ISSN 1346-8626

# NICT NEWS

National Institute of Information and Communications Technology

2004 SEPT.
《No.342》


# R&D Project for Highly Reliable P2P Information Transmission

## Asahikawa Highly Reliable Information Sharing Research Center


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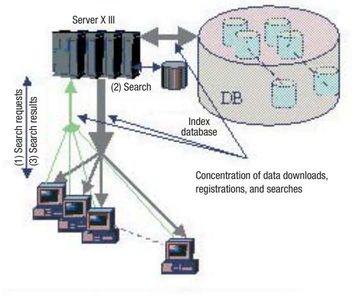
Joined IDO Corporation in 1990; participated in technological development of mobile phones and base-station wireless equipment. After company merger with KDDI Corporation in 2000, participated within the Technology Development Department, Office of CTO, in the development of a medical-image transmission system and a system to send physical checkup results to mobile phones. Temporarily transferred to Asahikawa Highly Reliable Information Sharing Research Center, TAO, in 2003. To present, engaged in R&D of P2P networks and security-related technologies.


## Introduction

Some people immediate associate P2P networks with Winny, a particular P2P file-exchange software program, and in fact P2P is widely stereotyped as being synonymous with illegal distribution. This impression was reinforced when the Recording Industry Association of America (RIAA) filed a lawsuit to halt the operations of Napster, a pioneering P2P music-distribution service launched in January 1999.

However, P2P offers numerous advantages as a network architecture, including significant reductions in database expenses, entrance lines, and other server-related costs. Given that P2P technology emerged just five years ago, I believe that it is possible to apply this technology to the development of valuable networks, if we first study the specific problems and enact appropriate measures in response.

**Figure 1: Client-Server Network**



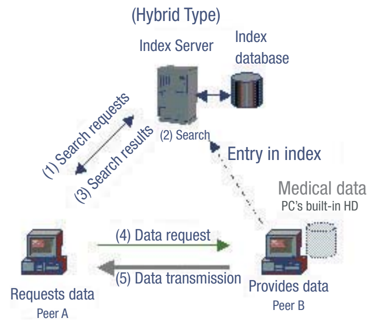

In client-server architecture, servers bear all loads associated with requests, uploads, and downloads. High-speed and high-capacity lines and devices are thus required.

We have adopted this promising network architecture and are conducting research into its application to the transmission of medical information, an application that demands the highest levels of security, efficiency, reliability, and speed.

## P2P and Client-Server Networks

I would first like to explain the difference between P2P networks and the client-server networks that are currently in wide use. Figure 1 shows a schematic diagram of a client-server network. Since all user access operations are concentrated in the servers, as shown in this diagram, the servers, lines, and databases must all be equipped for high speed and high capacity. As a result, the larger the network scale, the higher the associated costs.

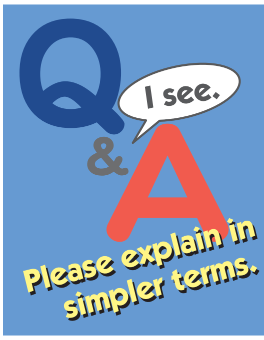
**Figure 2: P2P Network**




Server handles index information only, resulting in light loads on the server and database. Since the bulk of data is exchanged peer-to-peer, network loads are distributed among peers.

Figure 2 shows a schematic diagram of the network we use: a hybrid P2P network with an index server.

With the client-server architecture described above, servers store all data. In contrast, individual user computers ("peers"), store data in P2P networks; servers therefore are required only to handle the indexes used for rapid searching of items stored in these peers, with no need to store and manage large amounts of data on the servers themselves. Data is thus transmitted between peers, not through the server. As indicated in this diagram, a small index server will suffice, while the bulk of peer-to-peer data transmission takes place over the network.




**Q** What's a client-server network?

**A** With client-server architecture, server computers store information centrally, and users (clients) access these servers to make use of the information. This client-server architecture currently dominates the Internet and other networks. However, the efficiency and effectiveness of such architecture is limited when handling information on a large scale, as all of the information must be concentrated within the servers.

**Q** What's "peer" in P2P?

**A** P2P stands for "peer to peer." Peer normally means "fellow" or "colleague." On a P2P network, a "peer" usually refers to a PC. In this experiment, peers were situated in 16 locations—14 hospitals, a participating university, and the Asahikawa Highly Reliable Information Sharing Research Center. P2P is also sometimes written as "PtoP."

## R&D in Highly Reliable P2P Information Transmission

While it offers a range of valuable features, P2P architecture also poses a number of pressing problems. For example, personal medical data demands high security; however, it is difficult to ensure such high security in P2P architecture, where data is distributed over the network. In the case of music distribution, it becomes nearly impossible to keep track of who is receiving what music and when; this sort of lack of security is clearly unacceptable. For highly reliable transmission of information over P2P networks, we must establish an efficient and secure index server that can make the best use of the characteristics of P2P.

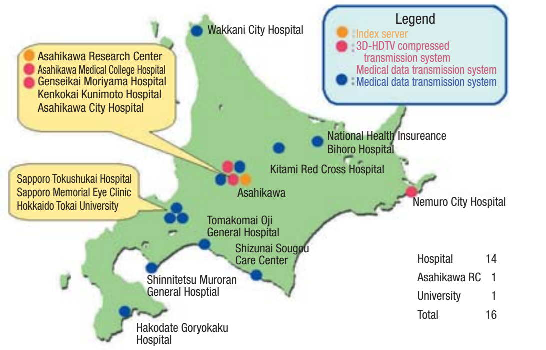
Security-related research consists mainly of four subjects: layering, encryption, disclosure control, and access history management. The accessible range of sections in patient charts is defined for healthcare workers (e.g., doctors and nurses) based on their respective access privileges, which are set using metadata (or "metadata items"); this is referred to as "layering." When you update a patient chart or create a new one on a peer, information is arranged based on the metadata and then saved as encrypted data. If this peer receives a request for transmission of this chart from another peer, the requester's access privileges (stored on in his or her IC-card) are examined; data is then extracted from the layered items based on the access privileges and sent. In other words, you are allowed to send a certain range of data based on the requester's access privileges, while the remaining data is prevented from being transmitted. This entire procedure is called "disclosure control." The saved data is sent to the requester through the disclosure control procedure without being decrypted. Through these measures, security is ensured even if data is stolen from a PC or tapped into on a transmission channel. In terms of data transmission histories within a P2P network, access histories are collected from peers and the index server and are then quickly grouped for analysis based on user IDs and information contained in the charts. Such access history management is expected to have a wide range of uses—for example, it will be helpful not only in finding causes of system failures and network congestion and taking appropriate measures, but also in detecting unauthorized use of IDs and leakage of information. Although I've been discussing security-related research so far, the Asahikawa Research Center also conducts research on distributed compressed transmission, layered coding and display methods for efficient transmission of exremely large size images containing importaint medical data, and on 3D-HDTV compressed transmission system.

## Demonstration experiments

This year is the final year of this project. Based on the research results so far, in April we began construction of a P2P network to link 16 locations, including 14 hospitals in Hokkaido. We began demonstration experiments in September. Figure 3 shows the locations of these demonstration experiments on the P2P network. Experiments are scheduled to last until sometime in December 2004.

On September 3, we held a demonstration for the news media.

Figure 3: Locations of Demonstration Experiments




We performed search and delivery of patient charts over the P2P network and demonstrated telediagnosis based on 3D-HDTV image transmission. This demonstration proved very popular; there were so many people in the hall that we ran out of chairs. Attendees eagerly asked questions about various aspects of the project, including the projected date of commercialization. Figure 4 shows a photo of the demonstration.


Figure 4: **Presentation to News Media**
Mr. Yoshida (Project Leader) demonstrates P2P patient chart transmission and telediagnosis using 3D-HDTV.

## Conclusion

Thanks to the participation of doctors in the 14 hospitals linked to the network, this project is now approaching a practical scale. Yet we still have a way to go, and must continue our efforts to ensure that this research will lead to commercial viability.

**Life & Technology**

### ● P2P Networks Expected to Improve Quality of Healthcare Services

The widespread use of broadband technology has established a network environment equipped to handle information communications in public services relating to healthcare, education, transportation, and the environment. With the continued development of this networked society, demand will increase for distributed networks, such as P2P networks, that can link clients directly without servers. The field of healthcare in particular requires highly reliable real-time data communication. Healthcare workers must often handle information independently distributed in multiple locations. Moreover, such information comes in various formats, from text to high-definition images. P2P-based medical information networks are expected to help prevent redundant examinations and medication errors, to reduce consultation times and healthcare expenses, and to increase the overall quality of community healthcare.


# How the Brain Works in Speed Reading


## Norio Fujimaki

Senior Researcher
Brain Information Group
Kansai Advanced Research Center
Basic and Advanced Research Department


Received Ph.D. in engineering from University of Tokyo in 1980. Worked at Fujitsu Laboratories Ltd. from 1980 to 1998. Joined Communications Research Laboratory (currently NICT) in 1999. First research theme involved a superconducting device; currently engaged in research on measurement and analysis of language-related brain activities.

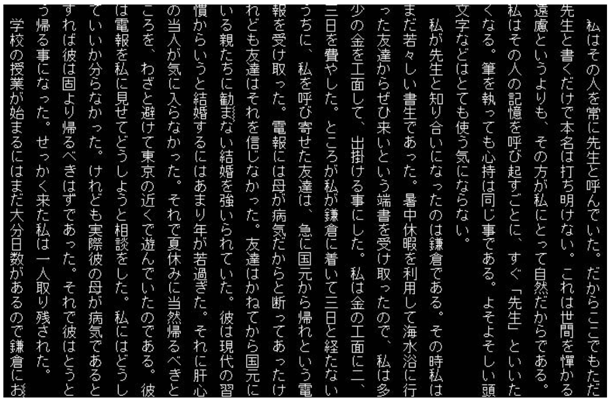
The Brain Information Group of the Kansai Advanced Research Center conducts research to enhance data analysis techniques (see pages 3 and 4 of CRL News No. 316, July 2002) and to measure brain activity using systems such as magnetoencephalography (MEG), functional magnetic resonance imaging (fMRI) and near-infrared spectroscopy (NIRS).

Reading enables people to acquire all kinds of information and to communicate with each other. To facilitate such communication and to enable easier use of a range of current and future information systems, we have conducted a study of the language-processing mechanisms of the brain involving the measurement and modeling of language-related brain activity—the process of reading, for example.

You are probably aware of the technique referred to as "speed reading." It usually takes dozens of seconds to read a page of a B5-size book without skipping lines or skimming. A well-trained speed reader, on the other hand, can read a page in one second or so. We initially became involved in the study of speed reading based on a request from NHK. In collaboration with Mr. Toyofumi Sasaki (President of the Japan Society of Speed Reading Education), we conducted an experiment to determine what part of the brain is active when people read at such high speeds.

In the experiment, trained rapid readers silently read vertical text (Japanese novels are usually written vertically) on the screen (Figure 1), and we used fMRI to measure brain activity. We used several novels, such as "Kokoro," by Soseki Natsume. The test subjects (readers) pressed a button to move to the next page. Four speed readers and four normal readers read a book for a little less than 10 minutes twice: at their fastest and at normal speeds. Thanks to the participation of a number of speed readers, we were able to measure brain activity not only at normal speeds (several words per second), but also at speeds 10 to 100 times higher (10 to 100 words per second).

When normal readers try to read faster, they can read at most two times faster than usual, and no significant change in brain activity is seen. When speed readers read at normal speeds, similarly there is no significant change in brain activity; however, when these subject speed-read, a decline in activity is seen in Wernicke's area (relating to comprehension of spoken words and selection of verbal sounds) and in Broca's area (relating to speech and grammar), which are primarily located on the left side of the brain. These areas play a key role


私はその人を常に先生と呼んでいた。だからここでもただ先生と書くだけで本名は打ち明けない。これは世間を憚かる遠慮というよりも、その方が私にとって自然だからである。私はその人の記憶を呼び起すごとに、すぐ「先生」といいたくなる。筆を執っても心持は同じ事である。よそよそしい頭文字などはとても使う気にならない。

私が先生と知り合いになったのは鎌倉である。その時私はまだ若々しい書生であった。暑中休暇を利用して海水浴に行った友達からぜひ来いという端書を受け取ったので、私は多少の金を工面して、出掛ける事にした。私は金の工面に二、三日を費やした。ところが私が鎌倉に着いて三日と経たないうちに、私を呼び寄せた友達は、急に国元から帰れという電報を受け取った。電報には母が病気だからと断ってあったけれども友達はそれを信じなかった。友達はかねてから国元にいる親たちに勧まない結婚を強いられていた。彼は現代の習慣からいうと結婚するにはあまり年が若過ぎた。それに肝心の当人が気に入らなかった。それで夏休みに当然帰るべきところを、わざと避けて東京の近くで遊んでいたのである。彼は電報を私に見せてどうしようと相談をした。私にはどうしていいか分らなかった。けれども実際彼の母が病気であるとすれば彼は固より帰るべきはずであった。それで彼はとうとう帰る事になった。せっかく来た私は一人取り残された。

学校の授業が始まるにはまだ大分日数があるので鎌倉にお

Figure 1: **Text Sample (changed to vertical orientation with black background for use in experiment)**
("Kokoro" by Soseki Natsume. Source: http:/www.aozora.gr.jp)

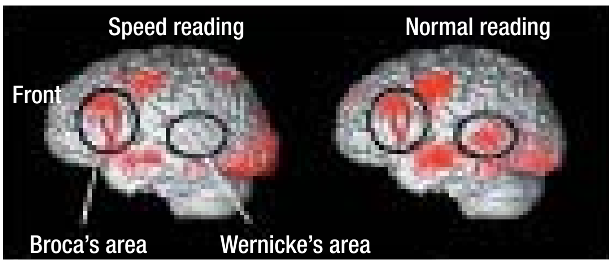
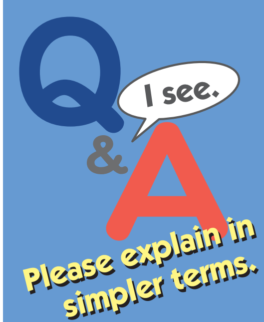



Figure 2: **Brain Activity in Speed Reader**




**Q** What's fMRI?

**A** fMRI stands for "functional magnetic resonance imaging." The "f" is conventionally written in lowercase. When people see or hear something, blood flow in the active parts of the brain changes within a few seconds. This instrument observes these changes in blood flow, studying active areas through imaging with millimeter-level accuracy.

**Q** What are Wernicke's area and Broca's area?

**A** Wernicke's area is located in the temporal-association area in the left hemisphere of the brain, and helps us understand the meaning of spoken words. This area was discovered by Carl Wernicke, a German psychiatrist, in the 19th century. Broca's area is located in the frontal-association area in the left hemisphere of the brain, and is responsible for the generation of speech and the writing of characters. This area was discovered by Paul Broca, a French surgeon, in the 19th century.

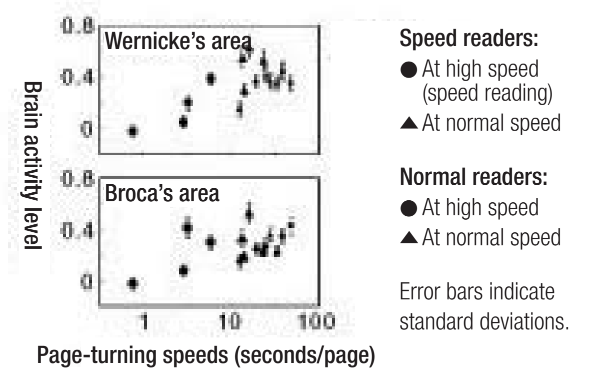
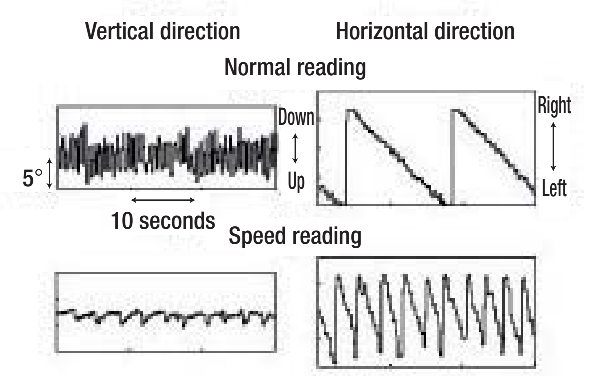



Figure 3: **Relation between Brain Activity and Reading Speeds**
(Speed increases from right to left.)




Horizontal and vertical axes indicate time and eye movements (angles), respectively. In the case of normal reading, eyes gradually move from right to left, following each line of vertical text from top to bottom along the way; in the case of speed reading, there are few vertical movements.

Figure 4: **Eye Movements in Reading**

in language processing. (Figure 2 shows an example of the decline in activity in Wernicke's area, and Figure 3 shows the different brain-activity patterns of the eight subjects.)

There have been many studies on the process of reading; we already know, for example, that when reading at normal speeds (several words or less per second), the language-processing areas of the brain become more active with an increase in reading speed. The results of this experiment, however, indicate that brain activity in fact is reduced when people read at extremely high speeds.

We also measured eye movement. In the case of normal reading by normal readers and speed readers, eyes gradually move from right to left, following each line of vertical text from top to bottom along the way. However, in the case of speed reading, speed readers' eyes move primarily right to left, with little vertical movement (Figure 4). This is probably part of the speed-reading strategy of understanding text at extremely high speeds, through control of eye movement and brain activity. Even when reading silently, as in this experiment, people usually convert characters they see into interior verbal speech ("inner speech"). Speed readers seem to reduce this inner speech processing to increase reading speed while continuing to understand the information in the text.

In information communications, people exchange information in front of devices or terminals. I believe that in the ultimate form of user-friendly information communications, a system would be able to process ambiguous expressions accurately and to respond in an attentive manner according to the context or the user's intention, as if there were someone (e.g., a capable secretary) present and listening to the user. If the brain's language-processing mechanisms are further clarified, it may become possible to develop a highly advanced communications system that can intelligently process information transmitted among users or between people and machines. With this vision of the future, we are now studying the brain's language-processing and other communication mechanisms in detail. We will pursue these studies in the hopes of contributing significantly to the future of information communications.

This article's description of measurement of the brain activity of speed readers was publicized in NeuroReport magazine (Vol. 15, on pages 239–243) in February 2004.

Life & Tech-nology

## ● Kansai Advanced Research Center's Temporal and Spatial Investigation of the Brain

By studying the language-processing mechanisms of the human brain based on the act of reading, it may become possible to develop a highly advanced communications system that can intelligently process ambiguous expressions and information in the transmission of information among people or between people and machines. NICT's Kansai Advanced Research Center conducts research in brain measurement using two types of data: temporal and spatial. To measure space in the brain in detail, we use fMRI, as described in this article. To measure time in detail, we use magnetoencephalography (MEG). MEG measures with millisecond-level accuracy the extremely weak magnetic fields caused by brain activity. Near-infrared spectroscopy (NIRS) uses the scattering of light to measure brain activity; measurement is possible even with some subject motion. Almost all universities and institutes that engage in brain research are equipped with one or two of these three instruments. However, the Kansai Advanced Research Center is said to be the only institute that uses all three instruments on its own to perform measurement and analysis in a comprehensive manner.


International Alliance Division, Strategic Planning Department
Public Relations Division, General Affairs Department

# Report on Exhibition at International ICT EXPO 2004

Thai Prime Minister Thaksin (left) visits the NICT booth

Exhibition at the NICT booth

Speech by Vice President Sakata (center)

The NICT attended the ICT EXPO 2004, an international exposition held in Bangkok, Thailand, from August 4 to 8, 2004. This exposition was hosted by the Thai government and was timed to coincide with the ASEAN Plus Four Ministerial Meeting. Institutes, organizations, and companies from various countries came together in the vast hall to participate, while a forum was also held in an annex hall.

The NICT ran a booth in the space allocated by the Thai government to Japanese exhibitions. Centering on the so-called “u-Japan Strategy,” we tried to express what lay in store for our ubiquitous society. In addition to introducing the new NICT organization, we displayed and demonstrated optical networks, UWB devices, an English educational database—one of the largest in the world—and presented research taking place at our Thai Computational Linguistics Laboratory.

The NICT booth received a number of VIP visitors, including Thai Prime Minister Thaksin, Information and Communications Technology (ICT) Minister Surapong, Transport Minister Suriya, and Mr. Tabata, Japanese Vice Minister of Internal Affairs and Communications. Overall, the exposition was bustling with visitors, exceeding 250,000 in total.

Some 400 people attended an international conference on e-learning in the forum hall. During this conference Mr. Sakata, Vice President of NICT, delivered a speech entitled “The NICT Vision of Asian Collaboration—e-learning via ICT Technology,” accompanied by a video presentation. In addition, the Computational Linguistics Group of the Keihanna Human Info-Communication Research Center reported on its research results.

Since it was the first time for us to attend this exposition, we were overwhelmed by the sheer scale and number of visitors over the five days; at the same time, we realized how actively the Thai people were working to develop ICT. We became keenly aware that PR activities at exhibitions such as this one represented an effective means of bridging the digital divide, particularly in light of the widespread use of ICT and the increasingly rapid globalization of socioeconomic activities.

Public Relations Division, General Affairs Department

# Report on Exhibition at the Junior Science Academy

On August 7 and 8, the Junior Science Academy event was held in Kashiwazaki City, Niigata Prefecture, under the sponsorship of TEPCO and the Television Niigata Network. At this event, NICT exhibited its “Infanoid” baby-like robot.

The Junior Science Academy began with the aim of providing the young leaders of the next generation with an opportunity to challenge their imaginations and senses through involvement with the latest science and technology. For the seventh time since inception, the theme of the event was “The Brain.”

Included among the many booths were interactive exhibits, a handcrafting class, and a maze, where children could learn science through hands-on experience. Scientific experiments and magic shows took place on an outdoor stage. Providing the opportunity to make learning science fun, these performances proved extremely popular among the children.

Since there were few robots exhibited at this event, the NICT booth was practically crammed with children eager to view NICT’s Infanoid. Those of us among the NICT public relations staff were delighted that many of the children already knew about Infanoid.

Thanks to fine weather despite the hot season, there were more than 40,000 visitors over these two days; the exhibition was thus highly successful.

# Report on Exhibition at the Kasumigaseki Tour for Kids

On August 25 and 26, the Kasumigaseki Tour for Kids was held in the first-floor lobby of Kasumigaseki Central Government Building No. 2, home of the Ministry of Internal Affairs and Communications (MIC). NICT participated in this event as an independent administrative agency under the jurisdiction of the MIC.

This event is held at this time every year under the leadership of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in order to provide elementary and junior high school children the opportunity to interact with their parents and to learn more about society in general during their summer vacation. Government ministries and agencies collaborate to explain their activities and to arrange worksite tours.

NICT exhibited its IP Control Cars, model cars equipped with wireless LAN functions for remote control through the Internet. We also prepared a special track that children could actually maneuver these cars around.

On the morning of the first day, we began to worry about the attendance due to a sudden rain shower, but this cleared up about an hour before the scheduled start of activities. Among the visitors were many children. The IP Control Cars were so popular that children lined up to test them; this line continued throughout the day—not only on the first day but also on the second. Mothers also showed interest in the cars, and enjoyed competing with their children.

Hisashi Koshizuka
Leader of Facility Management Group,
Contract and Property Division, Finance Department

# Damage from Typhoons (Hagane-yama LF Standard Time and Frequency Transmission Station)

There have been an unusual number of violent typhoons this year, some of which hit NICT's facilities located throughout the country. Typhoon No. 16, which came before dawn on August 30, caused serious damage in particular to the Hagane-yama LF Standard Time and Frequency Transmission Station located on the border between Saga and Fukuoka Prefectures. Along the city road between the station and the foot of the mountain, as well as on the premises of NICT, several mudslides occurred fallen trees brought down power cables, blocking the passage of cars and people. However, thanks to cooperation from Maebaru City, the Maebaru Forestry Office, and Kyushu Electric Power, the station had tentatively recovered by the following day. Fortunately, there were no injuries or serious damage to the station. Later, Typhoons Nos. 18 and 21 came in quick succession, causing some trees to fall, but we were again able to recover quickly thanks to cooperation from the same organizations.

We would like to express our deep gratitude to the people and organizations concerned for their cooperation and support in these emergency situations.

When the road was blocked and the staff couldn't return home, emergency food stocked in the station was extremely helpful. The General Affairs, Strategic Planning, and other relevant sections responded quickly in the recovery work and take measures to prevent any additional damage. I believe that this success is due to our having prepared for such emergency situations on a routine basis. Based on the lessons learned from this experience, we intend to continue our efforts to ensure that we can take adequate measures in the event of disasters or other emergency situations.

Hagane-yama LF Standard Time and Frequency Transmission Station

NICT NEWS
Sept 2004 No. 342
Published by:
Public Relations Division, General Affairs Department
National Institute of Information and Communications Technology
4-2-1 Nukui-Kitamachi, Koganei, Tokyo 184-8795 Japan
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