NICT 独立行政法人 情報通信研究機構 NEWS

National Institute of Information and Communications Technology

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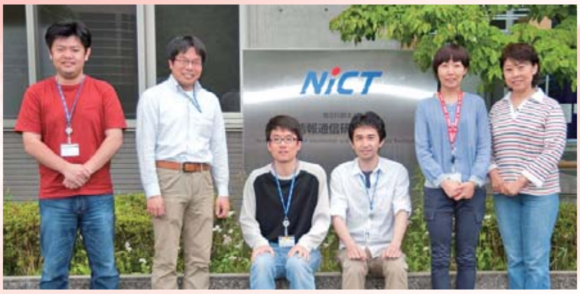
No.409
10

Accurate to Within 1 Second over 65 Million Years

–Long-distance Frequency Comparison Revealed for the First Time 10^{-16} Level of Uncertainty for Optical Lattice Clock–



From left: Motohiro Kumagai, Atsushi Yamaguchi, Tetsuya Ido, Hidekazu Hachisu, Miho Fujieda, Ying Li

Tetsuya Ido

Senior Researcher, Space-Time Standards Laboratory, Applied Electromagnetic Research Institute

Ido joined NICT in 2006 following the completion of a doctoral course in engineering and serving as a researcher at JST-ERATO (Japan Science and Technology Agency-Exploratory Research for Advanced Technology), a research associate at JILA (Joint Institute for Laboratory Astrophysics of National Institute of Standards and Technology, USA and University of Colorado). He has been studying laser cooling of Sr atoms and its application to atomic clocks, as well as the generation of vacuum-ultraviolet utilizing precision optical measuring and frequency comb technologies. Ph.D. (Engineering)

Background

The Japan Standard Time that NICT distributes across the country is not the so-called World Standard Time, but something that it generates at NICT using a number of atomic clocks. Therefore, it is crucial for NICT to keep time as accurate as possible. One second is defined as the 9.2 GHz microwave transition*[1] of cesium atoms according to the international system of units, and the cesium fountain atomic frequency standard developed at NICT neither gains nor loses a second in over 20 million years with 1.4×10^{-15} uncertainty. Just as the higher speed and great capacity were achieved by the shift of the telecommunication media from radio waves to optical wave, the performance of the frequency standard will be dramatically improved by establishing an optical method to replace the current microwave method. For this purpose, studies of optical atomic clocks have been eagerly promoted since the end of the last century. Several optical atomic clock mechanisms that outperform microwave clocks have been developed, provoking debate about redefining the second. Two mechanisms are currently available: single ion traps*[2], and optical lattice clocks that was invented in Japan. A key part of redefining the second is the technology for comparing and calibrating the remotely generated frequency standard. For everyone in the world to share the identical second as a standard, all clocks must generate exactly same period of time. It is therefore imperative to develop technologies to compare long-distance frequency comparison technology, as well, in line with the clock-ticking performance of optical atomic clocks. The Space-Time Standards Laboratory developed a strontium (Sr) optical lattice clock and began operating it in the middle of last year. We (see note) transferred the reference optical frequency generated by the clock at NICT to the University of Tokyo (hereinafter, referred to as UT) via a highly accurate optical frequency standard transfer system developed using optical fiber links in order to compare the frequencies of the clocks at NICT and UT. The goal was to verify the reproducibility of the optical lattice clocks and establish transfer and comparison technologies for the optical frequency standard.

What is an Optical Lattice Clock?

Optical atomic clocks are built by adjusting the laser frequency so that the laser frequency always resonates at the atomic transition. If atoms move during the spectroscopy, they would undergo Doppler shifts, so the atoms must be securely fixed in space (trapped). In the last century, the only method available to pin down atoms was ion trapping, where ions are trapped in an electric field. In 2001, UT Professor Hidetoshi Katori discovered that the frequency shift can be avoided also in neutral atoms by trapping in the interference fringe (optical lattice) of a laser beam at a certain wavelength, leading to the construction of a high-performance optical atomic clock. In 2003, professor Katori, working with the author, succeeded in obtaining narrow atomic spectrum with no Doppler shift. In 2006, the frequencies obtained not only at UT but also at research institutes in the U.S. and France showed excellent agreement, which proved that an atomic clock using the optical lattice method was highly reliable. Currently, research is being vigorously promoted at nearly 10 national standards agencies.

Highly Accurate Optical Frequency Standard Transfer Technology using Optical Fiber

In an optical fiber, the path length may change due either to expansion and contraction caused by temperature fluctuations and vibration, or to variations in a refractive index, leading to transferring an incorrect, Doppler-shifted frequency to the remote end. To correct this, a part of the light received at the remote end is reflected back to the local end via the same fiber, so that any phase noise generated in the transmission path can be detected and corrected with phase-compensation at the transmitting end to suppress the fiber noise. In this way, the optical frequency can be transmitted faithfully to the remote end. An experiment was conducted with a 60 km fiber between NICT and UT using the NICT-operating Optical Network Testbed JGN2plus (currently, JGN-X) between Koganei and Otemachi. It was confirmed that an optical frequency of about 400 THz can be transmitted with an accuracy of 1Hz or less in the averaging time of one second. In Japan, however, the fiber installation environment is usually poor in terms of noise because they are installed hanging loose in the air or close to railways. Hence, note that this accuracy was only obtained under favorable conditions of mild weather and at midnight. In Europe, a 1,000 km long link has been demonstrated using a fiber installed underground in a silent environment. To demonstrate the world's best transmission capability in the future, it is imperative to improve the fiber installation environment.

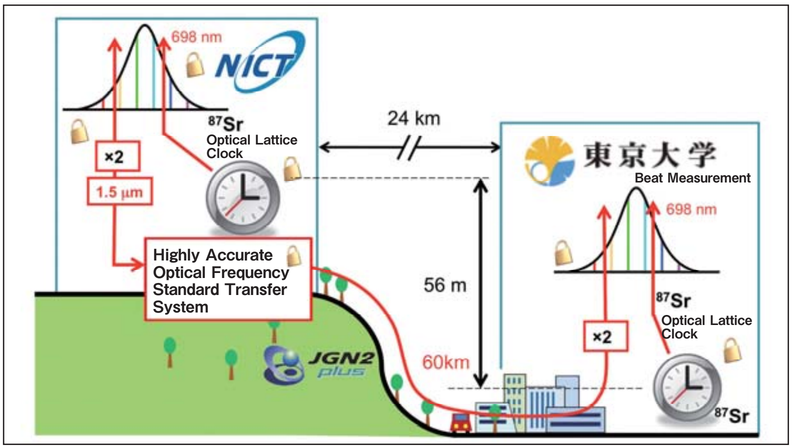


Figure 1●Frequency Comparison between Optical Lattice Clocks at NICT and UT via Optical Fiber Link.
NICT Koganei Headquarters, located on the Musashino Terrace, is 56 meters higher in altitude than the UT Hongo Campus.

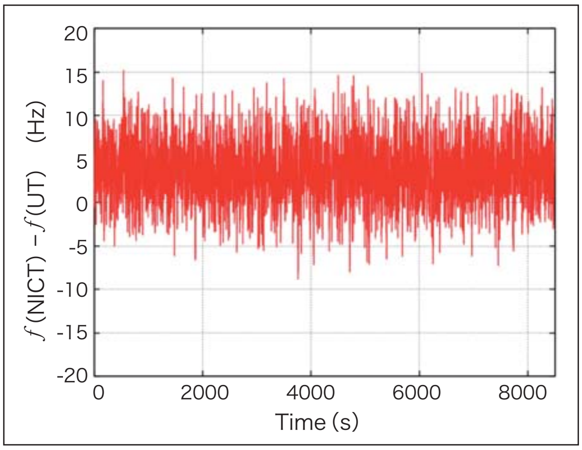


Figure 2●Frequency Difference between Optical Lattice Clocks at NICT and UT.
Each dot is obtained at an averaging time of 1 second. The optical lattice clock at NICT generates 698-nm light (430 THz) at a frequency 3.7 Hz higher than that of the optical lattice clock at UT.

Frequency Comparison between Optical Lattice Clocks at NICT and at UT

The frequencies of the optical lattice clocks remotely located at NICT and UT were compared using the setup shown in Figure 1. A strontium optical lattice clock generates optical frequency at the wavelength 698 nm, therefore, NICT (the transmitting side) first converted it to a wavelength in the communication band using an optical frequency comb*3, and then transmitted the signals to UT via the transfer system described above. At the UT side, the frequency of the transferred laser light was frequency-doubled to convert it to the visible wavelength, and the frequency comb at UT was phase-locked to the doubled light. Thus, UT now has the optical frequency comb coherently linked to the optical lattice clock at NICT, and the relative frequency difference between the two clocks can be measured in real time by measuring the beat frequency between the frequency comb and the optical frequencies generated by the clock at UT. Figure 2 shows the frequency difference between the two clocks obtained at an interval of one second. It was clearly observed that the frequencies generated by the clock at NICT were 3–4 Hz higher than those at UT, which means that the optical lattice clocks at the two different locations did not generate the same frequencies. The frequency differences, however, were mainly attributed to the 56 m difference in the elevation between NICT and UT, which can be calibrated. At UT, at a lower elevation and higher gravity than NICT, time passes more slowly as the general relativistic theory indicates, and therefore the frequencies get smaller. The gravity shift can be calculated with an uncertainty of 0.1 Hz or less based on the difference in elevation between the two locations. In the end, the unidentified frequency difference was reduced to as low as 0.04 ± 0.31 Hz (accurate to within 1 second over 65 million years) over 430 THz. It is essential for frequency standards that anyone in the world can share an identical frequencies anytime and anywhere. The results of this experiment provided the first confirmation of the agreement at an uncertainty level of 10^{-16} with remotely located clocks., which not only confirms the universality of the optical lattice clock invented in Japan, but also demonstrates the technology for transferring state-of-the-art frequency standards over a long distance.

Future Prospects

Following the start of operations in 2006 at the University of Tokyo (hereinafter: UT) and JILA, Sr optical lattice clocks were developed at national standards laboratories in France and Germany, in addition to the one at NICT. In this experiment, a 10^{-16} level of frequency agreement was confirmed between NICT and UT via an optical fiber. However, to push forward the optical redefinition of the second, it is necessary to make the clock itself even better and, at the same time, confirm the frequency agreement with optical lattice clocks between continents, where an optical fiber connection would be difficult. The Space-Time Standards Laboratory is now developing the frequency and time comparison technologies via the satellite link that is used for measuring the time difference between the world standard and Japan Standard Time, as well as developing a new time comparison technology that utilizes VLBI technology, so that we can further improve the accuracy of a intercontinental time and frequency comparison. As for the atomic clocks using the ion trapping method, NIST confirmed by inner-laboratory comparison that they have performance equal to or greater than that of optical lattice clocks. NICT is proceeding with the development of this type of atomic clock, as well, using an indium ion based on a different approach from that taken at NIST.

We would like to express our deepest gratitude to all the support given to us. The experiment was only possible with the cooperation of many joint researchers at both NICT and UT and those working on JGN2plus.

(Note) Joint Researchers
NICT: Motohiro Kumagai, Shigeo Nagano, Hidekazu Hachisu, Miho Fujieda, Atsushi Yamaguchi, Ying Li
UT: Tetsushi Takano, Masao Takamoto, Hidetoshi Katori
(Honorifics omitted)

Glossary

＊1 Microwave Transition
An atomic transition with a microwave energy difference that is relatively small for an atomic transition. Generally, an atomic transition in the microwave range is a transition linking two states that are generated by the weak interaction between nuclear spin and electron spin.

＊2 Single Ion Trapping Method
A method of stabilizing clock lasers using the absorption line of a single ion trapped in an electric field. In capturing an ion in an electric field, the same confinement potential is given at both the excited and ground states, so the electric field will not shift transition frequency. Trapping multiple ions generally causes a frequency shift due to the irregular electric field generated by the adjacent ions.

＊3 Optical Frequency Comb
A pulse laser being called an optical frequency comb because, if you look closely at the frequency spectrum, the spectrum looks like a comb with equally spaced frequency components. This comb-shaped spectrum can generally be obtained with a pulsed laser that has less phase noise and operates very stably.

Organic Materials Pioneer the Future of Optical Communications

–Organic Electro-optic Polymer Makes Optical Modulator and Optical Switch Faster and More Energy Efficient–

Akira Otomo

Director, Nano ICT Laboratory, Advanced ICT Research Institute

After completing a doctoral course, Otomo joined Communications Research Laboratory, Ministry of Posts and Telecommunications (currently, NICT) in 1996. He has been mainly studying the application of molecular photonics and nanophotonics to optical control technology. He serves as Coordinate Professor at the Interdisciplinary Graduate School of Science and Technology, Tokyo Institute of Technology. Ph.D. in Optical Science and Engineering.

Introduction

Information communications technology (ICT), which has allowed us to communicate with anyone, anytime, and anywhere, is now indispensable for our daily life. The development of information communications networks has been driven by optical communications technology, which has enabled faster speed and larger capacity. It is predicted that communications traffic will increase at a faster pace in the future and require even faster speeds and larger capacities. Power consumed by information communications systems, however, has already reached a non-negligible level. It is therefore essential to reduce power consumption. There are also increasing efforts movements around the world to review current networks drastically, which are swelling to an almost uncontrollable extent. One of these efforts is New Generation Networks, which is being explored by NICT. The hardware to support such new systems, however, must be more energy efficient, which is a challenge. It is not easy, however, to reduce power consumption to match the future increase in communications traffic just by extending existent technologies. We need innovative, revolutionary devices that will slash power consumption dramatically. Against this backdrop, NICT has been studying organic materials, aiming to speed up communications equipment and, at the same time, lower their power consumption by applying the excellent photoelectric functions of organic materials to optical control devices.

Speeding up Optical Communications with Organic Materials

The first step in optical communications is to convert the electric signals into optical signals. To do that, optical modulators incorporating an electro-optic (hereinafter: EO) effect are used (Figure 1). The speed of optical modulation determines the speed of optical communications, so much effort has been put into speeding up the modulation rate. As a result, the modulation rate has reached 40 Gbps per channel in today's commercial systems. The material currently used in optical modulators is lithium niobate ($LiNbO_3$; LN), an inorganic dielectric crystal. LN has long been used to speed up the photonic network through improved crystal growth and device processing technologies, but we cannot further speed up modulation rates using this material due to the limit peculiar to inorganic dielectric crystals.

EO effect is a change in the refractive index in response to an electric field. This physical phenomenon underpins the development of optoelectronics, from liquid crystal monitors to pulsed lasers. In optical modulators, the change in the refractive index in response to an electric field is converted into a change in the phase and intensity of the light in optical signals. Typical of optical modulators is the Mach-Zehnder*[1], shown in Figure 1. After the input light is branched, the phase is changed relative to the difference in the refractive index, and it alters the intensity of the output light using the interference that occurs when they are brought back together. The larger electro-optic effect the material has, the less voltage is needed to drive it. The "electro-optic effect" differs greatly in its mechanism depending on the type of material used, with greater variety in the magnitude of the effect and the response speed (Figure 2). Liquid crystals exhibit an extremely large change in the refractive index due to the effect attributed to the rotation of the molecules, but the response speed is slow—about a millisecond. Inorganic dielectric crystals, represented by LN, show a small electro-optic effect due to the effect originating from the displacement of ions, but high-speed modulation is possible. In the microwave range exceeding 1 GHz, however, it was believed that the operation speed would not exceed about 10 GHz because of the large refractive index, which would create a speed difference with the light pulse. Still, the latest device technology has increased the speed to 40 GHz, thanks to the ingenuity incorporated in the waveguide structure.

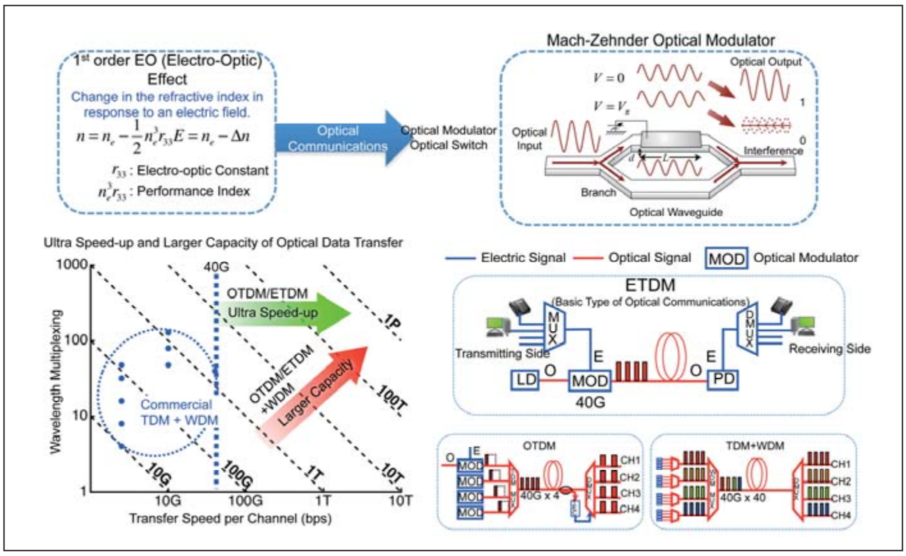


Figure 1●Electro-optic Modulator and Speed-up of Photonic Network

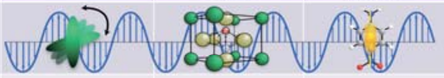
Material	Liquid Crystal	Inorganic Dielectric Crystal	Organic Dye Molecule
			
Resonance	Orientation Polarization (Dipole / Molecular Rotation)	Ion Polarization (Lattice Vibration)	Electron Polarization (Electron Transition)
Electro-optic Effect r (pm/V)	Extremely Large > 10,000	Small 32	Large > 150
Change in Refractive Index Δn	10^{-2} – 10^{-3}	10^{-4} – 10^{-5}	10^{-3} – 10^{-4}
Response Speed (seconds)	Slow 10^{-3} - 10^{-6}	Fast 10^{-10}	Very Fast 10^{-14}
Applications	Space Phase Modulator (Projector, Monitor)	High-speed Optical Modulator ~ 40 Gbps	Ultra-high-speed Optical Modulator/Switch > 100 Gbps

Figure 2●Comparison of Typical Electro-optic Materials

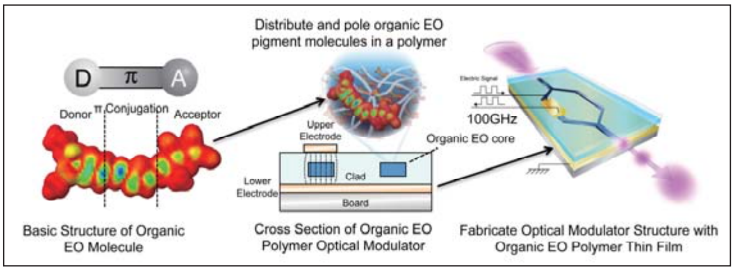


Figure 3●Organic EO Polymer Optical Modulator

But efforts to speed up LN modulators have already reached their limits. As for organic dye molecules, the fastest response time and a relatively large electro-optic effect can be expected because of the effect attributed to the electron polarization by the π-electron*2 response. Amid the recent growing demand for larger communications capacity and the challenge of optical interconnections in a chip in line with the speeding up of information technology equipment, ultra-high-speed optical modulators that are compact and consume little power are increasingly needed. This is accelerating the research and development of organic EO materials. As an example of those efforts, NICT has successfully developed a material that has a refractive index change twice as large as that of LN.

The basic structure of EO pigment molecules is an internal polarization structure linking an electron donor and an electron acceptor at the π conjugation as shown in Figure 3. The molecules with large internal polarization exhibit a high electro-optic effect, and therefore, in the development activities of EO pigment molecules, a great deal of effort has been put into looking for a structure with excellent properties by the area of a donor, πconjugation, and acceptor. As for the π conjugation and acceptor structures, those producing a large electro-optic effect have been discovered, but for the donor structure, an almost thirty-year EO molecule study has not seen significant progress. NICT has discovered a way in which an electro-optic effect can be augmented by adding a certain structure to the donor structure. The method is very simple and can be applied to most molecules. Especially, the larger electro-optic effect that a base molecule has, the greater the augmenting effect becomes. To fabricate an optical modulator using organic EO molecules, we distribute and pole*3 the EO pigment molecules in a polymer and create a waveguide structure. A higher density and degree of orientation of the organic EO molecules in a polymer will lead to a greater electro-optic effect, and, therefore, enhancing the degree of orientation of the molecules also is on our agenda. The next goal is to create a modulator structure using our unique high-performance EO polymer, thus advancing the research into ultra-high-speed optical modulation technology.

How Durable is an Organic EO Polymer?

Most of the organic matters that we see in our daily life tend to fade after exposure to the sun, so organic dyes are generally thought to be weak against light. The mechanism of color fading in organic dyes is mainly oxidation. Oxygen molecules in the air, however, are stable and do not directly react with organic matter, but when shifted to the state of active oxygen species, produce a strong oxidation effect. The active oxygen species generated by photoexcitation mainly include ozone and singlet oxygen*4. For oxygen molecules to become ozone or singlet oxygen, however, light with energy higher than about 1eV (with wavelength shorter than 1.27μm), such as ultraviolet rays and visible light, is required. The infrared light of a wavelength 1.3μm to 1.55μm bands is used in optical communications, and therefore the light will not cause ozone or singlet oxygen to be generated. If the light intensity is stronger, the chances increase that singlet oxygen will be produced due to two-photon absorption. The level of light intensity used for conventional optical modulation will not be an issue, but in the multiple-value modulation under consideration for future use, laser beans of ever higher output will be used. Therefore, research to eliminate the effect of oxygen will also be necessary.

As for thermal stability, EO pigments do not start decomposing at temperatures below 200°C, so there will be no problem fabricating devices. Over the glass transition temperature, however, the orientation of the EO polymers will become looser, deactivating*5 EO effect. The glass transition temperature of the developed EO polymer is about 135°C at this point, so this will not be an issue in normal-usage environments. Still, to ensure long-lasting reliability in heated environments, such as large-scale servers, we have also worked on a way to improve the thermal stability of organic EO polymers.

Future Prospects

Theoretically, organic materials with a larger electro-optic effect can be created, and NICT is determined to continue developing organic EO materials. One of the features of organic polymer materials is flexibility—they are easy to combine with other devices. At NICT, various research and development activities are underway to create key devices that will underpin future photonic networks. These activities range from further reducing of the power consumption of optical control devices and the micron level miniaturization through making on-chip optical buffer by combining materials with photonic nanostructures using highly accurate silicon treatment technology.

Organic matter is light in weight and resistant to cosmic rays and, thus, is suitable for use in satellites and planet probes. In addition, organic matter is very cheap and can provide various functions using common elements, such as carbon, hydrogen, nitrogen, oxygen, and sulfur, allowing it to be used for a wide range of applications. It is also easy to secure, since is is free of rare-metals.

Glossary

***1 Mach-Zehnder**

This is an interference method developed almost simultaneously but separately by L. Mach and L. Zehnder in 1891. The method employs a simple structure in which the light coming from a single source is branched, and then superimposed again after going through separate optical paths. The simple structure allows it to be easily constructed in an optical waveguide.

***2 π-electron**

The double bond of a molecule consists of an σ bond along the bond axis and a π bond orthogonal to the bond axis. The electrons in the π bond are called π-electrons. In a molecule with a π conjugation structure in which the double and single bonds alternate, π-electrons are delocalized and spread across the molecule.

***3 Poling**

Orientation means to align the direction of all the molecules. The pigments in a polymer usually face in all directions, which offsets EO effect of the aggregated pigments. Aligning all the molecules in the same direction by applying an electric field can maximize electro-optic effect of a polymer.

***4 Singlet Oxygen**

An oxygen molecule in the ground state is in the triplet state where the spinning direction of common electrons is the same. A singlet oxygen is an oxygen molecule in the excited state where the electrons have opposite spinning directions and a 0.98eV higher energy level than in the ground state. Singlet oxygen is not directly generated by photoexcitation, but through the triplet state of a photoexcited pigment.

***5 Deactivation**

A polymer becomes softer above the glass transition temperature, and the molecules start to move easily and end up facing in all directions. This causes EO effect of the the polymer to be lost.

Developing Brain Information Communication Technology

—Technology to Convey the Information that You Really Want to Communicate—

Yasushi Naruse

Senior Researcher, Brain ICT Laboratory, Advanced ICT Research Institute

After completing a doctoral course, Naruse joined NICT in 2007. He has been mainly studying brain information communications. Ph.D. (Science)

Introduction

Brain information communication technology (brain ICT) is a futuristic technology that aims to achieve freer, smoother communications without the limitations of languages by extracting information from the brain and transmitting it (see Figure 1). The goal is the kind of world shown in "Gundam" (Japanese animation), "GHOST IN THE SHELL" (Japanese animation), and "Matrix" (movie). Research into brain ICT has just started and such a world is a long way off, but these examples should give you a rough idea. The Brain ICT Laboratory has been researching brains from various angles in order to establish brain ICT.

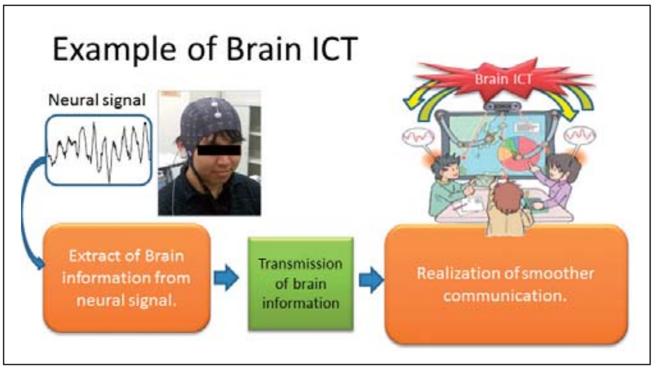


Figure 1●Example of Brain ICT

New Method to Extract Brain Information with High Accuracy

To develop brain ICT, the first thing we need is a technology for extracting brain information with high accuracy. To extract brain information from brain waves accurately, we first developed a statistical method for establishing a signal processing method suitable for brain waves. Fluctuations in brain wave signals have prevented existing methods from accurately extracting brain information from the waves. To overcome this hurdle, we have created a new statistical method by establishing a probabilistic model tailored to brain waves. The new method is based on findings of experimental research on brain waves and the research on a mathematical model. It utilizes Bayes' theorem to extract brain information. As shown in Figure 2, the method roughly works this way: break down the brain waves into amplitude and phase while reducing observation noise, and statistically examine the state change of the brain. This new method has allowed us to extract brain information with higher accuracy in terms of amplitude and phase than before, and also gives us additional information about the state change of the brain. In this way, by not being trapped in an old way of thinking or method but creating a new one, we successfully improved the accuracy of extracting brain information, as well as extracted new types information, thus building the foundation for establishing brain ICT.

Our study has now brought us closer to extracting brain information with higher accuracy. To interpret the extracted information in a meaningful way, something that tells us about the state of people's brain, for example, what they thought, what they felt, and how they liked something, we need to figure out the brain's mechanism for processing information and communicating. Utilizing diverse approaches, including neuroscience, engineering, and medical science, we have put a great deal of effort into interpreting the extracted brain information into something that tells us about the state of the brain in order to establish brain ICT.

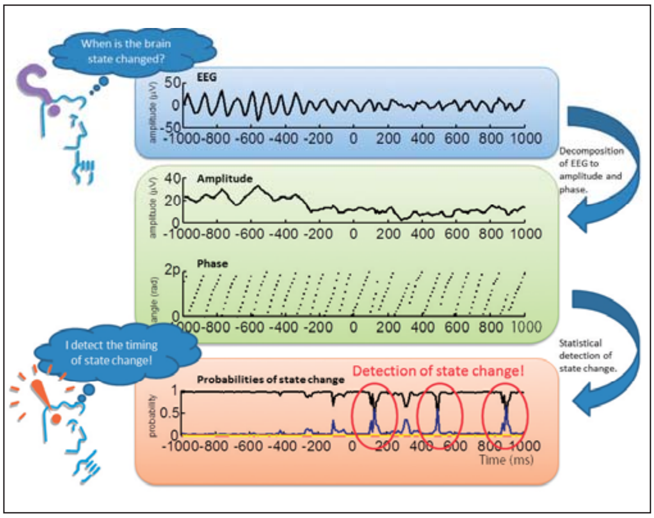


Figure 2●How to Accurately Extract Brain Information using the Developed Statistical Method

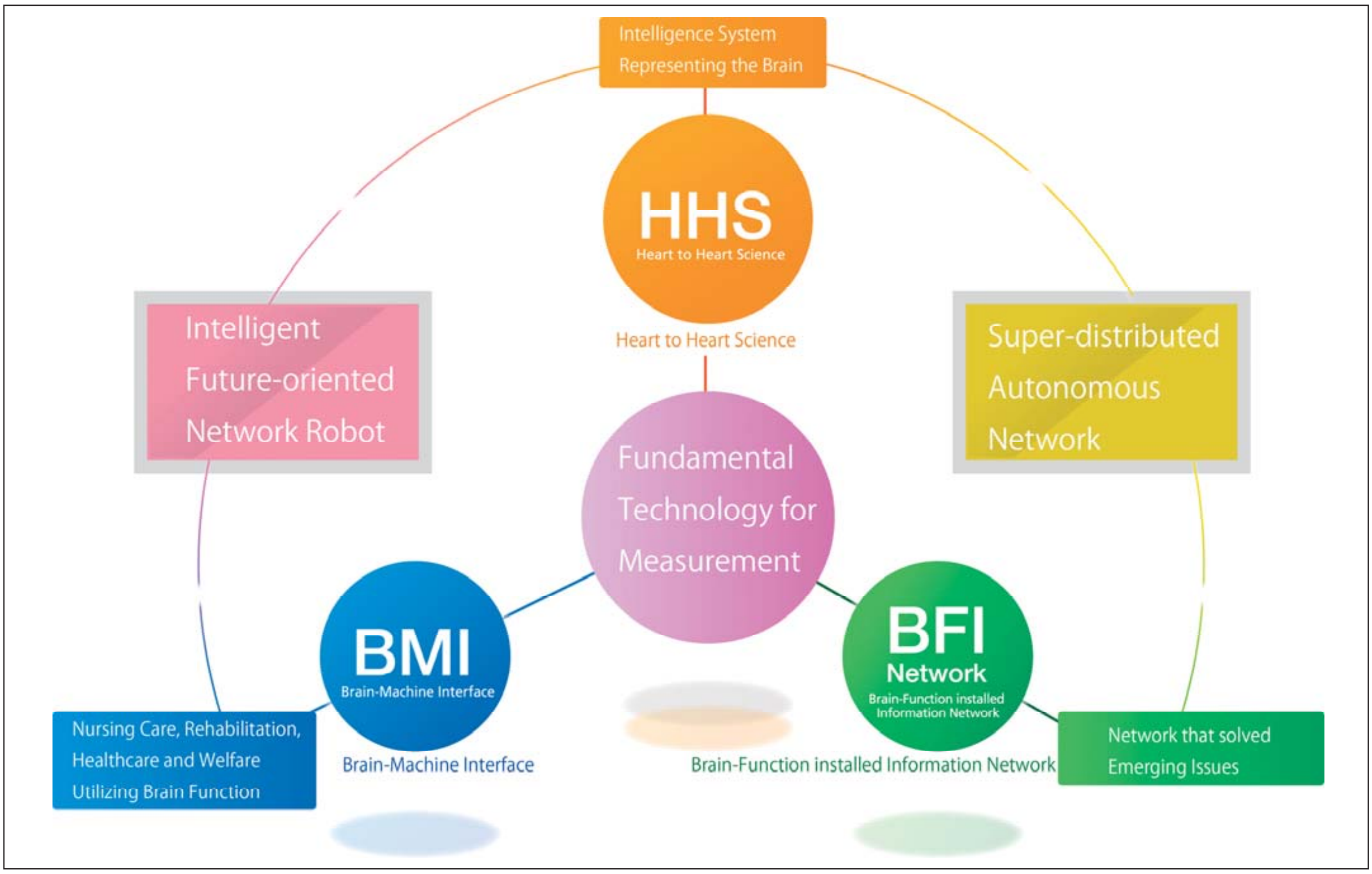


Figure 3●Study on Neural Systems and Information Networks

Study Started on Neural Systems and Information Networks

As mentioned above, establishing brain ICT requires incorporating knowledge from various research fields. To this end, NICT has started studying neural systems and information networks, and has incorporated various fields, such as information engineering, with conventional neuroscience. The studies of neural systems and information networks have four pillars: Heart to Heart Science (HHS) which looks scientifically into heart to heart communication from the brain function point of view; Brain-Function installed Information Network (BFI Network) which creates information network technology from what it learns from the brain; Brain-Machine Interface (BMI) which conveys information from brains to machines; and fundamental technology for measurement which establishes brain measuring technologies for the other three pillars (Figure 3). In this framework, the research results fall under the category of fundamental technology for measurement. Utilizing this technology, we would like to accelerate the other aspects of research of HHS, BFI Network, and BMI in order to establish brain ICT.

Many people may fear that brain ICT, once established, would be able to read minds, thus invading their privacy. Considering those concerns, we have been reviewing the ethical and safety aspects, i.e., what should and should not be conveyed with the technology, while proceeding with research. One of the efforts on the ethical aspect is summed up in the final agreement of "Panel Discussion concerning the Brain and ICT" issued by Ministry of Internal Affairs and Communications, with researchers from NICT participating as members of the panel. For those interested, please refer to
http://www.soumu.go.jp/main_content/000114261.pdf

Future Prospects

Brain ICT is a new area of study and has a long way to go before it starts to take shape. We will work out ways to establish brain ICT utilizing this new framework study on neural systems and information networks from a mid- to long-term standpoint. We would like to provide better communication means to elderly people and the physically challenged first, then, make it something useful for all people in the future.

Prize Winners

Prize Winner ● Yasushi Naruse / Senior Researcher, Brain ICT Laboratory, Advanced ICT Research Institute

◎Date：2011/6/3

◎Name of Prize：

26th Japan Biomagnetism and Bioelectromagmagnetics Society U35 Award

◎Details of Prize：

In recognition of excellent research presentation of "A novel method for detecting rapid phase modulation of ongoing oscillation in single trial" (written by Yasushi Naruse, Ken Takiyama, Masato Okada, and Tsutomu Murata)

◎Name of Awarding Organization：

Japan Biomagnetism and Bioelectromagmagnetics Society

◎Comments by the Winner：

This prize was awarded in recognition of the world's first successful detection of phase modulation in alpha rhythms, which occurs when people see something, from a one-time brain wave measurement. In a series of studies aimed at extracting brain information from alpha rhythms with great accuracy, this is the third prize that we have received from an academic society. This seems testimony to the high commendation of the study itself and gives us great encouragement. We will continue to be committed to establishing a technology that will enable more brain information to be conveyed.

Prize Winner ● Mohammad Azizur Rahman / Expert Researcher, Smart Wireless Laboratory, Wireless Network Research Institute
Chunyi Song / Expert Researcher, Smart Wireless Laboratory, Wireless Network Research Institute
Hiroshi Harada / Director, Smart Wireless Laboratory, Wireless Network Research Institute

◎Date：2011/6/3

◎Name of Prize：

CrownCom 2011 IEICE SR Paper Award

◎Details of Prize：

Development of a TV White Space Cognitive Radio Prototype its Spectrum Sensing Performance

◎Name of Awarding Organization：

CrownCom 2011 committee

◎Comments by the Winner：

It is a great honor for our paper to receive the IEICE Software Radio Award at the CrownCom 2011 conference. In the paper, we detailed our recent achievements in developing advanced algorithms and prototyping them for sensing primary signals in television white space (TVWS) bands. The prototype based on our algorithm is able to sense primary signals at an outstanding level of -120 dBm/8MHz, as well as has capability to access a TV band database and make cognitive decisions. We thank all who supported us during the project and would like to continue research and development of a system-on-a-chip for such devices.

From left, Mohammad Azizur Rahman, Chunyi Song, Hiroshi Harada, and Seiichi Sanpei, Professor of Osaka University, who presented the award

Prize Winner ● Amane Miura / Planning Manager, Strategic Planning Office, Strategic Planning Department

◎Date：2011/6/16

◎Name of Prize：

Highest Number of Presentations Award, Distinguished Service Award

◎Details of Prize：

In recognition of the contribution to theTechnical Committee on Antennas and Propagation by making the highest number of presentations. In recognition of the contribution to academic exchanges as a member of the paper group of the Technical Committee on Antennas and Propagation

◎Name of Awarding Organization：

Technical Committee on Antennas and Propagation of IEICE

◎Comments by the Winner：

It is a great honor for me to receive the Highest Number of Presentations Award from the Technical Committee on Antennas and Propagation of IEICE for a series of presentations we made on the Research and Development of Terrestrial/Satellite Cell Phone System Technology at the former Space Communications Group (currently, Space Communication Systems Laboratory) during FY2010. I would like to extend my deep appreciation to the group members who gave me the great opportunity to proceed with the study. I also received Distinguished Service Award for my two-year services as a member of the paper group of the said committee. I thank all the committee members who worked together.

Prize Winner ● Satoshi Maekawa / Senior Researcher, Ultra-realistic Video Systems Laboratory, Universal Communication Research Institute

Joint Prize Winners：

Sandor Markon
Former Guest Expert Researcher of NICT Ultra-realistic System Group (currently, professor of Kobe Institute of Computing/Graduate School of Information Technology)

Foucher Jean-Michel
Formerly with NICT Ultra-realistic System Group (currently with Kobe Digital Labo)

◎Date：2011/7/14

◎Name of Prize：

Excellent Paper Award

◎Details of Prize：

Interaction with floating images using depth information

◎Name of Awarding Organization：

3D Image Conference 2010 Organizing Committee

◎Comments by the Winner：

The prize was awarded in recognition of our paper that proposed an interaction system that can detect and present depth information as an application of the optical element with the ability to form a mirror image as a real image. Utilizing the fact that there is no focal length even if it is a planar image in the air, the display position can be freely changed in the depth direction. The use of multiple infrared touch panels has enabled a user to interact from the back side and to detect the vector of the fingers. My next goal is to return the profits to society by launching a venture company.

Report on 10th Business-Academia-Government Collaboration Summit

Business-Academia-Government Collaboration Summit, which had taken place in Kyoto in June until last year, was held at the Tokyo International Forum on Wednesday, September 21, and Thursday, September 22, 2011.

The Business-Academia-Government Collaboration Summit provides a place for first-line leaders, business persons, and others to discuss various study themes, transfer technologies, exchange information and interact with each other, in order to help solve concrete challenges with a view to drastically moving forward cooperation among industry, academia, and government.

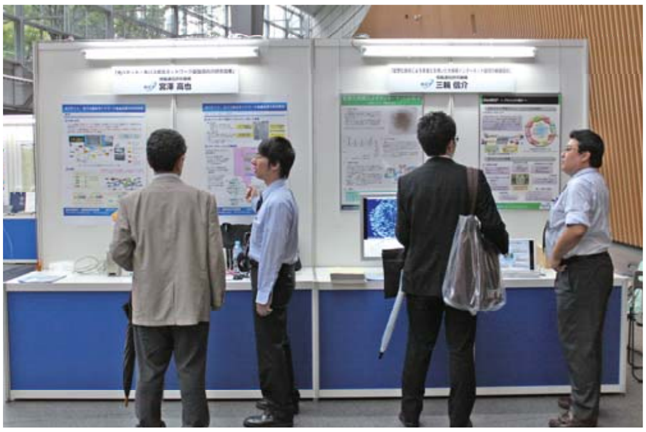
In this event, Minister for Internal Affairs and Communications gave "the Award for Promotion of Cooperation among Industry, Academia, and Government" to the best practices that have made a significant contribution to promoting cooperation among industry, academia, and government. And Iwao Hosako, Associate Director General of Advanced ICT Research Institute, received the prize jointly with the NEC Guidance and Electro-Optics Division and Professor Susumu Komiyama at The University of Tokyo for "Development of Terahertz Array Sensor and Handy Terahertz Camera".

Meanwhile, of the selected 20 young researchers who have produced extraordinary research results were given the opportunity to speak about their research and to display panels. On behalf of NICT the following researchers were selected. (1) Maya Mizuno, Senior Researcher of Electromagnetic Compatibility Laboratory, Applied Electromagnetic Research Institute (Analysis Method of Organic-Inorganic Composite using Terahertz Wave), (2) Takaya Miyazawa, Researcher of Network Architecture Laboratory, Photonic Network Research Institute (Research and Development of Fundamental Technology of Optical Packet and Circuit Integrated Network), and (3) Shinsuke Miwa, Associate Director of Network Testbed Research and Development Laboratory, Network Testbed Research and Development Promotion Center (Imitative Technology of Large-scale Internet Environment using Multiplexing by Virtualization Technology)

NICT also described using panel displays how a communications satellite system utilizing the cognitive wireless routers currently under development and the ultra-high-speed internet satellite WINDS (Wideband InterNetworking engineering test and Demonstration Satellite) contributed to relief efforts in the wake of the Great East Japan Earthquake.

●Associate Director General Hosako receiving the Award from Minister of Internal Affairs and Communications

●Senior Researcher Mizuno speaking about his research results



●Researcher Miyazawa and Associate Director Miwa explaining their respective research results

●Panel display of how our technologies were utilized after the Great East Japan Earthquake

Report on National Science and Technology Fair 2011 in Thailand

The National Science and Technology Fair 2011 was held from Saturday, August 6, to Sunday, August 21, at BITEC (Bangkok International Trade and Exhibition Centre) in the suburbs of Bangkok under the auspices of the Ministry of Science and Technology and other institutions in Thailand. NICT has participated in the fair since 2007. This time, NICT demonstrated the Real-time Terahertz Imaging System and Four-dimentional digital globe, Dagik Earth, to introduce a taste of advanced technologies in an easy-to-understand way.

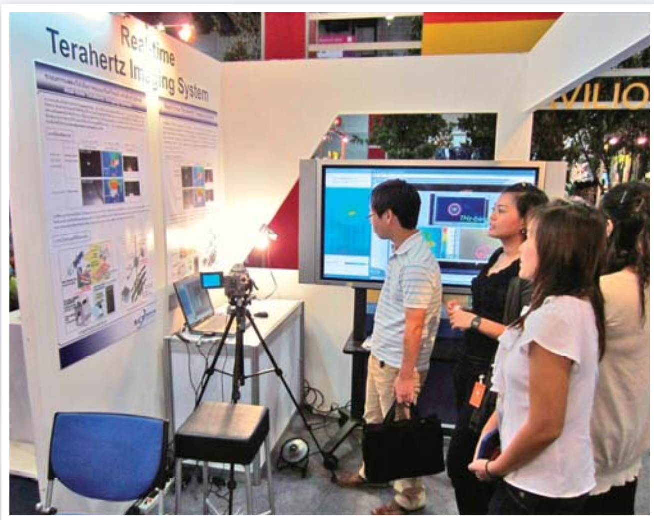
During the term, about 1.24 million people (according to the organizer) including experts, as well as elementary, junior high, and high school students, from all over the country visited the venue. On Tuesday, August 9, we had the pleasure of Her Royal Highness Princess Maha Chakri Sirindhorn's company at the opening ceremony. Later, she dropped by the NICT booth together with the minister of Science and Technology and showed interest in Dagik Earth and other presentations.

●Her Royal Highness Princess showing interest in Dagik Earth

●Her Royal Highness Princess rotating Dagik Earth with the controller of a game console

(Photo courtesy of National Science Museum, Thailand)

●NICT booth in the Japanese pavilion



●Visitors taking interest in the Terahertz Imaging System

Report on 2011 Youngsters' Science Festival in Koganei, Tokyo

As a part of regional cooperation, "2011 Youngster's Science Festival in Koganei, Tokyo" was held on Sunday, September 11, at the Koganei campus of Tokyo Gakugei University. NICT participated in the event this year.

The festival, positioned as one of the opening events of the Tokyo International Science Festival, is a big science event in the region, where many people of different affiliations, such as the Koganei City Society of Commerce and Industry, Junior Chamber, school boards, companies, universities, high schools, fire departments, police stations, and laboratories, gather to participate.

This year, 121 booths welcomed more than 7,000 visitors. Many people dropped by the NICT booth and had a good time while taking a shot at code-breaking and touching 10,000-year-old ice from Antarctica.

●Let's see how well you can do! Children trying to break a code by choosing two of many sheets.

●Children enjoying craft work, making artificial satellites, etc.

●Writing a postcard to be delivered with the postmark of Showa Station in Antarctica.

●Stamping a sheet with this year's Antarctica memorial stamp.

●Want to taste it! Parent and child touching 10,000-year-old ice from Antarctica.

NICT New Vision Presentation

— The Third Medium-Term Plan/Disaster and ICT —

Join us for the NICT New Vision Presentation. If you are interested, please register yourself in advance through the following web page.
http://www.nict.go.jp/nict-sympo/

No participation fee

Date 14:00-17:30 (doors open at 13:30) on Wednesday, November 9, 2011

Place Tokyo Conference Center Shinagawa

14:00
- Opening Address
- Guest Address

14:10 Presentation of NICT Basic Policy
- NICT's New Vision — **Hideo Miyahara,** President

14:40 New Tide in ICT Field (Keynote Lecture)
- Expectations Toward Study on New Generation Networks — **Hisashi Kobayashi,** Senior Distinguished Researcher Electronics and Computer Science at Princeton University (U.S.) Emeritus Professor at Sherman Fairchild University
- Paradigm Shift in Information Communications Technology Learning from Living Organisms — **Toshio Yanagida,** Distinguished Researcher, Director of Study on Neural Systems and Information Networks Center (Specially Approved Visiting Professor, Special Study Promotion Course, Graduate School of Frontier Biosciences of Osaka University)

Intermission (Coffee break & Looking around exhibitions)

16:00 Restoration Efforts after Disaster
- Restoration Efforts by NICT after Disaster (Including Fundamental Technology of Electromagnetic Sensing) — **Hiroshi Kumagai,** Vice President

16:25 Research Strategies as a New Challenge for NICT
- Network Fundamental Technology — **Masahiko Tominaga,** Vice President/Network Director General
- Universal Communications Fundamental Technology — **Yutaka Kidawara,** Director General of Universal Communication Research Institute
- Advanced ICT Fundamental Technology — **Kazuhiro Oiwa,** Director General of Advanced ICT Research Institute

17:20
- Closing Address

※Demonstrations and panel displays on the third mid-term plan will be held next to the presentation room.
※The contents of the program are subject to change without notice.

Information for Readers

The next issue will feature stereoscopic displays and look at the Glasses-free Stereoscopic Display Technology of the 200-Inch Monitor exhibited at CEATEC JAPAN 2011 and Electronic Holography Technology, the ultimate 3D image.

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