ISSN 0915-3160

New Breeze

Quarterly of the ITU Association of Japan

No. 3
Vol. 26 July 2014
Summer

平成二十六年七月十日発行（年四回一、四、七、十月の十日発行）通巻百三号　New Breeze

Special Feature

Vehicle-mounted Transportable Mobile Base Station and Backhaul Link for Disaster Relief Operation

A Wireless Relay System Based on Small Unmanned Aircraft for Disaster Situations

—Providing connections from the sky to isolated regions—

Compact and lightweight Small Satellite Earth Stations with Automatic Capture and Tracking

Oceangraphic Radar Tsunami Measurement System

New Breeze ISSN 0915-3160
Quarterly of the ITU Association of Japan
BN Gyoem Bldg., 1-17-11 Shinjuku, Shinjuku-ku,
Tokyo 160-0022 Japan
Tel: +81-3-5357-7610 Fax: +81-3-3356-8170
http://www.ituaj.jp/english/

Publisher: Michiaki Ogasawara

Editors: Yuzo Mori
Atsuko Ishii
Yasuyuki Matsuyama

Letters to *New Breeze*

New Breeze welcomes readers' opinions. Please send comments with your name, address, and nationality by e-mail, fax, or post to the editor.

E-mail address: newbreeze@ituaj.jp

Subscription forms are available on the ITU-AJ website:
http://www.ituaj.jp/english/subscription_form.pdf

Subscription Fee:

Single issue:	¥1,500
Annual subscription (4 issues):	¥6,000

CONTENTS

About the ITU-AJ

The ITU Association of Japan (ITU-AJ) was founded on September 1, 1971, to coordinate Japanese activities in the telecommunication and broadcasting sectors with international activities. Today, the principle activities of the ITU-AJ are to cooperate in various activities of international organizations such as the ITU and to disseminate information about them. The Association also aims to help developing countries by supporting technical assistance, as well as by taking part in general international cooperation, mainly through the Asia-Pacific Telecommunity (APT), so as to contribute to the advance of the telecommunications and broadcasting throughout the world.

Toward Connectivity for All

Candidate for the Post of Deputy Secretary General of the Asia-Pacific Telecommunity (APT)

Mr. Kondo, with his wide-ranging experience, in-depth knowledge, and excellent coordination capability in the international field, has the ability to steer the APT Secretariat in the most advantageous direction and achieve the developmental tasks that lie ahead.

He would like to focus on 5 agenda for the future of the APT as follows:

1. Refocusing the APT as a regional ICT focal point
2. Responding to the needs of member countries especially LDCs and Small Island States
3. Strengthening the APT's function in Collaboration with ITU and other ICT Related Organizations
4. Facilitating Private Sector involvement in APT activities
5. Reinforcing an Efficient and Effective APT

Mr. Kondo serving as the Deputy Secretary General of APT will contribute to more enhanced ICT development of the Asia-Pacific Region.

Mr. Masanori KONDO

PROFESSIONAL CAREER

2013	Senior Director for International Cooperation Affairs
2011	Director, International Economic Affairs Division
2010	Senior Advisor, International Policy Division
2008	Director, International Affairs Office, Postal Policy Division
2005	Director of the Research Department, Institute for Information and Communications Policy
2001	Deputy Director, International Organizations Office, International Policy Division (MIC)
1996	First Secretary, Embassy of Japan in Hashemite Kingdom of Jordan
1990	Joined the Ministry of Posts and Telecommunications (currently, MIC)

INTERNATIONAL EXPERIENCE

2013	Chairman of the working group3 of APT preparatory meeting for ITU PP-14
2010	Chairman of the working group of APT preparatory meeting for WTDC-10
2010	Deputy Head of Japanese delegation to the ITU Plenipotentiary Conference 2010 (PP-10) at Guadalajara, Mexico
2002	Member of Japanese delegation to the ITU Plenipotentiary Conference 2002 (PP-02) in Marrakech, Morocco

EDUCATION

Keio University (BS in Economics)
The London School of Economics and Political Science (MSc in Economics)

ACADEMIC CAREER

2013-	Lecturer, Keio University, Japan
2006-2007	Visiting Scholar, Rikkyo University, Japan
2006-2007	Visiting Scholar, Ohbirin University, Japan
2005	Lecturer, Waseda University, Japan
2004-2005	Associate, Harvard University (Weatherhead Center), U.S.A

Vehicle-mounted Transportable Mobile Base Station and Backhaul Link for Disaster Relief Operation

Yumi Ueda
Assistant Manager
Wireless Standardization Department
NTT DOCOMO, INC.

1. Introduction

Natural disasters like earthquakes and tsunamis have seriously affected people's lives in many parts of the world, and ITU is now involved in many activities and studies relating to disaster mitigation and relief operations, such as the ITU workshop on "Disaster relief systems, network resilience and recovery". In the field of radiocommunication, ITU-R (the ITU Radiocommunication Sector) recently enhanced its relevant Recommendation[1] taking into account the scope of two Resolutions[2, 3] so as to include a new application of disaster relief operations, which has been used in NTT DOCOMO's network.

Japan is known to be prone to large earthquakes such as the Great East Japan Earthquake of March 11, 2011, which also caused a huge tsunami. This devastating natural disaster destroyed or damaged much of the telecommunication infrastructure in the affected area, rendering it unusable.

For the quick and efficient recovery of cellular phone services in disaster-hit areas, DOCOMO has developed and introduced a number of vehicle-mounted mobile base stations, which operate in combination with transportable fixed wireless equipment for the backhaul link.

2. Disaster countermeasures for NTT DOCOMO's network

To ensure the availability of telecommunication services in the event of a disaster, we aim to build a disaster resilient telecommunication network by improving the reliability of our infrastructure systems (with particular regard to emergency communications) so that our telecommunication services can be recovered quickly.

To achieve better reliability, we have installed backup equipment and links, and we have reinforced our facilities, buildings and towers to make them more earthquake resistant. For emergency communications, we have adopted a call priority service that can be used in disaster situations to safeguard communications to and from regional municipal offices, and network control procedures that enable networks to cope effectively with emergency traffic.

Figure 1: Conceptual diagram of the vehicle-mounted disaster relief operation system

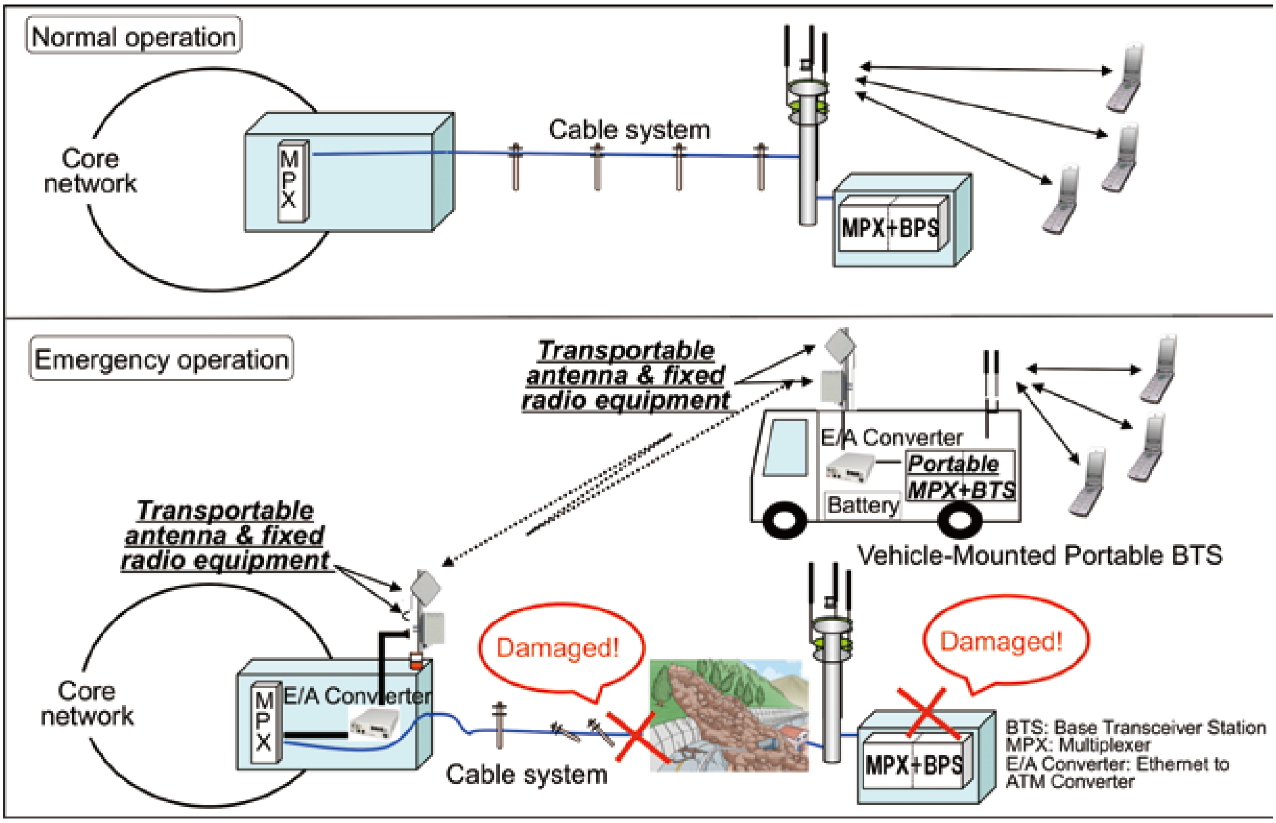


Photo 1: DOCOMO's vehicle-mounted transportable system

Table 1: Main specifications of transportable FWS for disaster relief operation

Frequency band*	Capacity	Interface	Antenna type	Transmission distance
Upper 4 GHz band (4.92-5.0 GHz)	7-35 Mbit/s	100BASE-TX**	36 cm flat panel	around 10 km
18 GHz band (17.85-17.97 / 18.6 18.72 GHz)	155.52 Mbit/s	STM-1	0.4-1.2 m diameter dish	around 3.5 km

*: The RF channel is selected within the assigned frequency band.
**: Connected to the MPX (multiplexer) via Ether/ATM converter.

Table 2: Example parameters of transportable mobile base station

Frequency band	Bandwidth (Carrier number)	Antenna type
800 MHz (830-845/875-890 MHz)	15 MHz (3 carriers)*	Corner reflector (40 cm × 37 cm)
2 GHz (1 940-1 960/2 130-2 150 MHz)	20 MHz (4 carriers)*	Corner reflector (23 cm × 42 cm)**

*: 5 MHz bandwidth per carrier.
**: Maximum aperture.

For the quick recovery of telecommunication services, we have prepared both hardware and software measures for disaster recovery. The former consists of vehicle-mounted transportable systems equipped with mobile base station and backhaul links, together with portable generators. For the latter, we have developed procedures for emergency network operations, organized disaster administrative offices, and instigated periodic disaster training.

This article describes our vehicle-mounted transportable systems.

3. Vehicle-mounted transportable mobile base station with fixed wireless backhaul links for disaster relief operations

A widespread disaster is liable to disable not only mobile base stations but also the access links to these base stations (using either a fixed wireless system (FWS) or a cable system). Relief vehicles should therefore have both a FWS backhaul link and a mobile base station so that both types of portable equipment can be easily interconnected in the affected area. These operating conditions make it possible to restore the telecommunication infrastructure effectively and to promptly restore services to end-users.

Figure 1 shows a conceptual diagram of the vehicle-mounted disaster relief operation system for this purpose.

As an example, Photo 1 shows such a vehicle-mounted system for DOCOMO's network. This vehicle-mounted system can be easily deployed in the disaster-hit area.

4. Technical system description

The transportable backhaul FWS uses different frequency bands depending on the interference conditions and/or the transmission distance required in the disaster-hit area. In particular, the upper 4 GHz and 18 GHz band systems are designed for use by compact lightweight equipment, which is easy to install on vehicles. The main specifications of these systems are shown in Table 1.

The main specifications of the transportable mobile base station that interconnects with the transportable FWS are shown in Table 2.

References

1 Recommendation ITU-R F.1105-3: Fixed wireless systems for disaster mitigation and relief operations

2 Resolution ITU-R 53-1: The use of radiocommunications in disaster response and relief

3 Resolution ITU-R 55-1: ITU studies of disaster prediction, detection, mitigation and relief

Cover Art

Fuji sanjurokkei
Toto Tsukuda oki

(The Sea at Tsukuda in Edo, from the series 36 Views of Mt. Fuji.)

Utagawa Hiroshige (1797-1858)

Woodblock print:
Courtesy of Sakai Kokodo Gallery

A Wireless Relay System Based on Small Unmanned Aircraft for Disaster Situations

—Providing connections from the sky to isolated regions—

Ryu Miura
Director
Dependable Wireless Laboratory, Wireless Network Research Institute
National Institute of Information and Communications Technology

1. Introduction

The Great East Japan Earthquake not only damaged structures such as roads but also resulted in many areas becoming cut off from telecommunication services due to power outages and the loss of communication facilities. This made it impossible to assess the disaster situation in these regions, thereby delaying rescue efforts and making it impossible to check the safety of local residents or request necessary relief items. To help mitigate these issues, the NICT has developed a wireless relay system based on autonomous computer-controlled small unmanned aircraft that are small enough to be carried by hand and can be launched by throwing. This system is expected to provide a useful airborne means of accurately ascertaining the disaster situation in isolated regions and promptly re-establishing communications in these regions, enabling quick rescue efforts, and checking on the safety of people in isolated regions.

In recent years, there has been a growing amount of interest in small unmanned aircraft (or “drones”) as a means of monitoring the disaster area from the sky, and bringing video cameras and environmental sensor equipment to the affected region. However, there have been very few instances (either in Japan or overseas) where this technology was used in the development of wireless relay systems for use in disaster-hit areas.

2. Overview of the wireless relay system

At the NICT, we have developed a wireless relay system based on small drone aircraft made in the United States (the world leader in this technology). This system is configured by a combination of drone-mounted wireless relays and simple ground-based equipment.

■ **Photo 1: Launching a small-scale drone by hand, and a close-up view of the on-board wireless relay**

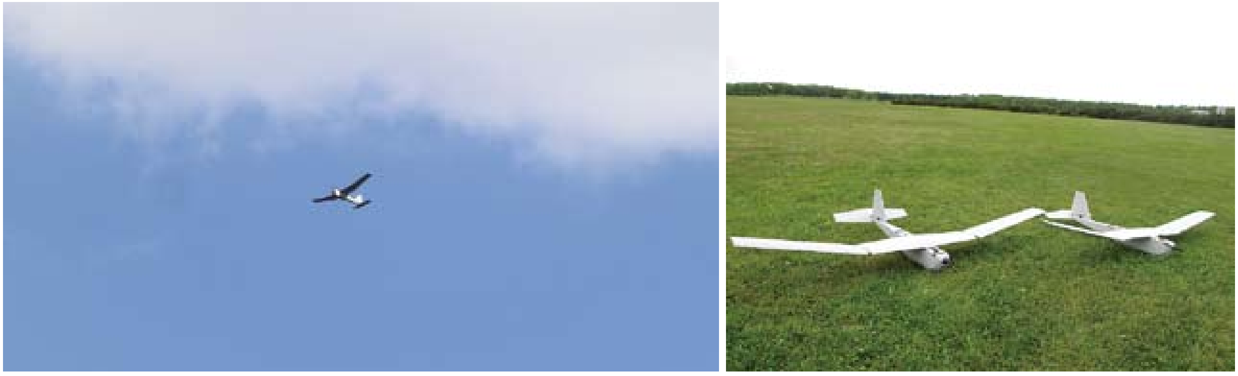
The system is equivalent to constructing a virtual relay radio mast hundreds of meters tall, allowing two locations on the ground to be connected without being blocked by intervening buildings or mountains. If two small drones are deployed simultaneously and interconnected by an air link, then it is possible to connect between locations that are even further apart. Our airborne wireless relay equipment (including its battery) fits entirely within a space measuring about 10 cm along one side, and at just under 500 g (including battery) it is also very light (Photo 1, lower right). The system operates in the 2 GHz band with a transmission output power of 2 W and an effective transmission rate of about 400 kbps, and can support communication for about an hour and a half. One of the two ground stations acts as a wireless LAN access point, while the other is connected to an Internet circuit. This makes it easy to set up a drone-based wireless LAN (Wi-Fi) zone in isolated regions. This LAN supports the sort of Internet applications that people use every day, allowing them to exchange emails, make IP phone calls, check up on friends and family and use electronic bulletin boards. It also supports the transmission of video pictures, albeit at limited resolution. The ground station can operate from its own power source such as a mini generator or battery during power outages or when there is no mains electricity available nearby.

The drones used by this system are electrically powered fixed-wing propeller planes with a wingspan of 2.8 m, an overall length of 1.4 m, and a mass of 5.9 kg. Depending on the air conditions, they can stay aloft for between 2 and 4 hours. As long as a suitably large clear plot of land is available, they can be put in flight by simply throwing them, so there is no need for a runway (Photo 1). The drones have detachable wings and can be packed into special bags for ease of portability, which means they can be carried to places where the roads have become impassable to traffic. They are equipped with GPS receivers and various sensors, and are fitted with an on-board microcomputer that cooperates with a ground-based control terminal so that the drone can continue flying along a predetermined course without the need for a human operator constantly interacting with the control terminal. The drones are almost inaudible when in flight, and can fly further and for longer periods than multi-rotor type drones, which have become commonplace in recent years.

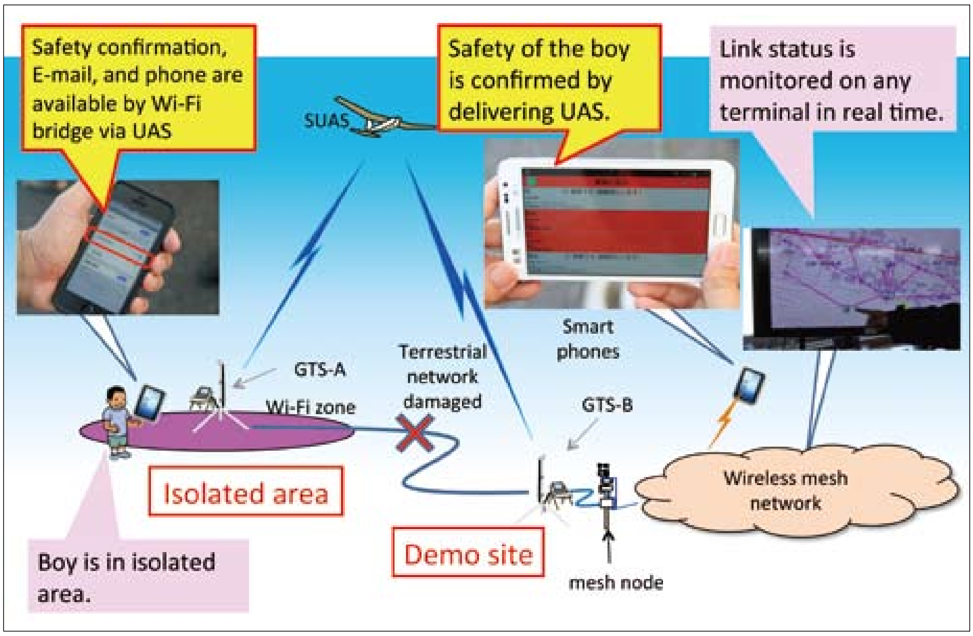
3. Flight testing

In March 2013, the first large-scale test was performed in

■ Photo 2: A drone performing a turning maneuver autonomously



■ Figure 1: Demonstration of how a miniature drone system can be used to check a person's safety in a disaster situation



the campus of Tohoku University (Sendai City, Miyagi Prefecture). There have since been over 100 flights, not only in Sendai but also in Taiki (Hokkaido) and Shirahama (Wakayama prefecture), where communication tests were performed using the drones under the conditions expected during a disaster (Photo 2 and Figures 1). In these tests, we verified that it is possible to use the drones in the event of a large-scale disaster to provide isolated areas with communication services including checking up on friends and family, making IP phone calls, and sending videos. We also confirmed that they support communication over a range of up to 20 km between the ground-based station and drone, depending on conditions. This is equivalent to a total range of 40 km, and shows that a single drone can provide a wireless LAN zone around a ground station in places where there are intervening obstacles such as mountains. It should be possible to extend this range to at least 50 km if signals are relayed using two drones instead of one. However, this distance varies with the conditions on the ground (forests, farmland, built-up areas), and we are currently on detailed analysis and modeling of their effects.

4. Applications of the wireless relay system

When settlements and refuge centers have become isolated after a natural disaster like an earthquake, tsunami or landslide, our wireless relay system can be used alongside other means of communication such as satellite links to provide emergency communications during the period until roads and communication infrastructure have been restored (typically 2–3 weeks). The drones can also use their miniature on-board cameras to acquire aerial video showing the isolation and damage caused by the disaster, and can relay these pictures wirelessly in real time. If there are places beyond the range of a single drone, another drone can be used as a relay so that video pictures can be sent without having to increase the transmitter power. There are many other possible applications for which this system could be used. These include tracking wild animals in mountainous areas, performing radiation measurements over a wide area, monitoring volcanoes in environments where piloted aircraft would be unable to enter due to the risk of engine damage by volcanic ashes, observing the growth of agricultural crops or the spread of wildfires, policing crowds at large-scale events, and patrolling international borders out at sea.

5. Conclusion

We hope that this system will become part of the standard disaster relief equipment held by local authorities, and that it can be used for disaster monitoring and environmental monitoring as well as for the provision of prompt communications in the event of a large-scale disaster. At the World Radiocommunication Conference 2012 (WRC-12), it was agreed that the 5030–5061 MHz band would be made available for the navigation of unmanned aircraft including control and non-payload communication (CNPC) links. The NICT is therefore working on using these frequencies effectively to develop technologies that can improve the reliability of drones with limited wireless resources.

Compact and lightweight Small Satellite Earth Stations with Automatic Capture and Tracking

Takashi Hirose
Senior Research Engineer, Supervisor
NTT Access Network Service Systems Laboratories
Nippon Telegraph and Telephone Corporation

1. Introduction

Satellite communication systems are useful in disaster recovery operations because of their wide coverage and the ease with which links can be established. The NTT Group's protocols for restoring communications infrastructure in the event of a disaster call for the use of satellite communication systems to provide evacuation and disaster response centers with temporary lines of communication while work is done to restore optical fiber and other transmission lines.

An older satellite earth station[1] for disaster response operations is shown in Figure 1. This system was built over fifteen years ago. Its setup procedure involves manual tasks such as manual alignment of the satellite dish, and can take at least one hour even when performed by experienced engineers. Furthermore, it is cumbersome to transport, and thus offers poor mobility and setup speed, which are essential factors in disaster response operations.

To overcome these issues, NTT Access Network Service Systems Laboratories have developed small satellite earth stations to provide communication links via specially installed public phones and Internet access points in evacuation and disaster response centers in the event of communications being disrupted by disasters and other emergencies[2]. These earth stations are compact and lightweight and use dish reflectors that can be dismantled and packed inside carrying cases. They are equipped with functions for automatically capturing and tracking satellites, and for remotely conducting uplink access tests. These functions make it possible to establish links rapidly, and reduce the setup operations that must be done by field workers.

Figure 1: Comparison of developed systems and older system

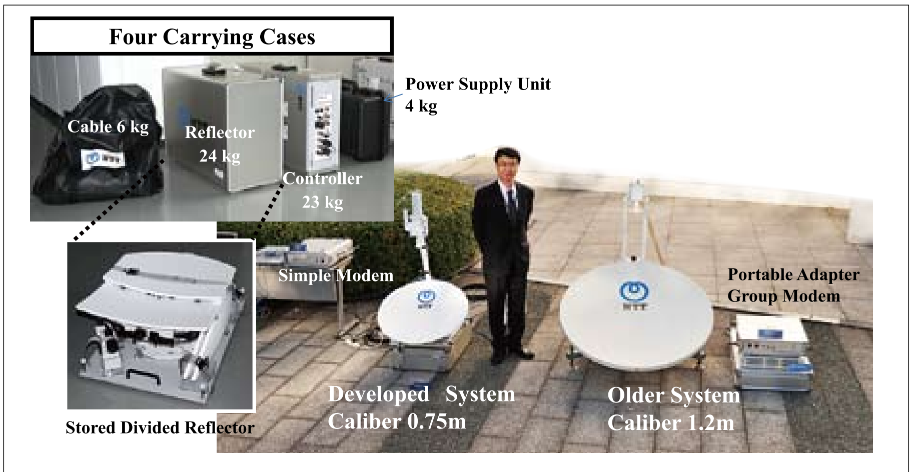
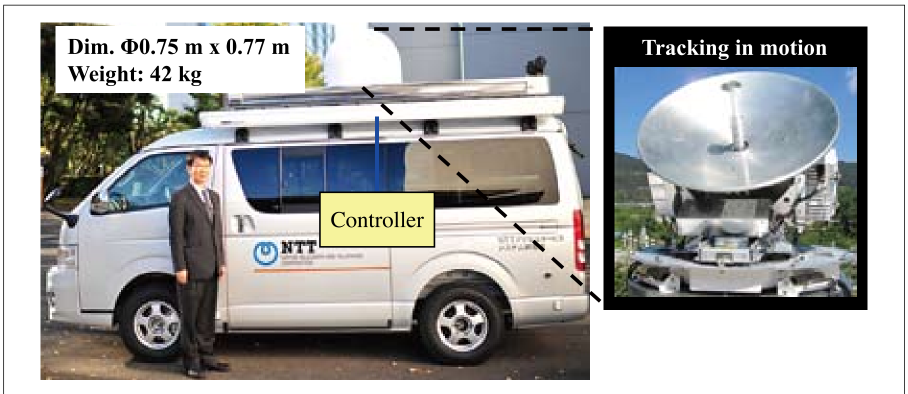


Figure 2: Vehicle -mounted antenna



2. Summary of development process

To reach this goal, we developed three new devices for the earth station terminal and a new program for the control station.

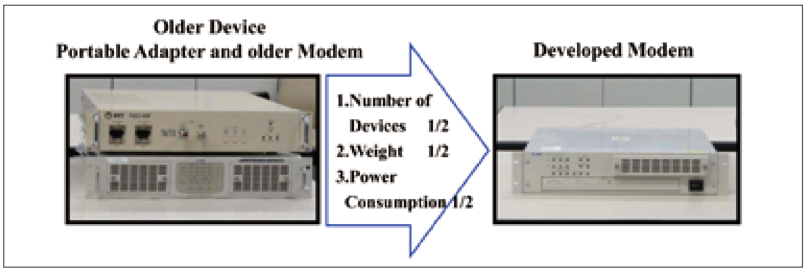
To offer terminal configurations suited to different kinds of disaster situation, we developed two different types of earth station — a flyaway type and a vehicle-mounted type. The flyaway type is easy to carry to a disaster area because it can be dismantled and packed into four separate carrying cases, while the vehicle-mounted type can be installed in a normal-sized car capable of reaching the stricken area quickly to help restore communications. Both terminals can be up and running in about 15 minutes owing to the satellite auto-capture function (older systems needed about 60 minutes). These stations support transmission speeds of up to 384 kbits/s for the return link, which can carry ten VoIP channels simultaneously.

The technologies that we developed are summarized in sections 2.1–2.4

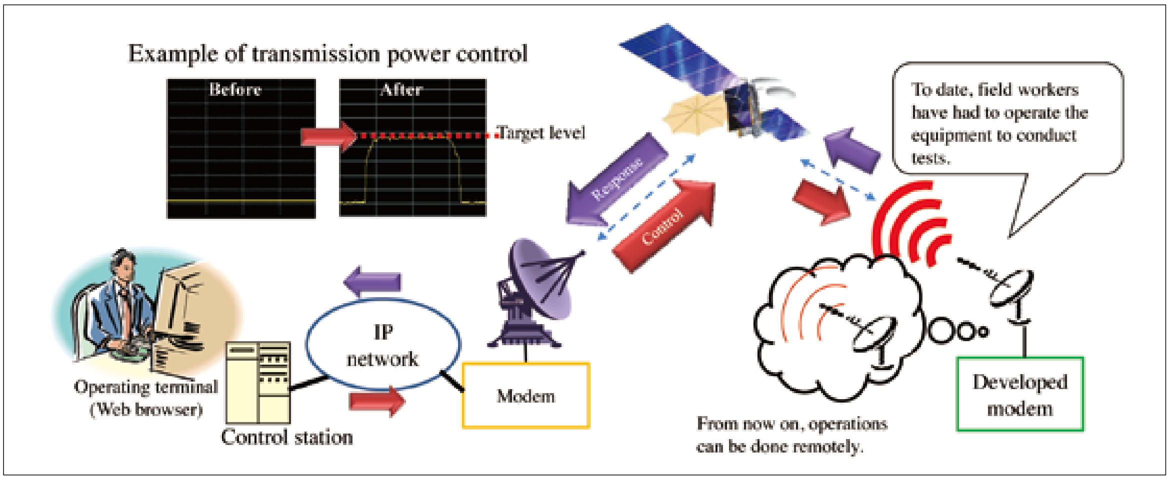
2.1 Flyaway antenna

Our flyaway antenna is shown in Figure 1. This antenna can easily be carried by hand into disaster areas that are inaccessible by car or other means of transportation. We chose to use a 75-cm reflector dish that can be dismantled and packed inside a carrying case. The

■ **Figure 3: Comparison of older modem and developed modem**



■ **Figure 4: Procedure for remote uplink access test**



other parts can also be carried in cases, which greatly increases their portability compared with existing devices. Moreover, no tools are needed for disassembly, packing, and reassembly and the automatic satellite capture function eliminates the need for operators to have special skills to set it up: setup can be finished within approximately 15 minutes.

2.2 Vehicle-mounted antenna

The vehicle-mounted earth station antenna that we developed is shown in Figure 2. This antenna is mounted on the roof of a vehicle and is suitable for use in disaster areas that are still accessible by vehicles. The dish diameter was reduced to approximately 60 cm to enable mounting even on ordinary cars. In addition to an automatic satellite capture function, it also has a function for automatically tracking satellites while the vehicle is moving. Antennas of this type are widely used in ships, but ours is considerably simplified, making it lighter in weight, lower in height, and less costly.

2.3 Modem

The modem that we developed for the earth station is shown in Figure 3. If a disaster affects a wide area, a large number of earth stations will need to be installed. However, there is a limit to the frequency range that can be used for satellite communications. Thus, to enable simultaneous use in as many places as possible, we have developed a modem with limited communication speed and frequency band for each earth station. This device uses the same transmission system as older satellite communication systems, and can thus be put to use with only minimal changes to the configuration and settings of existing base stations. By removing unnecessary functions and reducing the capacity to the minimum necessary, we were able to reduce the weight to one quarter and the size to one half of the older modem.

2.4 Remote uplink access test program.

In older systems, an uplink access test is carried out after the earth stations have been installed but before they begin operations. This test is conducted through phone conversations between technicians of the satellite operator and field workers to check that the antenna direction and power transmission levels are correct. Thus, in order to conduct these tests, the field workers need to be proficient in radio communication systems. However, in a large-scale disaster like the Great East Japan Earthquake of 2011, it can be difficult to assemble enough field workers with sufficient knowledge. To make it easy for field workers without specialist knowledge to set up earth stations in the field, NTT Access Network Service Systems Laboratories has developed an uplink access test program that can be operated remotely from a control station. The procedure for conducting this test remotely using this program is shown in Figure 4.

3. Conclusion

Small satellite earth stations can provide a communications infrastructure quickly in the event of disruption caused by a natural disaster. These systems were deployed by NTT Group during the 2012 fiscal year, and have been put to practical use in real disaster situations.

References
1 Akira MATSUSHITA, Taichiro SATOU, Isao YUMOTO, Yutaka YAMAGUCHI, Yuichi KAMEZAWA, and Hiroshi KAZAMA, "Satellite communication system used for isolated islands and disaster-affected areas", SAT2005-1(2005-5), IEICE Technical Report, 2005.
2 Takashi HIROSE, Yoshinori SUZUKI, and Yutaka IMAIZUMI, "Small Satellite Earth Stations for Disaster Recovery Operations", SAT2012-4(2012-10), IEICE Technical Report, 2012

Oceangraphic Radar Tsunami Measurement System

Satoshi Fujii
Professor
Department of Electrical and Electronics Engineering
Faculty of Engineering
University of the Ryukyus

1. Introduction

The Great East Japan Earthquake and Tsunami has renewed awareness of and interest in the importance of disaster prevention measures at sea.

It is also essential to understand various marine phenomena. However, most conventional marine observations have consisted mainly of direct point measurements of values such as wave height and current velocity, using equipment deployed over wide areas and requiring on-going maintenance and management for measurements, at great effort and cost.

In contrast, installation and maintenance of oceanographic radar on land is easy, and it can make continuous observations of broad areas over long periods of time, so coastal marine instruments are attracting attention. Oceanographic radar uses frequencies in the HF to low-VHF bands, and its utility was recognized at the 2012 World Radiocommunication Conference (WRC-12), when nine frequency bands, of width 25 to 500 kHz and in the range from 3 to 50 MHz, were allocated internationally for oceanographic radar.

2. Tsunami Observation using Oceanographic Radar

Oceanographic radar is able to measure changes in surface current velocities continuously, so its potential for detecting tsunamis was noted from the time it was first developed. Prompted in particular by the large amount of damage from the tsunami after the Sumatra-Andaman Earthquake in 2004, there has been much research on observing and detecting tsunamis using oceanographic radar.

Upon this background, the Great East Japan Earthquake and Tsunami occurred in March, 2011. This was the first tsunami observed using oceanographic radar, and coastal areas were observed not only in Japan but also across the Pacific Ocean in areas like California and Chile [1, 2, 3].

Changes in radial components of surface current velocities at 12 km offshore from 24.5 MHz radar installed in the Minato area of Wakayama City, together with records of sea surface height nearby, are shown in Figure 1. Fluctuations in surface current velocities detected 12 km offshore as the tsunami passed can be seen preceding the tide-gauge measurements in Kainan port.

It is also possible to compute tsunami height distributions from surface current velocities measured using oceanographic radar by a long wave approximation. Figure 2 shows the current velocity field measured by two 42 MHz radars installed on the Kameda Peninsula (one in Usujiri and one in Kinaoshi) of Hakodate City in Hokkaido, together with the tsunami height distributions estimated from them. The ability to obtain sea height distributions when a tsunami arrives in this way is extremely useful for disaster prevention.

3. Attempts to make Early Tsunami Monitoring Possible

If it is possible to use oceanographic radar to detect the arrival of a tsunami as far as possible from the coast, it will have great potential to reduce damage from the tsunami. To do this tsunami arrival must be recognized from changes in current velocities in real time.

However, current velocity measured by oceanographic radar include components due to tides and wind-driven surface currents, in addition to current velocity changes due to tsunamis. Such fluctuations due to other than tsunamis must be eliminated from current velocity values. Also, averaging is ordinarily done over periods of 15 minutes to one hour, to reduce the effects of noise

Figure 1: Tsunami observed in the Kii Channel[1]

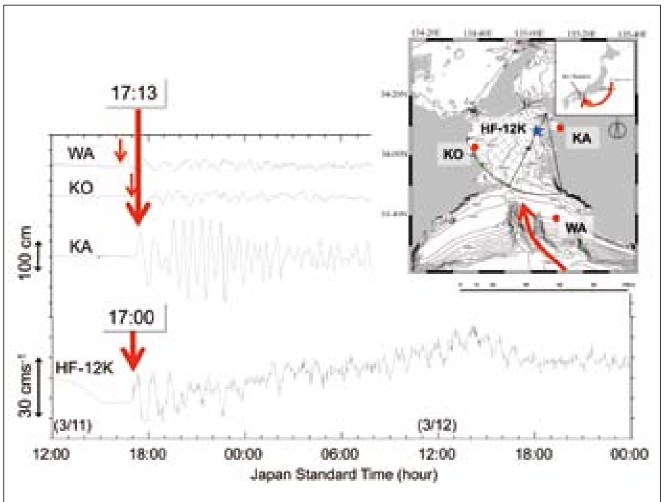
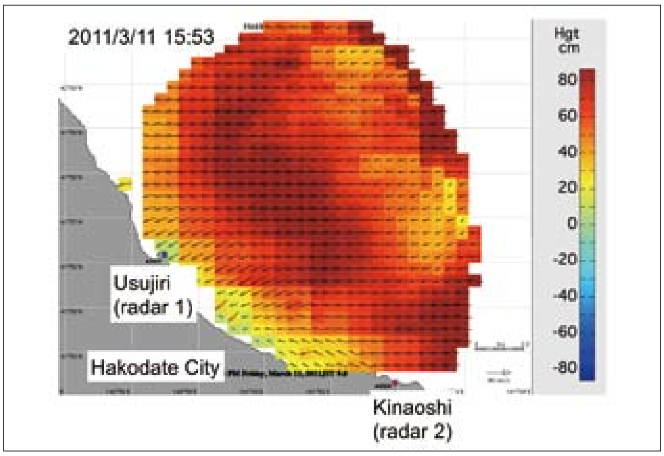
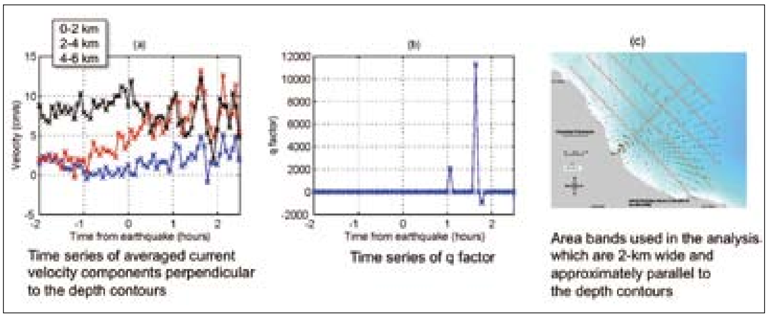


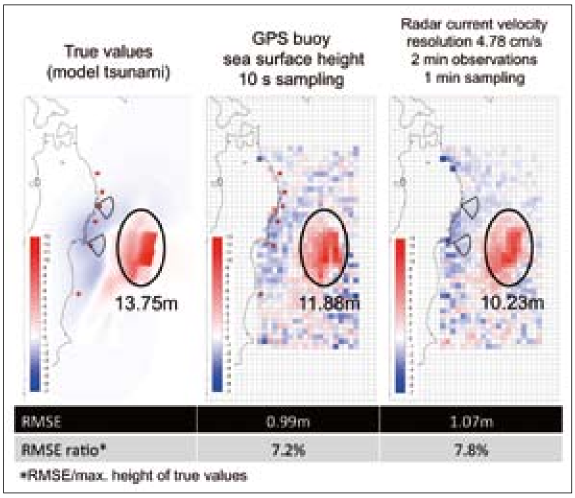
Figure 2: The tsunami height superimposed on the total current velocity field measured using two oceanographic radars[2]



■ Figure 3: Time series of averaged current velocity components and q factor, and bands used in the analysis[4]



■ Figure 4: Sea surface height field of model tsunami source, from sea surface heights measured by GPS buoys and from radial current velocities measured by oceanographic radar[5]



when computing current velocities using oceanographic radar, but tsunamis travel quickly and their period is short, so there is no time to perform such averaging. Because of this, current velocities are read from a Doppler spectrum with large noise effects. (Velocities in Figures 1 and 2 have tidal components removed and filtering applied.)

For these problems, a tsunami detection method with a simple computation using properties of tsunamis has been proposed [4]. With this method, radial current velocities obtained by short-term Doppler spectra (4-minute time resolution) in area bands 2-km wide and approximately parallel to depth contours, are resolved in the direction perpendicular to the depth contour and pointing onshore. These 4-minute velocity components are averaged over each band. An index indicating the arrival of a tsunami, called the q-factor, is computed by multiplying three values: the deviation in this time sequence from the average of the preceding hour, the difference with the velocity from two adjacent time intervals, and whether the velocities have increased or decreased with time in three adjacent bands, expressed as a value of 100 or 1.

Figure 3 shows time series of averaged current velocity components and the q-factors computed from them, for three 2-km bands ranging from 0 to 6 km, from the radar located in Kinaoshi, Hakodate City in Hokkaido. It is difficult to accurately determine when the tsunami arrived from the velocity time series, but the arrival time can be seen clearly in the q factor, by the sudden change in the value at the time. Computing the q factor itself is extremely simple, but it captures the characteristics of tsunami arrival well, so it is able to detect arrival early without needing to extract tsunami characteristics or perform complex filtering.

4. Application for Estimating Tsunami Origin

In the Great East Japan Earthquake, damage spanned broad areas including administrative facilities in populated areas, so the inability to know quickly, which areas were most severely hit, magnified the effects. On the other hand, if initial sea surface height of the tsunami can be obtained, it will be possible to numerically predict the areas of severe damage quickly. The accuracy of such numerical computations depends heavily on the accuracy of initial tsunami height distributions. Currently, we are attempting to compute the origin of the tsunami by back propagating sea-level data from GPS buoy point measurements, but if we can estimate how a tsunami spreads out from its origin using high resolution surface current velocity distributions from oceanographic radar, we can expect to increase the accuracy of estimating severely damaged areas significantly.

Using the 2011 Great East Japan Earthquake as a model, we verified the accuracy of using radial current velocities observed by oceanographic radar to estimate initial tsunami height as shown in Figure 4[5]. This result shows that computing initial tsunami height from the radial current velocities from two oceanographic radar stations, had approximately the same accuracy as values computed from data from six GPS buoys located over a wide area.

5. Conclusion

We have discussed how oceanographic radar measurement data has great potential for tsunami disaster prevention and mitigation, including detecting tsunamis, issuing early warnings, back-propagating to the origin of the tsunami, and predicting areas of serious damage. It is imperative to research these methods to further increase their accuracy. It is also desirable to improve the capabilities of oceanographic radar itself, studying spectral estimation methods for obtaining accurate Doppler spectra quickly, and increasing the SN ratio of receivers. It will also be important to establish hardware and operational methods that allow frequency sharing when operating multiple radar installations simultaneously.

Advancing oceanographic radar in these ways will contribute to preserving the marine environment as well as to tsunami disaster prevention, and we hope that building an oceanographic radar network that covers the nation-wide coast-line will demonstrate this capability.

References

1 H. Hinata, S. Fujii, K. Furukawa, T. Kataoka, M. Miyata, T. Kobayashi, M. Mizutani, T. Kokai and N. Kanatsu: "Propagating tsunami wave and subsequent resonant response signals detected by HF radar in the Kii Channel, Japan", Estuarine, Coastal and Shelf Science, Vol.95, pp. 268-273, 2011.

2 B. Lipa, D. Barrick, S. Saitoh, Y. Ishikawa, T. Awaji, J. Largier and N. Garfield: "Japan tsunami current flows observed by HF radars on two continents", Remote Sensing, Vol.3, pp. 1663-1679, 2011.

3 HELZEL: "WERA in Chile Observed Tsunami Signatures", WERA Newsletter, August 2011.

4 B. Lipa, J. Isaacson, B. Nyden and D. Barrick: "Tsunami Arrival Detection with High Frequency (HF) Radar", Remote Sensing, Vol.4, pp.1448-1461, 2012.

5 R. Fuji, H. Hinata, S. Fujii and T. Takahashi: "Influences of Time Integration on the Accuracy of Inversion based on Ocean Radar", Journal of Japan Society of Civil Engineers, Ser. B2, Coastal engineering, Vol. 69, pp. 436-440, 2013.

SHARP

Working on Super Hi-Vision in Preparation for the Tokyo Olympics

Kozo Takahashi
President, Sharp Corporation

With the growth of High-Definition (HD) digital broadcasting over the past 10 years, liquid crystal displays have made rapid progress in terms of their screen size and image quality, and now dominate the global television market. Recent trends in television include the move towards larger screen sizes approaching the screen sizes offered by projectors, and the introduction of 4K television with a resolution exceeding that of full-HD television.

Looking further ahead, the Japan Broadcasting Corporation (NHK) has proposed a next-generation TV broadcasting service called Super Hi-Vision (8K), which has a resolution of approximately 33 megapixels (7,680 horizontal × 4,320 vertical) — 16 times as many as full-HD television. This system produces video images that are extraordinarily realistic and moving. Japan is planning to start trial 8K broadcasts in 2016, and to start regular 8K broadcasting in time for the 2020 Tokyo Olympic and Paralympic games. Various manufacturers are now working to develop displays and TV receivers for next-generation broadcasting based on Super Hi-Vision.

In May 2011, in anticipation of the advent of next-generation high-definition TV, Sharp Corporation worked with NHK to successfully develop a Super Hi-Vision compliant ultra-high-resolution 85V liquid-crystal-display (LCD) television, which is the world's first[1] direct-view type display. This was made possible by adopting our proprietary UV^2A[2] technology to improve the display performance. Since then, at numerous demonstrations in exhibitions in Japan and overseas, audiences who experience Super Hi-Vision for the first time have expressed great surprise at the unprecedented levels of reality and presence offered by this technology.

Although Japan's 8K broadcasting standard is based on IP, the Internet standard technology, with a view to fusing broadcasting and telecommunications at some point in the future, Sharp is also working hard on developing standards for video coding (HEVC: High Efficiency Video Coding) and multiplexing/transport (MMT: MPEG Media Transport), which are the key technologies of 8K broadcasting. We are also actively participating in the standardization of broadcasting systems at the Association of Radio Industries and Businesses (ARIB), Japan. These technologies should not only create systems that are necessary for the implementation of a future broadcasting system, but should also give rise to new viewing styles.

Since our establishment in 1912, Sharp has been creating innovative world-leading products based on the philosophy that "we are dedicated to the use of our unique, innovative technology to contribute to the culture, benefits and welfare of people throughout the world". In a wide range of industrial fields such as liquid crystal displays, solar cells, Plasmacluster ion technologies[3], communication equipment and document solutions, we are constantly working to produce better technologies from the viewpoint of our customers, and conducting research and development aimed at spreading new value and happiness throughout the world. In particular, it is important for us to make further advances in the field of liquid crystal displays, mainly aimed at increasing resolution and reducing power consumption. In last year's medium-term management plan for the 2013–2015 business years, we set forth new five priority business areas as a way of leveraging our strengths and technology resources. These new priority business areas are "Healthcare & medicine", "Robotics", "Smart home/mobility/office technology", "Ensuring the safety of food, water and air", and "Education".

Through the further growth of existing business including next-generation television and the cultivation of the new priority business areas, we aim to provide all our customers with a "good life" in whatever way we can.

A super-high-definition direct-view 85V liquid crystal display

1 As of 19th May, 2011.
2 Short for Ultraviolet induced multi-domain Vertical Alignment. A photo-alignment technique that can precisely control the orientation of liquid crystal molecules in a liquid crystal panel with a simple structure.
3 Plasmacluster ion technology is Sharp's original air disinfecting technology for suppressing the effects of airborne viruses, and breaking down and removing airborne mold.

46th Celebration for World Telecommunication and Information Society Day

The ITU Association of Japan

May 17 marks the anniversary of the signing of the first International Telegraph Convention and the creation of the International Telecommunication Union.

This year, the ITU Association of Japan (ITU-AJ) marked the occasion by holding the 46th Celebration for World Telecommunication and Information Society Day (WTISD) at the Keio Plaza Hotel in Tokyo, Japan, with over 260 participants from the Ministry of Internal Affairs and Communications (MIC), the Ministry of Foreign Affairs and the ICT industry.

At the celebration each year, the ITU-AJ holds an award ceremony to recognize those who have furthered the aims of WTISD by helping to raise awareness of the possibilities that the use of the information and communication technologies (ICT) can bring to societies and economies, and by finding ways to bridge the digital divide. This is a historic award ceremony, spanning 42 years since it was first held.

The highest honor, the "Minister's Award," was presented to Dr. Kazuo MURANO, a former chairman of one of Japan's premier international ICT R&D organizations, Fujitsu Laboratories Ltd.

The "Special Achievement Award" was presented to Ms. Christel TAKIGAWA, a famous TV newscaster, for her outstanding contribution to the successful bid for the 2020 Olympics, which will be a great opportunity to demonstrate the appeal of the country's latest infocommunications technology.

Other ITU-AJ Awards, in the form of trophies, were also presented to prominent figures in the fields of standardization and international cooperation, as listed below.

Awards for accomplishment in the field of ICT (international standardization) were presented to ten winners, while awards for accomplishment in the field of international cooperation were given to seven winners. Encouragement awards were presented to seventeen winners in the field of ICT and three in the field of international cooperation, in expectation of their on-going contributions in their respective fields.

Group Photo

Video message from Ms. Christel TAKIGAWA

Trophies

List of the winners of the Awards is as follows:

MIC Minister's Award
- Kazuo MURANO, FUJITSU LABORATORIES (retired)

ITU-AJ Award: Special Achievement Award
- Christel TAKIGAWA, PHONICS

ITU-AJ Award: Accomplishment in the Field of ICT
- Masaharu ARAKI, DOCOMO TECHNOLOGY
- Yoshio HONDA, ERICSSON JAPAN
- Yoshinori ISHIKAWA, HITACHI
- Nobuyuki KAWAI, KDDI
- Takashi KOSHIMIZU, NTT DOCOMO
- Kazuo MURAKAWA, NTT EAST
- Radio Wave Propagation Standardization Promotion Team, SOFTBANK MOBILE
- Shigeru TOMITA, NTT
- Kaoru WATANABE, NHK
- Tetsuya YOKOTANI, MITSUBISHI ELECTRIC

ITU-AJ Award: Accomplishment in the Field of International Cooperation
- Yoshio ITO, NTT (retired)
- Hideki NAKAMURA, NTT (retired)
- Masaharu NONAKA, BHN
- NTT VIETNAM CORPORATION
- Project for Urgent Improvement of Communication Networks in Republic of the Union of Myanmar, SUMITOMO CORPORATION, NTT COMMUNICATIONS CORPORATION, NEC CORPORATION
- Koichi SENOUE, NHK (retired)
- Yuki UMEZAWA, KDDI FOUNDATION

Encouragement Award: Field of ICT
- Lan CHEN, NTT DOCOMO
- Suyong EUM, NICT
- Yasuyuki HATAKAWA, KDDI
- Takanori HIGUCHI, SKY PERFECT JSAT
- Yasuo ISHIGURE, NTT
- Takato KAWAMURA, NHK
- Kimihiko KAZUI, FUJITSU LABORATORIES
- Atsushi MINOKUCHI, NTT DOCOMO
- Homare MURAKAMI, NICT
- Takuya OHARA, NTT
- Shinya OTSUKI, NTT
- Anand Raghawa PRASAD, NEC
- Hitoshi SANEI, NHK
- Yumiko TAKANO, KDDI
- Hiroshi TAKECHI, LAC
- Hiroyuki TSUJI, NICT
- Takeshi YAMAMOTO, NEC

Encouragement Award: Field of International Cooperation
- Fumie FUKUSHIMA, BHN
- Hidetoshi SAITO, KDDI
- Yasuji SAKAGUCHI, NHK

Green Energy: The Megasolar System at NHK's Shobu-Kuki Radio Broadcasting Station

Satoshi Takeda
Senior Manager, Architectural Engineering Division, Engineering Administration Department, NHK

Masaki Ishihara
Senior Manager, Architectural Engineering Division, Engineering Administration Department, NHK

Chikashi Takita
Transmitting Division, Transmission & Reception Engineering Center, Engineering Administration Department, NHK

1. Introduction

In 2007, NHK drew up an environmental action plan and began working on a range of environmental protection measures to reduce its carbon footprint. As a result, we have been actively working on the introduction of energy-saving facilities and solar power generation.

Although solar power can be expected to provide clean renewable energy without using fossil fuels, it requires solar panels to be installed in places where there is plenty of sunshine. Although solar power facilities have been installed at NHK headquarters in Tokyo (240 kW) and at regional broadcasting stations throughout Japan (10 kW), these facilities are relatively small due to lack of space. To accelerate its environmental action plan, NHK decided to set up a "Megasolar" large-scale solar power generating system at the Shobu-Kuki Radio Transmitting Station, which has sufficient space for installing the facilities and also consumes large amount of electricity on-site. After thorough preliminary investigations and preparatory work, full-scale operations were started in August 2012. Table 1 lists the specifications of this system. (Photo 1)

2. Preliminary study for the installation of Megasolar facilities at a radio transmitting station

The Shobu-Kuki Radio Transmitting Station (Photo 2) is one of the largest medium-wave transmitting stations in Japan, and serves NHK's two radio channels (NHK Radio 1 and NHK Radio 2) to 21 million households mainly in the Kanto and Tokai areas. For the efficient emission of radio waves, grounding wires are buried underground in a pattern that radiates outwards over a large area from the surface of the antenna mast. The empty ground above these grounding wires was used for solar power generation.

Studies of adverse impacts between the transmitting facilities and the Megasolar system were conducted prior to the construction of the Megasolar system. This study included electric field strength

Table 1: Specifications of the Megasolar power plant at Shobu-Kuki Radio Transmitting Station

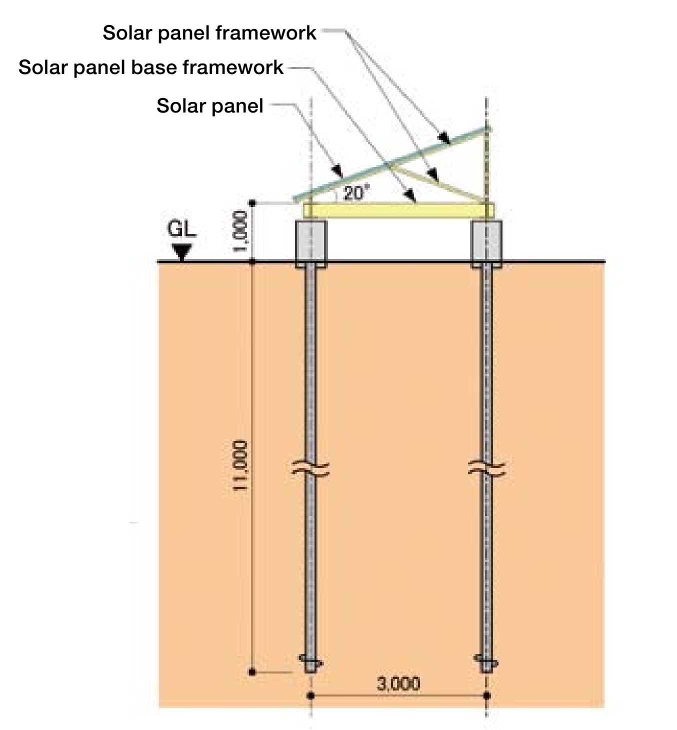
Site of equipment	Saitama Prefecture
Maximum power generation	2,000 kW (2 megawatts)
Annual power generation capacity (estimated)	2 million kW/h per year (equivalent to about 20% of the power used by the transmitting station, or enough for 500 ordinary households)
Reduction in CO_2 emissions (estimated)	1,100 t/year
Framework	Steel structure, attachment angle 20°
Panels	Monocrystalline silicon, 247 W × 8,120 panels
Inverters*	500 kW × 4

* Devices that convert the DC electricity generated by the panels into AC

Photo 1: NHK Shobu-Kuki Megasolar power plant

Photo 2: NHK Shobu-Kuki Radio Transmitting Station

■ Figure 1: Schematic view of framework



■ Photo 3: Winged steel pipe piles

■ Photo 4: Foundations and framework provided with expansion joints

■ Photo 5: Lightning protection system for solar panels

simulations of the broadcast waves and experimental verifications with a smaller 10 kW solar power system.

3. Megasolar facility

3.1 Equipment layout

The solar panel facilities were built at the south side of the transmitting site to avoid the shadow of the broadcast antenna while mitigating the effects of shadows from tall trees at the south-west boundary of the site and ensuring sufficient space for future renewal of the antenna guy wires. The panel tilt angles and the gaps between panels were designed to suit this site.

3.2 Solar panels and outdoor electrical equipment framework

The site used to be rice paddies, so the ground is very soft and is required to retain rainwater temporarily during heavy rainfall. Therefore, the equipment was installed at a height of 1 m above ground, and was built on piles sunk down to a relatively hard layer at a depth of 11 m below ground level (GL). Steel pipes were used for the pile foundations because they are low-cost, convenient for construction and can be installed without excavation. The ends of the steel pipe piles were wing shaped so as to resist the upward pulling forces to which they would be subjected during strong gales. (Photo 3, Figure 1)

The base framework was designed to deflect no more than 30 mm so as to avoid damage caused by contact between the framework and solar panels when the entire framework flexes under the load (wind loading + weight) from the panel supporting framework. Horizontal braces were also installed to increase the horizontal stiffness so that the framework behaves as an integral structure during strong gusts. Furthermore, since the framework has a maximum length of 117 m, some of the foundations were provided with expansion joints as a mechanism to absorb thermal expansion and contraction caused by changes of temperature. (Photo 4)

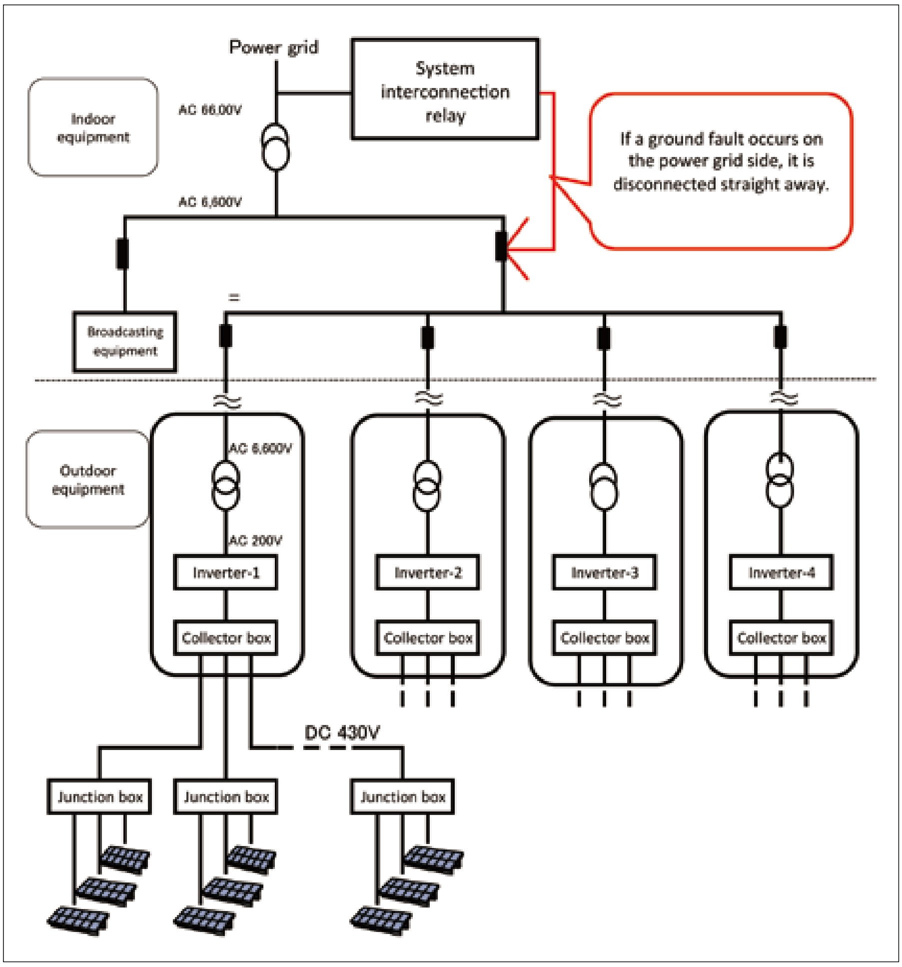
3.3 Lightning protection system for solar panels

To protect the solar panels from lightning strikes, overhead ground wires were provided above them. These wires are connected to the framework, and grounded through all the foundations. (Photo 5)

3.4 Outdoor power supply equipment

Fourteen solar panels (247 W each) are connected in series and input to four inverters as a supply of approximately 430 V DC. The panels are thus grouped into base units of 56 panels (14 across and 4 deep), and the generated electricity is gathered at

■ **Figure 2: Schematic view of the Megasolar power plant at NHK's Shobu-Kuki Radio Broadcasting Station**



a junction box attached behind the panels of each base unit.

All the electric power is gathered by a junction box in the collector box in the cubicles of the power supply equipment (Photo 6), and is input to the inverters. In the inverters, the power is converted to 200 V AC and then boosted to 6,600 V by a transformer before being sent to the indoor equipment. The voltage is stepped up so as to reduce the cable losses between the outdoor power supply equipment and the building (a distance of more than 200 m). Outdoor 500 kW power supply facilities are installed at four locations.

3.5 System interconnection

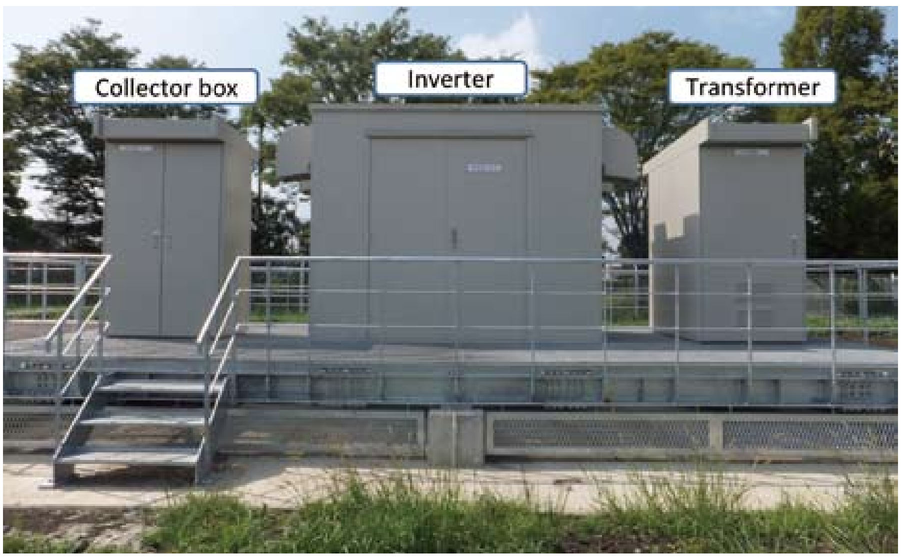
Each set of outdoor power supply equipment is joined to the indoor equipment via a separate power supply cable, and is fed to the transmitter as well as to the power grid. Thus, the power generated by the Megasolar system is initially used by the equipment inside the broadcasting facilities (including the transmitters), but when more electricity is being generated than can be used on-site, it will be fed into the public electricity grid. When the solar generated power is insufficient (e.g., at night), the station purchases power from the public electricity grid.

During the construction of the Megasolar system, it was decided that additional relays for interconnection control would be installed in order to avoid unintentional reverse flow from the Megasolar system to the power grid. The reverse flow of power generated by the Megasolar system to the public electricity grid is automatically controlled to be stopped immediately when a fault occurs on the power grid side. This control method ensures that the broadcasting facilities are not disconnected, so that the broadcasting equipment can continue to operate in any case. (Figure 2)

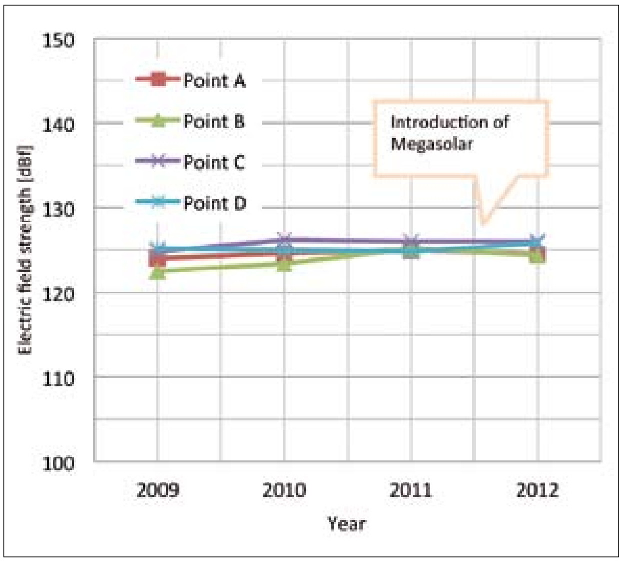
3.6 Impact after installation

Since the Megasolar system was installed, we have observed no particular changes in the electric field strength of broadcast waves or degradation of broadcast quality. (Figure 3)

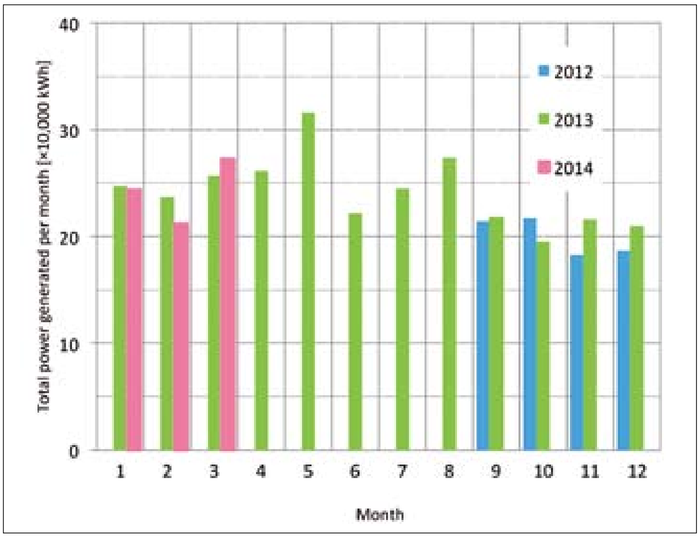
■ **Photo 6: Cubicles for power supply equipment**



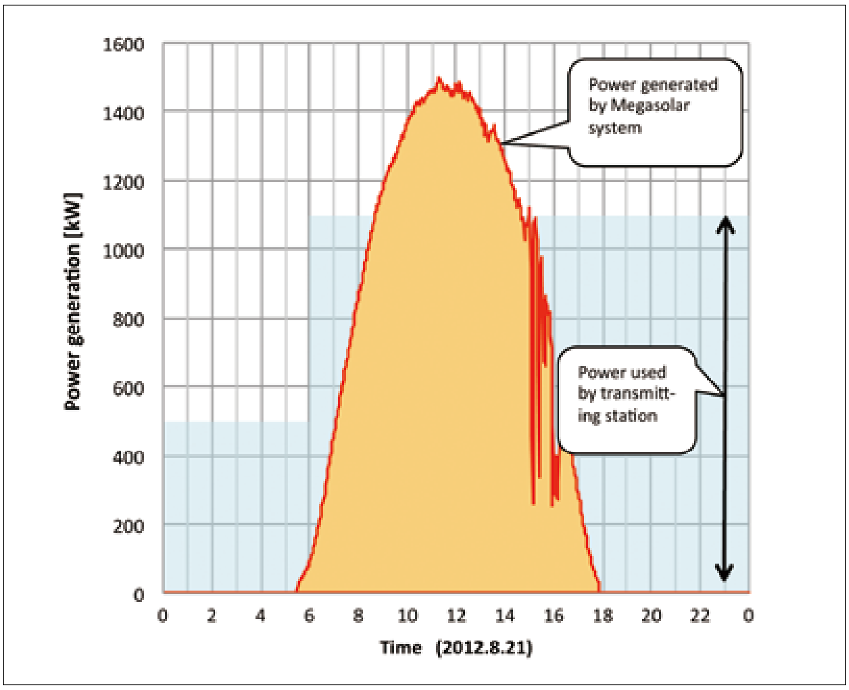
■ Figure 3: Changes in the electric field strength



■ Figure 5: Megasolar power generation performance (September 2012 – March 2014)



■ Figure 4: Megasolar power generation performance (August 21, 2012)



Although there is some induction of broadcast signals on the lines between the solar panels and the junction box, the induced voltage is as small as 8 Vp-p in a 430 V DC power supply, and has not caused any problems since the beginning of its operation.

4. Power generation details

4.1 Power generated per day

On a sunny day, the power generated by the Megasolar system starts climbing at sunrise, reaches a peak at about midday, then decreases and finally stops at sunset.

The Shobu-Kuki Radio Transmitting Station consumes 1,100 kW of electricity during the daytime, and about 500 kW at night when NHK Radio 2 goes off-air. When the Megasolar system generates electricity that exceeds the consumption of the station, the excess power is fed into the public electricity grid. At other times, electricity is purchased. The amount of electric power generated by the system may drop suddenly when, for example, the sun goes behind a cloud. In such a case, the electricity from the power company compensates to ensure continuous broadcasting. (Figure 4)

4.2 Operational results

The Megasolar system has been operating continuously without any problems since it was first put into service 20 months ago. The total amount of electricity generated over 19 of these months (from September 2012 to March 2014) was approximately 4,400 MWh. This is equivalent to about 20% of the station's power consumption.

The amount of electricity generated in 2013 was approximately 2,900 MWh, which is 1.4 times the original estimation. The power generation performance is shown in Figure 5.

5. Conclusion

To reduce out CO_2 emissions and suppress the peak daytime electricity demand, a 2 MW Megasolar system was installed at the NHK Shobu-Kuki Radio Transmitting Station, which is the largest radio medium wave transmitting station in Japan. The construction was successfully completed without any disruption to the transmission of broadcast services, and there was also no effect on the broadcast waves after installation. The amount of electricity generated by this system is exceeding expectations.

NHK hopes that the operational data from this Megasolar system will contribute to future natural energy projects.

Launch of a Raincloud Scanning Radar Satellite

—The Global Precipitation Measurement (GPM) mission gets under way—

Hiroshi Hanado
Research Manager
Applied Electromagnetic Research Institute
Radiowave Remote Sensing Laboratory
National Institute of Information and Communications Technology

Katsuhiro Nakagawa
Senior Researcher
Applied Electromagnetic Research Institute
Radiowave Remote Sensing Laboratory
National Institute of Information and Communications Technology

1. Introduction

Although seas and oceans cover about 70% of the earth's surface, the water that supports human life does not come from the sea but from the air in the form of precipitation (like rain and snow). Too much precipitation causes cloudbursts and flooding, while too little precipitation causes droughts. In both cases, the consequences can be disastrous. Thus, although precipitation provides us with life-giving water, it can also be a life-threatening hazard. Since precipitation has such a major influence on our lives, the Global Precipitation Measurement (GPM) mission aims to use satellites to make measurements of precipitation on a global scale.

2. Combining the precipitation radar and microwave radiometer

GPM works by combining observation data from a core observatory satellite equipped with precipitation radar and microwave imaging instruments and from a constellation of subsidiary satellites equipped with a microwave radiometer, resulting in frequent and accurate measurements of rainfall distributions worldwide. A precipitation radar is able to analyze the distribution of precipitation in the vertical as well as horizontal directions, which means it can produce detailed and highly accurate three-dimensional measurements. Microwave imaging is a two-dimensional imaging method that works by measuring the faint microwaves radiated from the earth's surface and atmosphere, but allows measurements of water vapor, clouds, precipitation and seawater surface temperatures to be made more frequently because it can cover a wider area with each measurement. The GPM core observatory satellite was developed jointly by Japan and the United States, and was launched by H-IIA rocket flight No. 23 on 28th February 2014. The GPM core observatory satellite is equipped with a dual-frequency precipitation radar (DPR) developed jointly by the Japan Aerospace Exploration Agency (JAXA) and National Institute of Information and Communications Technology (NICT), and a GPM microwave imager (GMI) developed by NASA. The primary role of the core observatory satellite is to measure the precipitation distributions simultaneously with two sensors (radar and microwave radiometer), allowing us to make more accurate measurements by improving the precipitation strength estimation algorithm of the microwave radiometers carried by the subsidiary satellites. The orbit of the GPM core observatory satellite is inclined at an angle of 65°, allowing it to make observations from the tropics to high latitudes. Since it is not synchronized with the sun, it can also measure daily changes in precipitation patterns. The satellite orbits the earth at an average altitude of 407 km and travels at approximately 7 km/sec, or about 90 minutes per orbit. It makes 15 or 16 orbits each day, and measures the precipitation distributions along each orbit.

3. Dual-frequency precipitation radar (GPM/DPR)

The dual-frequency precipitation radar (GPM/DPR) mounted on the GPM core observatory satellite is the successor of the world's first satellite-mounted precipitation radar (TRMM/PR) on board the Tropical Rainfall Measuring Mission (TRMM) satellite launched in 1997. The TRMM/DPR is still in orbit, where it is still making homogenous precision observations of rainfall distributions in the tropics without distinguishing between land and oceans, and measuring three-dimensional rainfall distributions inside typhoons during their early stages of development over the ocean,

Figure 1: Concept of radar precipitation measurements

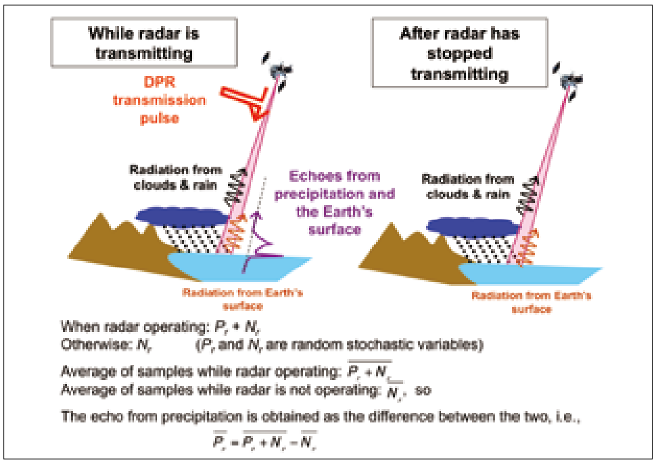
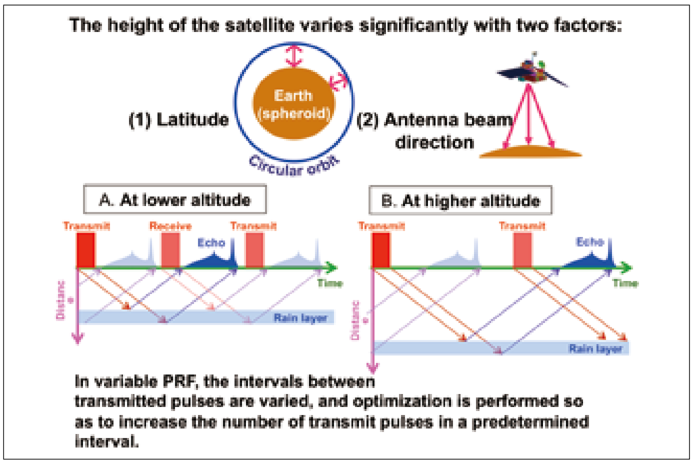
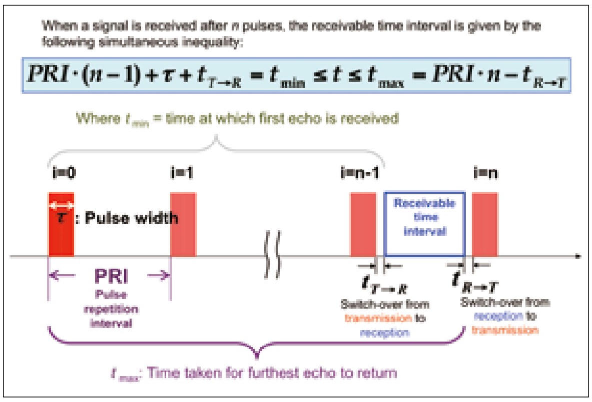


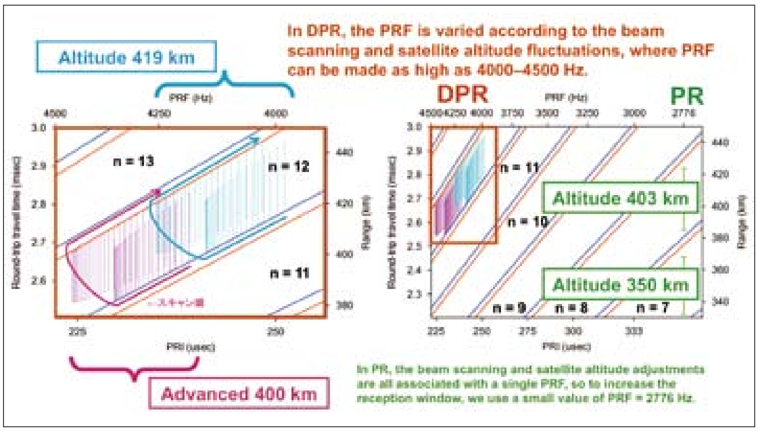
Figure 2: Schematic illustration of variable PRF (VPRF)



■ Figure 3: Conditional formula for determining the pulse repetition frequency (PRF)



■ Figure 4: Trying out VPRF to improve PRF



where they cannot be observed by land-based radar. As a result, it has provided a wealth of new knowledge to help explain climate mechanisms on a global basis. One role of the dual-frequency precipitation radar is to expand the success of TRMM/PR from the tropics into middle and high latitudes. For this reason, the GPM/DPR consists of two radars operating at different frequencies — a Ku-band radar (KuPR, 13.6 GHz) and a Ka-band radar (KaPR, 35.55 GHz). By using two frequencies, we can obtain detailed measurements of precipitation at a variety of high latitudes by exploiting frequency-based differences in the scattering and attenuation of electromagnetic waves by precipitation in order to estimate the precipitation intensity with greater accuracy and figure out the phase of the precipitation (i.e., to distinguish between liquid phases like rain and solid phases like snow). Table 1 shows the performance of the GPM/DPR and TRMM/PR radars. The KuPR radar is an improved version of the TRMM/PR with a higher transmitter output power and better sensitivity. The KaPR radar is a new addition that uses the shorter Ka band wavelengths to achieve higher sensitivity. It also has a dual observation mode where observations of the same volume are made simultaneously with the KuPR radar and a dual-frequency method is used to compensate for precipitation attenuation so that the precipitation intensity can be estimated more accurately.

■ Table 1: Main specifications of the GPM/DPR dual-frequency radar and TRMM on-board precipitation radar (TRMM/DPR) on the GPM core observatory satellite

	GPM/DPR		TRMM/PR
	KaPR	KuPR	
System	Active phased array (128 elements)		
Frequency	35.55 GHz	13.6 GHz	13.8 GHz
Scanning width	125 km	245 km	215 km
Horizontal resolution	5 km		4.3 km
Distance resolution	500 m	250 m	250 m
Observation altitude range	From ground level to 19 km		From ground level to 15 km
Minimum observable precipitation strength	0.2 mm/h	0.5 mm/h	0.7 mm/h
Dimensions (m)	1.4 ×1.2×0.8	2.5×2.4×0.6	2.2×2.2×0.6
Mass	324.0 kg	429.9 kg	464.87 kg
Power consumption	314.8 W	423.1 W	217.1 W

4. Improving the sensitivity of GPM/DPR (using variable PRF)

In addition to the scattered waves from precipitation, the signals received by the radars also contain additional noise — some from external sources and some generated inside the receiver equipment. To quantitatively measure the scattered waves from precipitation, we measure the precipitation echo (including noise signals) while the radar is transmitting, then measure the noise signal after the radar has stopped transmitting. The difference between the two is used to measure the intensity of the waves scattered from the precipitation (Figure 1). The waves that are scattered back to the radar from precipitation are the sum of scattered waves from many precipitation particles, so their intensity will vary with an exponential distribution in the same way as noise signals. A meaningful measurement value can be obtained by performing measurements multiple times and averaging the results together. The GPM core observatory satellite is in low earth orbit traveling at a speed of approximately 7 km/sec. Since the GPM/DPR radar has a horizontal resolution of 5 km and performs observations by scanning continuously without interruption, it is necessary to align the measurement direction 49 times in 0.7 seconds while performing a single scan. The GPM core observatory satellite has a large orbital inclination angle of 65° in order to perform observations at high latitudes, and due to the ellipsoidal shape of the earth, its distance from the ground varies more than the TRMM satellite. And so, whereas the TRMM/PR satellite used a fixed pulse repetition frequency (PRF), we used a variable PRF (VPRF) to enable efficient observations. A schematic illustration of VPRF is shown in Figure 2, and Figure 3 shows the formulation of this technique. Figure 4 shows the improvement in PRF compared with TRMM/PR.

5. Conclusion

GPM/DPR has passed its initial functional validation, and has now begun routine operations. At the NICT, in cooperation with JAXA, we are performing external calibration tests to check the radar performance and monitor any changes over time, and we are performing ground-based validation of the measurement data from the dual-frequency precipitation radar and the algorithm for extracting this data. We are planning to perform direct validation of the measurement data by conducting synchronized observations with the C-band precipitation radar (nicknamed COBRA) installed at the NICT's Okinawa Electromagnetic Technology Center and the PANDA (Phased Array Weather Radar and Doppler Lidar Network Fusion Data System) system that combines an X-band phased array weather radar and Doppler radar. We are also planning to verify our algorithms by performing balloon observations with the aim of making detailed measurements of the size of precipitation particles inside the melting layer of the sky where snow or ice melt to form rain.

FY2013 JICA Group Training Course

—Using international standards to improve ICT policy planning skills—

International Cooperation Department
The ITU Association of Japan

For about two weeks from 23 January to 7 February 2014, the ITU Association of Japan held a group training course at the request of the Japan International Cooperation Agency (JICA). This training course was aimed at cultivating the ability to investigate optimal ICT strategies for resolving social issues such as setting up an ICT infrastructure in member countries through the use of international standards, and included theoretical and practical training on how to provide communication infrastructures that are more effective and efficient based on international standards.

This course has been held by the ITU Association of Japan with the support of the Ministry of Internal Affairs and Communications (MIC) since the previous phase (FY2012), and it was decided that from this year's training course, as a new phase 1 lasting three years, the course would be run with updates to last year's contents.

This year there were fourteen trainees from ten different countries: Brazil (2), Cambodia (1), Iraq (2), Jordan (1), Laos (2), Myanmar (1), Malaysia (2), Pakistan (1), Tonga (1) and Vietnam (1).

Taking the Japanese government's policies relating to telecommunications as a starting point, the course encompassed a range of lectures and reports including ITU standardization trends, the activities of standards organizations in Japan, inception report publication, problem analysis techniques, standardization activities of related businesses and organizations, and the publication of individual reports. It also included visits to related facilities.

There were two lectures on Japan's policies regarding communications and standardization: *Telecommunications Policy in Japan and Standardization in the ICT Field*. ITU standardization trends were covered in the lecture *Standardization trends in ITU-T*, and the activities of Japan's standardization organizations and the like were covered in the lectures *Towards global standardization in TTC, Certification System for Telecommunications Equipment in Japan and Standardization of Radio Systems*.

On completing the lectures on Japan's policies regarding communications and standardization, and the standardization efforts of the ITU and Japan, the trainees moved on to a lecture on the analysis method called Project Cycle Management (PCM) where they extracted the issues relating to standardization in their own countries and took part in group discussions to share the level of knowledge between trainees. This PCM lecture was once again implemented just before the individual report presentations at the end of the training, and meetings were held where — based on group discussions — each trainee was able to sort out policies for problem-solving methods relating to the standardization of ICT in their own countries and deploy their own standardization plans.

Regarding the standardization activities of related companies and organizations in Japan, there were lectures on *KDDI's Strategy for Development of ICT Services & Technology, The Current Status on Standardization of Future Networks, Standardization of Mobile Communication Systems, Research and Development on ICT*

■ Photo 1: At the MIC

■ Photo 2: Lecture 1

■ Photo 3: Lecture 2

■ Photo 4: Participants attending a lecture at the NICT

■ Photo 5: Closing ceremony

and standardization activities in NICT, Smart City, The Setup of Digital Terrestrial Television Broadcasting Networks, The Roles and Convergence of Broadcasting and Communications and Hybridcast: An Integrated Broadcast Broadband System.

The facility tour consisted of visits to the NTT DOCOMO Show Room (Future Station), the NTT DOCOMO Network Operation Center, NEC Innovation World, and the Panasonic Tokyo Center. The trainees were able to see the development and standardization of new technologies at each company/organization, and gained a deep understanding of the latest technologies and standardization efforts at each company.

At the NTT DOCOMO "Future Station" show room, the trainees saw the shape that mobile communications will take in the near future, and observed the operation of mobile communications at DOCOMO's Network Operation Center. At the NEC Innovation World, the trainees saw NEC's latest technology and were given a lecture on *Wireless Broadband Access*. At the Panasonic Tokyo Center, the trainees saw the ICT of the near future being put to use, and were given lectures on *Panasonic's Approach to Global Standardization, The Global Standardization of Broadband PLC Technology and Standardization Activities for LTE — A Global Standard for High-Speed Mobile Communication*. Furthermore, at the NICT (National Institute of Information and Communications Technology), the trainees were given a lecture on the NICT's standardization activities.

On the final day of training, the trainees presented their individual reports. The individual reports discussed the use of PCM methods to tackle the topics of this training course, such as the current state and future development of standardization in each trainee's country, and were followed by active discussions on the prospects of ICT standardization activities in each country.

This training course received generally good ratings from the trainees, but in order to further improve the satisfaction of trainees, the ITU Association of Japan will listen to any issues that arise during the course by evaluating the content and text of lectures delivered by trainees at the end of the course, and listening to their appraisals, opinions and requests regarding site visits and field trips. By analyzing and investigating these evaluation results, we will shed light on any practical problems with the course and reflect them in subsequent versions of the program.

Recent Activities of NICT's Resilient ICT Research Center

Hiromitsu Wakana
Planning Office
Resilient ICT Research Center
National Institute of Information and Communications Technology

1. Introduction

On April 1, 2012, the National Institute of Information and Communications Technology (NICT) established the Resilient ICT Research Center, a world-leading research establishment in the Katahira Campus of Tohoku University, with the aim of developing information and communications technology that is resistant to disaster and can help to revive economic activity in disaster-affected areas. Building work at the center was completed at the end of last year, and an opening ceremony was held on March 3, 2014, followed by an opening symposium at Sakura Hall in Tohoku University. This article first describes the Resilient ICT Research Center and its research facilities, and then gives an overview of the opening ceremony and symposium, and the plans of this project.

2. Opening of the Resilient Research Center

The Great East Japan Earthquake of March 11, 2011 caused severe disruption of telecommunication networks, and the failure of information gathering and delivery systems. To prevent this from happening again, the Ministry of Internal Affairs and Communications (MIC) established and funded R&D programs aimed at the development of "unbreakable networks" — i.e., disaster-resistant and disaster-resilient information and communication technologies. The participants in these projects consisted of universities and private bodies including Tohoku University, NTT DOCOMO, NTT, NTT DATA, KDDI, NHK, SkyPerfect JSAT, NEC and Mitsubishi Electric. Ten of the projects were initiated in 2012. These were aimed at strengthening current wireless, mobile, broadcasting and core networks, and developing network control technology for traffic congestion avoidance. NICT has been coordinating the cooperative research and development efforts of industry, academia and government bodies, and has been preparing testbed facilities in the disaster-affected parts of the Tohoku region. In January 2012, NICT and Tohoku University entered into a comprehensive collaboration arrangement and established a Resilient ICT Research Center in the Katahira Campus of Tohoku University.

This research center is a new 4-story steel frame building with a total floor area of 2,200 m^2, containing testbed facilities for resilient ICT R&D and laboratories for collaborative research by universities, private companies and local governments. It consists of three laboratories: (1) the Information Distribution Platform Laboratory, which aims to implement an information distribution platform to support rapid and adequate assessment of disaster conditions when a disaster occurs, (2) the Robust Network Platform Laboratory, which aims to build photonic network infrastructure to reduce communications congestion by dynamic resource control when a disaster occurs, and (3) the Wireless Mesh Network Laboratory, which aims to implement disaster-resilient wireless networks using terrestrial wireless mesh network and satellite communications. NICT's testbed consists of three platforms designed for these three research subjects and laboratories.

On the first floor of the building, there is a 400-node computer server with 4,800 cores, 38.4 terabytes of memory and 10 petabytes of disk storage for the information distribution platform. This disaster-resilient platform uses information analysis and natural language analysis techniques to collect and organize vast amounts of disaster-related information from cyberspace, including social networking services like Twitter, and can provide information that aids comprehension of the disaster situation, leading to better decision making. The platform's services will become available in autumn 2014.

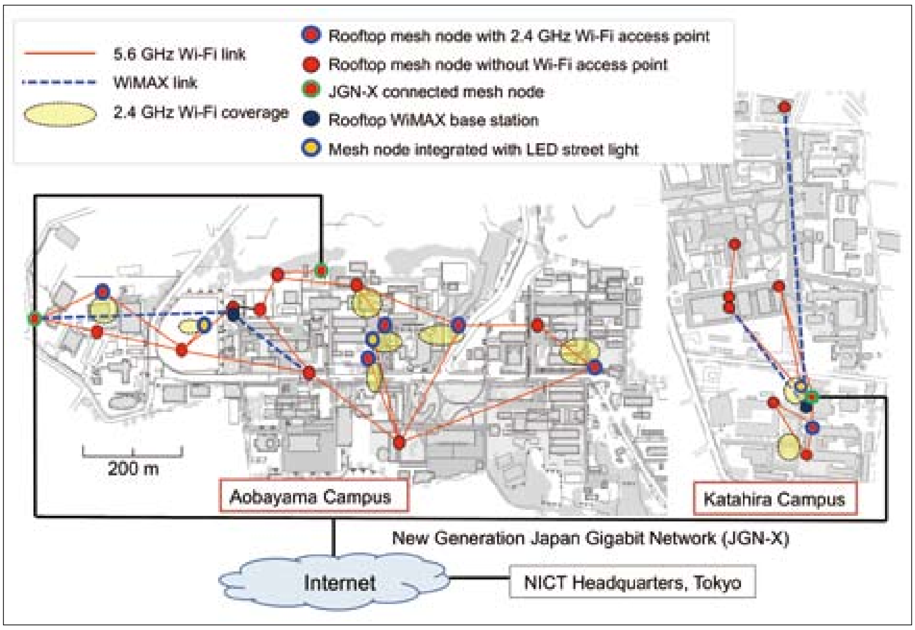
On the second floor, there is a robust photonic network platform including optical packet/optical path integrated nodes, a reconfigurable optical add-drop multiplexer (ROADM) and portable burst optical signal amplifiers. These technologies ensure that the platform can provide disaster victims with equal access

■ Photo 1: The Resilient ICT Research Center

■ Photo 2: Information distribution platform (400-node servers)

■ Photo 3: Optical packet/optical path integrated nodes

Figure 1: Wireless mesh network testbed



to information about the disaster situation, and are necessary for confirming and ensuring the wellbeing of victims and mitigating the effects of disasters.

The third floor consists of collaboration laboratories with capacity for more than 30 people from universities, industries, and local governments.

A wireless mesh network testbed aimed at robust, dependable, disaster-resilient wireless networks is located on the fourth floor and outside the building. It consists of a terrestrial wireless mesh network, which can achieve flexible control of communication traffic by bridging communication links through satellites and unmanned aerial vehicles (UAVs). The testbed includes outdoor wireless mesh access points located on the building roofs, and digital signage equipment that was constructed in the Aobayama and Katahira campuses of Tohoku University. It also includes three Ka-band vehicle-mounted earth stations for satellite communications using Japan's experimental WINDS satellite (short for "Wideband InterNetworking engineering test and Demonstration Satellite"). Details of these studies and facilities can be found in previously published articles[1, 2].

At the opening ceremony, held in the Resilient ICT Research Center on March 3, 2014, the attendees expressed a common resolve for the center to promote the R&D of resilient ICT technologies to meet the growing needs of the society through its research facilities, and to promptly expand its achievements with the aim of becoming a world-leading research center. The ceremony ended with closing remarks by Dr. Yoshiaki Nemoto, the Director General of the NICT's Resilient ICT Research Center, in which he set forth the Center's policies and mission. There were 60 attendees in the ceremony, including people from Tohoku University, government agencies, local governments, the private sector and NICT.

3. Opening Symposium

The Opening Symposium of the Resilient ICT Research Center (hosted by the MIC and NICT) was held in the afternoon

Photo 4: Opening Symposium for the Resilient ICT Research Center

of the same day. After two keynote speeches, representatives from industry, academia and government delivered lectures relating to the direction of the research center and the promotion of collaboration between industry, academia and government. Results of the ten resilient ICT projects mentioned above (which were directly commissioned by the MIC) were also presented. Activities for further practical applications of the research results were also introduced. In this symposium, it became clear that we all share the same perceptions of the situation of resilient ICT research, the formation of a base and the importance of collaboration between industry, academia and government. An exhibition of research results also took place on the first floor of Sakura Hall. There were 187 participants in total for both the symposium and the exhibition.

4. Future work

For the early implementation of resilient ICT in society, the Resilient ICT Forum was established in May 2012 with members from universities, private sector organizations who are participating in MIC-funded projects, and NICT. This year, we have established two working groups in the Forum: One is for promoting standardization and public relations of resilient ICT technologies and the other is for investigating local disaster management models to promote introduction of research results to local governments. In the Shikoku Island of Japan, some members of the Forum have carried out demonstrative experiments for rapid information transfer to residents and the reinstatement of adequate communications infrastructure in disaster-hit areas.

NICT is committed to the establishment and early practical application of resilient ICT by extending collaborative relations in the Forum and with local governments, and by accelerating research and development based around the NICT Resilient ICT Research Center established in cooperation with Tohoku University. We will also strive to implement the resilient ICT in areas that are thought to be vulnerable to a Nankai trough earthquake, such as Shikoku Island, and in other Asia-Pacific countries.

References

1 H. Wakana, Y. Awaji, K. Hamaguchi, M. Inoue, R. Miura, B. Jeong, and K. Ohtake, "Report on Resilient ICT Research Symposium and Demonstration," New Breeze, 2013 summer, pp. 16-19.

2 Y. Nemoto and K. Hamaguchi, "Resilient ICT Research Based on Lessons Learned from the Great East Japan Earthquake," IEEE Communications Magazine, March 2014, Vol. 52, No. 3, pp. 38-43.

Toward Connectivity for All

Candidate for the Post of Deputy Secretary General of the Asia-Pacific Telecommunity (APT)

Masanori KONDO

FOR FURTHER INFORMATION, PLEASE CONTACT
Tel: +81-3-5253-5935 Fax: +81-3-5253-5937 E-Mail: kondo-jp@ml.soumu.go.jp

New Breeze
平成二十六年七月十日発行（年四回一、四、七、十月の十日発行）第二十六巻第三号（通巻百三号）
定価 一冊 一、六二〇円（本体価格 一、五〇〇円、消費税 一二〇円） 年間購読料 六、四八〇円（本体価格 六、〇〇〇円、消費税 四八〇円）