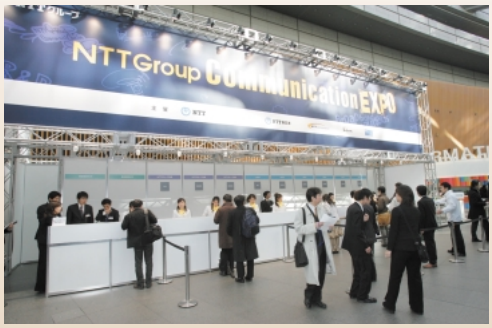
NTT Group Communication EXPO—R&D Exhibit Report

Abstract

Marking the 20th anniversary of NTT's privatization, the NTT Group Communication EXPO was held from December 20th to 22nd, 2005 at the Tokyo International Forum to let people experience the ubiquitous broadband society envisioned by the NTT Group.



1. EXPO overview

April 2005 marked the 20th anniversary of NTT's privatization. In the years to come, the NTT Group aims to continue in its role as a unified group of companies that can be relied upon to provide safe and secure services at all times. In this spirit, the NTT Group held the NTT Group Communication EXPO to show the general public the novel ways in which it intends to deal with the challenges of the future.

This event was quite diverse. In addition to talks given by NTT's President and CEO Norio Wada and the presidents of various NTT Group companies, it included a wide array of seminars, celebrity appearances including one by the Seattle Mariners' Ichiro Suzuki, who appears in NTT Group commercials, and exhibition corners to enable visitors to experience for themselves the ubiquitous broadband society envisioned by the NTT Group. This article focuses on the Future Square and the Technology Lab., two exhibition corners that incorporated many examples of R&D accomplishments from the NTT Group.

2. Future Square

How will the world of tomorrow envisioned by the NTT Group take shape? The Future Square corner was designed to enable EXPO visitors to experience the lifestyle of the near future that the field of information-communications will help to bring about. Future Square was divided into four zones—Experiencing, Learning, Living, and Meeting—as described below.

2.1 Experiencing

This zone consisted of seven demonstrations under the theme of "Discovering New Means of Perception." These were "Space Collaboration" that enables physically separated sites to share a common screen, "Dream Boutique" that provides virtual-reality experiences, "Aroma Salon" that transmits healing aromas, "Virtual Humanoid" that enables alter ego communication, "MeetBall," a conversation conductor, "Information Snow," where information appears to alight on one's hands, and "Mirror Interface," which enables users to communicate seamlessly across the border between real and virtual [1].

In Information Snow, a video image of falling snow was projected onto the floor of the exhibit area. Upon entering the area and noticing this image of falling snow, a visitor could hold out his hands and let snow crystals fall onto his palms. These snow crystals then melted on his palms changing into an image on each hand. This system lets users receive information by the act of catching falling snow flakes. A user may also fuse the image on his left hand with the image on his right hand to form a new image related to those two images. In short, a user may manipulate received information to access new information.

Information Snow demonstrates a novel interface

that aims to create a new relationship between information and the user. In contrast to signs, posters, and displays on the street, the palms of a person's hands provide a private space for only that person. Furthermore, the information received by purposely holding out one's palms is apt to become more familiar to oneself than information that aimlessly flows in front of one's eyes. The NTT Group is researching similar methods that change the way in which people encounter information through technology.

Figure 1 shows a general view of the demonstration system, which is centered about a piece of equipment called "MeetBall." This equipment was developed as a communication-support tool. It determines the current state of the communication site through image and audio sensors and presents stimuli through projected displays to help smooth out the communication process. The Information Snow exhibit used MeetBall to support encounters with information. When a user steps into the area below MeetBall, the equipment determines the position of the user's body and that of the user's hands through image-recognition techniques. The positions of both hands can be determined by extracting flesh-colored areas of the image. Then, by projecting images in accordance with the positions of the user's palms, information can be displayed directly on the palms. The angle of the projected image can also be adjusted based on the positional relationship between the user's body and palms with the result that the video image is always displayed in the correct direction. The exhibit used two MeetBall units, each capable of recognizing three persons simultaneously and projecting images for each of them. Also, when combining specific images on visitors' palms, the two MeetBall units could be linked with externally connected lighting equipment to provide a light show while music played in the background. Many visitors to this exhibit enjoyed the experience of receiving and manipulating information on the palms of their hands.

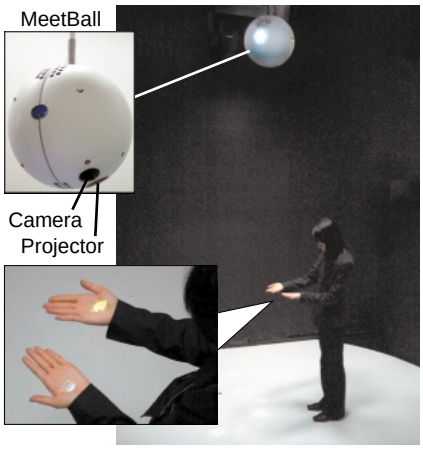


Fig. 1. Information Snow exhibit system.

2.2 Learning

Under the theme of "Stimulating Curiosity," the Learning zone consisted of five demonstrations. *Nazuki* is a Japanese-language search engine capable of semantic analysis. "At-home Culture School" has teachers come to you over the network. "Global Academy" [2] enables users to explore the night sky in the southern hemisphere and the earth itself. "ViscuitLand" [3] is created jointly by users on a dream (illusory) campus. "EcoGeo Research" enables users to observe the world in a natural manner from the viewpoint of a bird.

The "Viscuit" in ViscuitLand is a tool for creating programs by pictures with the aim of animating those pictures. It enables anyone to program with ease. With this tool, one can draw pictures and create sounds on a personal computer and animate those pictures while multiple users are working on a single picture or animation over the network. Viscuit was developed to facilitate communication through the free use of pictures and animation without users having to understand the concepts of a network or files. At this EXPO, visitors were able to get hands-on experience with Viscuit and create an animated picture book under the theme of "Christmas Night on Viscuit" (**Fig. 2**). The pictures drawn by people using Viscuit for the first time on six personal computers were displayed on large screens in front of the users by three projectors with the entire display becoming one animated picture. This, together with a common background of a starlit night that scrolled slowly

Fig. 2. ViscuitLand exhibit.

Fig. 3. Remote control of an excavator in a mountain in Chile.

Fig. 4. The heartwarm@home demonstration.

across the large screens in the horizontal direction, made for a beautiful animated picture that provided the exhibition site with a Christmas-night performance. Pictures that people drew at the exhibit could also be viewed at home on their own personal computers over the Internet [3].

In Global Academy, the exhibition site in Tokyo was connected via an optical network to an astronomical observatory in Chile, South America, on the other side of the world. This demonstration system let visitors observe the southern sky, which normally cannot be seen from Japan. Visitors were also able to remotely control a copper-mine excavator in the heart of a mountain in Chile (**Fig. 3**).

2.3 Living

The Living zone consisted of eight demonstrations under the theme of "Turning Hopes into Reality." The "heartwarm@home" system provides a feeling of being connected at all times, "*Keitai de go*" makes life more enjoyable with a cellular phone, "Talking Home Appliance Net" makes housekeeping a more pleasant endeavor, "Net Life Showcase" supports connecting, talking, viewing, and enjoying, "Optical network-based Future Theater" provides an ultra-high-quality viewing experience, "NaviShop" promotes smart shopping, "Pet Hotline" lets you be with your pet anytime and anywhere, and "Health Check over the Net" provides daily and enjoyable support for one's physical condition.

The heartwarm@home demonstration introduced a new style of communication whereby family members living far from each other can mutually convey their general condition in a continuous but unobtrusive manner over an optical broadband connection (**Fig. 4**). Consisting of a PC-based videophone and a traditional lamp with a built-in human sensor, heartwarm@home indicates the presence of the other person via sensor data. The demonstration system consisted of three PCs with touch panels, which provide a simple and fun interface ideal for children and the elderly. Visitors to the exhibit were able to experience this sense of continuous connection with another person. With the coming of the aging society, we are proposing the heartwarm@home system as a new communication-support system that anyone, including the elderly, can operate with ease.

In the *Keitai de go* demonstration, the streets of Kamakura provide a stage where visitors could experience the convenient and enjoyable lifestyle made possible by the cellular phone, now an indispensable part of daily life, providing camera and wallet functions in addition to calling and messaging.

2.4 Meeting

Under the theme of "Resonant and Open Interaction," the Meeting zone presented two exhibits: "Broadband & Ubiquitous Cafe," where people can have fun and be entertained over the network, and "Messaging Tree," a net community where everyone has a leading role. The Broadband & Ubiquitous Cafe featured five stands: the i-mode stand, OCN stand, goo stand, FLET'S stand, and character stand.

The character stand demonstrated a trial service that lets users access content on the Internet through the recognition of two-dimensional (2D) and three-dimensional (3D) objects in the real world. In this demonstration, visitors were asked to use a camera-equipped cellular phone to capture an image displayed on a liquid crystal display (LCD) or to take a picture of a 3D figure. The obtained image was then sent to a server, where it was recognized and used for returning the address of a corresponding Web site (**Figs. 5** and **6**). Many visitors that experienced this

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Fig. 5. Capturing a recognition target with a camera-equipped handset.

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Fig. 6. Character stand exhibit.

trial service said that they were very impressed.

Here, the process of recognizing the images of objects is performed by object-recognition technology embodied in software placed on an NTT image-recognition server. This technology enables a system to learn (extract) the features of objects from various directions in a statistical manner and to register those features in a dictionary. The image of an object captured by a handset is then compared with the dictionary while varying the size and position of data pulled from the captured image. The image is recognized if a match is found. Further enhancements to the feature-extraction and learning methods will make for an effective, practical technology that can deal with changes in lighting, partially concealed objects, and complex backgrounds, i.e., one that is generally robust to the picture-taking environment.

This exhibit was part of a joint experiment conducted with Sega Corporation. NTT was in charge of the handset software and image-recognition server, while Sega was mainly in charge of the content-delivery server. In the demonstration, 2D and 3D figures from Sega and the OCN logo were used as objects targeted for recognition.

This technology is being studied within NTT for future business possibilities by the Business Creation Team in NTT Department III in collaboration with NTT Cyber Space Laboratories.

3. Technology Lab.

Technology Lab. was set up to publicize the diversity of NTT R&D, the interlinking of NTT technologies, and the high level of individual NTT technologies that provide strong support in diverse ways for the NTT Group and its work toward a ubiquitous broadband society. The exhibit assembled key technologies under the five themes of "Natural Communication," "Net Life Technology," "Net Security," "Key Technologies for Achieving High-speed, Large-capacity Communications," and "Ecology & Science."

3.1 Natural Communication—connecting people to people and people to technology

The Natural Communication corner was divided into three technologies and seven systems (services) targeting the exchange of high-quality information (**Fig. 7**).

(1) High-quality audio processing technology

One exhibit presented a technology called "Cralinet" that can read out any Japanese text accurately and in an natural-sounding synthetic voice. The exhibit included a demonstration of how Cralinet could be used to provide realtime synthesis of high-quality speech approaching that of a human announcer.

The "Wonderhorn" singing-voice synthesis system

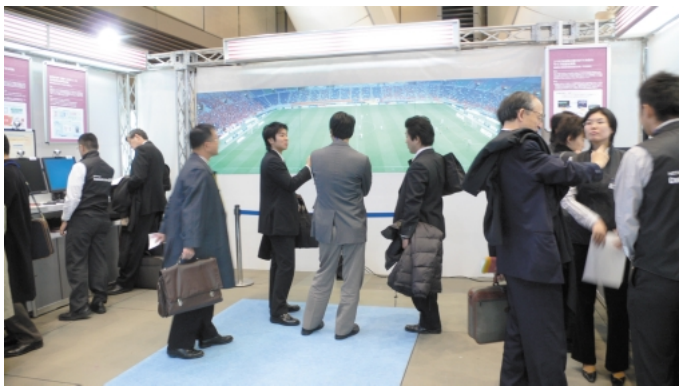

Fig. 7. Natural communication corner.

was also demonstrated. This system enables a user to synthesize a natural-sounding singing voice using a voice type, lyrics, and melody of the user's choosing.

Also presented was a "Directional AGC Echo Canceller" that can convey the voices of people far from and close to the microphone in an audio conference at the same volume to participants at the other site. It achieves high-quality audio conferencing in which the position of the microphone is no longer an issue. The technology introduced here is not limited to audio conferencing—a video showed how it can also be applied to family situations in the home.

(2) High-quality video processing technology

A super-high-resolution video codec (SHR-codec) developed by NTT for high-reality large-screen video communications can achieve live transmission of ultra-HDTV images never before experienced by people. This codec technology can provide high-reality live services using SHR levels of either 4000 × 2000 or 6000 × 1000 pixels, both of which exceed the pixel count of HDTV (high-definition television). The actual demonstrations of the SHR-codec made visitors feel as if they were actually there and showed how the ultimate in broadband video communication services has become a reality. Visitors expressed much interest in the levels of resolution used in the demonstrations.

Next, the "Touch-type DFD Interface" applies a display technology that makes use of a phenomenon called depth-fused 3D (DFD) that lets you experience 3D viewing without having to wear special glasses. Combined with a touch panel that allows direct input from a screen, this interface lets you manipulate buttons and switches as if they were the real thing. In the demonstrations, visitors found that they could operate these 3D buttons and switches in a very intuitive manner. In addition to simplifying display operation, this touch-type DFD interface will promote the design of truly attractive screens through the use of beautiful 3D displays.

(3) Applications of high-quality audio and video technologies

The "Senior Phone" is a video communication service for the aging society that provides an intercom-like experience between an elderly person and that person's family. With a touch panel that makes for intuitive operation and remote Web-cam operation that allows one party to control the other party's camera, visitors were able to experience the ease-of-use and reliability of Senior Phone and to enjoy conversations over high-quality video and audio connections.

Also in relation to the aging society, the "Care-prevention System" aims to prevent elderly persons from becoming bedridden. The demonstration of this system introduced a scientifically proven program of preventing the four main causes of a bedridden life: broken bones from falling, incontinence, poor nutrition, and a shut-in existence.

3.2 Net Life Technology—for a richer life

Six technologies aiming to provide people with a richer life were introduced in the Net Life Technology corner.

The first was "KANSHINJI Antenna" (*Kanshinji* is a Japanese word meaning interest), a Japanese-language concept-based filtering system developed as a search service for Web portals. The demonstration showed how information of interest to the user could be obtained from recent news and blog (Web log) articles by the highly accurate acquisition of articles related to the semantic content of keywords or sentences input by the user.

Next was "BLOGRANGER," a next-generation blog-search system that can arrange search results from multiple perspectives. It features a unique interface that classifies search results of blog articles by topics, favorite bloggers, links to news and other items, and review-related expressions such as "interesting." The demonstration enabled visitors to experience how easy searching can be performed with BLOGRANGER [4].

Then, in the context of providing Web services, the "Web Universal Design" demonstration introduced guidelines for creating content based on a Web universal design that aims to support the production and use of a World Wide Web (WWW) for everyone including the elderly and physically challenged individuals. It also introduced the "TalkingBlog" browser that reads out a blog for the user by synthesized speech.

There was also a "Home Service Harmony" demonstration that showed how convenient services could be provided by combining home appliances as desired over a home network. The demonstration showed how appliance-usage history could be learned by the system and how operations became more intelligent and easier to use the more the system was used.

Another demonstration introduced "Broadband Appliance Configuration Technology," a communication platform for the broadband era. Visitors were introduced to new terminal technology providing novel functions centered about next-genera-

tion means of communication. These included a function for controlling home appliances using a familiar user interface, a function for starting up services by simply holding up something in front of the terminal, a function supporting remote operation, and a function that provides various types of information using a standby screen.

Fig. 8. *RedTacton* exhibit.

Finally, the "*RedTacton*" demonstration introduced a technology that uses the human body as a path for transmitting signals, enabling close-range communications using everyday actions and gestures. This is an innovative human-area networking technology that uses electric fields on the surface of the body as a transmission medium. The demonstration showed how *RedTacton* could be used to exchange digital business cards by simply shaking hands, a capability that attracted much interest (**Fig. 8**).

3.3 Net Security—making the network society safer

The Network Security corner introduced seven technologies for creating a safer network society.

NTT's "MovingFirewall" technology protects networks and servers from distributed denial of service (DDoS) attacks, a form of network crime that can create serious obstacles to Internet use. This technology can accurately detect the occurrence of DDoS attacks, analyze specific attacks, create countermeasures, and make full reports. Detection rules can also be customized to support policies unique to each customer—up to 30,000 detection rules can be set using a dedicated board.

"SENACSY" is a system that provides secure access to a corporate network. It automatically selects an access line in accordance with the site being connected to and provides simple and safe "one-click" connections. The demonstration showed how SENACSY eliminates the need for end users to make complicated network-connections and how a secure and convenient access system can be achieved in a low-cost manner.

"STRAGEX" is a security management system consisting of personal computers with no built-in disks (diskless PCs) and a large-capacity remote storage unit. It prevents information leaks and disaster-related data loss by providing centralized and uniform management of PC operating systems (OSs), applications, and data at a remote location. The demonstration of STRAGEX technology showed how a diskless PC can be booted and operated with the same feeling as an ordinary PC and how a set of management functions can perform OS management without bothering the end user.

NTT's "Single-chip Fingerprint Authentication" system was also presented. While conventional fingerprint-authentication devices use high-performance processors to recognize fingerprints read in by a sensor, this system performs the full range of tasks from fingerprint reading to authentication on one chip the size of a fingertip. As a result, fingerprint authentication can now be incorporated in small and inexpensive devices as opposed to relatively large devices like PCs and cellular phones as done in the past. This capability generated much interest in the demonstration.

The "Data Tracing System" developed by NTT performs quality control in the distribution process. Taking the perishable-foods industry as an example, the demonstration showed how quality control could be performed in the transport process by combining wireless terminals and built-in temperature and humidity sensors with cases of fresh food.

Also, in the area of encryption technology, which is becoming crucial to ensuring security in various types of services on the network, the EXPO introduced the "Camellia" encryption algorithm and "quantum cryptography." Developed as a joint project with Mitsubishi Electric Corporation, the Camellia algorithm features the world's highest level of performance. As a cipher that can be flexibly implemented in accordance with the usage environment and that can achieve high-speed processing on any platform, Camellia is the first Japan-produced encryption algorithm adopted as a next-generation standard cipher for ISO/IEC and Internet use.

Quantum cryptography, on the other hand, is the ultimate encryption technology that can guarantee secure operations unconditionally through the use of the uncertainty principle in quantum mechanics. NTT is demonstrating the effectiveness of quantum cryptography by proposing a new protocol (differential-

phase-shift quantum-key distribution) and conducting transmission experiments using optical fiber.

3.4 Key Technologies for Achieving High-speed, Large-capacity Communications—developing the network

This corner introduced nine elemental technologies for achieving high-speed, large-capacity networks in the four network categories of subscriber networks, relay networks, intra-building and intra-office networks, and mobile communications networks.

(1) Subscriber networks

This network category consisted of three exhibits: "Free-bending Optical Fiber Cord," "Advanced Optical Wiring Kit for Fiber to the Home (FTTH)," and "B-FLET'S Splitter."

The free-bending optical fiber cord can transmit optical signals even if bent, folded, or knotted, which would cause ordinary optical fiber to leak light and would disable communications. Visitors to the exhibit were impressed that this cord can be used just like metal-wire-based ones by ordinary people without any special knowledge of fiber optics.

The advanced optical wiring kit for FTTH applications, which was developed jointly with Matsushita Electric Works, provides a full set of components for installing optical wiring in the home from the optical cabinet installed on the premises to optical outlets situated inside the house. This kit eliminates the need for special skills in installing optical wiring and shortens the time required for installation.

The B-FLET'S splitter is an optical splitter that utilizes planar lightwave circuit (PLC) technology. This splitter is now being used as a key device in subscriber networks that provide B-FLET'S services. PLC, which is an original NTT development, is known for its high reliability and high affinity with mass production. It uses quartz glass having extremely stable properties, which makes it possible to ensure high-reliability operation and low-loss, high-reliability connections with optical fiber that uses the same type of quartz glass.

(2) Relay networks

Four elemental technologies were introduced in this network category: "Generalized Multiprotocol Label Switching (GMPLS) Technology," "PLC Optical Switch," "Arrayed Waveguide Grating (AWG) for Dense Wavelength Division Multiplexing (DWDM)," and "Photonic Board."

Generalized multiprotocol label switching was developed to achieve flexible optical networks. It was introduced here as a platform technology for constructing multi-function large capacity networks in an economical manner.

The PLC optical switch and AWG for DWDM are typical optical components based on PLC technology. The former integrates many optical-switch elements in various circuit configurations all on a single chip, while the latter multiplexes and demultiplexes many optical signals of different wavelengths resulting in a key device for wavelength division multiplexing (WDM).

The photonic board is a function integration board that integrates node functions into PLC and improves the functionality of a photonic network. It provides essential node functions including optical add drop multiplexing, variable optical attenuation, and wavelength switching.

(3) Intra-building and intra-office networks

A "Pluggable WDM System" that can use WDM by sensing local area network devices was introduced in this network category. Based on a pluggable unit that simplifies the insertion and removal of small optical modules, this system facilitates the economical construction of diverse systems that use WDM. The demonstration presented actual examples of the devices used by this system.

(4) Mobile communications networks

The demonstration held in the network category introduced a "1-Gbit/s High-speed Transmission Experiment" as a step toward a 4th-generation mobile-communications system. On May 9, 2005, this experiment achieved realtime packet-signal transmission at a maximum data-transfer rate of 1 Gbit/s on the downlink. This 1-Gbit/s realtime signal transmission can be achieved even in wireless environments with weak radio signals by applying NTT DoCoMo's proprietary signal-separation technique based on a short processing time in a 100-MHz frequency bandwidth.

3.5 Ecology & Science—focusing attention on society and the future

The Ecology & Science corner introduced six technologies related to ecology, the theme most recently taken on by NTT Laboratories, and science, its earliest theme. At first glance, it may seem that ecology and leading-edge science are the furthest apart among all the themes researched by NTT Laboratories, but in reality, they have a very close relationship. In short, one useful way of directly applying leading-edge science for the betterment of society is ecology.

(1) Ecology

Three ecology-related technologies were exhibited:

"Hepchin Pollen Information," "Clean Energy System," and "High-capacity Micro Fuel Cell."

The Hepchin Pollen Information system provides realtime forecasts of the ever-changing dispersion of cedar pollen. Pollen sensors automate measurement tasks and a pollen-dispersion simulator predicts the amount of scattered pollen. This system issues pollen-distribution forecasts hourly and can make predictions up to 48 hours in advance. The information can be displayed on a map on either a Web site [5] or cellular-phone screen.

The demonstration of NTT's Clean Energy System introduced a long-life, high-performance power supply whose compact and lightweight configuration makes it ideal for use as a transportable power supply during natural disasters. It uses clean nickel metal hydride storage cells containing no lead. The High-capacity Micro Fuel Cell demonstration introduced a micro fuel cell that uses hydrogen as fuel and enables nine hours of continuous talk time for FOMA handsets.

(2) Leading-edge science

Among the various research topics related to leading-edge science, the Ecology & Science corner exhibited the "Mimamoni Monitoring System," the "Quantum Computer," and an "Experience Melding Vestibular Electrical Stimuli with Sensory Computer Graphics."

The Mimamoni Monitoring System can accurately detect movement and facial features in a video signal. The detected image can then be used to display areas or persons of interest in an easy-to-view manner even on the small displays used on cellular handsets. (Mimamoni is derived from the Japanese words *mi* to see, *mamoru* to protect, and *monitor*)

As a type of computer that exploits the principles of quantum mechanics to the full, the quantum computer, if realized, would require only a few seconds to solve problems—such as factoring a large prime number—that would normally take 10,000 years for today's most advanced computers. In a quantum computer, the unit of information is a quantum bit. NTT Laboratories has successfully made such a quantum bit in a promising solid-state system. At the EXPO, an actual single-quantum-bit chip was presented under a microscope and a quiz to deepen one's understanding of quantum mechanics was given (**Fig. 9**).

Finally, in the demonstration introducing an experience that melds galvanic vestibular (inner-ear) stimulation with sensory computer graphics, a feeling of acceleration obtained by sending weak electric currents through the inner ear (vestibule) was combined with a racing simulator to produce a unique sensory attraction that can be enjoyed even at home. Many visitors to this exhibit had the opportunity to experience this novel technique.

Fig. 9. Quantum computer exhibit.

4. After the EXPO

The NTT Group Communication EXPO provided visitors with the opportunity to experience for themselves a variety of projects that herald the future of communications envisioned by the NTT Group. It was a meaningful and productive event that enabled the NTT Group to hear various opinions from many people about the R&D that it is promoting and to engage in energetic discussions on desired services. To respond in earnest to these valuable opinions and sincere requests, the NTT Group intends to devote even more energy to its R&D endeavors.

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References

[1] E. Hosoya, I. Harada, H. Sato, and A. Onozawa, "Mirror Interface—An Interactive Communication System Utilizing the Metaphor of a Mirror," NTT Technical Review, Vol. 4, No. 5, pp. 22-27, 2006 (this issue).
[2] H. Uose, M. Oinuma, K. Noguchi, Y. Sakai, K. Tatematsu, E. S. Vera, N. Baloian, H. Pulgar, M. Ramos, and L. F. Mujica, "Global Academy—Remote Network Applications Connecting Japan and Chile over GEMnet 2 and R&E Networks," NTT Technical Review, Vol. 4, No. 5, pp. 28-39, 2006 (this issue).
[3] http://www.viscuit.com/ (in Japanese).
[4] http://ranger.labs.goo.ne.jp/ (in Japanese).
[5] http://kafun-info.hi-ho.ne.jp/index.html (in Japanese).