is conducted behind closed doors—which, of course, is true for both sides. Our group feels it would be interesting if we could develop technology that influenced networking and guided it in a certain direction. We enjoy attempting different research tasks with that in mind.

Introducing NTT Technology to the World through International Activities

E: Please outline the sort of joint research your group is conducting with overseas organizations.

T: Our group is collaborating with two overseas organizations. One is the Electronic Visualization Laboratory (EVL) of University of Illinois Chicago. EVL focuses pretty much on the development of virtual reality devices. To provide EVL with services in the future, we are working with them to study their product quality requirements and network configurations. We are also providing them with system proposals. The second overseas organization is the Information Society Technologies (IST) Programme, an EU program. Our group worked with IST from 2000 to March 2003 by participating in the Layer Interworking in Optical Network (LION) project for conducting experiments with mutual connectivity of optical devices. The second project, the Next-generation Optical network for Broadband in Europe (NOBEL), is scheduled to begin this fall. IST has asked NTT to participate in this new project as well, and we probably will do so.

E: What activities does your group conduct with international forums and committees?

T: Concerning activities related to standardization, we took the initiative when we participated in activities of the ITU-T and the Internet Engineering Task Force (IETF) and Optical Internetworking Forum (OIF) in the U.S. Normally we would also participate in the vendor-related MPLS Forum, but in considering the benefits to us versus the time and funds required we decided not to participate. Based on our strengths as a telecom carrier, our standardization strategy is, first, to approach ITU-T, and then to approach OIF and IETF more forcefully.

E: What reaction has there been thus far to your group's research results and other activities?

T: In 2001 we prepared a dynamic presentation of the HIKARI router for display at the SUPERCOMM that year in the U.S. Many companies expressed a strong interest in the router at the show, even asking about when the product would be marketed. That display, I am convinced, told the world that NTT is much more than merely a telecom carrier. We heard the same response when we participated in the LION project. Also, at last September's World Telecommunications Congress – International Switching Symposium (WTC-ISS), held in France, we conducted open experiments of our optical restoration system. By coincidence, France Telecom showed a similar system at the same symposium. It seemed clear to me at that time that France Telecom was surprised at NTT's presentation. Some of those attending the symposium asked us straight out how the results of our experiments would compare with France Telecom's system if we operated our system under the same conditions as theirs.

E: Tell us about the sort of tasks your group faces in the future.

T: Our most important technical task is to shorten the unavailable time of restoration. The ultimate objective in restoration research is to provide the same performance as if there were exclusive backups for each link. It is no exaggeration to say that accomplishing that task would contribute to NTT being recognized as a worldwide telecom carrier conducting successful research in networking. Another major task facing our group, as a research lab in a private corporation, is to make our overall system economical. At the same time, I would like to see us move forward with selling to the outside, through companies in the NTT Group, some of the products and functions we eventually develop. Having technology that we can market will allow us to contribute to the overall revenues of the NTT Group. We would also like, of course, to offer unique services of our own. Those are roughly the major tasks we face for the future.

Making the Most of Widespread Research Experience to Pursue Best Technology

E: What major fields of research have you been involved in up to now?

T: My major research at Waseda University was wireless power transmission using microwaves and millimeter wave bands. In one research task the objective

was to equip a satellite with solar cells, generate electricity—which is done efficiently in space—and transmit power back to earth. The two main problems were how to convert electric power into microwaves, and how to accurately control their direction of the propagation.

After joining NTT in 1982, I spent ten years in R&D related to ISDN subscriber systems, from the start of the research project, through the start of service, and afterward on making the system more economical. The system I worked on was introduced to 4,000 telephone offices nationwide. After that, my research shifted to Passive Optical Networks (PON) for ATM. In that research as well I was involved from the start of the project and stayed with it until just prior to service commencement. The period happened to coincide with the NTT's multimedia trials, and I participated in experiments conducted in Yokosuka and Urayasu on a new image distribution service. After that, I moved over to NTT Communications and was involved in promoting ATM multimedia services through the Asia Multimedia Forum (AMF). Three years ago I returned to NTT in the Photonic Transport Network Laboratory and since then have been involved in the research I am doing now. The targets of my research, including my university studies, have changed greatly over the years. The wide gamut of research being conducted at NTT was one of the attractions for me when I joined the company, and I consider myself fortunate for always having been involved in research I enjoy.

E: Why do you think NTT selected you to head the Group?

T: There were probably several reasons for considering me as the most appropriate person to head the Group. Because of my varied experience, for example, it was obvious that I understand the basic research process. Also, I have overseas experience in promoting NTT's products and services, and have been involved in high-level discussions with non-researchers in government. When I was involved in the ATM-PON research project, moreover, I submitted as many as 25 different papers to the ATM Forum as part of my activities related to international standardization. At the time, that was a tremendous number of papers for a Japanese researcher to submit to the ATM Forum. Perhaps that was one more reason for my selection.

E: Based on your experience to date, how do you think the rest of the world views NTT?

T: NTT proposed a number of technologies in the area of network infrastructure that later became international standards. So among telecom carriers NTT is recognized as having sophisticated technology usable anywhere in the world. When it comes to the Internet, however, NTT's name, unfortunately, is not well known yet. When router vendors come together at forums and other conferences and hear the name NTT, they sometimes ask if NTT is a subsidiary of Northern Telecom (laughs). Even in this area, though, NTT has outstanding technologies. That's another of our future tasks: to make the NTT name more familiar in the Internet field.

E: Please share with us some of your thoughts about the future.

T: It would be nice three to five years from now if NTT could be providing networking services, collaborating with other companies and organizations along the way, and producing the best possible technology to represent the overall NTT Group. Personally, meanwhile, I would like to work with experimental studies of the basic constituent technology. I have done much research up to now related to systems. I was left pretty much to myself, and achieved a certain level of accomplishment. But there was little opportunity during that time to write papers related to formulas and experiments, i.e., the basic constituent technology. Doing so would give me additional experience and allow me to broaden myself as a researcher. If the company allowed it, that is something I would like to do.

E: What has the NTT Laboratories meant to you personally?

T: The NTT Laboratories has not only let me confirm my technical competence, my overall capabilities, and my opinions and views at an international level but has also allowed me to improve myself further. One of the old-timers at NTT once said to me many years ago that NTT's laboratories were kinds of training places for researchers. Today I understand what he meant, and I agree with him. In the NTT research environment I was allowed to do work that I enjoyed and that had meaning for me. Today, many young people are choosing to work in situations not directly related to technology or R&D. There is nothing wrong with that, of course, but if matters continue as

it is, Japan will have no technology of its own in the future. To prevent that from happening, we must get young people, including university students, to understand and appreciate the attractive qualities of technically oriented corporate groups such as NTT. That can probably be listed as another of our Group's roles in the future.

Interviewee profile

■ Career highlights

1980 Graduated from Electronic Communications Department, Faculty of Engineering, Waseda University, with B.A.

1982 After graduating from Graduate School of Waseda University with M.S., entered Nippon Telegraph and Telephone Public Corporation (now NTT).

2000 Photonic Transport Network Laboratory of NTT Network Innovation Laboratories

■ Major awards

1989 NTT President's Award

1996 NTT President's Award

1998 NTT President's Award

■ Professional associations

Member of the Institute of Electronics, Information and Communication Engineers