R&D Spirits

Optical Access Systems: The Key to Making Broadband Services Economical

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Today we are finally seeing the all-out commercial introduction of optical access systems around the world. In the midst of that development, what next-generation optical access systems does NTT envision for the future? Also, how is NTT working toward international standardization of its optical access systems? We asked these and other questions to Yoichi Maeda of NTT Access Network Service Systems Laboratories. Mr. Maeda, the group leader in the Full Service Access Systems Group, has promoted systems development for many years and has been aggressively involved in promoting international standards for optical access systems.

Optical Access Systems as Economical Social Infrastructure that Anyone Can Use

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

Maeda: Our group is currently conducting R&D of optical access systems aiming to provide economical broadband services for Internet access and video content distribution. Actually, high-speed broadband communications using fiber optics for access has been an R&D theme at NTT's research laboratories for over 25 years. It is only in the past few years, however, that the results of that research have been pulled together and made economical to use. My personal research has been mainly in applications of ATM technology, in applications of transmission technology at the optical medium level, and in communications control technology for point-to-multipoint networks shared by multiple customers through a single optical fiber (passive optical networks (PONs)). Besides R&D, I have participated in international standardization activities for leading-edge technology.

E: What are the main technical points of optical access systems?

M: The most important point in our research is the PON. In a passive network, optical splitters are installed between central offices and customer premises for combining or splitting power from optical fibers. That technology enables economical communications by allowing up to 32 customers to share a single optical fiber. Once that happens, it means that the customers also share the devices in the central office. In the future, when optical access develops to the point where it handles millions or even tens of millions of users, PONs will become effective as a means of coping with a shortage of space in central offices. A second important point is a communications protocol for efficiently transmitting signals for the Internet, images, and sound at a high quality level. A new protocol will be needed to transmit various types of signals by multiplexing them through a single optical fiber and sending them to multiple customers.

E: What is the current status of your group's work, and what specific tasks does your group face?

M: The initial basic report for our B-PON (Broad-

band PON) system (Fig. 1) that provides Internet access in the 100-Mbit/s class was submitted to ITU-T in 1997. As of the end of 2002, a total of eight Recommendations were prescribed and one series of standardization was completed. Now the remaining tasks are in progress, such as making the technology economical to use and introducing it as smoothly as feasible. Those tasks are mainly to be carried out by the NTT Group companies with the support of NTT Laboratories. Our group will then move toward conducting R&D for next-generation technology. A concrete example is research to raise the access speed ten fold, i.e., from the Mbit/s to Gbit/s class.

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

M: As an extension of current research, three years from now we can expect to see a Gbit/s-class PON developed. That technology will make it possible to provide a full range of services, including the transmission of higher quality digital images and voice. Five years from now, we can expect to see an access network that utilizes wavelength division multiplexing (WDM) and provides speeds in the 10-Gbit/s class.

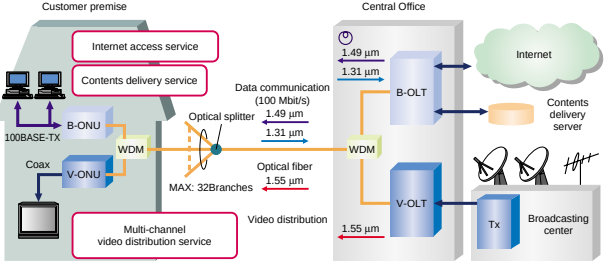
Remember, however, that our research is not aimed solely at achieving higher transmission speeds. We hope that by improving the performance of access networks it will become possible to transmit data that previously could not be transmitted, thus leading to the creation of new services. Eventually, networks capable of quickly transmitting large volumes of data will become part of the social infrastructure, much like water pipes and expressways. Our aim is to provide networks that all sorts of customers can use with the convenience and security.

Widespread International Activities with Ultimate Aim of Contributing to Common Standards

E: What are the main domestic and overseas trends in optical access systems research?

M: Optical access systems are expected to become the social infrastructure that supports the future age of broadband information technology. Among the different access technologies being studied, B-PON is expected to become the most standard and stable technology. In 1997, NTT was the first company in the world to offer B-PON services commercially. The service at that time was aimed at business customers utilizing dedicated lines. From September 2002, a B-PON for use with B-FLET'S was introduced for general users, and there are now already over 150,000 subscribers to that service.

In North America as well, SBC, Bell South, and



B-ONU (Broadband-optical network unit)
V-ONU (Video-optical network unit)
Tx (Video signal transmitter)
B-OLT (Broadband-optical line terminal)
V-OLT (Video-optical line terminal)

Fig. 1. Broadband passive optical network system (B-PON).

Verizon—three leading carriers—announced in June 2003 that they would jointly procure optical access systems using B-PON. Their overall plan is large scale, with expected purchases of over one million systems. PON systems can thus be said to have finally reached the stage of all-out introduction. North American carriers, however, are just beginning to use optical fibers. Preconditions for those carriers, therefore, from the viewpoint of cost/effectiveness are providing triple plays which include telephone, video distribution for CATV, and data communications over the PON system. That is quite different from Japan, where PON systems are developing solely for use with data communications.

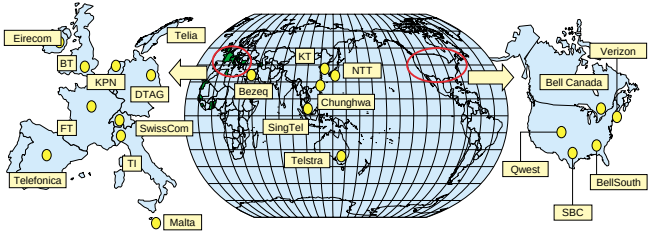
In Europe, moves toward commercializing PON systems began quite early. Before long, though, large amounts of capital were required to purchase the rights to use wavelengths for mobile communications. That derailed the business strategy of the European carriers. Although they were quite aggressive in their approach, they have therefore not yet been able to introduce systems on a large scale.

E: What international activities does your group conduct, including in the area of standardization?

M: I have participated in international standardization activities since 1989, initially with CCITT (International Telegraph and Telephone Consultative Committee; today's ITU-T), mainly related to defining common standards for ATM technology for B-ISDN and optical access systems. I am currently vice-chairman of ITU-T SG13 (SG: study group) and WG Chairman (WG: working group) of the Full Service Access Networks (FSAN; see Fig. 2) consortium. Because of those activities, my schedule has me traveling overseas more than 100 days a year.

E: What are ITU-T's main activities at present?

M: Four years is considered one research period at ITU-T, and next year marks the end of the current period. Discussions are thus underway for selecting research themes for the next four-year period. In SG13, NTT wants to work toward a common standard for networks that will be linked to its concept of resonant communication networks. Optical access related discussions, the bailiwick of SG15, are currently focused on resolving problems that occasionally arise with B-PON systems and initiating a new effort for standardizing PON networks operating at bit-rates above one Gbit/s.



As of September 2003, 21 telecom carriers and 29 vendors

AFC	Agere	Alcatel	Broadcom	BroadLight	CISCO	Entrisphere
Ericsson	FlexLight	Fujitsu	Hitachi	Iamba	Infineon	INOVIA/ECI
Intel	Lucent	Marconi	Mitsubishi/Paceon		Motorola	NEC
Nortel	OFN/Oki	Optical Solutions		Quantum Bridge		
ST Microelectronics		Samsung	Terawave	Vinci	Zonu	

Fig. 2. Companies participating in FSAN.

Our work at ITU-T, incidentally, is not to create standards after networks or systems have been completed but to prepare them ahead of time. There are researchers who believe that differentiation should be a company's top priority and that standardization has a low priority. But researchers working together to provide a clear direction to future research can lead to enhanced R&D activities. That is why I do not view my standardization work as simply a side job. It is also physically tiring work, but that is no reason to stop either.

E: What are some of the activities of FSAN?

M: FSAN was founded in 1995 on the initiative of NTT. At present, its members include 21 carriers from around the world, centered on NTT and six European carriers (BT, FT, etc.), and 29 vendors. As its name implies, the group's goal is to create common standards for access systems that will support a wide variety of services. The carriers create the basic policy for technological development and the vendors propose specific solutions. FSAN is also a venue for the participating companies to exchange opinions, thus promoting quick standardization. Once issues have been basically agreed upon in the FSAN group, they are proposed to ITU-T.

World Interest on Japan as Most Advanced Nation in Optical Access

E: What reaction have you seen from overseas regarding your group's research results and other activities?

M: Most of our overseas work is related to standardization activities. At ITU-T, all the Recommendations and proposals NTT offered concerning ATM and B-PON were eventually officially accepted and carried to completion. There were even several cases where I was the designated editor. Also, as I mentioned, because Japan is the most advanced country in terms of introducing optical access systems, there has been quite an increase over the past two years or so in invitations I have received to give lectures and write papers on trends in standardization and commercialization. Our accomplishments and the favorable response from others are due mainly to the support of many persons. I interpret that to mean that our activities to date, including meeting so many other researchers, have been evaluated positively.

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

M: From 1989 to 1990, I spent one year as an exchange research engineer at BT Research Laboratories in the UK. That experience provided me the opportunity to view NTT from the outside. Eventually, I came to realize there are few organizations like NTT anywhere in the world that conduct wide-ranging research on such a large scale. Today, in fact, NTT might be the only organization in the world with such laboratories. In a large research organization like NTT Laboratories, it is possible to conduct widely varied discussions on a single theme. And when technical proposals are made, it is possible to obtain various background supports, making the final proposals highly credible. Concerning standardization as well, even before I began participating actively, NTT personnel before me made great contributions at the international level. The Synchronous Digital Hierarchy (SDH) used today in trunk systems, for example, resulted from the tremendous efforts of current Director Yuji Inoue of NTT and current Vice President Katsuya Okimi of NTT Communications. So I think it can be said that NTT is viewed favorably overseas in terms of its technology, its human networking, and its ability to influence the adjustments made among differing opinions.

E: What direction would you like to see your research take in the future?

M: My greatest interest is in seeing many people around the world using optical access systems inexpensively. Based on a high-performance transmission mode, I would like to provide an environment in which NTT can compete for service at a higher level. I would also like to see more quality control technology and various applications linked to R&D and systems development for handling them efficiently. That's where the real competition will begin. For those purposes, I would like to contribute even further to networking with other researchers around the world and to constructing a future standardization strategy for NTT.

With Rich Human Resources, NTT Provides an Ideal Environment for Systems R&D

E: What was the original stimulus for starting your present research?

M: My main motivation was to take high-quality, stable optical transmission technology, which makes it possible to transmit large volumes of data over long distances, and apply it to access networks where there is a strong demand for economy. In pursuing economical use, it was necessary not only to conduct pure R&D of technology but also to obtain feedback from mass production. I would also like to contribute, through the standardization process, toward networking with other researchers and building a scheme that will provide for common components.

E: What have been your principal research themes up to now?

M: Actually, optical access research has taken up only the second half of my career. In graduate school, my studies were totally different from today. I conducted research into electronic engineering using microwaves in the medical field. Specifically, I studied non-contact methods of measuring body temperatures for use in the early detection of breast cancer.

After joining NTT, my initial research was Data-Over-Voice technology for transmitting 100 bit/s of data over telephone lines. After that, I moved to the LSI Design Labs for about two years to conduct research into making subscriber circuits for digital exchanges smaller and more economical. Up to then, resistors and capacitors had been used in those circuits. I proposed terminal circuits that processed digital signals. One result of my research was two patents that earned me special recognition in the company at the time. That experience showed me how pleasant it was to know that the results of my research could be used in real-life situations. After that experience my research shifted with a major move by NTT to build ultra-highspeed networks that could handle multimedia. My specific research was in the development of ATM transmission technology and efforts to have it included in international standards. That position led directly to my current research in access-related areas.

My original major field was thus related to microwaves. Optics, my present field of study, also involves waves, and many aspects of optics have points in common with microwaves. PON systems, in particular, are identical to microwaves in that many signals can propagate through the same spatial medium. Thinking like that, it was perhaps fortuitous for me that I began my research career by studying wireless systems. Perhaps it is exactly because I did not begin my career as a specialist in optical fibers that I was able to come up with some fresh ideas in the field of optics.

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

M: Rather than saying that I personally want to be involved in some particular research in the future, I would prefer to say that as a manager I want to create a research environment in which young researchers can gradually come to gain confidence in their research work. There is also still much difficult work for me to do in the areas of standardization and international collaboration. Regarding international collaboration, in particular, it is important to work further to solidify the presence of NTT Laboratories on the world stage. In that context, I am continuing to work toward creating a joint scheme with the research laboratories of SBC, Bell South, BT, and FT. Meanwhile, NTT Laboratories is now reviewing its organizational structure and its relationship with its business companies. Looking at the present situation, it is certainly important to consider the business chances we see before our eyes. From a long-term perspective, however, it is also pretty important to have an organization which carries out investigations with new ideas and new points of view from the perspective of future, new ideas. Based on the company's domestic and international activities, a clearer direction must be provided for the future. Nothing would please me more than to have such considerations lead to the creation of an environment that would make it easier for young researchers to conduct their research.

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

M: Research by an individual, even a genius, does not build systems. Systems require an organization like NTT Laboratories, where there are outstanding researchers in numerous fields working together. Such a group is extremely important for conducting research into systems. There is great freedom along with responsibility in conducting research in NTT Labs, and if a researcher wants very much to work on a particular theme, the organization is basically flexible enough to allow him to do so. We often hear from overseas researchers that the environment in NTT Labs is not one where researchers sign confidential agreements with the organization and then conduct research only on themes assigned to them. In that

sense, researchers in NTT Labs are blessed with great freedom. Although there are areas that need improvement, NTT Labs has many fine points compared with research organizations in the advanced Western countries and we should strive to keep them.

Interviewee profile

■ Career highlights

Yoichi Maeda received the B.E and M.E. degrees in electrical engineering from Shizuoka University, Hamamatsu, Shizuoka Prefecture, in 1976 and 1978, respectively. Since joining NTT in 1980, he has been engaged in research and development on access network transport systems for broadband communications, including SDH, ATM, and IP. From 1988 to 1989, he worked for BT (formerly British Telecom) Research Laboratories, UK, as an exchange research engineer. He is now a senior manager of Global Strategy and manages the Full Service Access Group of NTT Access Network Service Systems Laboratories.

Since 1989, he has been an active participant in ITU-T SG13 and SG15. He is currently serving as the vice-chairman of ITU-T SG13 and as WG chairman of the FSAN committee. He is a member of IEEE and the Institute of Electronics, Information and Communication Engineers (IEICE) of Japan. He has published several books on B-ISDN standards, including *Introduction to ATM Networks and B-ISDN* (John Wiley & Sons).

■ Major awards

2002 ITU-AJ (the ITU Association of Japan Inc.) Award

2003 TTC (The Telecommunications Technology Committee) Award