R&D to Create the Resonant Communication Environment

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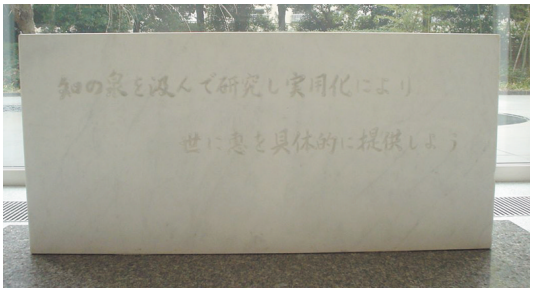
Abstract

This article summarizes the speech given by Yuji Inoue, Senior Vice President and the Executive Director of Department III, at the NTT R&D Forum 2005 held in February 2005. He talked about NTT's R&D activities for achieving NTT Group's medium-term management strategy and creating a resonant communication environment.

1. Origin of NTT's R&D

Within the main building of the NTT Musashino R&D Center, stands a memorial on which is inscribed "Do research by drawing from the fountain of knowledge and provide specific benefits to society through commercial development." (**Photo**). This memorial was unveiled in the Center on December 1, 1950 when the scattered facilities of the Electrical Communication Laboratories were brought together at this Center in Musashino, Tokyo. Fifty-five years on, those words of Dr. Yoshida, the first Director of the Electrical Communication Laboratories, have not faded. My interpretation of his words is that NTT's R&D should always aim to bring benefits. Specifically, its mission is to create new businesses, contribute to the advance of science and technology, and train and produce world-class talent.



Photograph. The fountain of knowledge.

2. Medium-term management strategy and R&D

The medium-term management strategy of the NTT Group, which was announced in November 2004, identifies the direction for specific actions up to 2010. The R&D unit is expected to be the primary force powering strategy. There are four main considerations related to the R&D development addressed by the strategy, as shown in **Fig. 1**. The first two were already mentioned in the previous article by Norio Wada, NTT President [1]. The third is how much our R&D results, knowledge, and know-how can contribute to creating new revenue of 500 billion yen, including non-traffic services, and reducing capital expenditure by 30% in order to make up for the shrinking revenue from existing services, such as fixed-line telephony. The fourth is to promote universality and standards in order to be able to promote alliances with others because there are limits to what the NTT Group can do alone.

3. Basic R&D principles

To fulfill the objectives of the R&D mission mentioned above, it is important to balance the resources of the three types of source that NTT's R&D will form, as shown in **Fig. 2**. As the source for business creation, R&D must identify specific business needs and undertake commercial development. This means that it is necessary to create products that are or will

be needed by the operating companies. Core technology development, which is central to R&D's role as the source of technical capabilities, is required to cover a wide range of fields and generate seeds for commercial development. As the source of knowledge, NTT's research must address topics that can be identified by looking ten years ahead and produce revolutionary, groundbreaking results. The R&D resources will be distributed approximately equally between activities that become the source of business creation on the one hand and technical capability and knowledge on the other, in order to ensure the growth of sufficient seed ideas for future development.

4. New organizational mechanisms for R&D

The current organization of NTT Laboratories is hierarchical with three Laboratory Groups at the top. Such an organization is suitable for deepening R&D in individual fields. However, it is not agile enough these days when it is necessary to arrange collaboration quickly between different fields in order to respond to a rapidly changing environment. I believe that today it is necessary to adopt a multi-angle approach to R&D. The three specific mechanisms being pursued to achieve this purpose, shown in **Fig. 3**, are as follows.

4.1 Comprehensive producer mechanism

Started about one and half years ago, the comprehensive producer mechanism is an R&D management approach that is supplemented by the infusion of the viewpoints from the business

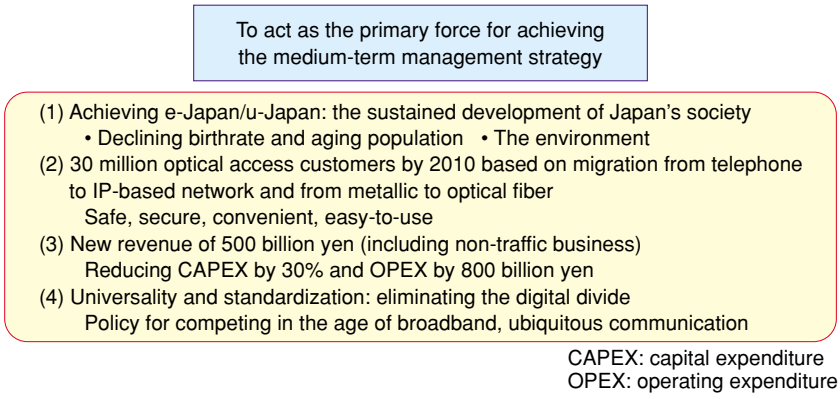


Fig. 1. Mission of the R&D development.

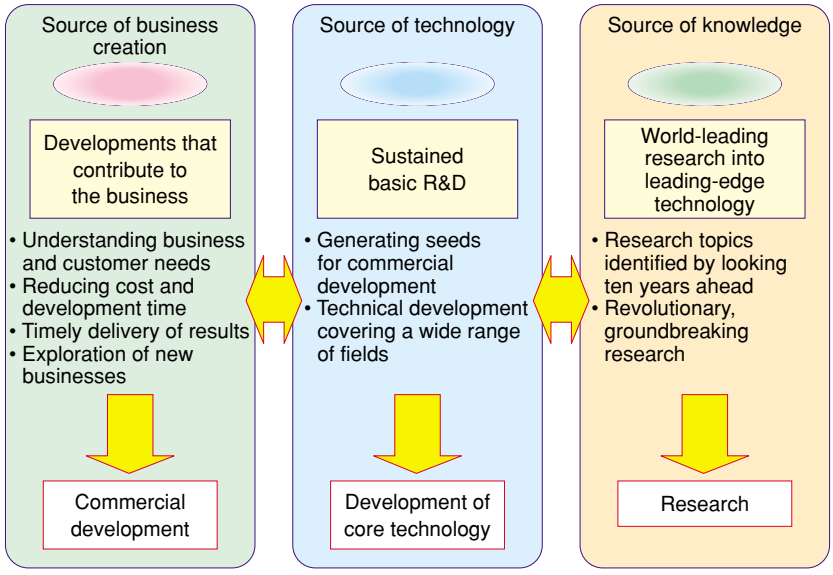


Fig. 2. R&D basic principles.

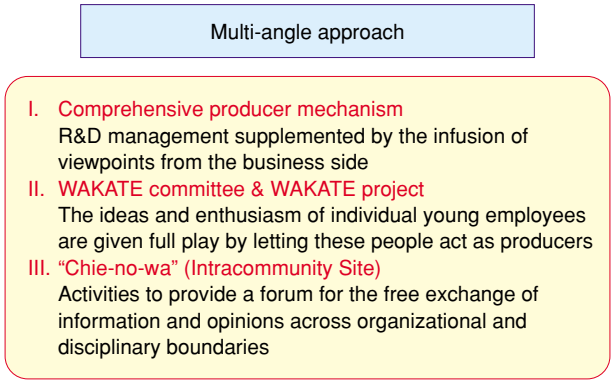


Fig. 3. New R&D mechanisms.

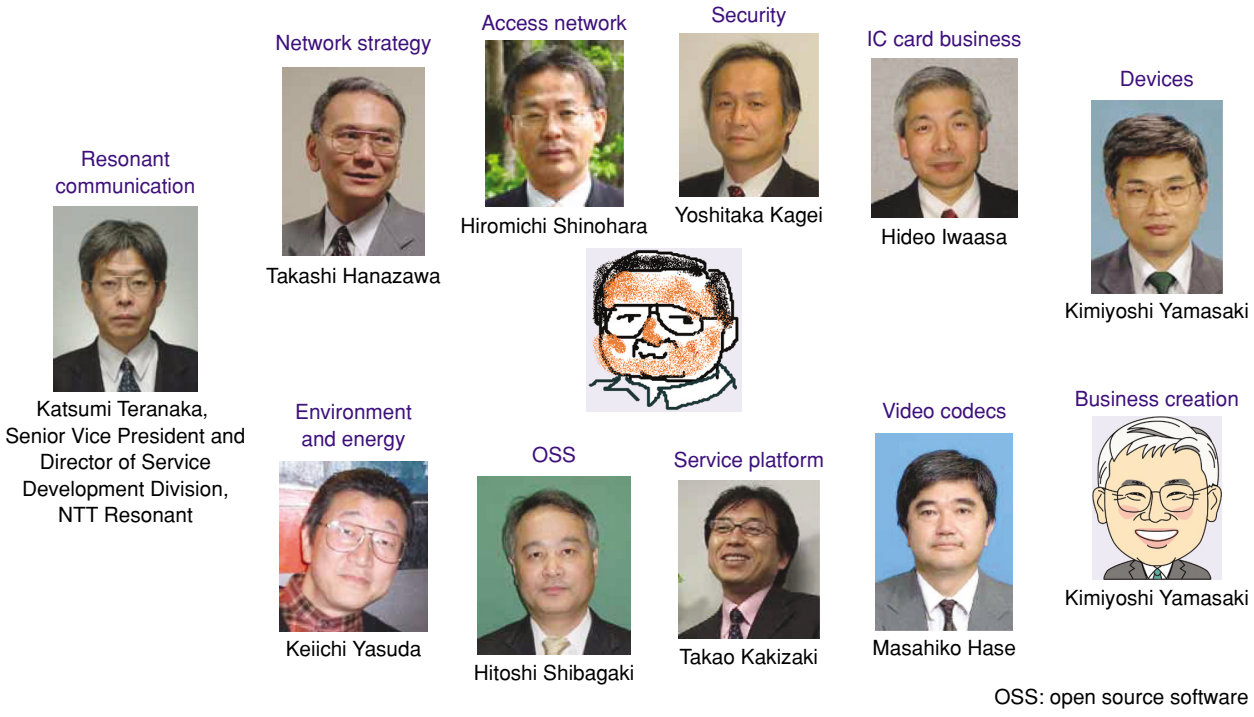


Fig. 4. Chief Producers and their areas of responsibility.

side. The mechanism was initially applied to seven topics, but this number has since grown to eleven (**Fig. 4**). The Chief Producer for each topic bears the responsibility for formulating plans, managing progress, and producing results. This is meant to ensure that the development team responds to business needs quickly.

(1) Optical network

Let me describe our network strategy and technical development of the optical infrastructure, including access networks and devices. Naturally, the construction of the optical infrastructure cannot be completed in a matter of one or two years. The flow of technical developments to date related to the optical infrastructure is shown in **Fig. 5**. Although it includes only a few representative R&D results, the figure is intended to indicate that the launch of the B-FLET'S service in 2000 and the subsequent introduction of B-PON (broadband passive optical network) and more recently GE-PON (gigabit ethernet PON) services have resulted from 30 years of steady R&D on optical infrastructure, starting with the method of producing optical fiber, and continuing with the creation of optical devices and the introduction of optical technology first to the core network and then to access networks. The technical development of infrastructure indeed requires considerable time and patience.

NTT has announced a series of visions, from the VI&P (visual, intelligent and personal) concept to the vision of the new optical generation, and then to last year's medium-term management strategy. In 1996, as part of the series of such visions, NTT disclosed the mega-media initiative which aimed to provide a 10-Mbit/s optical access service at a monthly charge of 10,000 yen by 2005. The fact that the charge for a 6.3-Mbit/s leased line service was 960,000 yen per month at the time the vision was formulated goes to indicate how aggressive a research goal it was to provide a slightly higher rate at one-hundredth this leased-line charge. However, this goal was not set without a supporting technical basis. After only four years, in 2000, NTT East and NTT West started to provide such a service. The progress has continued and this year a gigabit-class service will become available for a few thousand yen. This example shows how important it is to drive R&D with a well-established goal.

Figure 6 illustrates recent R&D results that support the optical network. The optical cross connect (OXC) to be used in the core network, the reconfigurable optical add-drop multiplexer (R-OADM) whose introduction to metro-networks is being studied, and the optical splitter being used in access networks all employ filters and switches based on NTT-developed planar lightwave circuit (PLC) technology, which

writes optical waveguide circuits onto glass substrates. In addition, the optical transceiver to be used in optical interfaces is built using laser diodes, for which NTT has been leading the world.

(2) High-definition video service

Next, I'll introduce the main technologies related to video coding and related business creation. **Figure 7** illustrates potential applications of a high-definition video service with video quality four times higher than conventional high-definition TV (HDTV). Since Digital Cinema is mentioned in the previous article [1], I will describe a high-reality live service and the development of the video codec (coder/decoder) that supports it.

If a soccer game is broadcast live, as shown in **Fig. 7**, approximately one hundred people in front of a large high-definition display can enjoy the pictures and sound that provides them with a high sense of reality, allowing them to feel as if they were at the soccer stadium. Although such an application has been imagined for a long time, it requires a huge amount of equipment. In contrast, our newly developed super-high-resolution (SHR) system only requires compact hardware, similar in size to a desktop PC. Therefore, the system is easy to transport and can provide live broadcasting at a variety of sites, wherever access to an optical network is available.

In 2002, NTT developed VASA (versatile and advanced signal processing architecture), a single-chip, HDTV-compatible LSI video codec. This is employed by various HDTV codec system devices used for a service for nationwide transmission of raw video material, a program editing service, and a high compression and transmission service, which together support terrestrial digital broadcasting and are provided on a core network as part of NTT Communications' digital transmission service (**Fig. 8**). VASA is

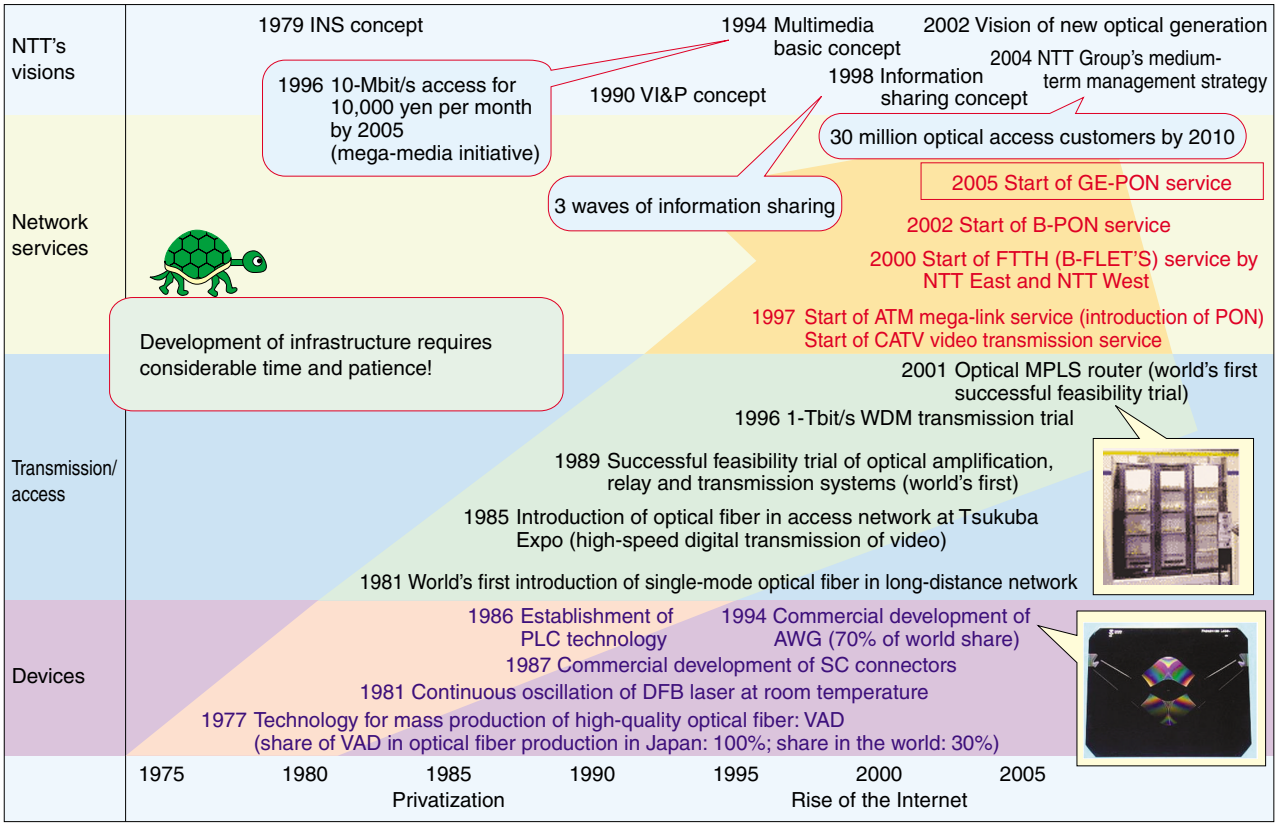


Fig. 5. Flow of technical developments related to optical infrastructure.

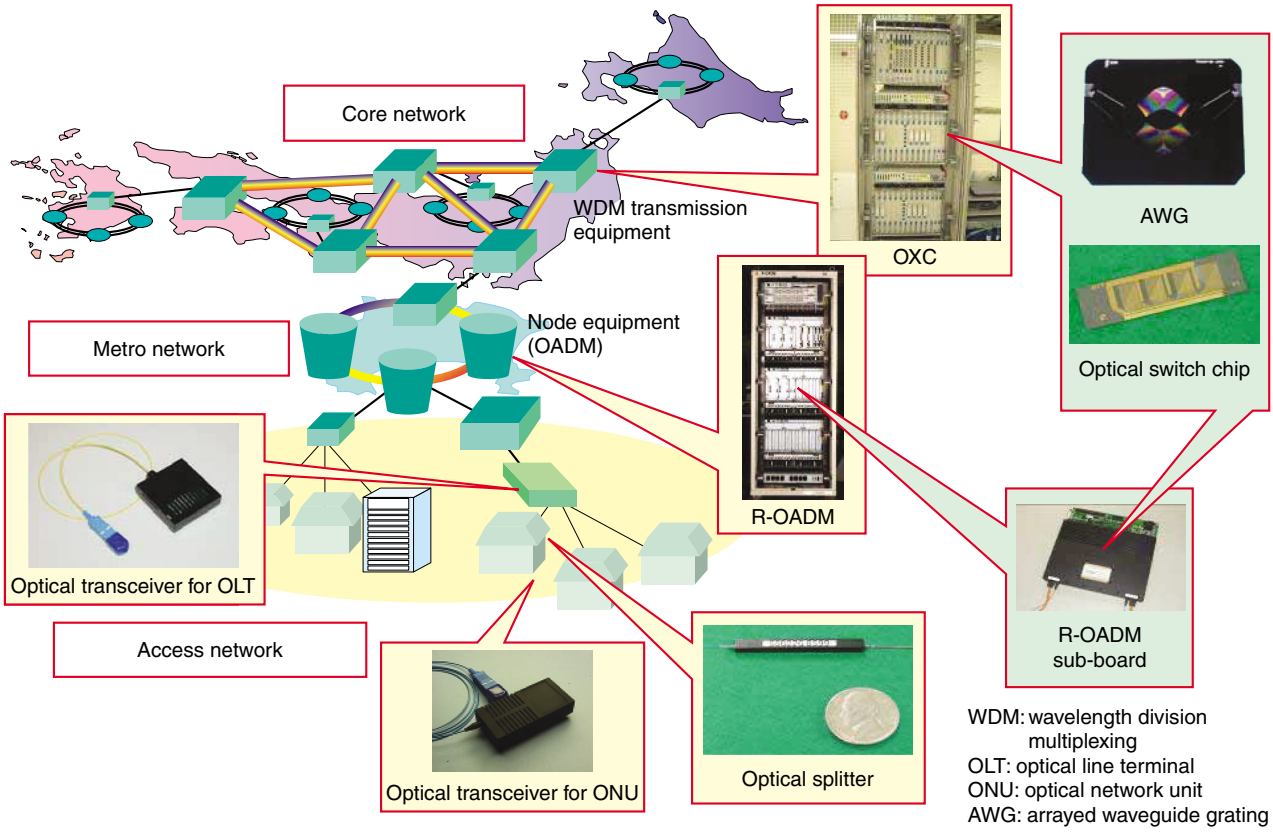


Fig. 6. R&D that supports optical networks.

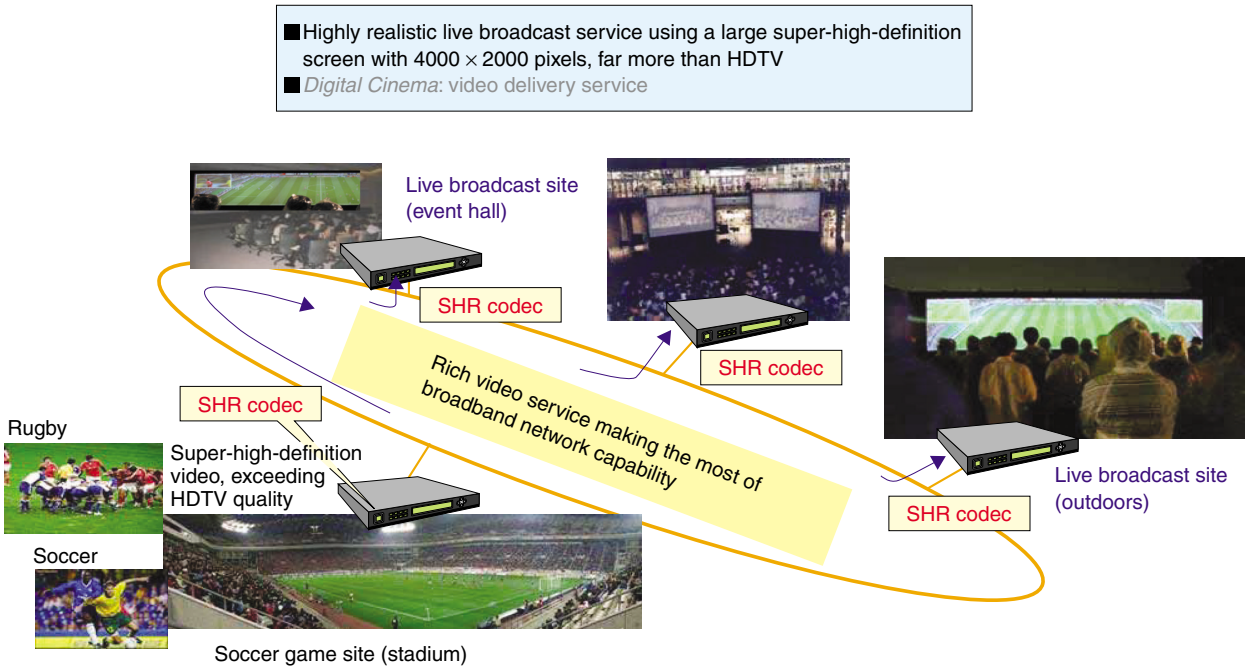


Fig. 7. Deployment of high-definition video service.

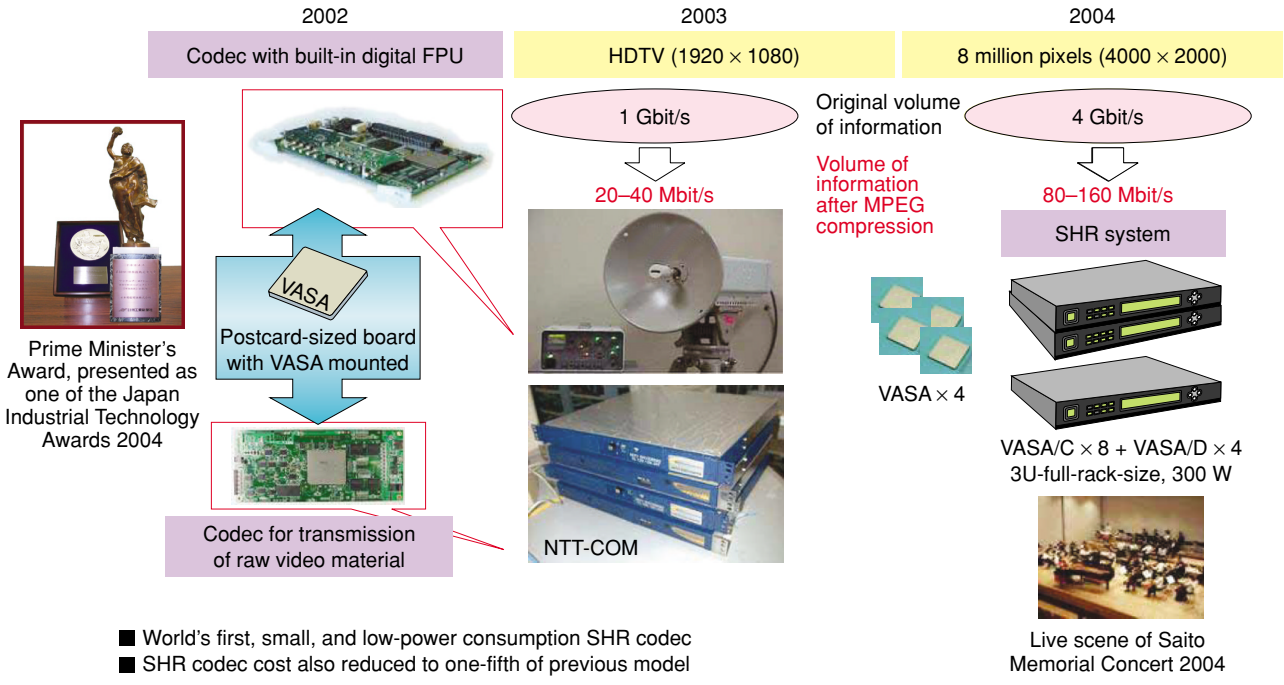


Fig. 8. Track record of the use of the video codec VASA.

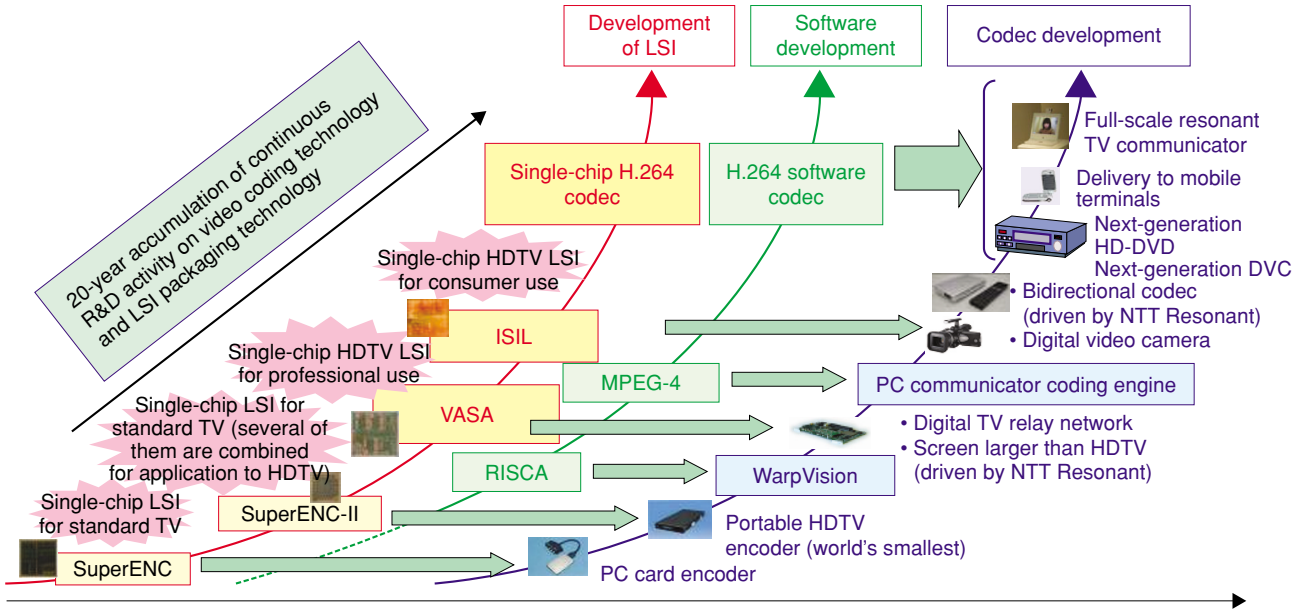


Fig. 9. Development of video coding technology and flow of products.

also mounted on the digital field pickup unit (FPU), a small board used for wireless transmission of HDTV video from a field site. Last year, NTT received the Prime Minister's Award, one of the Japan Industrial Technology Awards, for the development of VASA. Using four VASA chips, the SHR system can provide a 4000 × 2000-pixel screen, which is four times the resolution of HDTV. The SHR codec is one-sixth the size of the previous model and its power consumption is a quarter that of the previous model. Last year, a trial was carried out to enable the audience at a hall in Tokyo to enjoy a live video of the Saito Memorial Concert with the well-known conductor, Seiji Ozawa, held annually in Matsumoto City.

As with the optical infrastructure, the video codec is the culmination of continuous R&D activity span-

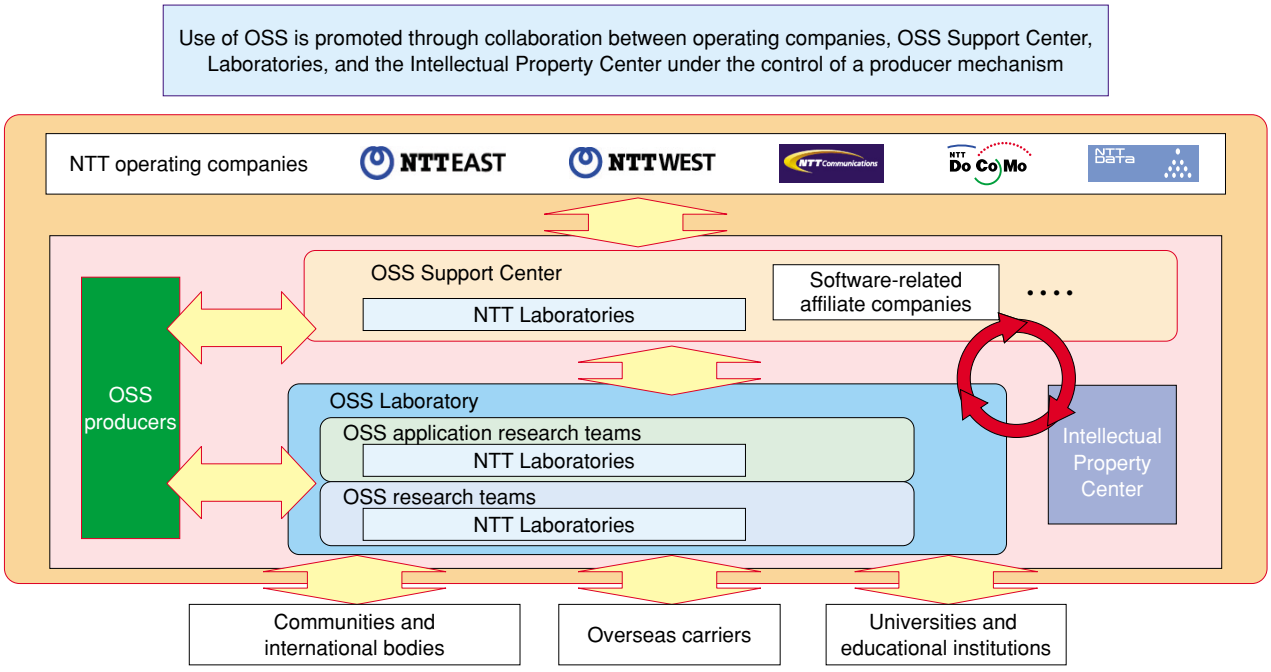


Fig. 10. Establishment of NTT-Group-wide OSS-promoting organizations.

ning more than 20 years, as shown in **Fig. 9**, or nearly 30 years if we include the very early days. Supported by the emergence of the high-speed network, the codec has now found specific applications. At present, a single-chip implementation of H.264, a coding technology with a higher compression rate than MPEG-2, and a software codec are being studied in order to prepare for the full-scale deployment of bidirectional video communication services.

(3) Open source software (OSS)

The third producer theme that I will mention is open source software (OSS). The use of OSS in larger systems is a policy adopted and pursued energetically by the entire NTT Group. Under the OSS producer mechanism, NTT Laboratories and software-related affiliate companies have formed the OSS Support Center, which is backed by the OSS Laboratory, which is fully supported by NTT Laboratories. This activity also involves NTT Intellectual Property Center and alliances with external organizations (**Fig. 10**).

4.2 WAKATE committee and WAKATE project

Since I reported on the WAKATE project in this Forum last year, one year has passed and considerable progress has been made. At present, there are seven projects in progress. I describe three of them below (**Fig. 11**).

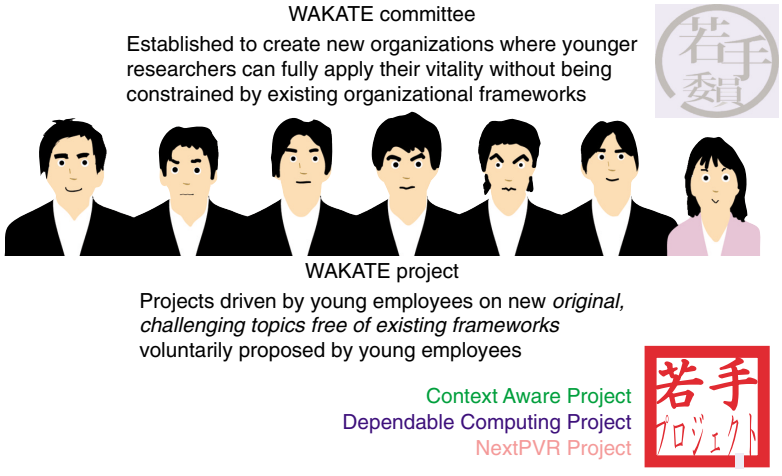


Fig. 11. WAKATE committee & WAKATE project.

The first is a service called “surprise message” which has emerged from the Context Aware Project. I initially found this service to be the hardest to understand. However, following a successful joint trial with an operating company, it is the closest service to commercial deployment. It takes advantage of mobile phone location information. For example, if you find a good pasta restaurant, you can leave a photo and a message for your friends so that when

Fig. 12. Surprise message.

they happen to pass by that restaurant on another day, the photo and the message suddenly appear on the standby window of their mobile phones (**Fig. 12**).

Next is the Dependable Computing Project, which has yielded an inexpensive fault-tolerant system, PREGMA, using OSS. The system can be introduced without requiring the replacement of existing facilities.

The third is the NextPVR project, which has produced technology for transmitting DVD-grade video stably even on a best-effort-based network, such as that used to provide the B-FLET'S service (PVR: personal video recorder). The technology makes possible low-cost network transmission and time-shift playing of video with quality equivalent to that of a video-on-demand service using leased lines.

These projects are completely independent of existing laboratory organizations and entirely managed by the WAKATE committee.

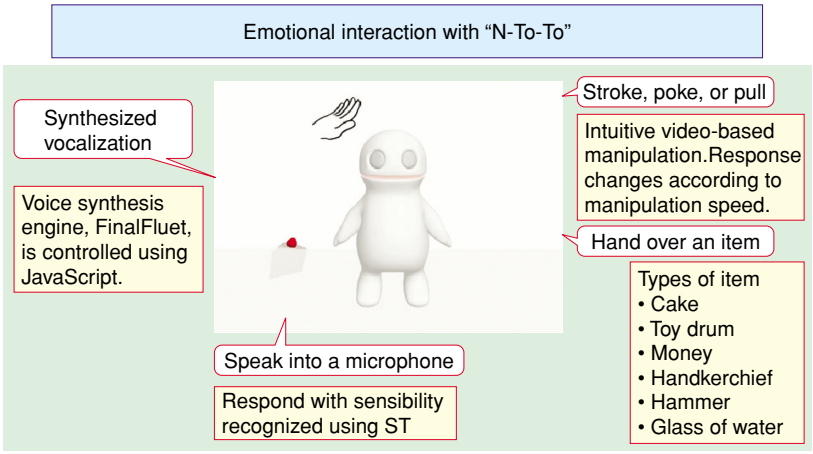


Fig. 13. Virtual Friend called "N-To-To".

4.3 Chie-no-wa

"Chie-no-wa" (Intracommunity Site) is an activity to provide a forum for the free exchange of information and opinions across organizational and disciplinary boundaries. It can be considered a kind of "intra-blog". As far as I know, the company that has been the most successful in using such an intra-blog is Google, which is said to conduct almost all business discussions by starting blog (Web log) threads. In the Chie-no-wa website, free but responsible opinions are exchanged vigorously and are yielding tangible and useful results. As a part of this activity, we encourage trips abroad to attend unique academic events and workshops, which are unlikely to be considered in the ordinary conduct of business, or lectures by external speakers, so that researchers will have opportunities to review their own R&D activities from different perspectives. One of the outcomes of this activity is the birth of joint research with A.G.I. Inc. [2], who is developing technology for the communication of sensibility under the theme of "From information technology (IT) to sensibility

technology (ST)".

The virtual friend called "N-To-To" shown in **Fig. 13** is a virtual creature capable of emotional dialog, an outcome of the combination of the Interactive Reality Technology (CyberCoaster) [3] of NTT Laboratories and the vocal sensibility recognition technology (ST) of A.G.I. Inc. The user can enjoy a variety of reactions that N-To-To is capable of producing, in response to the strength of the user's voice and finger-clicking.

Some results of the "Chie-no-wa" activity were exhibited at the "Chie-Labo" held in Akihabara, Tokyo on March 25 and 26, 2005. They were well received by ordinary people who came to the event and operated products as they liked.

5. Research

Under the slogan of "Get over the wall", NTT's basic research is exploring what needs to be done to get over the quantitative and physical barriers (such as the volume of information and transmission speed) and the walls of the human senses (such as those addressed by cranial nerve science and cognitive science). Two examples of such research activities are described below.

The first is research in the field of nanobiotechnology, one of the priority themes being undertaken in NTT Basic Research Laboratories. Thanks to advances in micromachining technology, micro-processing with a granularity equivalent to the size of a protein molecule is now possible. A possible first phase in this research may be to mount protein molecules, which might, for example, be sensitive to light of a specific wavelength, on a substrate produced using such nanotechnology, in order to develop a device that can detect a faint current generated when exposed to a specific type of light (**Fig. 14(a)**). As the second phase, it may be possible to position several proteins, each sensitive to a different light, in parallel, to produce what might be called a "Nano-EYE" that can react to different colors or to arrange

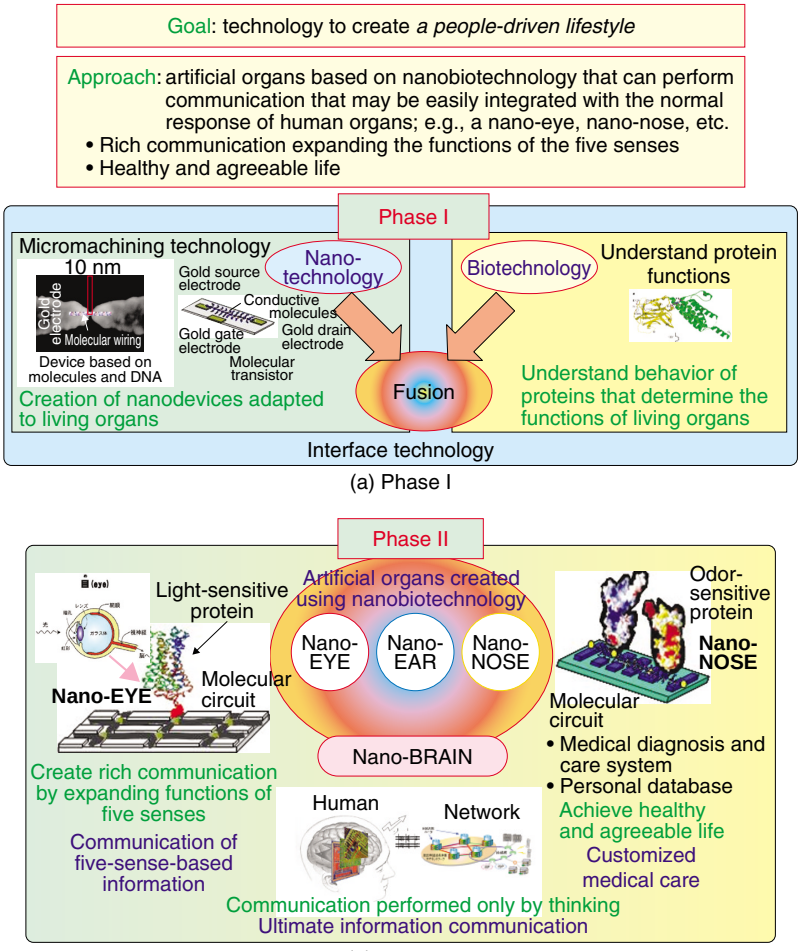


Fig. 14. Nanobiotechnology.

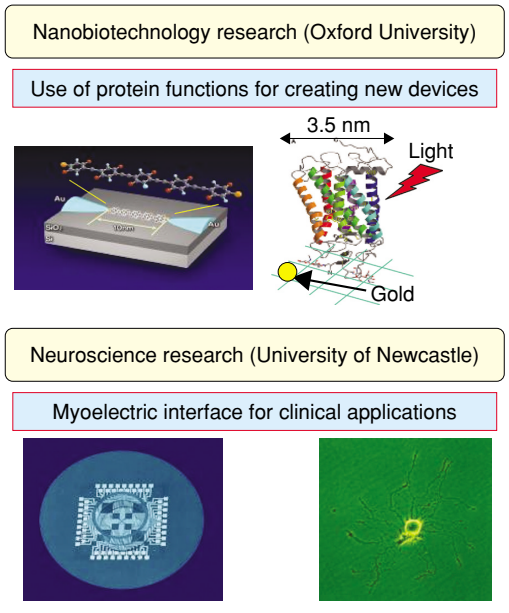


Fig. 15. Joint research with the U.K.

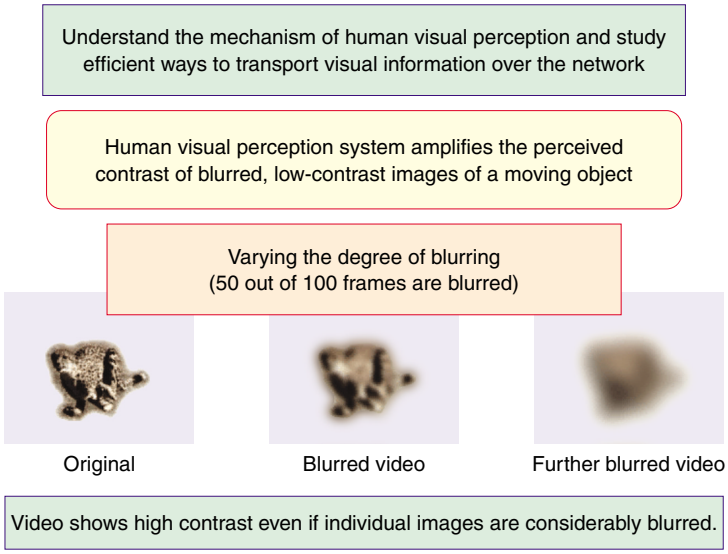


Fig. 16. Research into optical illusions.

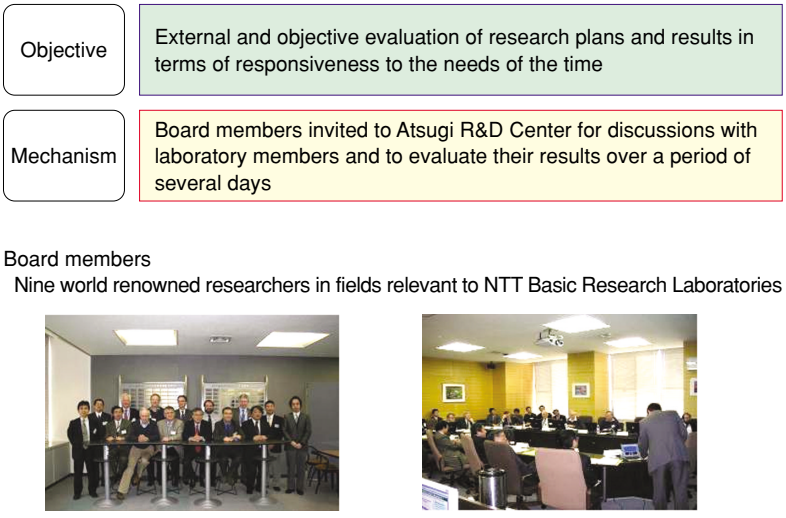


Fig. 17. Advisory Board of NTT Basic Research Laboratories.

several proteins that are sensitive to different odors in a group to produce what might be called a "Nano-NOSE" (**Fig. 14(b)**). NTT started a joint research activity on this subject with Oxford University in the U.K. in 2005 (**Fig. 15**).

Next, as an example of research into overcoming the sensibility wall, I'll describe the study of optical illusions undertaken by NTT Communication Science Laboratories. The mechanism of human visual perception is such that, even if 50 out of 100 video frames are blurred, the perceived contrast is increased so that the video image looks closer to the real one. The images of a cheetah in **Fig. 16** appear blurred as still images on paper, but the video projects realistic, lively motion. Human visual perception has several characteristics similar to this, known as optical illusions. We believe that transport over the network of visual information, represented efficiently by making the most of human characteristics, may become a useful transmission technology.

Finally, in order to ensure objective, external evaluation of NTT's basic research, an Advisory Board has been established (**Fig. 17**). NTT Communication Science Laboratories and NTT Basic Research Laboratories take turns in organizing annual board meetings. This year, nine world-renowned researchers were invited to NTT Atsugi R&D Center for several days for discussions with laboratory members about their results.

Since the previous R&D Forum held a year ago, the comprehensive producer mechanism has been functioning well and has produced a number of results that are likely to make significant contributions to NTT's business. In addition, as part of the multi-angle approach to R&D, the activities of WAKATE project and the Chie-no-wa have also begun to yield specific results. We are striving to create and reinforce such R&D activities to generate an even greater number of results.

References

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