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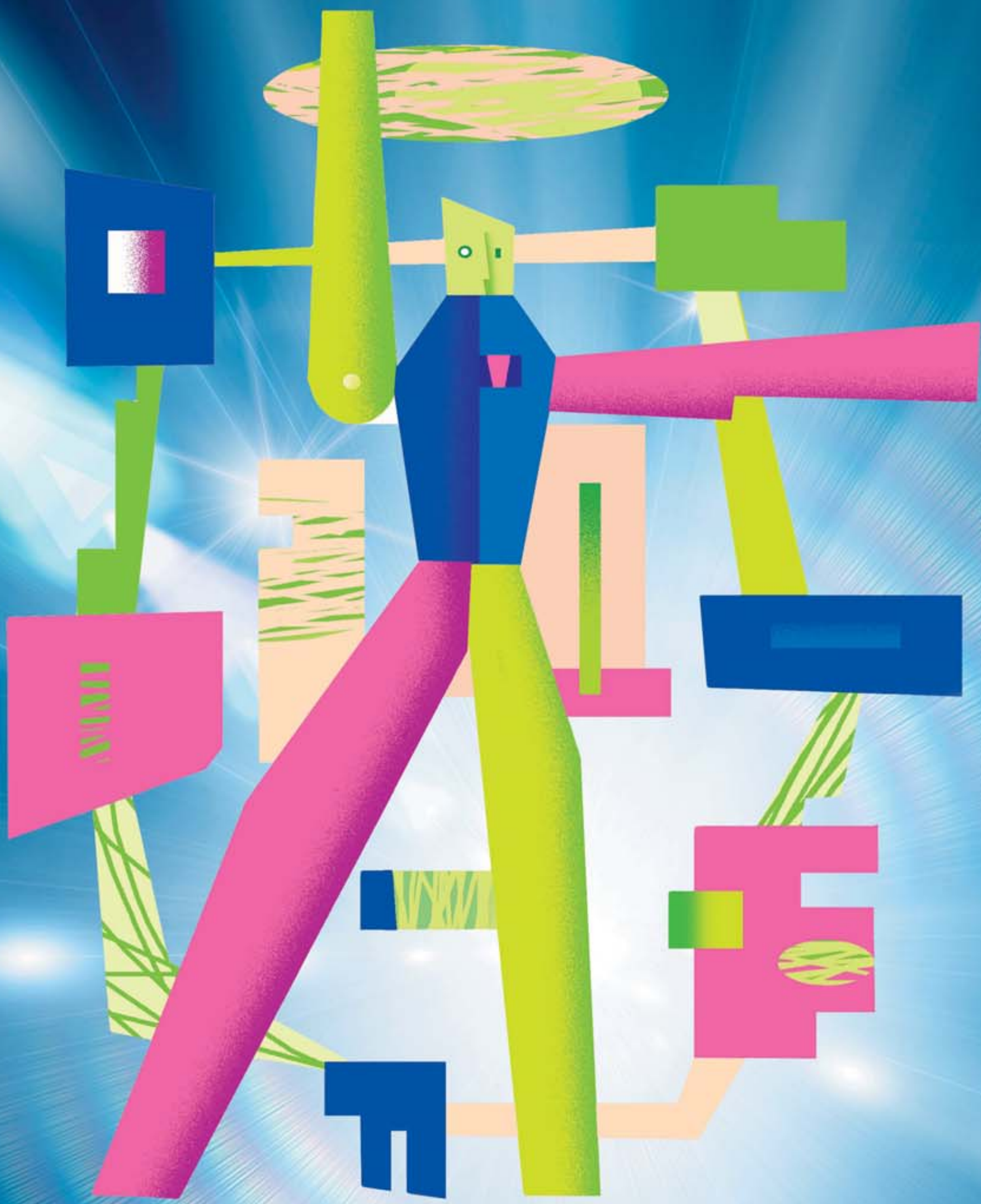
NICT NEWS

National Institute of Information and Communications Technology



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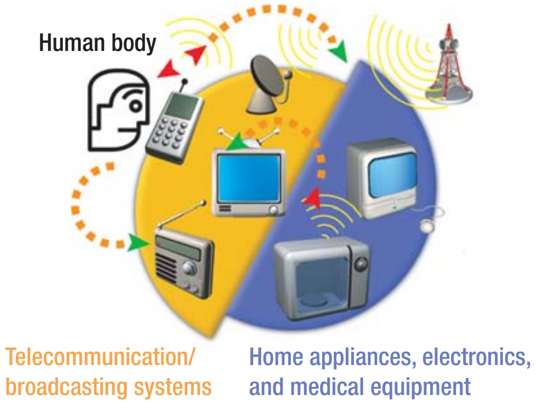
EMC Unit Activities
— Toward R&D Base of EMC Field —

Yoshiaki Suzuki, Unit Executive Director, EMC Unit

Introduction

In the ubiquitous network age, when various types of electronics operate as wireless terminals, a range of pressing issues will arise: the coexistence of wireless and wired communications, the malfunctioning of instruments, the biological effects of radio waves, and information leakage due to weak electromagnetic-wave interception, to cite a few. To ensure security and safety in the ICT society, part of NICT's mission, we need to improve electromagnetic compatibility (EMC) as we develop ICT technologies. Accordingly, the EMC Unit carries out its research activities with the overall aim of promoting coordinated use of radio waves and creating a safe and favorable electromagnetic environment.



Three categories of EMC

EMC is classified into three categories. Our work involves both assessment and the development of measuring techniques used for assessment; these methods are applied to each category, as described below.

• **EMC of instruments**

Research in this area addresses the assessment and the reduction of interference waves caused by instruments.

Our work contributes to the R&D and the international/domestic standardization of EMC (emission, immunity) measuring methods for a wide range of instruments. In July of this year, CISPR (Comité International Spécial des Perturbations Radioélectriques: International Special Committee of Radio-electric Perturbations) decided to extend the scope of regulations against radiated emissions from information technology equipment (ITE) from the present 30 MHz–1 GHz range, shifting its upper limit to 6 GHz. In response, we are now looking into methods of assessing measuring sites for frequencies of 1 GHz or higher. We also began preparations for domestic standardization (further to a report by the Information and Communications Council). We're also performing research in the increasingly important area of electromagnetic-wave security (Figure 1), in collaboration with the NICT Information Security Unit and the Information Security Technology Study Group (IST), a private institution focusing on such security.

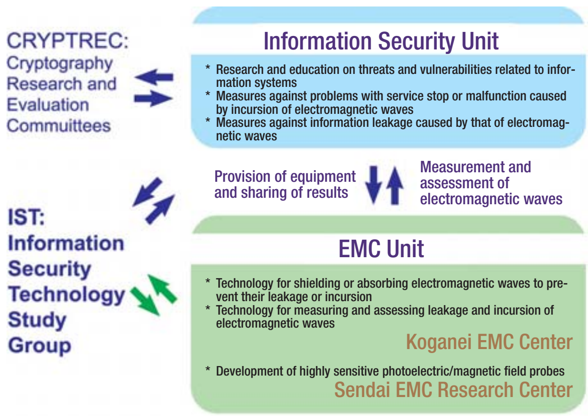
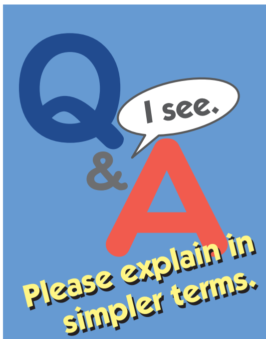


Figure 1: Collaboration with Information Security Unit

We take part in the formulation of electromagnetic-wave security standards and the standardization of various measurement methods, through the measurement of electromagnetic waves emitted from PCs and printers, as well as with experiments involving unauthorized reproduction of image data or printed information (Figure 2). We're also developing the measurement techniques that will be required to implement new measures in electromagnetic-wave security. We have begun research on techniques to measure weak electro-



Q What do you mean by electromagnetic "Emission" and "Immunity?"

A In the context of EMC, the word "Emission" refers to the leakage of electromagnetic interference waves from electronics designed not to emit radio waves. Immunity is the ability of interference-affected electronics to resist noise, functioning normally without degradation of performance. To resolve EMC-related problems, it is important both to reduce emissions from the causing side and to improve the immunity of the affected side.

Q What do you do specifically and what results have you achieved so far in your joint research activities with medical and biological institutions?

A In collaboration with the World Health Organization (WHO) and the Ministry of Internal Affairs and Communications (MIC), we're currently conducting a variety of joint experimental projects, involving medical and biological institutions both domestic and foreign. Specifically, we're assessing the effects of radio waves on the eyes, on brain functions, and their potential contribution to the development of cancer; epidemiological studies are included as well. Based on our work so far, we have confirmed that radio waves weaker than the criteria of the Radio-Radiation Protection Guidelines have no harmful health effects. For more details, refer to the ministry's website (http://www.tele.soumu.go.jp/j/ele/index.htm).

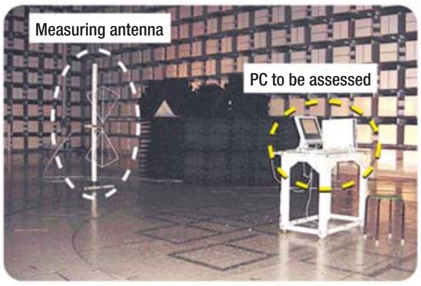
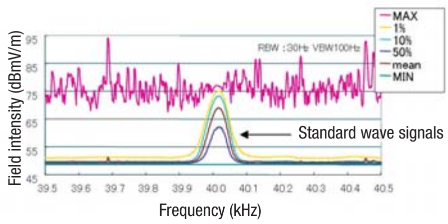


Figure 2: Experiment on electromagnetic-wave security

magnetic waves up to the millimeter band, enhancing the sensitivity of probes used in such measurement. We plan to enhance probe accuracy using electro-/magneto-optic crystals and to develop a highly accurate and sensitive near field electromagnetic measurement system, through precision machining and integration technologies, together with optoelectronic/RF electronic circuit technologies, and so on.

Further, we're working on the measurement and assessment of electromagnetic environments in the long-wave band, to evaluate potential electromagnetic interference with increasingly popular radio-controlled clocks (Figure 3).

Figure 3: Measurement of electromagnetic environment in long-wave band



• EMC research on biological effects

We're researching the biological effects of radio waves, as part of a strategy to promote their safe and secure use.

We're taking part in the establishment of the IEC international standards and MIC notifications, through the development of procedures to check mobile terminals for compliance with the Radio-Radiation Protection Guidelines (Figure 4). We developed whole-body numerical models of average Japanese adults, and now offer these models for free to Japanese and foreign non-profit research institutions (currently numbering about 30). We've also developed radio exposure equipment used in animal testing to assess various biological effects, and are now applying this equipment to joint research with medical and biological institutions.

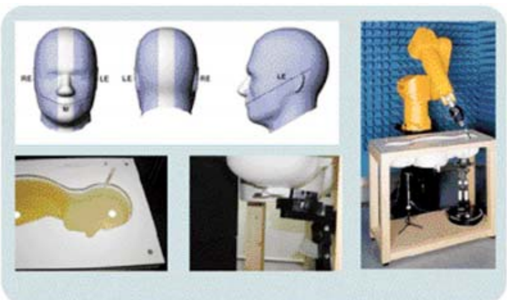


Figure 4: SAR measurement

• EMC research in communications

We're conducting R&D involving communications systems harmonizing with electromagnetic environments in the era of broadband and ubiquitous networking.

As for amplitude probability distribution (APD), used in the assessment of electromagnetic interference (EMI), we clarified the relationship between APD and communications failure due to EMI through a range of experiments and theoretical analysis (Figure 5).

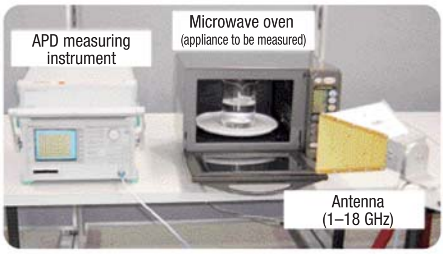


Figure 5: Assessment of electromagnetic interference based on amplitude probability distribution (APD)

These findings were then adopted by the CISPR as new guidelines in the assessment of electromagnetic interference waves emitted from ordinary electric and electronic appliances. In this context, to grasp and predict a given electromagnetic environment, we developed a vehicle to measure three axis electromagnetic environment (Figure 6), as well as imaging equipment to measure microwave electromagnetic fields. Further, we are assessing the electromagnetic effects and interference-related measures of modern communications systems (such as wireless LANs and UWBs), from a variety of viewpoints. Through these research activities, we are continuing to contribute to the upkeep of electromagnetic environments, in preparation for an age of widespread broadband and ubiquitous networking.

Figure 6: Electromagnetic environment measurement vehicle

Other activities

The EMC Unit also carries out research in a number of additional areas (details omitted here because of space limitations): type approval tests of radio equipment commissioned by the MIC; calibration of radio equipment based on the Radio Law and development of the required calibration methods; techniques to measure and reduce radar spurious emissions; and methods to measure effective radiated power of next-generation radio equipment with built-in antennas, etc.

Plans for the future

Through these research activities, we intend to work to help prevent the leakage of information and interferences to communications from electronics, to counteract the malfunctioning of electronic medical instruments and the interference to other radio stations due to electromagnetic-wave emissions from radio equipment, and to contribute to the formulation of guidelines for biological protection.

Life & Technology

● To help bring about a safe and enriching ubiquitous network society through improvement of EMC in three categories

As the use of radio waves becomes more common in a ubiquitous network society, concerns are growing with respect to interference between electronics as well as the effects of radio waves on the human body. Radio-wave use must be optimized accordingly. In this endeavor, EMC-related research activities play a largely unsung role in the establishment of safe and enriching ubiquitous networking for all.

Observing Geostationary Satellites with Optical Telescopes

— Development of Star-Guided Geostationary Satellite Positional Measurement Software —

Masaaki Takahashi

Expert Researcher
Space Cybernetics Group, Kashima Space Research Center
Wireless Communications Department

Since 2003, he has been developing geostationary satellite observation equipment using optical telescopes and positional measurement software.

Introduction

Satellites poised 36,000 km above the equator revolve around the Earth with the same period as the Earth rotation, and thus appear to remain stationary when observed from the ground (Figure 1). These satellites are therefore referred to as "geostationary." Geostationary satellites are widely used in many countries due to their fulltime usefulness for communications and broadcasting in their service areas. However, orbital space for such satellites is limited. According to an agreement by the International Telecommunication Union (ITU), each satellite must stay "within ±0.1 degree from its specified position" to prevent radio interference with other satellites.

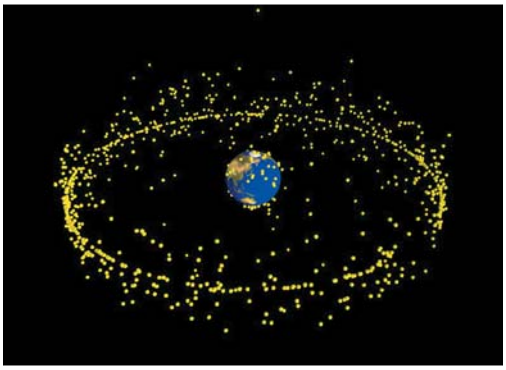


Figure 1: CG image of geostationary orbit

For this reason, it is essential that we are able to monitor the quality of radio waves transmitted from geostationary satellites and to determine orbital satellite positions. The Kashima Space Research Center has been pursuing R&D in satellite position measurement technologies. In this article, I will describe a technology in which optical telescopes are applied to geostationary-satellite positional measurement.

Optical observation

Traditionally, radio waves have been used to determine the directions of geostationary satellites. However, it is difficult to track out their absolute directions with sufficient accuracy, as no effective method is available to correct the effects of the atmosphere inherent in satellite azimuth and elevation angle data.

Figure 2: Optical observation system for geostationary satellites

In contrast, satellite position measurement by optical telescope cancels the effects of the atmosphere, because the relevant phenomena equally affect both the sunlight reflected from the satellite and starlight as the position reference.

To perform observation, a telescope is pointed at a target satellite and the shutter is opened at the specified time. As a result, stars appear as lines due to the Earth rotation, while geostationary satellites are seen as points. Since astronomical observation in many

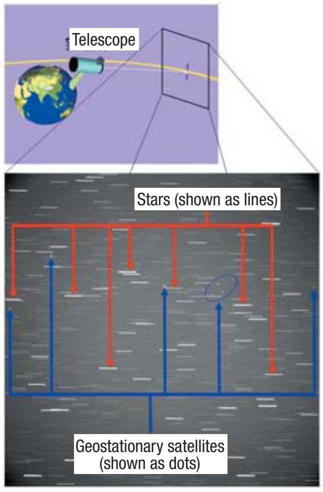
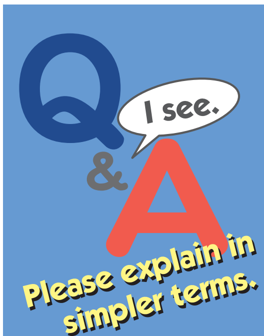


Figure 3: Observation principle and an observation image



Q Why is available space for geostationary satellites limited in the first place?

A It's a simple question of physics: there is only one geostationary orbit around the earth. The geostationary orbit is calculated from factors such as the perigee and the apogee altitudes, the orbital inclination, and the orbital period. Only one orbit satisfies the conditions of identical perigee and apogee altitudes, an orbital inclination of 0°, and an orbital period of 23 hours and 56 minutes. Communications, broadcasting, and weather satellites are all placed in this orbit, where the total number of such satellites amounted to 800 in 2000.

Q According to this article, two telescopes are used in observation. What kind of telescopes are they?

A Each is a 35-cm optical reflecting telescope with a field-of-view angle of 1.1° x 1.1° and measurement accuracy of 0.001°. By placing two of these telescopes in parallel, it becomes possible to observe geostationary satellites repeatedly many times in a given night. It is also possible to use the telescopes in sequence—for example, to observe a fast-moving satellite. These telescopes are located on the roof of the Kashima Space Research Center's Main Research Building.

years has yielded precise positions for stars, we can determine the position of a given satellite using a coordinate system based on the positions of the observed stars. We have developed a software for matching star catalogs for use in such astrometric observations with observed images.

Improvements in mechanical accuracy

A telescope drive unit consists of a motor and gears, which are elements that may cause mechanical errors. Initially the total mechanical error was beyond the reach of correction using motor control, and sometimes exceeded 1 degree. Currently, however, this error can be reduced to approximately 0.02 degree, enabling the automatic measurement of satellite positions. Moreover, by entering a preset predicted satellite direction and the corresponding telescopic directional deviation in advance (using a newly developed software program designed for this purpose), it becomes possible to estimate the telescope direction with accuracy of 0.01 degree.

Facing significant difficulties

The Kashima Space Research Center is located near the coast and is exposed to sea breezes and airborne sand. All-night observation is a challenge in such unfavorable conditions. As a result two telescopes are used alternately, with continuous maintenance to ensure that the observation system remains reliable. In this way, we've been able to reduce the total cost while ensuring continued reliability, as compared to the use of a single strongly-built telescope.

Near the coast, star or satellite images may be disturbed by atmospheric fluctuations. In fact, this was the most serious concern when we selected this observation site. However, based on actual observation results, we have confirmed that our observation system adequately provides the required level of accuracy in orbital monitoring. Moreover, since the system is located close to the Center, we can respond to problems immediately and attempt a range of different observations. Needless to say, research efficiency has improved.

More and more often these days we are seeing the term "light pollution." This has recently become an issue at the Center, with a growing number of facilities in the vicinity using lights in their operations. Our observations are affected by streetlights and searchlights, and airplane lights also show up in photos from time to time. Moreover, the cooled CCD cameras mounted on the telescopes detect infrared rays emitted from surrounding objects. And on rare occasions, cosmic rays even show up in observed images. Given these conditions, we used two telescopes to observe the same geostationary satellite throughout the night, confirming that our system is capable of the position measurement precision of 0.001 degree.

Use of data

The photo in Figure 4 is the same as that in Figure 3, but with a superimposed grid representing latitude and longitude, showing the position of geostationary satellites on a map of the world. Current satellite positions can be read directly from the photo. This ability to process observation data in easy-to-use forms is one of the defining characteristics of the Center's unique technique of optical observation. Processed photo data are gradually coming into use by radio-wave monitoring authorities and satellite control operators, to avoid overcrowding in the geostationary orbit in which the number of satellites only continues to increase.

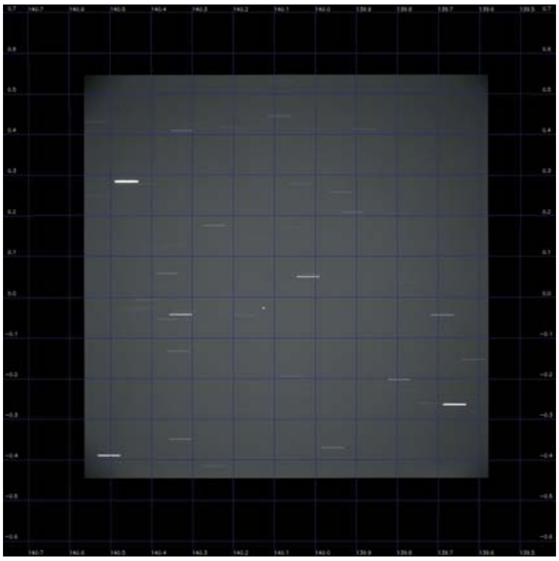


Figure 4: Image with latitude/longitude grid directly below geostationary orbit

Conclusion

Eight years have passed since we began the development of our optical observation equipment. However, there is still room for improvement in terms of mechanical accuracy and environmental durability. We can also foresee shortening the time required to process large amounts of photo data. Hereafter, we also intend to develop a system that can make even greater use of observation data—for example, by automatically adding orbital elements to detected satellites, and issuing satellite approach warnings. We are now considering the development of a tool that will allow the user to find object satellites instantly, for example by simply entering, "satellites approaching each other within 30 km in the next 3 days." We hope to build a database for precise data management to prevent collisions in the geostationary orbit, offering such information in real time when necessary.

Life & Tech-nology

● A need to optimize satellite orbits

Weather forecasting, car navigation systems, BS/CS channels…reliance on satellites is now a daily fact. Many are nevertheless unaware that the geostationary orbit is crowded with satellites. It is essential that we use this orbit, a common asset we share, more efficiently. To this end, research is underway on technologies and software that can pinpoint the exact positions of satellites and accurately control and calculate satellite orbits. These technologies are expected to streamline and optimize the use of the geostationary orbit, which will in turn bring significant benefits to daily life.

Their Majesties the Emperor and the Empress Visit NICT Kashima Space Research Center

Shoichi Hirayama
Group Leader, Kashima Management Operations Group
Kashima Space Research Center

On Sunday, June 5, 2005, Their Majesties the Emperor and the Empress visited the Kashima Space Research Center after the 56th National Arbor Day Festival, held in Suigo Kenmin no Mori in Itako City. Their Majesties observed the center for an hour and a quarter, accompanied by Internal Affairs and Communications Minister Aso and NICT President Nagao.

In the main conference room, Their Majesties listened to explanations of the NICT outline, presented by President Nagao, along with explanations on an information and communications system for use in disasters, and an international joint research on Earth monitoring using celestial radio waves ("e-VLBI") by Vice-President Shiomi.

Next, Their Majesties viewed a 13-meter satellite communications antenna and a 34-meter radio telescope, accompanied by Center Director Chujo.

Finally, in the space communications museum, Their Majesties listened to explanations of a helicopter-satellite communications technology and a portable satellite phone for use with the ETS-VIII satellite by Executive Director Suzuki of the Wireless Communications Department. Executive Director Kumagi of the Applied Research and Standards Department also offered explanations on the so-called "e-VLBI" technology.

In connection with e-VLBI, His Majesty the Emperor specifically asked about the movement of the United States' west coast in terms of measuring continental drifts. Mr. Kumagi answered that unlike Hawaii, the North American continent is not situated on the Pacific plate, and moves in a different direction and more slowly relative to Japan. Additionally, Her Majesty the Empress asked whether it would be possible to use the satellite mobile phone in a disaster such as the one that afflicted the former Yamakoshi Village. Mr. Suzuki answered that communications would indeed be possible, using a smaller satellite phone, in such a situation.

Prime Minister Koizumi Visits NICT Yokosuka Radio Communications Research Center

Ryu Miura
Director, New Generation Mobile Network Project Office
Yokosuka Radio Communications Research Center

On Saturday, May 28, 2005, Prime Minister Koizumi visited the Yokosuka Radio Communications Research Center at YRP to review some of the Center's latest research results. Shortly after 3 p.m., Mr. Koizumi arrived at YRP accompanied by Yokosuka's Mayor Sawada and President Kotani of Keihin Electric Express Railway, along with an array of news reporters and a security detail. In the NICT Laboratory within the YRP Center No.1 Building, President Nagao of NICT presented the Prime Minister with an outline of research activities at NICT dealing with radio communications. Center Director Ogawa then described the results of research on the "Advanced Anti-Disaster Radio Relay System," which uses several motorbike-mounted radios to enable communications over a wide area without the need for base stations, and a so-called "software-defined radio" that provides mobile-phone functions, wireless LAN, and digital broadcasting simply by switching among software programs. Mr. Koizumi was then provided with actual demonstrations of the relevant prototypes.

Before leaving for his next destination, the Prime Minister wrote a word relating to "communications" on a traditional shikishi (paperboard) using a calligraphy brush, in response to a request from Dr. Nagao. Prime Minister Koizumi seemed relaxed during his visit; he sometimes asked questions of our staff and did not hesitate to inspect and handle the prototypes.

We would like to express our gratitude to all those who offered their assistance in this event.

Tetsuya Yasui
Research Center Supervisor
Yokosuka Radio Communications Research Center

Opening Ceremony of Ubiquitous UWB Sensor Network Test Bed

On June 2, 2005, NICT held an opening ceremony for its Ubiquitous UWB Sensor Network Test Bed at the YRP Center No. 1 Building in Yokosuka Research Park, with some 200 people in attendance. This test bed was aimed at the progress of UWB technology potential and developing UWB networks on a global scale, through collaboration among industry, academia, government, and other countries. This is the world's first comprehensive UWB research test bed, providing (1) automatic measurement with a simulated practical-use environment, (2) flexible setting of UWB conditions, and (3) today's most advanced measuring equipment.

Ribbon-cutting ceremony

First, a number of honored guests presented congratulatory speeches, including Mr. Kito (Director-General for Technology Policy Coordination, MIC), Mr. Sawada (Mayor of Yokosuka), and Mr. Imai (Executive Director of NTT DoCoMo Network Laboratories), followed by a ribbon-cutting ceremony. NICT then provided an overview of the test bed. Lectures then followed by Dr. Kohno (Group Leader of the NICT UWB Technology Group and Professor of Yokohama National University); Dr. Sanada (Associate Professor of Keio University, and Leader of the UWB-WG, MMAC Forum). Using the test bed, we conducted a number of demonstrations relating to UWB technology. The ceremony was a lively event and an overall success.

The Ubiquitous UWB Sensor Network Test Bed consists of test facilities and devices, from the UWB Test Room to the UWB Signal Test Bed. The UWB Test Room is designed to measure the propagation characteristics, and to assess the interference and the performance of UWB wireless systems in practical use environments, such as the office or the home. This room has a three-dimensional positioner (to position antennas, for example) mounted to the ceiling and a movable wall to allow the room size to be modified to one of three configurations. When measuring the operating characteristics of a UWB wireless system spatially, this wall can be manipulated to change the room shape with the furniture arranged practically. The positioner can be also used in combination with various measurement instruments.

NICT is currently soliciting proposals for joint experiments based on this test bed. For more information, contact the NICT Yokosuka Radio Communications Research Center (phone: 046-847-5432; contact: Mr. Yasui, Mr. Nishiyama) or YRP R&D Promotion Committee (phone: 046-847-5040; contact: Mr. Nishiyama)

Background and Benefits of the Ubiquitous UWB Sensor Network Test Bed