An R&D Revolution—Creating New Business Worth 500 Billion Yen per Year

Yuji Inoue, Senior Vice President, Executive Director of Department III, NTT

Abstract

As telecommunication undergoes a big wave of change from telephone networks to IP networks, NTT's R&D must also adapt, rapidly and responsively, so as to provide a sharp focus on business. At the same time, there are research areas that must be pursued steadfastly, unaffected by short-term changes. This article is based on the presentation "NTT R&D Revolution", given by Yuji Inoue, Senior Vice President, Executive Director of Department III, NTT, at the NTT R&D Forum in February 2004.

1. R&D revolution

There are two types of things: things that must change and things that must not. NTT R&D has embarked on a comprehensive reform, reviewing the position of each issue on a scale bounded by these two extremes. Some of those things that must change are grouped under an umbrella of what we call "NB5000!" This term stands for "New Business 500 billion yen[*1]", implying that our R&D results must contribute to yielding an annual revenue of 500 billion yen from new businesses. It is an expression of our determination to reform ourselves and to be always conscious of business objectives in all processes of R&D. This article focuses mainly on our approach to "revolution", namely those items that must change.

2. History of NTT's R&D

NTT has a long history of R&D (**Fig. 1**). Up to 1985, when NTT was privatized, it had concentrated on the internal development of telecommunications technology. From that time on through 1999, when NTT underwent a major reorganization, NTT strove to introduce the technology it had developed to the global market. During these two periods, most of the fruits of R&D were applied to network devices and services provided by NTT or phones, faxes, and other devices used by customers. Since, for a long time, most of NTT's revenue had been derived from telephone-related businesses, R&D resources were mostly expended on the development of new technology that would reduce network costs, facilitate the expansion of networks, or enhance network reliability, and there was a steady and successful flow of these results to NTT's businesses. In short, NTT's R&D was very useful in supporting NTT's business.

However, from 1995, when the world entered the age of the Internet, the technology and products used in telecommunications networks experienced a dramatic change. For example, the routers that play an important role in the Internet were not developed by NTT Laboratories. In fact, they are products mainly from US vendors, such as Cisco Systems and Juniper Networks. NTT now uses tens of thousands of them in its IP networks. As this example clearly shows, telecommunications technology has shifted to become IP-based, and only global products are employed in networks.

As this new era dawned, NTT R&D spent a couple

*1 In Japanese, 500 billion yen is written as 5000 oku yen, where oku is a widely used unit of quantity equal to 100 million.

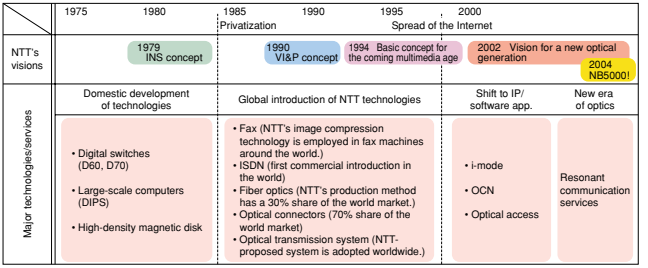


Fig. 1. History of the NTT Group's R&D activities over the last 30 years.

of years exploring where it should go. Recently, we have finally begun to focus on two subjects. The first is services based on optical networks. As we aim to create a resonant communication environment, a concept announced in November 2002, we will study the best way to increase the use of FTTH by customers and provide services that capitalize on its advantages over ADSL in bi-directional communication. The second is not to limit the application of our R&D results to telecommunications alone but to contribute to Japan's industry at large, by exploring a wide range of applications. NB5000! was launched with the intention of focusing on these two perspectives: services based on optical networks and new businesses.

3. NB5000!

We have selected three principles for NB5000!:

I. Overcome the "Valley of Death" and create new businesses
II. Provide solid technology to contribute to the launching of new businesses
III. Provide disruptive technology, born in Japan, to lead the world

Specifically, we will press ahead within a framework involving the following initiatives.

1. Launch a "Comprehensive Producer Function" to facilitate the exploitation of R&D results
2. Share responsibilities between creators and sellers of technology applications
3. Divide resources evenly into those for commercial development and those for core technology development
4. Start initiatives to accelerate the conversion of R&D results into business

First, the Comprehensive Producer Function, which was announced in November 2002, was launched in July 2003 as a way of improving the exploitation of R&D results. Second, while the conventional approach to turning R&D results into business was to make the creator of a technology also sell what he or she has created, we have now clearly separated these responsibilities into those of the creator and those of the seller. Third, we have decided to allocate our resources evenly between the core technology and the commercial development of technology. We built the 2003 R&D plan based on this principle and were able to proceed largely as planned. We will continue in a similar way for the 2004 R&D plan. Finally, in pursuing business opportunities, we will look both inside and outside the NTT Group to seek a variety of partnerships.

4. Comprehensive Producers

We launched this system in July 2003 as a means of turning R&D results into business successfully (**Fig. 2**). Until then, each of the 12 Laboratories in NTT independently carried out the series of processes from R&D to business deployment, ranging from research, through core technology development and

commercial development, to collaboration with NTT Group companies. This may have worked at the time when it was possible to introduce developed technology into the market without significant efforts at adaptation. However, these days when we try to start a business based on technology that we have developed, we usually find that something essential for full implementation of the business is missing. A mechanism we have adopted to solve this problem is to allow Laboratories to concentrate on R&D while introducing a "producer" at the stage of commercial development to facilitate the transfer to full business deployment. Based on this principle, we have made organizational changes and also modified the flow of funds. When the stage of commercial development is reached, a development project team is organized. Team members are gathered from different Laboratories, as appropriate. The project leader, called the Director, is responsible for the products. The Director must put together products that satisfy the requirements, such as quality, cost, and deadline, put forward by the producer.

The producer system is a mechanism for exploring various possible applications and outputs from the source of core technology developed by the Laboratories. The producer compares the Laboratory-developed core technology with that on the market and that of competitors, analyzes market trends, takes into consideration the needs of the operating companies, looks for alternatives, and conducts marketing. After assessing the core technology concerned from these various perspectives, the producer proposes the appropriate direction, for example developing a business that will be integrated into those of the NTT operating companies, creating a new business, or selling the technology outside NTT by forming alliances with other companies. Of course, such a study may not be completed by the producer alone. He or she may choose to have in-depth discussions with vendors, trading companies, or university staff.

The Comprehensive Producer Function is gradual-

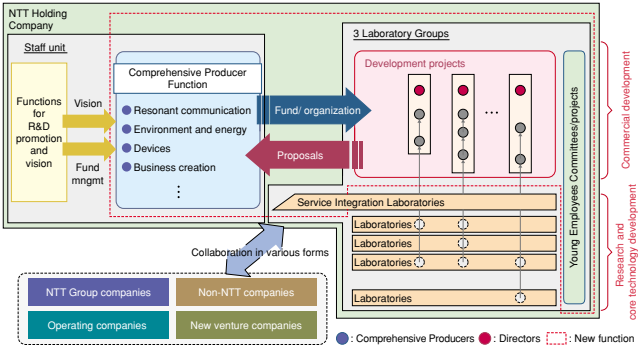


Fig. 2. Organization for commercialization since July 2003.

ly gaining public recognition and has begun to be reported in newspapers. We hope to use this mechanism to produce many successful outcomes and ultimately achieve NB5000!

5. Themes under the Comprehensive Producer Function

Examples of ongoing themes placed under the Comprehensive Producer Function are shown in **Fig. 3**. These themes are described below in some detail.

(1) Resonant communication

We have made various advances towards resonant communication over the past year. For example, we have succeeded in achieving realtime bi-directional video communication between a FOMA (NTT DoCoMo's 3rd-generation mobile phone service) and a PC. To transform such individual activities into a large business, NTT-Resonant Inc. was founded in December 2003 and several producers were transferred there in order to bring resonant communication services to reality. In addition, some 150 people, mostly service developers in the Laboratories, are being transferred to the new company in April 2004. Its total staff of 600 is expected to nurture the various business seeds produced in the Laboratories and see them grow into a variety of real businesses.

(2) Devices

Recently, we have poured resources into optical devices. As a result, many world-class results have been achieved in the areas of semiconductor laser sources and light waveguides for telecommunications. We have drawn on this power to explore new areas not yet covered by Blu-ray or other semiconductor lasers and have succeeded in producing laser light colored orange (589 nm), yellowish-green (560 nm), and green (546 nm) (**Fig. 4**) as well as miniaturizing these devices. Business applications for laser microscopes and nitrogen oxide measuring instruments are being studied. Using similar technology, we have also developed lasers at wavelengths much longer than the visible spectrum. Business develop-

- Resonant communication
  - Realtime bi-directional video communication between FOMA and PCs
  - Establishment of NTT-Resonant Inc.
- Devices
  - Compact lasers that generate specified arbitrary wavelength light
- Environment and energy
  - Solar-powered mobile power source for portable devices: Pocket Energy
- Business creation
  - Digital watermark: Cyber Squash
  - Vocal singing synthesis: Wonder HORN
  - New hologram memory: Info-MICA
  - High-quality MPEG-2 codec LSI: VASA and ISIL

Fig. 3. Examples of themes promoted under the Comprehensive Producer Function.

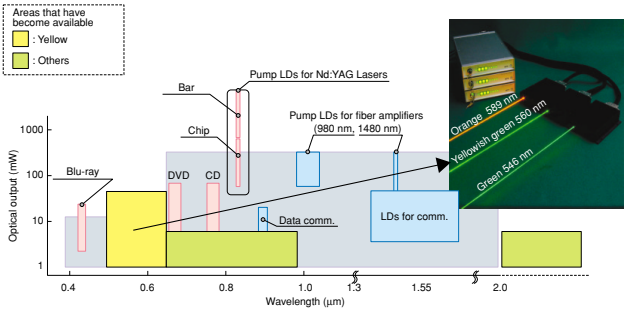


Fig. 4. Compact lasers generate light of any desired wavelength (Press-released on February 10, 2004).

ment in this area is also considered.

(3) Environment and energy

The Pocket Energy device shown in **Fig. 5** combines a single solar cell with a battery and ultralow-voltage-input booster technology. Normally, a single solar cell produces a low voltage of only 0.5 V. Therefore, if the requirement is 10 V, 20 cells must be connected in series. A problem with this arrangement is that, if a single cell is damaged, the required voltage cannot be produced.

NTT has a patent on ultralow-voltage-input booster technology, which makes it possible to boost a voltage of 0.1 V efficiently up to 5–10 V. The Pocket Energy device uses this patented technology. The technology is applied to a wide-surface solar cell to boost the cell voltage to the required level. Since only a single cell is used, damage to part of the cell may lower the efficiency in proportion to the surface area damaged, but the Pocket Energy device will still continue to produce the required voltage.

At first, we intuitively assumed that Pocket Energy would find a wide range of users, and we decided to target consumers for its first business application. We asked large home appliance stores in Akihabara to sell the product. However, our request was turned down because Pocket Energy was deemed too expensive for consumers. With the current technology, the selling price cannot be reduced below 20,000 yen, which meant that consumers were not the right target. So, our first attempt at finding a business application for the first trial product in fiscal 2002 did not succeed.

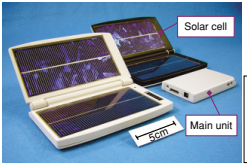
After repeating similar failures and each time reviewing the obstacles, the producer decided to target different users. The trial product in fiscal 2003 was designed for applications in power supplies used during a disaster, mobile information terminals for business use, and digital cameras. In particular, digital cameras are very widely used for recording the progress in work at construction sites. Since they have a high power consumption, there should be a strong demand for Pocket Energy for this application. Thus, targeting users who will buy the product even at a price above 20,000 yen, we developed a second trial product and looked for sales channels. As a result, NTT Advanced Technology Corporation will to make sales. We will continue our research to reduce the price so that eventually we will be able to target the general consumer market.

This story shows that there may not be a quick and simple solution to turning R&D results into business. It also shows that it was thanks to the Comprehensive Producer Function that we finally succeeded.

(4) Business creation

Business creation is our endeavor to study how various R&D results from the Laboratories can be applied to some form of business and how to select the appropriate directions for commercial developments or business applications. Four specific examples are provided below to give an idea of the scope of this endeavor.

The first example concerns digital watermarks. While digital watermarking was initially considered to be mainly applicable for copyright management, it has found a new application in the advertising industry. Digital watermarks are printed in journals, newspaper, posters hung in trains, or other printed material. The watermark is not visible and thus not intrusive to viewers. However, when a part of the printed material is photographed using a digital camera in a cellular phone and sent to a server using a dedicated application, secondary information relevant to the particular situation is sent back to the cellular phone. This information may include a URL so that the user can access it with a single click to get more detailed information. Thus, the user can receive detailed informa-



Maximum output power: 10 W
Charging capacity: 4.8 Wh
Dimensions/weight:
Solar cell: 150 × 91 × 22 mm, 200 g
Main unit: 98 × 61 × 14 mm, 83 g

Fig. 5. Solar-powered mobile power source for portable devices: Pocket Energy (Press-released on February 13, 2004).

tion about something that interests him or her by simply taking a picture of an item of printed material and sending it to a server via built-in wireless Internet access without any need to type in complicated Web addresses.

Watermarking is an extremely advanced technology that can, without affecting image quality, be used to embed certain numbers uniformly on a surface so that the number can be identified from even an arbitrary section of the printed matter. After several studies looking for business applications of this sophisticated technology, a user-friendly application was finally found: all the user needs to do to access the information related to something on a piece of printed material is take a picture.

The second example is "Wonder HORN". This is an improvement over the HORN, which is technology for synthesizing a variety of singing voices from a database storing the singing voices of individual persons. When any lyric and melody are entered, the computer produces a realistic voice, as if the specified individual were actually singing. This was press-released in 2000. Wonder HORN allows even the style of singing, such as the use of grace notes or vibrato, to be adjusted. For example, the singing can be made to take on the style of pop music or that of a traditional Japanese ballad, allowing the singing to become even more realistic. Wonder HORN can be used to simulate a duet with a famous personality in karaoke, to make a robot sing and dance, or to produce educational tools for music lessons.

The third example is "Info-MICA," a new hologram memory.

There is a wide variety of recording media on the market (**Fig. 6**). Discs that cost less than 100 yen each include CD, DVD, MD, and UMD (Universal Media Disc), and these range from 6 to 12 cm in diameter. There are more handy media, such as flash memory and mask ROM, but they cost 10,000 to 20,000 yen per gigabyte at present.

Info-MICA was developed in the belief that low-cost and extremely small media would enjoy a high demand. It is about the size of a postage stamp and is made of plastic. The target price is around 100 yen per GB, dropping eventually to the same price per 10 GB. Consisting of about 100 plastic layers pasted together, Info-MICA is only 2 mm thick. A hologram pattern is printed on each layer. To read data, a laser beam is directed from the side, and the hologram pattern in each layer is read out and decoded into the original data. The recorded content is extremely difficult to copy, which is ideal for preventing counterfeiting. Since the operating width of the laser needed for recording and playing is around 2 mm, the same as the thickness of the Info-MICA itself, the drive for Info-MICA can be extremely small and energy-efficient.

Potential applications include the recording of games software for sale and product demonstration videos included in magazines. Since data readout is

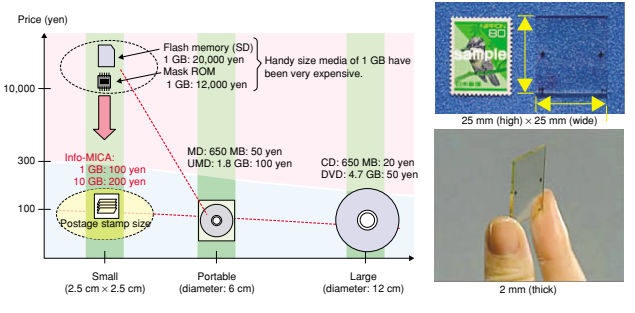


Fig. 6. New hologram memory: Info-MICA (Press-released on February 12, 2004).

not affected by smears on the surface, the Info-MICA is particularly suitable for handouts or other forms of casual distribution. It is also environmentally friendly: no metal is used so segregated disposal is easy, and it can be easily dissolved for recycling. Currently, great efforts are being made for commercial development, including an attempt to make a rewritable version of the Info-MICA, which is currently read-only. To accelerate these efforts, NTT has an industry-university joint program with Kyoto University and other universities, along with participation by several companies including materials vendors.

The last example I would like to share with you is VASA and ISIL. NTT R&D has a long history of studying video coding technology and is proud to have made many contributions to the global standardization of video coding, based on these studies. Unfortunately, video coding technology has hardly led directly to the creation of any new business.

VASA and ISIL, which are described below, promise to be the light at the end of the tunnel. VASA is a one-chip HDTV encoder and decoder. It is designed for professional applications and is used by NHK and other TV companies to transmit digital programs between broadcasting stations.

In contrast, ISIL is a consumer LSI, the size of a coin. Yet it provides the high video quality of VASA. ISIL is incorporated into a consumer high-definition digital video camera (GR-HD1) supplied by Victor Company of Japan. We are exploring various applications of this camera. One potential application being studied is its use as a security camera. Usually, when an image taken by a ordinary security camera is enlarged, a person's face in it is substantially blurred. However, an image taken by an HDTV camera using ISIL will be less blurred, so it should be possible for an individual to be identified from his or her face in the recorded video. Since interest in crime prevention has been rising lately, we expect a considerable demand for this application.

As illustrated by these four examples, the producers look for various applications of the fruits of R&D, have commercial products developed, and strive to find business opportunities.

6. Approach to open source software

Another area where our approach departs from the conventional flow of R&D is in the use of open source software. Recently, various items of open source software, such as Linux and PostgreSQL, have begun to be widely used. NTT R&D is considering encouraging this trend in NTT's businesses. There may be some misgivings about introducing current open source software, as it is, into the large network systems being operated by the NTT Group. In order to remove this anxiety, we decided to participate in the development of highly reliable (carrier-grade) open source material. Specifically, we became a member of the Open Source Development Labs (OSDL) in February 2004. OSDL is a non-profit organization, founded in December 2000, to promote the use of Linux for enterprise computing. It has facilities in Portland, Oregon, U.S.A. and Yokohama, Japan.

NTT R&D plans to make full use of open source software as the basic OS for the systems it will develop. Open source material will be employed in situations ranging from NTT's core systems to applications. Our objective is to work with all others concerned to develop carrier-grade open source software that will work without failure 24 hours a day, 7 days a week.

7. Activities of the Young Employees Committee

Another new approach we have adopted is the establishment of the Young Employees Committee in June 2003. This is a mechanism for allowing younger employees to manage projects without being shackled by research themes dictated from above. The intention is to give the ideas of younger people full play and thus help expand their abilities.

The ideas of young people are often not accepted by older supervisors despite the fact that plenty of today's technology is related to the Web, PCs, and cellular phones, for which only younger people can produce bright ideas. The Committee's mission is to take a discerning view of these ideas and support their development. This role may be regarded as a modified, younger-generation version of the Comprehensive Producer Function.

The Committee consists of seven members, who are given authority and entrusted with the establishment and management of projects. When an idea is proposed by a young employee and approved by the Committee, a budget is allocated and a project is launched. Since the project is independent of the organization to which the proposer belonged, he or she can concentrate on the project without being constrained by his or her position or research theme in the past organization.

This is an open, proposal-based mechanism to discover R&D themes in which younger people act as

producers for the ideas of younger people. Already six projects have been launched. At the inception of a project, a commitment is made as to the required budget and the target date for accomplishment. The Committee monitors the progress of each project and provides assistance in the management of the project. No external pressure is applied to the Committee. Everything is left to the discretion of the Committee members.

8. Leading-edge research, looking forward ten years from now

As I said at the beginning of this article, there is a need for two opposing perspectives in the management of R&D: things that must change and things that must not. One of the latter is the pursuit of leading-edge research. NTT R&D continues to set aside certain resources for this area.

Leading-edge research aims to overcome various barriers (**Fig. 7**). In particular, crossing the barrier of human senses is difficult. Our approach is therefore to go inside the barrier, rather than crossing it, so we mainly focus on analyzing how a human being's visual and auditory senses process information. We believe that, by replacing these information processing functions with computer tools, we will be able to support human activities in various situations.

We are also working intensively on bio-nanotechnology. We expect that it will take ten years or so before useful results are produced, but you may find a computer running on bio-nanotechnology principles sitting on your desk 10 or 15 years from now.

9. Roles of R&D

As described above, the principal roles of the R&D carried out by the NTT Holding Company are to create new businesses and maximize the synergy among the NTT Group companies. As we continue trying new approaches, we are determined to produce valuable and high-quality results through an appropriate balance of what should change and what should not. It is our sincere desire to increase the opportunities for collaboration with parties both inside and outside the NTT Group in order to bring together the strengths of all parties concerned.

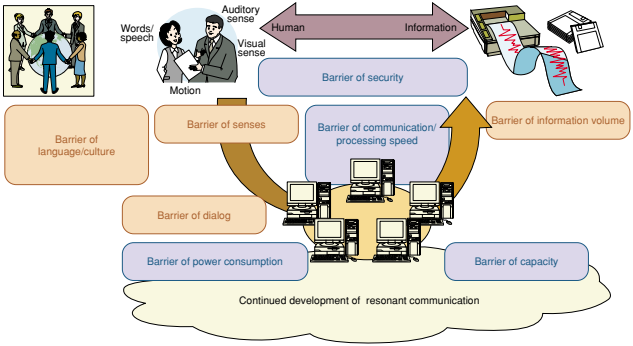


Fig. 7. Leading-edge research looking ahead ten years from now.