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Energy-Saving Mechanisms in Biological Molecular Machines

—Approach to the molecular mechanism for the force-maintenance state of bivalve muscles with low energy expenditure—

YAMADA Akira

Senior Researcher, Bio ICT Laboratory, Advanced ICT Research Institute

After completing a doctoral course and serving as a Research Fellow for Young Scientists (PD) of Japan Society for the Promotion of Science, he joined Communications Research Laboratory (currently, NICT). He is mainly engaged in biophysical research and development related to *in vitro* reconstitution systems by using biomolecules such as proteins. Ph. D. (Science).

Energy saving muscles

It is extremely important matter in today's society how we use limited energy efficiently. This can be said to the world of living organisms: there are various energy strategies for organisms as well. Studying energy-saving strategies of biomolecules is significant for both researchers developing technology that use natural biomolecules such as protein molecules, and for researchers aiming to find clues to technology development from energy strategies of biomolecules.

In the area of the energy-saving strategies of organisms, we have been focusing our research on mechanism seen among the muscles of bivalves called catch. When you cook bivalves such as clams and scallops by boiling or grilling, the shells open widely. This is because the elasticity of a hinge which connects two shells, and the shells are made to open when there is no external force. However, while the shellfish is alive, its clamshells are usually almost closed. The adductor muscles are muscles which play a role of keeping the shells closed by generating external force, they need to keep their forces at all time. It is equivalent to the muscles of hands and arms of humans to continue holding a heavy object, and steadily consuming energy which makes them tired. On the other hand, the adductor muscles can keep their forces without consuming much energy. Such state of low-energy consumption of adductor muscles is called catch, and its mechanism has been clarified relatively recently.

In many cases, the adductor muscle of a shellfish consists of two parts. Figure 1 shows a giant oyster and a noble scallop. Each adductor muscle consists of a large circular part and a smaller elongated part aligned with the former. In general, the muscle is made up of bundles of numerous protein filaments in two types. They are actin filaments and myosin filaments, each of which is a few micrometers long. But their alignments are different depending on the type of muscles. Figure 2 shows the differences among cross striated muscle, obliquely striated muscle, and smooth muscle, but all of them contract by sliding movements between the two types of filaments. Each panel in Figure 2 shows the muscle before (upper) and after (lower) contraction. The smaller parts in both species are smooth muscles. The larger parts are an obliquely striated muscle in the giant oyster and a cross striated muscle in the noble scallop. The two parts of each adductor muscle have slightly different characteristics and roles. Both muscles are used to close the shells, but the cross striated muscle and the obliquely striated muscle contract quickly, allowing the shells to close quickly. Our muscles in hands and arms are also cross striated muscles and have similar characteristics since they contract rapidly. The smooth muscles on the other hand, contract slowly and get into the catch state keeping the shells closed.

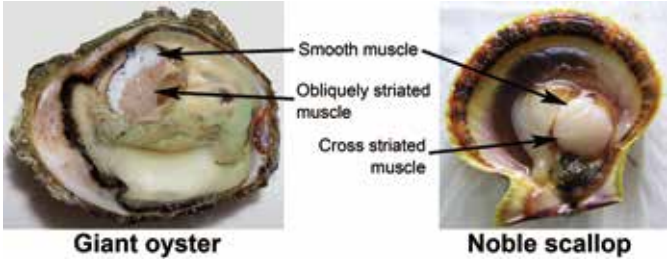

Figure 1 Adductor muscles of a giant oyster and a noble scallop

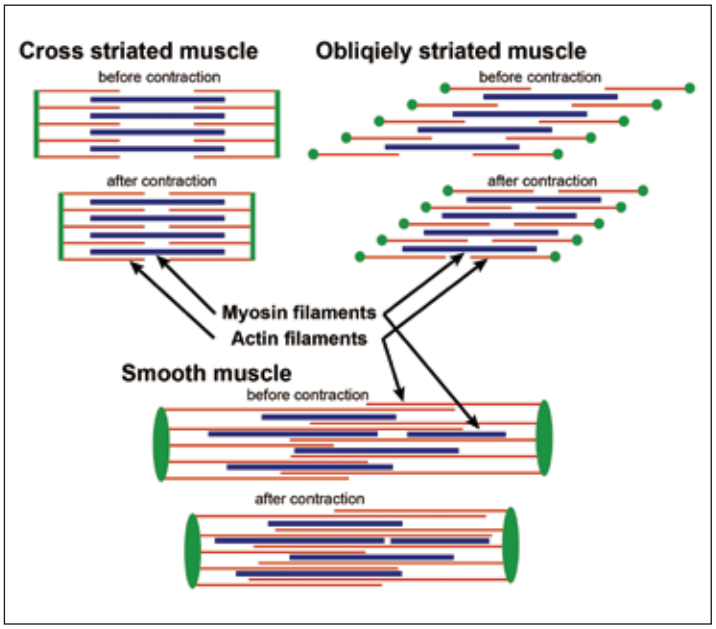

Figure 2 The differences in the alignments of filaments between different types of muscles

Reconstitution of the catch state, and energy consumption

We have succeeded in reconstituting and observing the catch state under a microscope by using actin and myosin filaments taken from muscles. In this state, we have found that these filaments are bound to each other. Also we have found that it needs another protein called twitchin. Twitchin works as a switch between the two states, the catch state where the muscle keeps a large force and the relaxed state where the catch is released. Figure 3 shows our results of the two states of filaments observed under a microscope. Only myosin filaments could be seen under the dark-field observation, while only actin filaments could be seen under the fluorescence observation. In the catch state, both filaments bound to each other forming bundles, while in relaxed state, they did not. In the absence of twitchin, they did not bind, and thus they were in the relaxed state. Intrinsically, obliquely striated muscles contain only a small amount of twitchin, but we found that they could be in the catch state if they contain a large amount.

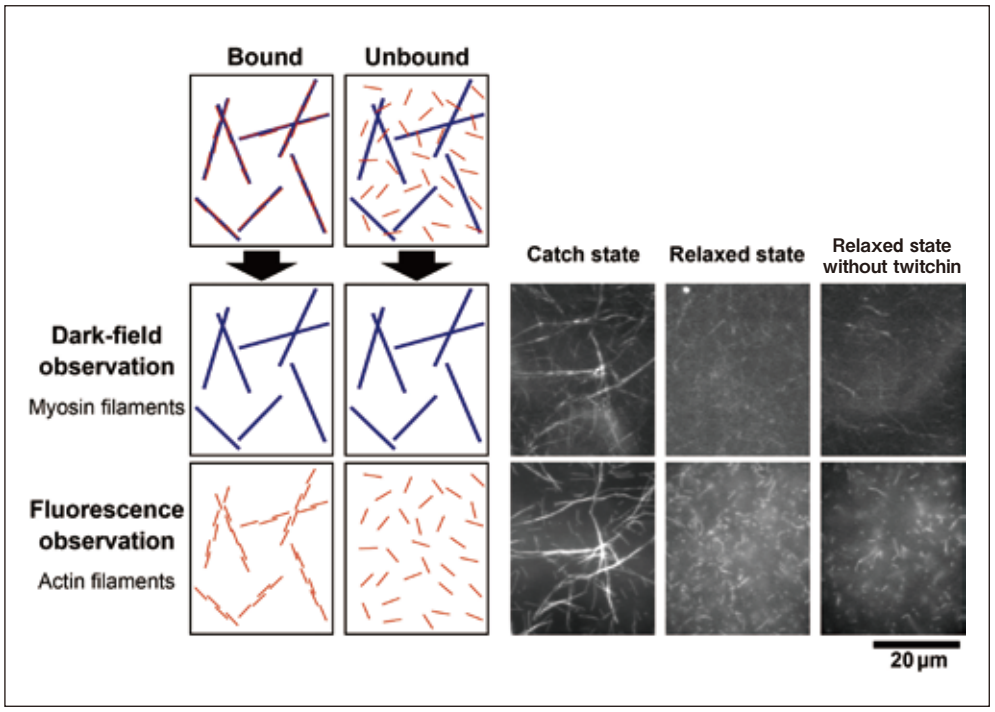

Figure 3 Observations of interactions among filaments under an optical microscope

Figure 4 shows the rates of energy consumption under the different reconstituted states of the smooth muscle and obliquely striated muscle of a giant oyster: contracting state, catch state, relaxed state, and relaxed state without twitchin. We measured the hydrolysis rates of ATP (adenosine triphosphate), the immediate energy source for muscle contractions. The obliquely striated muscle contracts more quickly and consumes larger amount of energy. Interestingly, in the catch state, both muscles consume energy to a little extent and the obliquely striated muscle consumes more energy than the smooth muscle. We assume that in their process of evolution, they took the energy-saving strategy to develop smooth muscles separately instead of making obliquely striated muscles to be able to be in the catch state.

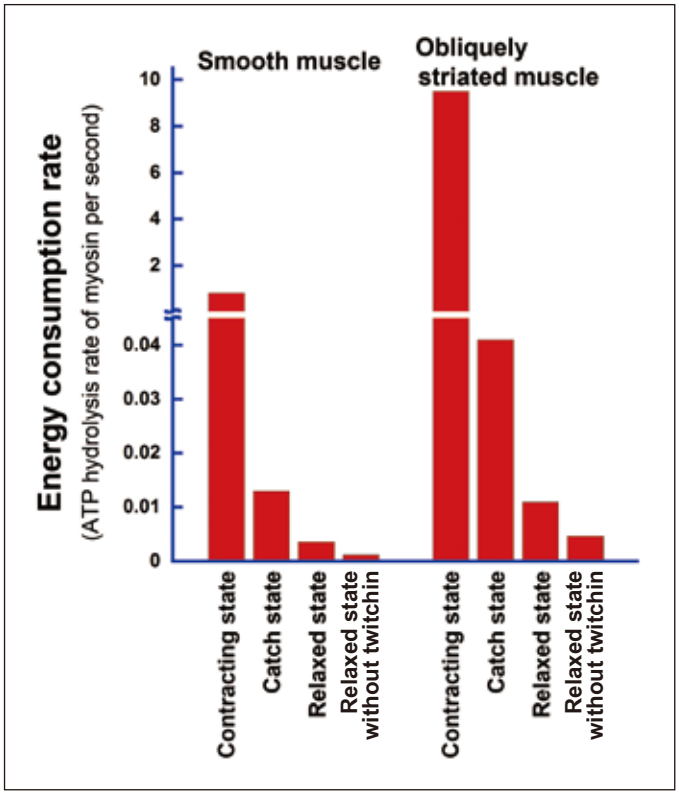

Figure 4 The comparison of energy consumptions by the states of two muscles in a giant oyster

Future prospects

As the word bio-diversity shows, various organisms on earth are keeping their lives with their own strategies. The energy-saving strategy of bivalves is one among them, and we have been studying its molecular mechanisms. The sea urchin, starfish and sea cucumber have completely different energy-saving strategy where they keep their postures by using connective tissues mainly consisting of collagen fibers. There are many things yet to be clarified, and we would like to clarify the mechanism of this energy-saving strategy, which is different from that of bivalves described here. We believe that such new findings of the energy-saving strategies in living organisms will be useful when applied to save energy in information and communications system.

Verification of Cryptographic Protocols and Opening of Portal Web Site

—Toward suitable application of security techniques for ICT systems—

MATSUO Shin'ichiro

Director of Security Architecture Laboratory, Network Security Research Institute

He started research on information security and applied cryptography in 1996 at NTT DATA Corporation. In 2009, he joined NICT, and he has been promoted to the present post since 2011. Ph.D. (engineering).

Cryptographic protocol that supports security of ICT system

Information system we use on a daily basis uses many security technologies. For example, when you access an online banking service or online shopping site, authentication technology is used to confirm that the connection destination is correct web server, and after authenticated, encrypted communication is operated to ensure the security against eavesdropping on communication channel. Also, similar authentication and encryption technology are used for wireless LAN which is widely spread today.

Such security technologies are generally called "cryptographic protocol".In other words, this technology allows realizing enhanced security such as authentication and privacy protection by combining basic encryption algorithm like encryption and electronic signatures with communication transactions among servers and terminals.

Cryptographic protocol is used not only for aforementioned cases like access to web sites, but also for develop technologies towards various applications such as authentication of emails, prevention of alterations of data, and time-stamping. More than 400 technologies are standardized at ITU, ISO/IEC, IETF, and IEEE.

Security evaluation for cryptographic protocol

Cryptographic protocol supports the security of the network we use every day, but it is a big issue whether each cryptographic protocol will ensure the security users expect. As mentioned above, there are many standard technologies, but on the other hand, vulnerability of cryptographic protocol is sometimes reported. This is because even though the basic cryptographic protocol is secure, there are chances of vulnerability due to insufficiency in system architecture in combination with communication. For such reasons, security evaluation of cryptographic protocol that meets with the security requirement of users is needed.

There are different methods in the security evaluation of cryptographic protocol, but the way of thinking is very simple: It basically checks if the attack method, a combination of behaviors in attacking protocol by freely combining attacker's capability to compromise the expected security of protocol, exists. As a method of checking, one method is to explore state transition one by one, another method logically certifies the possibility of attacks (Figure 1).

Past efforts achieved by NICT

At NICT, we have previously conducted security evaluation for authenticating correct users/servers against ISO/IEC 9798-2, 3, and 4, international standard of entity authentication, and have found a deficiency in system design. We have reported this evaluation result with revision to deficiency in system design, and revised the international standard as NICT researchers playing a central role. This evaluation result also contributed to the selection of "entity authentication" of e-Government Recommended Cipher List that was revised in 2013. Although there are various evaluation methods for cryptographic protocol, the details are different depending on the method of evaluations.

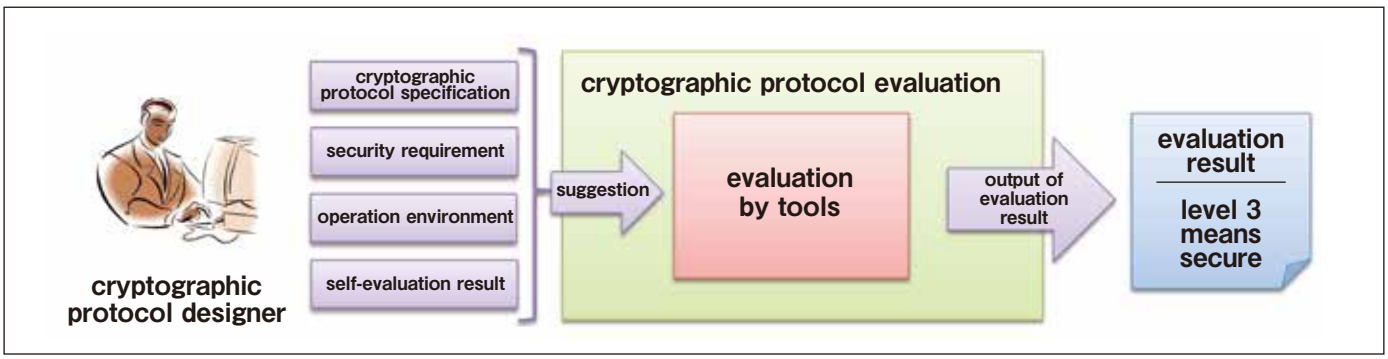

Figure 1 Basic composition of cryptographic protocol evaluation

Accuracy

Protocol Assurance Level	PAL1	PAL2	PAL3	PAL4
Protocol Specification	PPS_SEMIFORMAL Semiformal description of protocol specification	PPS_FORMAL Formal description of protocol specification	PPS_MECHANIZED Formal description of protocol specification in a tool-specific specification language, whose semantics is mathematically defined	
Adversarial Model	PAM_INFORMAL Informal description of adversarial model	PAM_FORMAL Formal description of adversarial model	PAM_MECHANIZED Formal description of adversarial model in a tool-specific specification language, whose semantics is mathematically defined	
Security Property	PSP_INFORMAL Informal description of security property	PSP_FORMAL Formal description of security property	PSP_MECHANIZED Formal description of security property in a tool-specific specification language, whose semantics is mathematically defined	
Self Assessment Evidence	PEV_ARGUMENT Informal argument that the specification of the cryptographic protocol in its adversarial model achieves and satisfies its objectives and properties	PEV_HANDPROVEN Mathematically formal paper-and-pencil proof verified by human that the specification of the cryptographic protocol in its adversarial model achieves and satisfies its objectives and properties	PEV_BOUNDED Tool-aided bounded verification that the specification of the cryptographic protocol in its adversarial model achieves and satisfies its objectives and properties	PEV_UNBOUNDED Tool-aided unbounded verification that the specification of the cryptographic protocol in its adversarial model achieves and satisfies its objectives and properties

Figure 2　Protocol Assurance Level by ISO/IEC 29128

Therefore, we have drafted ISO/IEC 29128 (Verification of Cryptographic Protocols) that defines evaluation level in four steps that can be realized by each evaluation method (Figure 2).

We also conducted security evaluation of time-stamping protocol (ISO/IEC 18014) and privacy protection authentication protocol for RFID, and presented the research result.

Launching cryptographic protocol evaluation portal site and its role

The security evaluation results of cryptographic protocol need be public as much as possible so that people will not use vulnerable cryptographic protocol that can be attacked. Especially for ICT designers, constructers, and operators of the system, it is important to select cryptographic protocol with least possibility of being attacked, and latest information need to be provided to them. However, there has been apparently no effort to collect and publish security evaluation results of cryptographic protocol worldwide.

There upon, NICT opened a portal web site for cryptographic protocol evaluation on July 1, 2013, the world's first effort of its kind (http://crypto-protocol.nict.go.jp/index_en.html) (Figure 3). The contents on the site provide following evaluation results using cryptographic protocol evaluation tools that are publically available:

- -Description of cryptographic protocol
- -Description of required security functions
- -Description of attacker's environment
- -Output of cryptographic protocol evaluation tool and its explanation

When there is no possibility of attack, nothing will appear. When there is a possibility of attack, its procedures will appear. In other words, by looking at the files, user can check if there is a procedure for attack against each cryptographic protocol. Anyone can retest the content again by using the tools.

Future prospects

At NICT, we will continue to evaluate cryptographic protocol of standard technology, and will publish the evaluation results. We will also add the function that becomes a common infrastructure for promoting the research of this area for researchers in and out of Japan. We will continue to promote research and development of advancing cryptographic protocol evaluation technology, and plan to aim at making the web site the center of this research area by conducting cryptographic protocol evaluation and providing evaluation results, and contributing to international standardization.

Figure 3　Portal web site for cryptographic protocol evaluation

Radio Wave Transmission via an Optical Link

—Toward the realization of ultra-high-speed radio communications by using advanced optical communication technologies—

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After completing a doctoral course and having worked at Venture Business Laboratory in University of Tsukuba, He joined NICT in 2006. He engages in research on high-speed optical modulation/demodulation technique, microwave and millimeter-wave radio-over-fiber technology, and terahertz communication. Ph.D. (Science).

KURI Toshiaki
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Research Institute

After completing a doctoral course, he joined Communications Research Laboratory (currently, NICT) in 1996. He engages in research including radio-over-fiber systems and optical communication systems. Ph.D. (Engineering).

KAWANISHI Tetsuya
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Photonic Network
Research Institute

After completing a doctoral course and working as a research fellow at Kyoto University Venture Business Laboratory, he joined Communications Research Laboratory (currently, NICT) in 1998. He engages in research including optical modulation devices, millimeter-wave/microwave photonics, and high-speed optical transmission technology. In 2004, he became a visiting researcher at University of California, San Diego. He has been named an IEEE Elevated Fellow. Ph.D. (Engineering).

Encapsulating radio wave in lightwaves

As smart phones gaining popularity at a rapid rate, people are now able to connect to the Internet anytime. However, there are many so called radio dead-zones where radio wave is hard to receive in places like inside a tunnel, underground shopping street, mountainous areas and in upper floors of skyscrapers. Of course it is always better to set up a new base transceiver station, a device to send/receive radio waves, but how can we transmit radio wave when we cannot set up the station due to restrictions on costs and locations? Using coaxial cable made of metal only reaches several tens of meters because the attenuation quantity is large at the microwave band used by mobile devices. On the other hand, optical fibers used in optical communication can transmit optical signals to over tens of kilometers away, with one-thousandth attenuation compared to coaxial cable. Therefore radio-over-fiber technology has been developed (Figure 1) which uses electrical-to-optical converter to convert radio wave information into optical signals when transmitting radio wave to radio dead-zone, and transmit optical signals by using optical fiber with extremely low attenuation, and another optical-to-electrical converter at a receiving end converts back to radio wave. This behaves as if the radio waves are encapsulated into lightwaves. Also the core of optical fiber is made of glass, and is relatively easier to be placed in a thin piping. This allows radio wave to deal with the limitation of costs and location. The radio-over-fiber technologies are already used to solve radio dead-zone issues for mobile phones and terrestrial digital broadcasting.

Applying advanced optical communication technology to wireless communications

Practical use of optical communication with communication speed of 100 gigabit per second is around the corner. Then how do we realize 100 gigabits per second high-speed

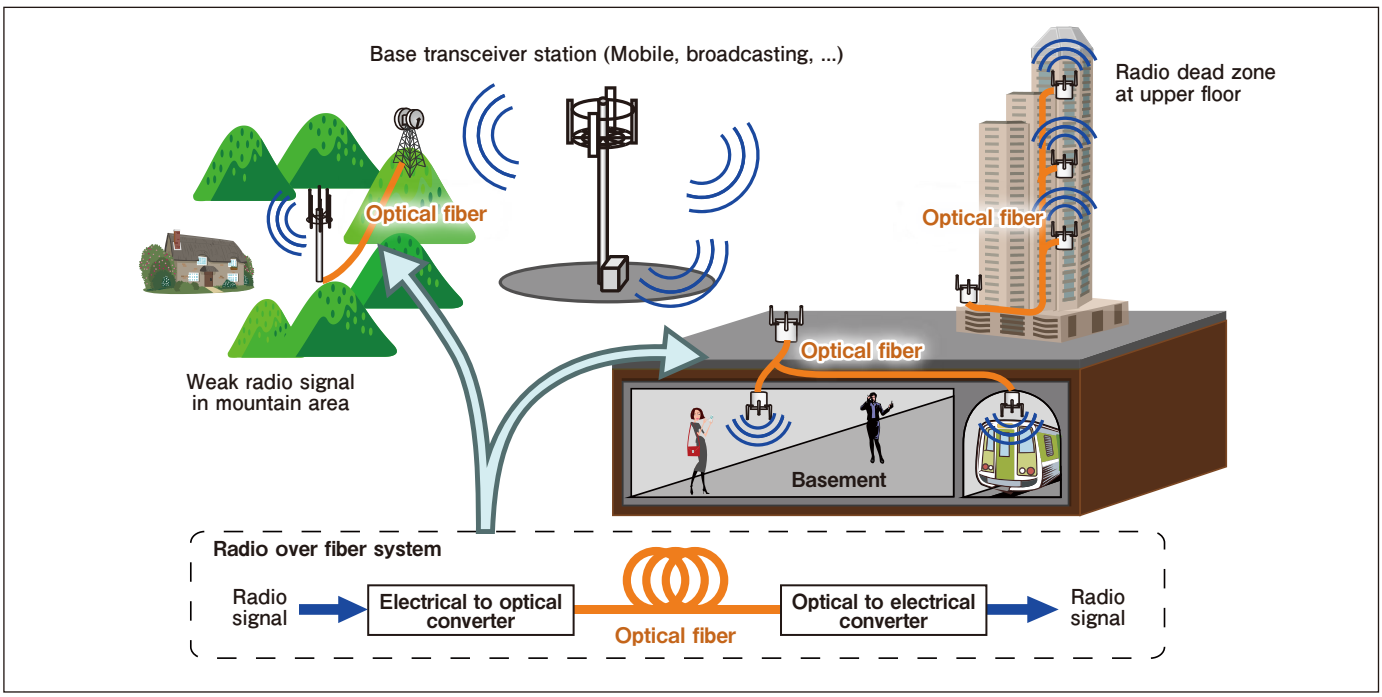


Figure 1 The compositional element of radio-over-fiber technology and its uses

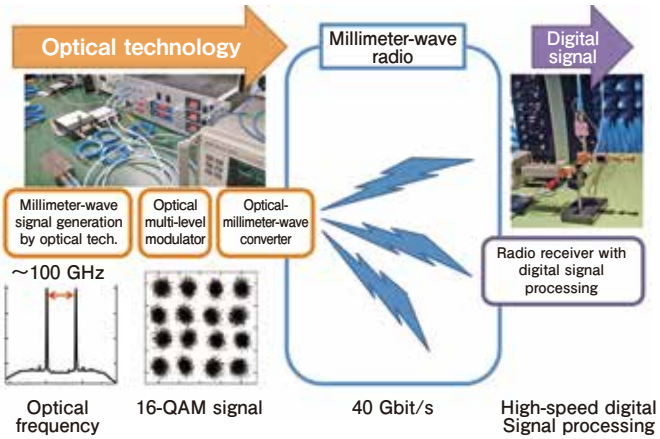


Figure 2 Schematic drawings of high-speed wireless transmission by millimeter-wave band radio-over-fiber technologies

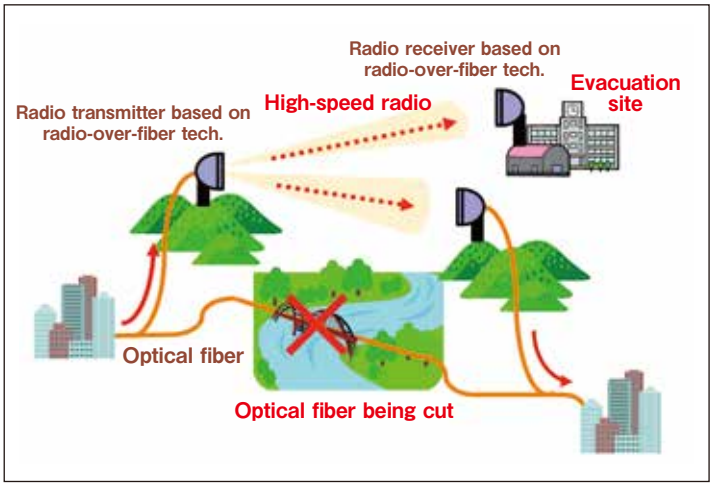


Figure 3 Temporarily constructed high-speed wireless with high degree of compatibility with optical fiber communication

communication with radio? To make that happen, we first need to enhance the frequency of radio wave from microwaves of around 2 GHz frequently used by mobile phones to much higher degrees. The data are sent with modulation, a transmission of signals by varying its waveform (the amplitude and phase of waves) in every interval, when the frequency of a radio wave is high, the period of a wave becomes short, allowing larger amount of waveform to be transmitted with shorter intervals. For example, by using millimeter-wave (a radio wave at the frequency of 30–300 GHz), it can generate wireless communication signals that are even faster than microwaves used in mobile phones. Until today, it has been difficult to generate stable millimeter-wave signals with optical technologies, but by combining the advancement and radio-over-fiber technologies, it has been enabled to generate stable optical signals to send 100-GHz millimeter-wave. At NICT, we are studying radio-over-fiber technologies with enhanced stability and precision, and developing millimeter-wave signal generation technology as well as that of sub-millimeter-wave (frequency of over 300 GHz) which is higher in frequency than millimeter-wave.

So how high-speed data can be carried in millimeter-wave radio? The available frequency band that can be used for radio wave are restricted by the radio regulations, and because the bandwidth in radio is much narrower than that used in optical communication, the data need to be squeezed into a narrow bandwidth in order to generate high-speed signals. For example, when modulating waveform of signals to be defined as (1) with radio wave, (0) without radio wave, it can transmit one bit at a time, but when one can modulate it to 0, 1, 2, 3, … by varying the waveform intricately, one can transmit more data at a time. This is called multi-level modulation technique, and is already used in communication technology of mobile phones. For example, in Long Term Evolution or LTE Standard, it can transmit signals of 150 megabits per second with bandwidth of 20 MHz, and it uses a modulation technique that can transmit more than 7-bit data at a time. This advanced modulation technologies of wireless communication have begun to be applied to advanced optical communication, allowing optical communication to transmit more than 2-bit signals simultaneously.

Furthermore, by combining the technology of generating millimeter-wave by using optics from radio-over-fiber technology with multi-level modulation technique, it has been enabled to generate high-speed wireless communication signals in millimeter-wave which was difficult to achieve by solely using electronic technology. At NICT, we have succeeded in generating radio-over-fiber signal of 16-ary quadrature amplitude modulation, a multi-level modulation method of transmitting 4 bits per second, with a symbol rate of 10 GHz in practice. Not only sending radio wave information in optical fiber, we also succeeded in transmitting radio wave over air generated by optical-to-electrical converter (Figure 2). The data transmission speed has reached 40 gigabit per second, which is equivalent of 2 hour-long film on Blu-ray Disc to be transmitted in approximately 10 seconds.

Towards more useful radio-over-fiber technology

The radio-over-fiber technology is in the process of standardization at International Telecommunication Union Telecommunication Standardization Sector (ITU-T), the International Electrotechnical Commission (IEC), and at the Institute of Electrical and Electronics Engineers (IEEE). At NICT, we are proposing radio-over-fiber system implementation and evaluation methods for signal qualities. We are seeing chances of realizing ultra high-speed wireless communication by advancing radio-over-fiber technologies. For example, when optical fibers are disconnected due to disasters, it can be used as a backup or a protection link, an alternative to optical fiber link by connecting the cut end to high-speed wireless transceivers (Figure 3). We are advancing the research and development of efficient optical/electrical conversion technologies, battery-powered radio transceiver equipment, and space-division-multiplexing method for increasing the speed, to realize radio-over-fiber system that can be used for both optical communication and wireless communication. The radio-over-fiber technologies will be used in various purposes in the future as a fundamental technology for connecting to the network anywhere, any time.

[Acknowledgements]

Our research on high-speed radio-over-fiber has been conducted in collaboration and cooperation with researchers around the country. We'd like to express our gratitude to the academic institutions, research institutions as well as corporations including Osaka University, Waseda University, Aoyama Gakuin University, KDDI R&D Laboratories, Hitachi, Ltd., Fujitsu Laboratories Ltd., Sumitomo Osaka Cement Co., Ltd., and Trimatiz Limited.

Utilizing "Subsidies for Part of Production Costs for Captioned Programs or Narrated Programs"

Towards realization of information barrier-free CASE 2

Superposing captions on video and checking them on monitor


Mr. USUI Kenichiro, Director, Programming Department, Kyushu Asahi Broadcasting Co., Ltd., TV-Asahi News Network (KBC)


Mr. KOGA Akira, Production Manager, Q-caption Center (Q-CAP)

At NICT, we are working to realize an information barrier-free society by supporting projects with various subsidy programs. In order for the larger public to understand and be able to make use of these subsidies, we introduce activities of corporations and organizations which provide communication/broadcasting services by utilizing this grant program.

"As a media serving the local community, It is our mission to bring beneficial information to people in the community" says Mr. USUI Kenichiro, Director of Programming Department at Kyushu Asahi Broadcasting Co., Ltd.(KBC), TV-Asahi News Network, who is passionate about captioned broadcasting program. We have interviewed Mr. USUI and Mr. KOGA Akira, Production Manager at Q-caption Center (Q-CAP), a company that provides caption production for KBC's programs.

—Could you give us an overview of your organization?

USUI: My company is radio/television broadcaster commemorating 60th anniversary this year. Our station is TV Asahi Corporation affiliate. The broadcast covers all area of Fukuoka and Saga prefecture, and part of Oita, Kumamoto, Nagasaki, Yamaguchi prefecture. When described in household numbers, it reaches 2,860,000 households.

KOGA: Our company started operating as a first production company of captions and subtitles for broadcasting programs in Kyushu region in Dec. 2004. It is the special subsidiary company of Kyushu Electric Power Co., Inc. and has six employees with disabilities working on caption productions. We receive the video from the broadcasters of each area in Kyushu and other places before airing, and place captions of nearly 300 hours of programs per year.

—When did KBC start producing captioned broadcasting program?

USUI: We started working on adding captions to broadcasting programs in 2004, by a program called "アジアへGO!" (Let's Go to Asia). It was a time my colleagues in my station as well as the members in TV Asahi corporation were becoming increasingly aware of caption production, and we decided to implement captions on national broadcast program with many viewers at first. At that time, there was no company producing subtitles in Kyushu region, so we asked subtitle production companies in Tokyo. Later Q-caption Center was founded, and we started to ask them for subtitles.

—What kind of programs do you place captions?

USUI: Currently, we broadcast captioned programs for pre-shot video production programs. Captions are placed in two regular weekly programs on regional network, and a national broadcast program we produce twice every year. These programs receive subsidy for caption production.

—How do you produce captioned programs?

USUI: The production methods are different depending on the type of programs, but basically, we request production of captions at Q-caption Center by sending DVD of the program we produced, and once the captions are ready, we receive the data and air the program with captions by superposing them on our machine. The time needed for producing captions are different by the length of a program, but it takes roughly one or two days to produce captions.

To superpose captions, you first need to set the tape of the program image and the floppy disc containing caption data into the machine (Figure 1) and superpose them in the process of inputting them into the server of the program. The timecode* is added to the video used for broadcasting, and caption data also contains timecode information.


Figure1 Setting video tape and a disc with caption data on the machine

* Timecode
An electric signal to arrange positions of unique numbers given per one frame of the video signal.

The staff members at Q-caption Center produce the captions as they check the burn-in timecode on DVD. The center also checks the font color and positioning, so our job is to make sure the captions disappear when the commercial starts, and check for literal errors.

Figure2 Snapshot of captioning work

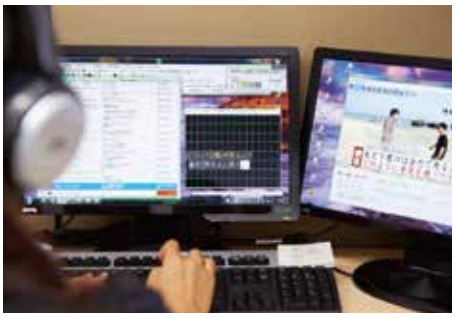


Figure3 Carefully arranging positions of letters and blank spaces for captions

—How do you produce subtitles?

KOGA: We convert the DVD data to a file format that can be edited on caption production software, and upload it to a server. Then our staffs will access the server to work on their part, and transcribe by listening. How they do this may vary slightly depending on staff members, but they repeat the process of transcribing, editing time, positioning, and coloring.

One staff produces captions for a program of 15 minutes in length, but when a program is longer, tasks are divided to multiple staffs (Figure 2). For an hour-long program, about three to four staffs work on production. They hold a meeting in advance to clarify the production rules, so that the person in charge of compiling the video can smoothly collect standardized production outcomes of each individual staff members.

When the captions are completed, other staff members who do not take part in captioning preview the video with captions. By checking the captions with the eyes of multiple staff members, we prevent errors as much as possible.

—What are the efforts made in caption production?

KOGA: We produce captions with an emphasis on conveying the content of the program. In broadcasting standard, it has twelve font colors for captions, but only four colors are actually used for captions since the days of analogue broadcasting, so we still use maximum four colors. We use yellow for the speech of the person who plays the leading part, and cyan for the secondary role, green for the third role, and white for other parts. When a program has many performers such as variety shows and is difficult for viewers to distinguish the speech made by different performers, we place the name of the performer in captions at the start of the speech. We also arrange the position of the captions so that the telop of the program or the mouth and faces of the performer do not get covered by the captions (Figure 3). The maximum numbers of characters for one scene are 31, we use blank space and a line break to improve readability and we follow the standard for translation subtitles to place 4 characters per second.

The notation for describing Katakana characters and the specification of signs and colors varies among stations, so we have created a list of rules and request by each station so that all of our staff members can view.

The work hour of caption production is from 9 A.M. to 6 P.M. in principle, but we implement early shift and late shift as well as holidays shift to meet the requested deadline of the broadcaster.

—What are the challenges in producing captioned broadcasting program?

USUI: We would like to add captions to news programs that cover local community, but it requires real-time captioned broadcasting to produce and place captions at the time of airing the program. The human resource for real-time caption production is in great demand but the resources are far from meeting the demand. I suppose only stations in Tokyo and Osaka are able to operate real-time captioned broadcasting. So we are considering various possibilities for operating real-time captioned broadcasting in cooperation with affiliated / individual stations in Fukuoka. We would like to operate short news programs to be aired with real-time captions in the next two or three years.

KOGA: We think that real-time captions are the biggest challenge for us as well. We do not have enough staffs to operate real-time captions because it requires several teams of three to four people each. In addition, high-speed transcription is a special skill which requires training. We are exchanging information with companies in Tokyo that already operate real-time caption production, but we think it requires one to two years for preparation before we start operating real-time caption production.

—What is your aspiration for the future?

USUI: It is our reason for existence to bring beneficial information to people in the community, so we would like to continue to produce programs viewers can enjoy. In order to step up efforts to bring captioned broadcasting programs, we hope to work on spreading captioned broadcasting programs in cooperation with Q-caption Center.

KOGA: We would like to add captions to all the pre-shot video programs. As Mr. USUI mentioned, in cooperation with the stations, we would like to work on real-time caption production as well.

—Thank you so much.

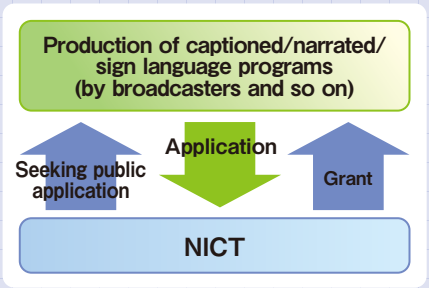
About subsidies for part of production costs for captioned programs and narrated programs

This subsidy program seeks applications from the public on February of every year and grants up to half of the additional expenses of enterprises in producing/providing programs essential for a person with visual and hearing disabilities such as captioned or narrated programs, and sign-language programs (The limit of expense covered in this grant varies: Up to one-eighth for the five key stations in Tokyo, one-sixth for four sub-key stations in Osaka. For real-time captioned programs, half of the expense is will be granted).

To be qualified as an applicant, you have to meet the following eligibilities. 1. The granted program should be aired within the same fiscal year as the grant. 2. Applicant should be broadcasting organization that produces captioned or narrated programs or sign-language programs essential in watching television broadcast for viewers with visual and hearing disabilities. 3. The additional cost of producing/providing captioned or narrated, or sign-language programs must not be sponsored (There are exceptions depending on broadcasters). Programs with age restrictions will not be eligible for the grant.

If you seek funds from the grant program, please submit an application following the instructed format. After NICT examines the application documents, we will conduct a survey on actual situation as necessary, upon which grantees will be decided.

A performance report should be submitted after completing the project. NICT will examine the report and proceed with grant payment.



For more information about the grant and application process, please contact the following:
TEL: +81-42-327-6022 FAX: +81-42-327-5706 E-mail: jimaku@ml.nict.go.jp http://www2.nict.go.jp/ict_promotion/barrier-free/102/index.html

Report on "The 4th Earthquake Technology Expo at Miyagi"

Applied Electromagnetic Research Institute
Resilient ICT Research Center

For two days on August 8 and 9, 2013, "The 4th Earthquake Technology Expo at Miyagi" was held in Sendai City of Miyagi Prefecture (organized by: the Miyagi committee of "Earthquake Technology Expo"), and NICT gave a seminar and exhibited at the event. Themed in "Building a Bright Future by Making the City Resilient", the event consists of exhibitions and seminars about countermeasure technologies for earthquake, tsunami, flood disaster, and mudslide disaster, and 3,613 visitors in total joined. People from various industries such as construction, communication, disaster prevention, healthcare services and local municipalities visited NICT booth. And exhibitions such as the use of Polarimetric and Interferometric Airborne Synthetic Aperture Radar System (Pi-SAR2) at the time of disaster conducted by Applied Electromagnetic Research Institute, a nondestructive test for buildings, and explanations about overview of the Resilient ICT Research Center and experiment facilities of wireless mesh network attracted their strong interest. At the seminar, HAMAGUCHI Kiyoshi, Director of Wireless Mesh Network Laboratory, Resilient ICT Research Center gave a talk about the state of resilient ICT project by collaboration between government, industry and academia and its task. In the question-and-answer session, the audience engaged in discussion about challenges in communication technology that can be connected at the time of disaster.

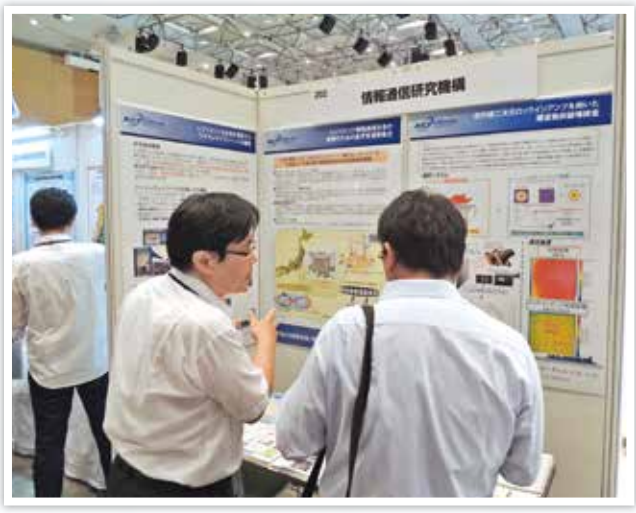
We would like to continue to advance research and development from the feedback visitors gave us at the exhibition event.

● Exhibitions by NICT:

- Observing Sendai Airport after tsunami by Pi-SAR2 [Applied Electromagnetic Research Institute]
- A nondestructive test for buildings using an infrared 2-D lock-in amplifier [Applied Electromagnetic Research Institute]
- A base for collaboration among industry, academia and government towards realization of resilient information communication society [Resilient ICT Research Center]
- Construction of wireless test-bed to demonstrate resilient society [Resilient ICT Research Center]

● Seminar

"The state of resilient ICT project by collaboration between government, industry and academia and its task"
HAMAGUCHI Kiyoshi, Director of Wireless Mesh Network Laboratory, Resilient ICT Research Center



Snapshot of the exhibition

A talk given at the seminar

Report on "Children's Day for Visiting Kasumigaseki"

NICT participated in "Children's Day for Visiting Kasumigaseki" held by the Ministry of Internal Affairs and Communications on August 7 and 8, 2013. The event was held in cooperation with ministries and agencies in Kasumigaseki with an aim to bring opportunity for children to experience larger society as they interact with their parents, and promote understanding of the government measures by visiting ministries and agencies, and listening to the explanation about officials' duties.

Under the theme of "Let's take a look at the latest technology for cyber attack analysis", NICT exhibited the visualization engine by Network Incident analysis Center for Tactical Emergency Response (nicter). The nicter observes and analyzes various security threats occur in cyberspace, and displays the situation. Even though the exhibition content was slightly complicated, many children curiously looked at the view of cyber attacks. Our booth attracted many participants in both days, with participants deepening their understanding of research and development of NICT.

Snapshot of NICT booth

Awards

Recipient ● **INOUE Shin-ichiro** / Senior Researcher, Nano ICT Laboratory, Advanced ICT Research Institute

◎Award Date: April 1, 2013

◎Name of Award:
The 60th JSAP Spring Meeting 2013 Poster Award

◎Details:
In recognition for distinguished excellence in research results that contribute to the advancement of applied physics in the presentation "Development of high-efficiency Electro-Optic Polymer/ Silicon Hybrid Photonic Crystal Slow-Light Optical Modulators" given at the 60th JSAP Spring Meeting 2013.

◎Awarding Organization:
Japan Society of Applied Physics

◎Comment from the Recipient:
I am very honored to receive this award as a memorable first recipient. This award was established in 2013 to award distinguished research results (approximately less than 2 percent of all the poster presentations) that contribute to the advancement of applied physics regardless of age. I have developed an organic electro-optic (EO) polymer/ silicon hybrid photonic crystal slow light optical modulator and my report on the success in demonstration of an optical modulator which was equivalent to performance of 1/1,000 of size of conventional modulator, and in-device performance of more than 10 times than that of lithium niobate (LN) was highly evaluated. I'd like to express my gratitude to everyone involved in supporting my research.

Recipient ● **NARUSE Makoto** / Senior Researcher, Photonic Network System Laboratory, Photonic Network Research Institute

Co-recipients: TATE Naoya, The University of Tokyo
OHTSU Motoichi, The University of Tokyo

◎Award Date: April 25, 2013

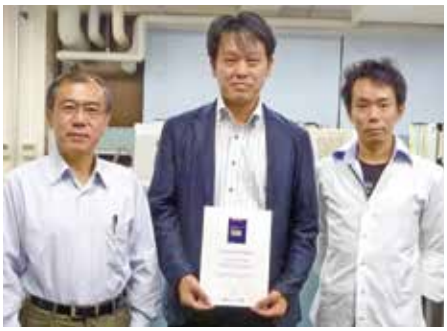
◎Name of Award:
Journal of Optics, "Highlights of 2012" collection

◎Details:
In recognition for the paper presented in "Journal Optic", an academic journal published by IOP Publishing on 2012. The paper has been selected by the editors of Journal of Optics to be included in the exclusive "Highlights of 2012" collection. Papers are chosen on the basis of referee endorsement, novelty, scientific impact and broadness of appeal.

◎Awarding Organization: IOP Publishing

◎Comment from the Recipients:
We would like to express our deep gratitude to relevant people, in receiving such an honorable award "Highlights of 2012" for our paper "Optical security based on near-field processes at the nanoscale" published in the 14th volume of the journal pp. 094002 1-13.

We are extremely delighted to find that the information systems based on optical near-field processes have been highly evaluated in the area of optics, which has long tradition and honorable history, and we would like to continue to advance the research.



From left, OHTSU Motoichi, NARUSE Makoto, TATE Naoya

External Use of "Photonic Device Lab. Clean Room" is Started

—NICT aims at new cooperation by utilizing the R&D facilities—

At NICT, we operate "the external use system of the R&D facilities", a system that allows research institutes such as the government, local municipalities, universities, and corporations to use part of the R&D facilities owned by NICT for research purposes, by simply submitting applications.

We are happy to announce that the Photonic Device Lab. Clean Room (Figure 1) is now part of the facility that can be used under the system. The Photonic Device Lab. Clean Room has various process equipment inside the environment of air cleanliness class 10,000 and class 100. The room has exposure related devices for conducting intended patterning on substrate (Figure 2), dry etching equipment that performs processing of substrate materials, electron beam vacuum evaporator for manufacturing electrodes (Figure 3), chemical vapor deposition equipment that generates dielectric insulating film and is well equipped for prototyping optical devices such as semiconductor laser and optical modulator toward the construction of high-speed large-capacity optical communication system. For safety, applicants are required to take a lecture about use of the clean room.

If you wish to use the facility, please make an inquiry below.
R&D Activities Support Office,
Outcome Promotion Department
E-mail: gaibu-riyou@ml.nict.go.jp Tel: +81-42-327-5860

Figure 1 Photonic Device Lab. Clean Room

Figure 2 Draft chamber

Figure 3 Electron beam vacuum evaporator

For more details about the external use system of the R&D facilities, please visit the following URL in Japanese.
http://www.nict.go.jp/collaboration/research/kyouyou/index.html

Recruitment Information FY 2014 (Permanent Researcher)

In order to promote information and communications development here at NICT, we are recruiting distinguished and motivated research staff extensively, regardless of age. We actively employ foreign nationals, from both within and outside Japan, and we also employ both men and women, regardless of gender.

● **Start of employment**
Apr. 1, 2014 (in principle, but negotiable)
● **Persons to be recruited**
Permanent researcher, a few persons
● **Application deadline**
Oct. 31, 2013 (no exceptions)

For details, please visit the following URL
and see the Employment Information FY 2014 (Employment of Permanent Staff).
URL: http://www.nict.go.jp/employment/permanent/2013perm-kenkyu.html

● **Inquiry**
E-mail: jinjig@ml.nict.go.jp Tel: +81-42-327-7304

Information for Readers

The next issue will feature observation of Sakurajima by Pi-SAR2, and Space Weather Forecast.

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