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Special Report on Earthquake Response Operations

●Facilities

●Topics


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We wish to extend our deepest sympathies to the people who have suffered as a result of the Tohoku Region Pacific Coast Earthquake that occurred on March 11, 2011. We wish for the earliest possible recovery from this unprecedented tragedy. This issue introduces how NICT has responded to the earthquake disaster.
NICT will continue to work on the studies that make a significant contribution even in a disaster.

Pi-SAR2 used for Emergent Observation of Area Stricken by the Great East Japan Earthquake

Seiho Uratsuka

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After completing a master's course, he joined the Radio Research Laboratory, Ministry of Posts and Telecommunications (currently NICT) in 1983. He has been engaged in radio wave remote sensing research, particularly synthetic aperture radar. Ph.D. (Engineering)

From 7:30 am to 10:45 am on March 12, 2011, the day after the quake, NICT conducted emergent monitoring of the Pacific coast and around the main roads in the Tohoku district using the Polarimetric and Interferometric Airborne Synthetic Aperture Radar System* (hereinafter, referred to as Pi-SAR2).

Right after the earthquake, we contacted Diamond Air Service Incorporated (hereinafter, referred to as DAS), which owns the aircraft (a Grumman Gulfstream II) that carries the Pi-SAR2, and asked them to quickly mount the device, a process that usually takes 2 days, in just 12 hours. It was immediately after we gave clear instructions and requests to DAS that the telephone service went down. A data recording module from the Pi-SAR2 was brought back to the NICT Headquarters (Koganei city) in order to process the observation data that had been gathered from Shinmoedake just before the quake (March 9). Therefore, we also needed to transfer the module to the Nagoya airport urgently, where the aircraft was based and most of instruments of Pi-SAR2 were on stand-by. In addition, all train services were shut down, including bullet trains, right after the earthquake, and so we had to secure transportation means to Nagoya for the observers, too. Thus, we had few options, but we hastily arranged a rental car to transport the devices and observers and managed to rent a van to carry loads. If we had been slower to make a decision, we might not have been able to start observation as quickly.

Usually before operating the Pi-SAR2, a flight plan must be filed with the Civil Aviation Bureau. The Pi-SAR2 team in NICT was collecting as much information as possible through the media immediately after the quake and urgently prepared the flight plan shown in Figure 1. We e-mailed DAS to begin the urgent application procedure and got in the car. The three members who were to board the aircraft left NICT around 11:00 p.m. The Koshu-kaido and other roads were jammed with cars, but once they got on the Chuo Expressway, traffic flowed very smoothly. They arrived in Nagoya at around 5:00 a.m. the next morning and entered DAS.

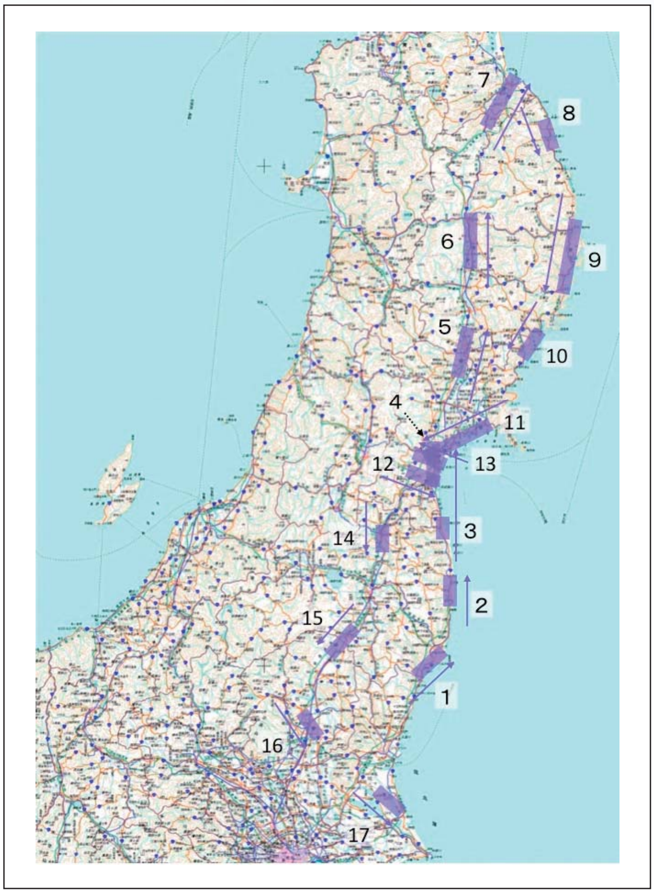

Figure 1●Flight Plan for March 12, 2011 (Map provided by: Geographical Survey Institute)

The rectangular parts in purple represent observed areas. The numbers indicate the order of the observations. Following the instructions from flight control, we did not make observations along some parts of our flight path.

Table 1●Time Sequence to Data Release

Event	Operation	Time	Elapsed Time from Start of Observation (hour)
Earthquake occurrence		14:46	-
	Flight negotiation Setup of Pi-SAR2 system Travel from Koganei to Nagoya		
Takeoff		07:30	-
Observations across the path in Figure 1		08:16	0
	Data processing on the airplane		
Landing		10:45	2.48
	Preparation for data transmission		
Images received at NICT		12:14	3.97
	Preparation for data release		
Data release		14:23	6.12

Figure 2●Image of area around Sendai Airport at about 8:00 a.m. on March 12, 2011.

The black parts dominating the image are the areas flooded by the tsunami.

Immediately after arrival, we checked the wiring, inspected the devices for proper operation, and entered the observation parameters. At about 6:50 a.m., we checked the weather and discussed the flight course and other necessary matters, and then boarded the aircraft. At that time, NICT Vice President Hiroshi Kumagai, who had been to Osaka on a business trip the previous day, joined us in Nagoya and directed the observation process.

We took off from Nagoya airport at 7:30 a.m. and proceeded with observations according to the flight plan prepared the previous day. However, flight control told us to divert around the Fukushima Daiichi nuclear power plant, so we observed other areas. Since observation with the Pi-SAR2 is basically done along a straight flight path, data is not acquired during turns. During the time between observations, we processed several images utilizing the on-board processing system. These images were limited to a 2 km square for quicker processing. After observations were completed and the aircraft had landed in Nagoya, we tried sending the processed image data to the Pi-SAR2 team in NICT at around 11:00 a.m. But perhaps because of the convergence in communication after the disaster, the data that we had so urgently processed on board the aircraft only was successfully sent around 3:00 p.m., almost 24 hours after the earthquake. We published special pages on NICT’s website to make the data available to the public.

Table 1 shows the time sequence from the observation to the data release. We brought the data back to Koganei, started detailed processing the next day (5 km square, color image using polarized waves) and posted them on NICT’s website one by one. One of the images, shown in Figure 2, is an image of Sendai Airport. The black parts dominating the image are the areas flooded by the tsunami. The data from the observation on March 12, including this image, and the image data from the subsequent observation on March 18 have been published on the website linked below. The Pi-SAR2 is capable of 30 cm resolution, but images that provide both broad spectrum and high resolution at the same time generate too much data. Therefore, we gave priority to broad spectrum and reduced the resolution to around 2 m.

We released this data in the hope that it will be utilized for life-saving services and restoration work in the disaster-stricken area, and at the same time, generally inform the public about the situation. We believe this data served those purposes to some degree. But interpreting radar images requires some specialized knowledge, and we need to work on this point in the future.

Lastly, we would like to offer our sincerest prayers for the victims of the Tohoku Region Pacific Coast Earthquake and Tsunami on March 11, 2011 and wish for the earliest possible recovery from this unprecedented tragedy.

NICT Column

＊ Polarimetric and Interferometric Airborne Synthetic Aperture Radar System (Pi-SAR2)

Synthetic aperture radar (SAR) is a radar technology that can observe the ground in the manner of aerial photographs by emitting radio waves from an aircraft to the ground. One of SAR’s advantages is that the use of radio waves enables observation in all weather conditions, whether cloudy or rainy, and even at night.

NICT has developed a synthetic aperture radar system (Pi-SAR2) that is capable of widely observing the ground from an aircraft flying at an altitude of 12,000 m. The “P” in Pi-SAR2 stands for Polarimetry, which resolves the ground textures in greater detail by using the oscillating direction of the radio waves (polarized wave). The “i” as in the Pi-SAR2 represents interferometry, which measures the height of the ground through the parallax of two antennas while taking an image.

Pi-SAR2, which is the 2nd version of the instrument, boasts the world’s best performance with dramatically improved resolution (image fineness) from 1.5 m in the first machine to 30 cm.

〈The observation results collected by the Pi-SAR2 in the disaster-stricken area are available on the following website.〉
http://www2.nict.go.jp/pub/whatsnew/press/h22/announce110312/index.html

Special Report on Earthquake Response Operating “KIZUNA” (WINDS) in Miyagi Prefecture

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After completing a master's course and serving as a fellow of science and technology, Akioka joined the Communications Research Laboratory, Ministry of Posts and Telecommunications (currently NICT) in 1993. He has been studying space environment, space technology, etc. Ph.D. (Science)

Wideband InterNetworking engineering test and Demonstration Satellite “KIZUNA” (WINDS)

KIZUNA, the Wideband InterNetworking Engineering Test and Demonstration Satellite (hereinafter, referred to as WINDS), was launched by an H2-A Rocket (No.14) from the Tanegashima Space Center in February 2008. It has been about three years and three months since the launch, and it has been operating satisfactorily, actively conducting various experiments. The biggest feature of WINDS is that it boasts the world’s fastest satellite-based communications, providing the entire Asian Pacific region with broadband IP communications. WINDS is equipped with an ATM Baseband Switch subsystem (ABS) regenerative switching device developed by NICT. In its regenerative switching mode, the WINDS satellite communications network achieves a transmission rate of 155 Mbps with multiple points connected simultaneously. In the bent pipe mode, which bypasses the ABS, WINDS can communicate between two given points at over 1.2 Gbps. These capabilities have been applied in various experiments and events.

For example, WINDS successfully transmitted next-generation high-capacity video content, including super high-definition video and 3D video taken with a high-definition 4K camera. In July 2009, to transmit the video of a total solar eclipse, we brought an on-vehicle station to Iwo Island and transmitted four high-definition video channels to NICT Headquarters (Koganei city) in real time. Those videos were delivered to viewers across the nation through news shows via the internet. In January 2010, WINDS connected an operating theater at Yamato Seiwa Hospital in Kanagawa Prefecture with the Kobe Convention Center and successfully relayed 3D video of cardiac surgery.

The earth station equipment for WINDS is connected to external devices via Ethernet, which is widely used on the terrestrial network. Therefore, we can use most network compliant devices, including computers, video conference equipment, and IP telephones, just by connecting with it. This simple and easy-to-use interface makes the cutting-edge WINDS communication satellite very user friendly.

Use of Satellite Communication in Disaster

One of the biggest strengths of WINDS is that, unlike a ground-based fiber-optic network, WINDS can immediately open high-capacity broadband lines to an earth station equipment anywhere that does not have a terrestrial communications network. This is especially helpful in the wake of a serious disaster when conventional communications systems fail. Those who had been engaged in firefighting operations in the field had strong interest in this aspect of WINDS. In the APEC Ministerial Meeting of the Telecommunications and Information Industry that was held in Okinawa in October 2010, we worked with the Tokyo Fire Department on an exhibition in the use of WINDS in disaster rescue operations. Based on discussions we had about the kind of communications-related problems we may face and how important communications capability is when an emergency aid group is dispatched to a far-away disaster, we have just implemented a concrete plan for working together right after the 3rd mid-term plan gets rolling in April.

Then, Tohoku Region Pacific Coast Earthquake hit the nation on March 11th. NICT Headquarters immediately began collecting information from the institutions concerned, but the phone lines were not working very well. Just watching TV, we knew that the disaster stricken areas were suffering an unimaginable calamity. In case WINDS was to be used, we began opening the schedule for satellite operations and collecting the necessary equipment. Then, before dawn on the 12th, we received a call from the Tokyo Fire Department asking to use WINDS to communicate with the emergency fire response team that was to be dispatched. We shifted into full swing, checking how much equipment was secured, collecting information, and getting ready. We also coordinated with the Japan Aerospace Exploration Agency (JAXA), a joint developer of the WINDS project, and asked them to rearrange the WINDS schedule and help us secure the necessary resources. We managed to make the minimum necessary arrangements and left the Tokyo Fire Department in Otemachi on March 14th with the Tokyo unit of the emergency firefighting aid groups, which were to be sent as reinforcements.

We entered Kesennuma City late at night on the same day, and on the morning of the 15th, arrived at the Kesennuma Fire Station and Disaster Control Center, where the disaster countermeasures office for Kesennuma City was located. Right away, we chose where to install our equipment and started to check and adjust the power source and signal line routes. Thanks to the prompt and smooth work by the team members working in Tokyo,

Wideband InterNetworking engineering test and Demonstration Satellite "KIZUNA" (WINDS)

● Ultra high-speed network via satellite
1.2 Gbps/beam (bent pipe mode)
155 Mbps/beam (regenerative mode)

● Simple interface with terrestrial high-speed network (Ethernet)

● Ultra wideband high-power transponder

● Ka-band multibeam antenna & array antenna

● ATM Baseband Switch subsystem (ABS)

	MBA	APAA
Frequency	Uplink: 27.5 - 28.6GHz / Downlink: 17.7 - 18.8GHz	
Coverage Area	Across Japan and ten cities in Asia	Across Asia Pacific regions
EIRP, G/T	68 dBW or more, 18 dB/K or more	55 dBW or more, 7 dB/K or more
Polarization	Linear (Horizontal and Vertical)	Linear (Vertical)
Relay Modes	Regenerative switching and bent pipe relay modes	

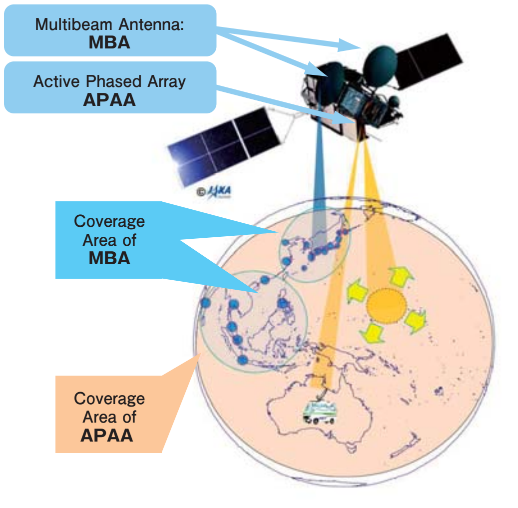


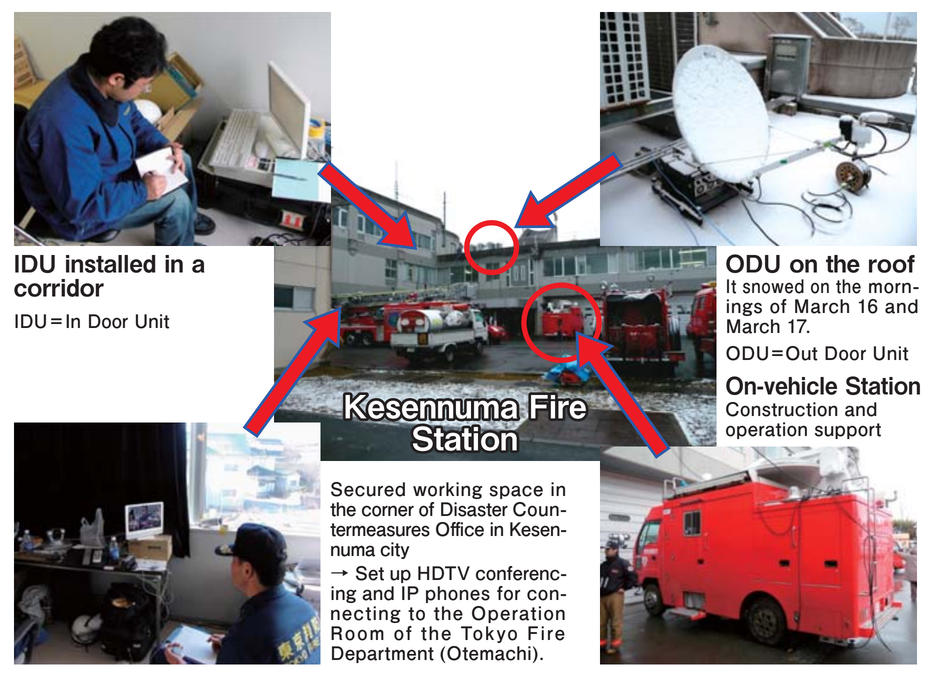
Figure 1●Outline of Ultrahigh-speed Internet Satellite "KIZUNA" (WINDS)

we were able to set up the satellite lines to the Plan Office of the Tokyo Fire Department in Otemachi by 4:00 p.m., including setting up the antennas, installing cables in the room and at the fire brigades, and launching the application equipment.

Then, we moved to the Matsushima air base with the unit dispatched from the Japan Air Self-Defense Force and set up broadband communication lines between Iruma (Saitama Prefecture) and Matsushima.

Looking Back at the Activities in the Disaster Stricken Area

Although we are engaged in studies associated with disaster prevention, NICT is not a disaster prevention agency. The WINDS team was just about to begin such studies that would contribute to the efforts of disaster prevention institutions, so we do not think we were able to make the most of the WINDS capabilities. Shocked to see in the media the magnitude of the damage in the stricken area, we were simply compelled to do something to help if we could at that time, and set out without sufficient preparation. Nevertheless, we believe that the use of WINDS in the field, where recovery operations actually took place, did help affected people and aid workers in some ways. The experiences also opened our eyes to new possibilities and gave us many practical tips on how we should proceed.



It snowed on the mornings of March 16 and March 17.

Secured working space in the corner of Disaster Countermeasures Office in Kesennuma city
→ Set up HDTV conferencing and IP phones for connecting to the Operation Room of the Tokyo Fire Department (Otemachi).

Figure 2●Activities in Kesennuma City

Deployed transportable VSAT on the roof and routed the cables through windows to the disaster countermeasures office

Through these activities, we learned that satellite-based communications, including high-definition video conferencing, using WINDS and satellite lines to skillfully connect IP telephones and cell phone with wi-fi capability, can be quite effective in a disaster-stricken area. By using WINDS, we can go straight to the Internet, which supports rescue operations and assistance to affected people in a disaster-stricken area. File-sharing tools and VPN are also useful. These tools and VPN demonstrated their readiness once again as we were able to open broadband lines in just about half a day. One of the valuable lessons we learned is that the tools used in a stricken area may become a burden rather than an aid unless they can be accessed wirelessly. Not to mention that it is very important to have a source of continuous power. There is not enough space to spell out everything we learned, but some of the lessons seem very obvious in hindsight.

The experience made us fully realize, in addition to research and development of cutting-edge technologies in satellite communications, the things we need to do to put those technologies into practical use. It seems that the media and concerned institutions are reviewing the importance of satellite communications, including satellite-based cell phones. For those things our activities revealed to require verification, we started experiments and investigations right after we returned from the disaster-stricken area. We hope to promote research and development while learning about the field from those who actually operate in the field.

Lastly, may those died by the Great East Japan Earthquake rest in peace. We wish the earliest possible recovery in the disaster-stricken areas.

Deployment of Internet Wireless LAN Environment in the Disaster Stricken Area

—Using Cognitive Wireless Routers Developed by NICT—

Homare Murakami

Senior Researcher, Smart Wireless Laboratory, Wireless Network Research Institute

After completing a master's course in 1999, Murakami joined the Communications Research Laboratory, Ministry of Posts and Telecommunications (currently NICT). He was a visiting researcher at Aalborg University in Denmark from 2003 to 2005.
He has been studying wireless communications protocols, mobile networking, and cognitive radio technology.

We would like to express our heartfelt sympathy to the affected people of Tohoku Region Pacific Coast Earthquake and pray for earliest possible recovery.

Smart Wireless Laboratory has set up fifty-three cognitive wireless routers, with thirty-two routers in evacuation centers in Iwate Prefecture and twenty-one in Fukushima Prefecture (as of May 19, 2011). These routers have been providing high-speed and stable access to the Internet to aid the recovery efforts.

Thinking about those who face a harsh reality, about whom we learned through news reports right after the earthquake, we asked ourselves what we could do as a national research institute conducting research and development on communications. The Smart Wireless Laboratory studies various wireless systems, such as cell phones and wireless LAN, as well as cognitive radio technology that promotes effective use of radio waves and efficient information communications networks. Using these technologies, we can deploy an internet network in a short time and also efficiently utilize cell phone networks (see Figure 1).

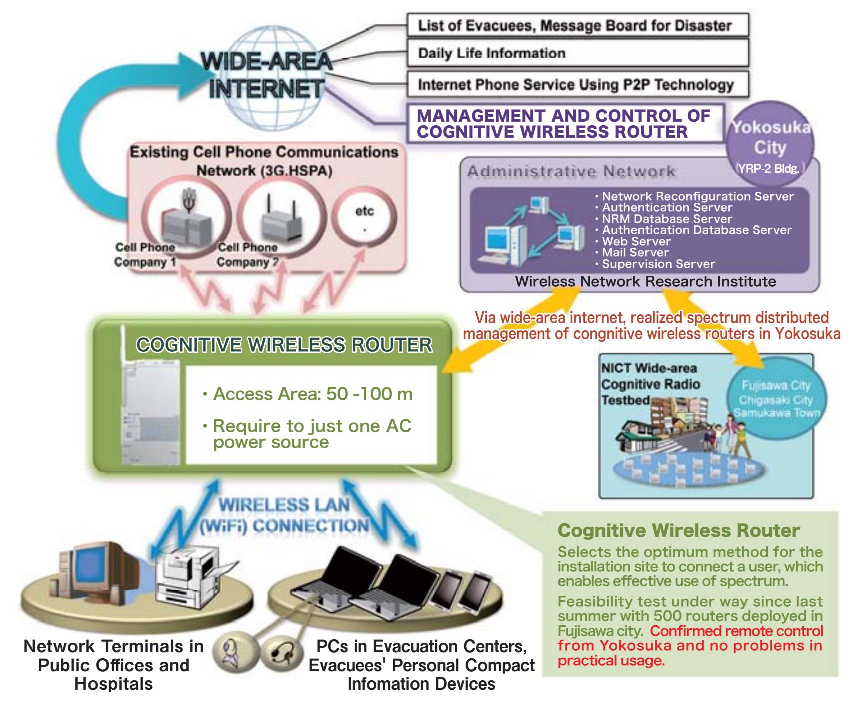


Figure 1●Configuration of the cognitive radio system

These cognitive wireless routers are currently deployed in a wide-area cognitive radio testbed in the Shonan district (Kanagawa Prefecture) as part of a large-scale feasibility study. The testbed environment has been put to practical use by many users and is very portable and fault tolerant. Since we can complete to set up a wireless LAN with Internet access in just 5 minutes or so, we decided to offer some of the routers to disaster-stricken areas.

By March 15, we had finished retrieving the equipment from the testbed, but then we faced a difficult problem: We had no idea where to set them up and whom we should ask. After trying all of our connections, we finally got a chance to talk with a person in charge in Tohno City in Iwate Prefecture via the Basic Human Needs Association which was providing aid for the disaster stricken area in Iwate Prefecture. We learned that Tohno City served as a support base for the stricken municipalities along the Pacific coast. We received a request to aid these municipalities and arrived in Iwate Prefecture on April 4.

At first, we viewed these activities as separate from our original research work, simply hoping to be of help to someone. Therefore, we did not intend to announce our activities to the public. However, after issuing a press release through the Public Relations Department to make the activities known to more people, we received a huge response, including a request from Fukushima Prefecture to set up the same equipment there, along with detailed information about the evacuation centers where they wanted us to provide Internet access. That made us realize once again how important it is to send out information. By early May, we had made available a total of fifty-three cognitive wireless routers.

The cognitive radio system is compliant with IEEE 1900.4, a control method for cognitive radio. Our laboratory was heavily involved in the standardization of this control method. Various kinds of information, such as the operational status of the devices, the spectrum environment, and the traffic volume are collected by the management server in our laboratory and automatically analyzed. The results of the analysis are fed back to the cognitive wireless routers so that we

Figure 2●Cognitive wireless router providing Internet access

Figure 3●Internet access via a cognitive wireless router set up in evacuation center at elementary school

Figure 4●Evacuees seeking information using a PC

can maintain a stable and high-speed communications environment.

The routers (see Figure 2) installed in the disaster-stricken area have been utilized in various ways. The Ohtsuchi Choritsu Ando Elementary School in Iwate Prefecture, which serves as an evacuation center for communities along the coast, was the first place that the routers were set up. The evacuees went online to check video reports of the damage caused by the tsunami as well as information about people they knew using the PCs that were installed along with the routers (see Figures 3 and 4). What was very striking at that time was how they said with surprise, “This is how the tsunami came!” while watching the videos, although more than twenty days had passed since the quake. They were also searching for information about relief goods, while children watched videos for a pastime. We then noticed that they also used the Internet as means of obtaining peace of mind, which is necessary when living in an environment with limited information. Some people got information by connecting their portable devices to the wireless LAN. The Internet network that we set up served as a means of communication for the disaster countermeasures office when aftershocks temporarily knocked out their communications systems, for doctors in hospitals to access medical databases, and for volunteers who work in the disaster stricken area to communicate.

Applying the lessons learned from the Great Hanshin-Awaji Earthquake in 1995, the relief supplies and manuals for measures to be taken in a disaster were well stocked. So, how about the communications environment? In this constantly advancing world of communications technology, the ideal form of communications in stricken area seems quite different now. First, the widespread use of cell phones allows any individual to call someone or exchange email. When we first arrived in the disaster stricken area, many evacuation centers already had set up temporary telephones installed using the satellite lines. Of course, the people appreciated these telephones very much, but the situation was far from satisfactory because even in evacuation centers with Internet access, sometimes access was limited to the staff or a time limit was imposed, making it difficult for individuals to communicate freely. Now that people can communicate with each other through blogs, SMS, bulletin boards, and social networks such as Twitter, we believe that an infrastructure that allows people to get through word-of-mouth and other sources information that might be difficult to obtain through a television or telephone can provide at least some peace of mind in inconvenient situation.

So from now on, we will proceed with our research and development projects while always asking ourselves what kind of technology will be needed to enable communications after a disaster, keeping pace with advances in communications technology. As the Smart Wireless Laboratory has been promoting studies of cutting-edge communications technology, especially over the past several years, we have been focusing on how that technology can be put to practical use. As a part of the process, we have made a proposal to the standardization group to integrate the specifications for commercialization and, in cooperation with the private sector, verified the technology so that some of the functions could be commercialized. The cognitive wireless routers we used were one result of those efforts. We have many more technology research and development projects under way, and we will keep up the efforts to make such technologies available to everyone, not just after a disaster.

Due to the closing and consolidation of evacuation centers and the restoration of wired Internet lines, some of the devices that we originally installed have been moved to other places. We have also started receiving requests to install them in the provisional-housing districts, whose construction has just begun. Hearing such news here at out institute in Yokosuka, we now feel more confident that Japan is on a steady recovery track. The disaster-stricken area still has a long way to go for full recovery. We sincerely hope that our system can somehow contribute to the recovery process.

Monitoring Sea, Rain, and Wind of Okinawa by the Advanced Radar,

Okinawa Electromagnetic Technology Center Contributes to a Wide Range of Fields, from Natural Disaster Prevention to Maritime Safety

The Okinawa Electromagnetic Technology Center comprises three observation facilities on the islands of Okinawa and Yonaguni and the Onna Research Center. The Okinawa Electromagnetic Technology Center develops technologies for monitoring the natural environment (sea, rain, and wind). Okinawa offers two important advantages; its unique climate, and the availability of a large plot of land for the Center's facilities. We will look closely at these facilities and the research activities that we are conducting.

Ocean radars monitor surface currents and wave heights to ensure maritime safety

The Yonaguni Ocean Radar Facility is located on the north coast of Yonaguni Island, which is to the southwest of the main island of Okinawa and the westernmost point of Japan. The long-range ocean radar (see Figure 1) at this facility has been monitoring the southern area of the East China Sea since 2001. The long-range ocean radar transmits an electro-magnetic signal in the 9 MHz band. The signal is scattered off the ocean surface and returns as a backscattered echo.

This echo is used to estimate the speed of the surface layer (tide and ocean current) and the height of waves. The ocean radar on Yonakuni Island can monitor ocean conditions as far away as 200 km, up to the continental shelf area of the East China Sea.

The ocean radar is located near a cliff overlooking the ocean. It comprises a transmitting antenna, a linear array of sixteen receiving antennae extending about 250 m, and a container housing the transmitter and receivers, computers for radar control and data processing, and an emergency power supply. The radar is controlled remotely from the Onna Research Center. The collected data is also forwarded over the network. The emergency power supply enables continuous observation even during power outages caused by typhoons, etc.

The long-range ocean radar on Yonaguni Island also is used to observe the Kuroshio curent, which runs through the Okinawa sea between Yonaguni Island and Taiwan.

Figure 1●Receiving antenna for the long range ocean radar

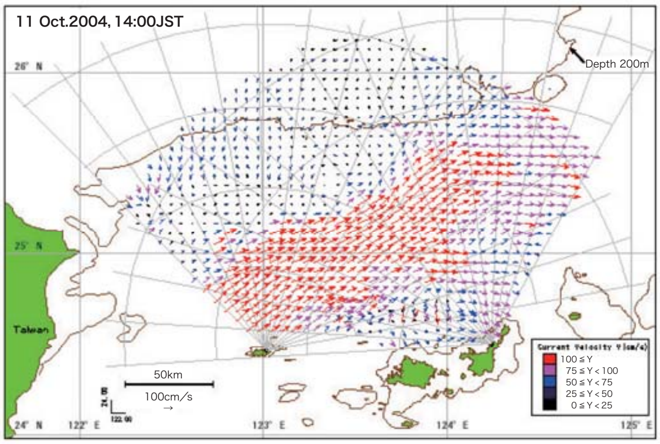


Figure 2●The Kuroshio current, or Black Stream, as observed by the long-range ocean radar

Combining its data with data from the other long-range ocean radar that was operated on Ishigaki Island until 2010 revealed that the Kuroshio current changes direction near the continental shelf, moving in a south-north direction (see Figure 2). These discoveries about the Kuroshio current have been used in studies of oceanography. The data is also provided to the Japan Coast Guard to ensure maritime safety.

COBRA uses polarization to estimate the rainfall rate with high precision, and aims to determine the raindrop type

COBRA is located at the Nago precipitation radar facility in Nago City, near a mountaintop at an altitude of 343 m (see Figure 3). COBRA uses microwaves in the C-band (5.34 GHz). Its 4.5 m-diameter parabolic antenna is installed in a radome on a steel tower and can be freely oriented in any direction vertically and horizontally. COBRA monitors precipitation within a 300 km radius (see Figure 4).

Two development activities using COBRA have been conducted. One is the application of polarization to improve the monitoring capabilities, and the other is the application of pulse compression technology to the weather radar.

Figure 3●Rain radar's radome (left) and the radar (right) inside the radome.

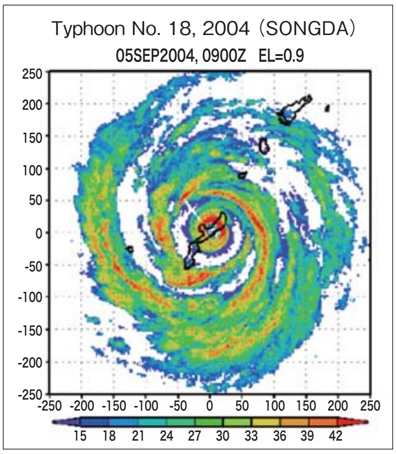


Figure 4●Example of COBRA monitoring a typhoon

The intensity of scattering due to raindrops is proportional to the radius of raindrops to the sixth power (Rayleigh approximation). The rainfall rate is a product of the volume and speed of the raindrops, and is approximately proportional to the fourth power of the radius of the raindrops. Therefore, it is important to know the size of the raindrops in a rainfall (raindrop size distribution). While small raindrops (1 mm-diameter or smaller) are roughly spherical, larger ones are squashed due to air friction and become wider horizontally than they are tall.

We observe this geometrical difference using electromagnetic waves that vibrate horizontally and vertically (horizontal polarization and vertical polarization) and use the difference to estimate the raindrop size distribution. This research to improve the rain radar using polarization started in the 1980's. Initially, we used the echo intensity ratio of the horizontal and vertical polarizations. However, in recent years, we have since adopted a method that uses the propagation phase differences between the two polarizations.

Our COBRA analysis of polarization data in the C-band resulted in the addition of polarization monitoring capability to the currently deployed radar of the Ministry of Land, Infrastructure, Transport and Tourism. Moreover, while raindrops are liquid near the ground, they are solid high in the sky, where the temperatures are low. Polarization is also being actively studied as a means of differentiating these hydrometeors (snow, ice crystals, and hail). We observe hydrometeors inside clouds by simultaneously using COBRA and a particle observation equipment called videosonde in collaboration with university researchers. The goal is to correlate the types of hydrometeors seen in video images with the quantities observed by the polarimetric radar.

Pulse compression is a technology for transmitting a low-power, modulated, and stretched signal, and demodulating and compressing the scattered echo. It provides the same level of performance as a high-power, short-pulse signal . While this technology is widely used for point target radars, such as air traffic control radars, it is also applied to rain radars and other radars for targets distributed throughout a space that has violently changing echoes and difficulty reducing the false echoes called range sidelobes. We used COBRA to develop and demonstrate a pulse compression technology with a low level of range sidelobes. The technology is applicable to rain radars that use either a klystron amplifier with a 250 kW-output for short-pulse (2 μsec) measurements or a travelling-wave-tube amplifier (TWTA) with a 10 kW-output to measure pulse compression. We have demonstrated that rain radars equipped with this technology can be used for monitoring a variety of situations, including thunderstorms and monsoon fronts (baiu zensen) without the use of a high-power, short-pulse signal.

Another benefit of pulse compression technology is that it narrows the bandwidth and reduces emissions outside the band by controlling the rise and fall times of pulses. Electron tubes require a high-voltage power source, such as a magnetron oscillator or a klystron amplifier. ,In the future, rain radars are expected to use pulse compression technology with low-power semiconductor amplifiers, which are easier to maintain.. These radars also will have fewer emissions outside the band and make better use of frequency real estate.

Currently, COBRA measurements are being taken in wind fields within a precipitation area using an improved bistatic receiver. While a rain radar can measure the wind speed in a precipitation area along the wind speed component using the Doppler shift of the rain echo, determining the three-dimensional wind speed requires simultaneous measurement by multiple radars. The bistatic receiver, on the other hand, employs receivers in other locations to measure the bistatic echo of precipitation and estimate the wind field from the Doppler shift in the precipitation area. Which is more economical than simultaneous measurement by multiple radars. It also is superior in terms of the simultaneity of observed volume. However, conventional bistatic receivers require a wide-angle antenna to cover a wide observation area , and the antenna sidelobes cause interference. “Improved” bistatic receivers employ a combination of a sparse array geometry and digital beam-forming to reduce the interference with antenna sidelobes. For gathering precipitation measurement data, a four-element sparse antenna array is currently installed on the roof of the Onna Research Center to demonstrate the technology's feasibility.

COBRA also is used for verifying the rain radar data obtained from satellite observations. NICT and JAXA jointly developed the world's first satellite rain-radar, the Tropical Rainfall Measuring Mission/Precipitation Radar (TRMM/PR). Launched in 1997, this satellite has been monitoring precipitation in tropical regions. NICT and JAXA are currently developing its successor, Global Precipitation Measurement / Dual-frequency Precipitation Radar (GPM/DPR) , to be launched in 2013. While the TRMM/PR used only one frequency in the Ku-band (13.8 GHz), the GPM/DPR is dual-frequency, adding the Ka-band (35.55 GHz) to improve the precision of the rainfall rate, distinguish between solid precipitation (snow and ice) and rain, and increase the sensitivity. We develop and verify the DPR processing algorithm before the launch and will conduct simultaneous measurements after the launch to validate the rainfall rate calculated using the DPR processing algorithm from the observed data.

Wind profiler collects fundamental data for weather forecasts

Unlike the Nago precipitation radar facility, which is situated on a mountain, the Ogimi wind profiler facility is in a valley. A wind profiler at the facility monitors the winds high in the atmosphere (see Figure 5). The wind profiler has two sets of one-dimensional phased array antennae with 24 elements. The wind profiler not only directs its beam directly above, but also is capable of directing its beam in four additional directions by tilting the beam ten-degree s to the east, west, north, and south by adjusting the transmission phase of the electromagnetic waves from each element and switching between two sets of antennae. The transmission frequency is 443 MHz. The monitoring height is affected by atmospheric conditions, but ranges from several hundred meters to over a dozen kilometers, into the upper troposphere (see Figure 6).

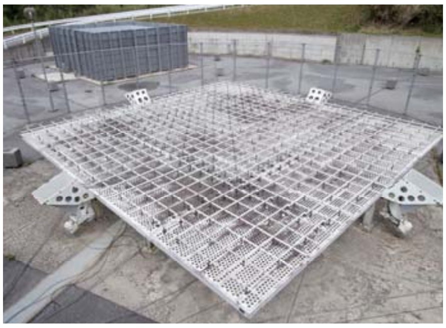


Figure 5● The wind profiler is installed in a valley to minimize interference from other radio stations.

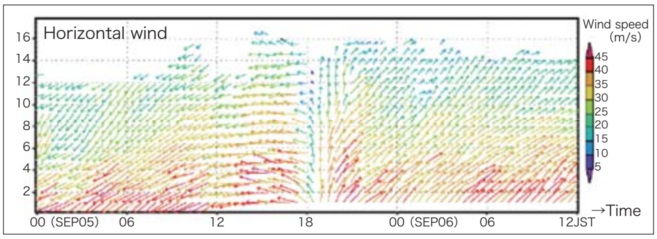


Figure 6● Observation data from an arriving typhoon Normally, the winds in the lower altitudes are weaker than the winds in the higher altitudes. When a typhoon passes by, however, the winds are stronger in the lower altitudes.

The Japan Meteorological Agency is currently developing WINDAS, a network of wind profilers across Japan. Still, NICT's wind profiler is the only one on the main island of Okinawa. Therefore, the observation data from the wind profiler at the Ogimi wind profiler facility is being provided to the Japan Meteorological Agency to be used as initial data for the numerical forecasting model for weather forecasting.

A wind profiler measures wind speed by measuring minute scattering echoes that are caused by fluctuations in the refractive index, which, in turn, are created by turbulent flows in the atmosphere. Variations in the refractive index, caused by variations in atmospheric densities, propagate as a sound wave front with a scattered echo, much like a large speaker projects a sound wave into the atmosphere. A Doppler shift of this scattered echo enables the sound speed to be measured as the sound wave front moves through the atmosphere. Because the sound speed is related to the temperature of the medium through which the sound propagates, we can measure the atmospheric temperature up to 3 to 5 km. This technique, called Radio Acoustic Sounding System (RASS), estimates the temperature by combining the sound wave and electromagnetic wave. We are conducting simultaneous measurements of wind speed and temperature using RASS at the Ogimi wind profiler facility during the daytime. We do not conduct RASS measurements during the night in consideration of the neighboring residents. We are currently reconsidering the sound source so that we can conduct nocturnal observations.

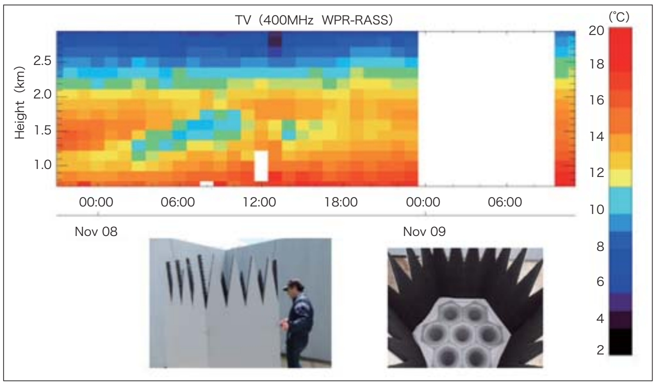


Figure 7●Temperature distribution obtained by RASS observation and its speaker

Onna Research Center controls three facilities

The Onna Research Center, which is located near Manza Beach, can control the three radars introduced in this article. All of the radars are operated in this Center, and the observation data is processed and analyzed here before being forwarded to data servers in Koganei, near Tokyo. In an area facing the ocean are a short-wave ocean radar that uses the 24 MHz-band and a long-range ocean radar that uses the 9 MHz-band. The latter was moved from an observation facility on Ishigaki Island. Using these two ocean radars, we will begin developing a distributed ocean radar in in fiscal year 2011. Conventional ocean radars have a receiving antenna array evenly spaced along a straight line on a large, flat, rectangular piece of land. This has been a major constraint in building these radars. To overcome this constraint, we are aiming to develop a system with antennae placed at irregular locations along the seashore but able to provide the same level of observation performance as evenly-spaced antennae placed along a straight line.

In addition to its role as a research and development center for advanced radars, the Onna Research Center has two large antennae that act as ground stations for two satellites. In September 2010, JAXA launched a quasi-zenith satellite, the Michibiki, to conduct experiments in supplementing GPS positioning measurements and improving their accuracy. NICT is responsible for the Michibiki's time management system. The Okinawa Time Management Station (see Figure 8 left) has been operating around the clock since the last December. The Okinawa Station takes advantage of its location in low latitudes to cover even the Australian sky, which is difficult for the Koganei Time Management Station to cover. Furthermore, in December 2010, a large ground station for an ultra-high-speed Internet satellite, Kizuna (WINDS), was relocated from Iejima Island (see Figure 8 right).

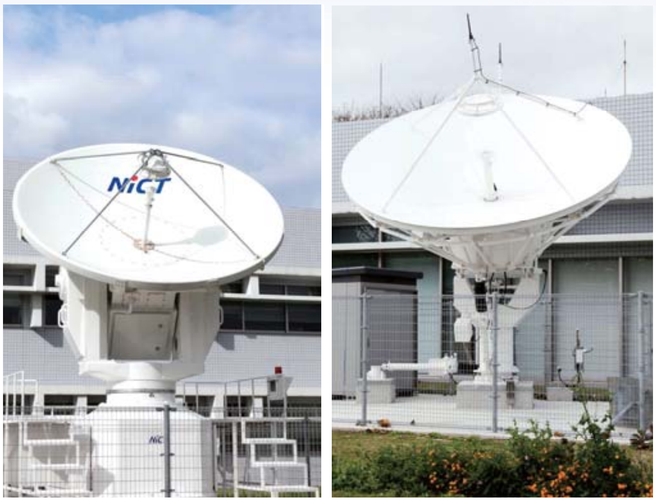


Figure 8● Antennae at the Onna Research Center for Michibiki (Left) and Kizuna (Right) satellites

Figure 9●The exhibit room at the Center displays drawings and models to describe the principles of radars.

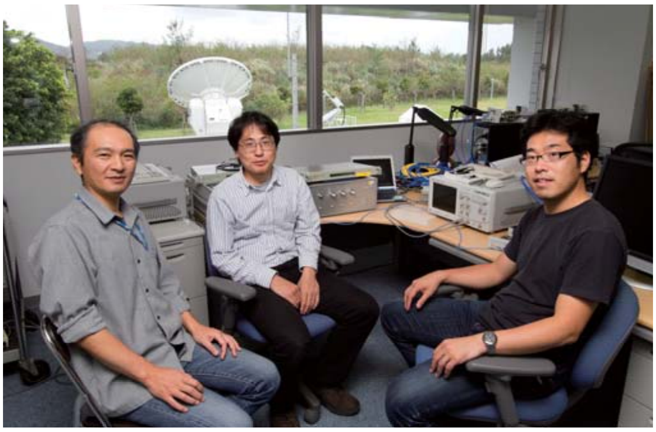


Figure 10●(From left to right) Sugitani Shigeo, Technical Expert; Hanado Hiroshi, Director of Okinawa Electromagnetic Technology Center; and Kawamura Seiji, Senior Researcher

Prize Winners

Prize Winner ● **Daisuke Inoue** / Director, Cybersecurity Laboratory, Network Security Research Institute

◎Date: September 15, 2010

◎Name of Prize:
Certificate of Appreciation

◎Details of Prize:
To honor contributions made as secretary of "Special Section on Cryptography and Information Security"

◎Name of Awarding Organization:
The Institute of Electronics, Information and Communication Engineers, Engineering Sciences Society

◎Comments by the Winner:

I served as secretary for the 2008 and 2009 issues of "Special Section on Cryptography and Information Security," the journal in English published by the Institute of Electronics, Information and Communication Engineers, Engineering Sciences Society. Thanks to the hard work of the guest editor, associate editors, and reviewers, as well as the Publishing Department of the institute, we were able to publish the special sections. I am deeply grateful that we were able to do so and intend to continue making humble contributions to the development of the security field through academic and other activities.

From the left: President Toshiyasu Matsushima, Daisuke Inoue

Prize Winner ● **Hiroyuki Tsuji** / Senior Researcher, Space Communication Systems Laboratory, Wireless Network Research Institute

Joint Prize Winners:
Yoshihiko Konishi (Mitsubishi Electric Corporation) and Moriyasu Miyazaki (Mitsubishi Electric Corporation)

◎Date: November 24, 2010

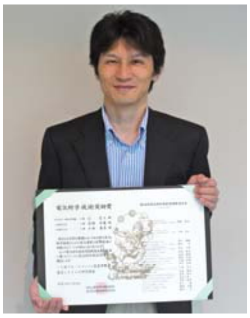
◎Name of Prize:
OHM Technology Award

◎Details of Prize:
To honor the huge contribution in advancing and developing electrical science and engineering in Japan through research and development of a millimeterwave broadband and high-speed mobile communications system

◎Name of Awarding Organization:
The Promotion Foundation for Electrical Science and Engineering

◎Comments by the Winner:

I have been working with Mitsubishi Electric Corporation on the project for five years since 2005, with the goal of creating a millimeter wave wireless link of over 100 Mbps between the ground and a commercial aircraft. I am truly honored that the project led to my winning of this award. I also wish to extend special thanks to those who gave me guidance for the project.



Prize Winner ● **Satoshi Shinada** / Senior Researcher, Photonic Network System Laboratory, Photonic Network Research Institute
Hirotaka Terai / Research Manager, Nano ICT Laboratory, Advanced ICT Research Institute
Zhen Wang / Distinguished Researcher, Advanced ICT Research Institute
Naoya Wada / Director, Photonic Network System Laboratory, Photonic Network Research Institute

◎Date: February 28, 2011

◎Name of Prize:
Photonic Network Research Award 2010

◎Details of Prize:
Fabrication and Characterization of 1550-nm band optical input interface for SFQ buffer memory

◎Name of Awarding Organization:
Technical Committee on Photonic Network, IEICE Communications Society

◎Comments by the Winner:

It is truly a great honor to have our paper chosen as the best paper of the year in the PN Group of the Institute of Electronics, Information, and Communication Engineers. The achievement is due to collaboration between the groups in the organization to integrate and develop optical packet switching technology and superconductive circuit technology. Integrating the light detector and superconductive circuit technologies will greatly advance both technologies. Lastly, we would like to take the opportunity to express our gratitude to the researchers in the Superconductivity Engineering Laboratory and National Institute of Advanced Industrial Science and Technology who kindly provided technological support.

From left: Hirotaka Terai, Satoshi Shinada, Zhen Wang, Naoya Wada

Prize Winner ● **Shinsuke Miwa** / Associate Director, Network Testbed Research and Development Laboratory, Network Testbed Research and Development Promotion Center
Toshiyuki Miyachi / Expert Researcher, Network Testbed Research and Development Laboratory, Network Testbed Research and Development Promotion Center
Hiroshi Nakai / Limited Term Technical Expert, Network Testbed Research and Development Laboratory, Network Testbed Research and Development Promotion Center
Satoshi Ohta / IEICE Technical Committee on Information Networks

Joint Prize Winners:
Takeshi Nakagawa (Fujitsu Hokuriku Systems Limited)

◎Date: March 2, 2011

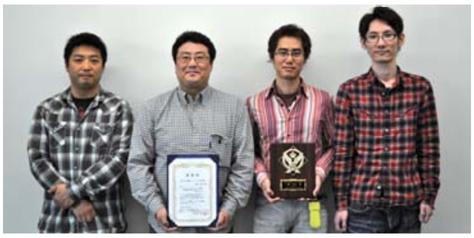
◎Name of Prize:
17th Information Network Research Award

◎Details of Prize:
Issues on the testbed for cloud computing technologies

◎Name of Awarding Organization:
The Institute of Electronics, Information and Communication Engineers, Information Network Research Expert Committee

◎Comments by the Winner:

The paper that won the award outlines the role of the StarBED testbed and the challenges faced in operating it to support research and development associated with cloud computing for the Cloud Computing Competition project under the auspices of Interop Tokyo, with whom we have been collaborating since 2009. We would like to acknowledge the great debt that we owe those who kindly supported us, and will continue to promote testbed research involving various technologies, including cloud computing.



From left: Satoshi Ohta, Shinsuke Miwa, Toshiyuki Miyachi, Hiroshi Nakai

Location of NICT Facilities

[Headquarters]

○ **Photonic Network Research Institute** ○ **Network Security Research Institute** ○ **Applied Electromagnetic Research Institute**

(Headquarters for three laboratories)
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Tel: +81-42-327-7429 (Main)

[Institute]

○ **Wireless Network Research Institute**
3-4 Hikari-no-Oka, Yokosuka, Kanagawa 239-0847, Japan
Tel: +81-46-847-5050 (Main)

○ **Advanced ICT Research Institute**
588-2 Iwaokachoiwaoka, Koubeshinishi-ku, Hyogo 651-2492, Japan
Tel: +81-78-969-2100 (Main)

○ **Universal Communication Research Institute**
3-5 Hikaridai, Seikacho, Sourakugun, Kyoto 619-0289, Japan
Tel: +81-774-98-6300 (Main)

[Promotion Center]

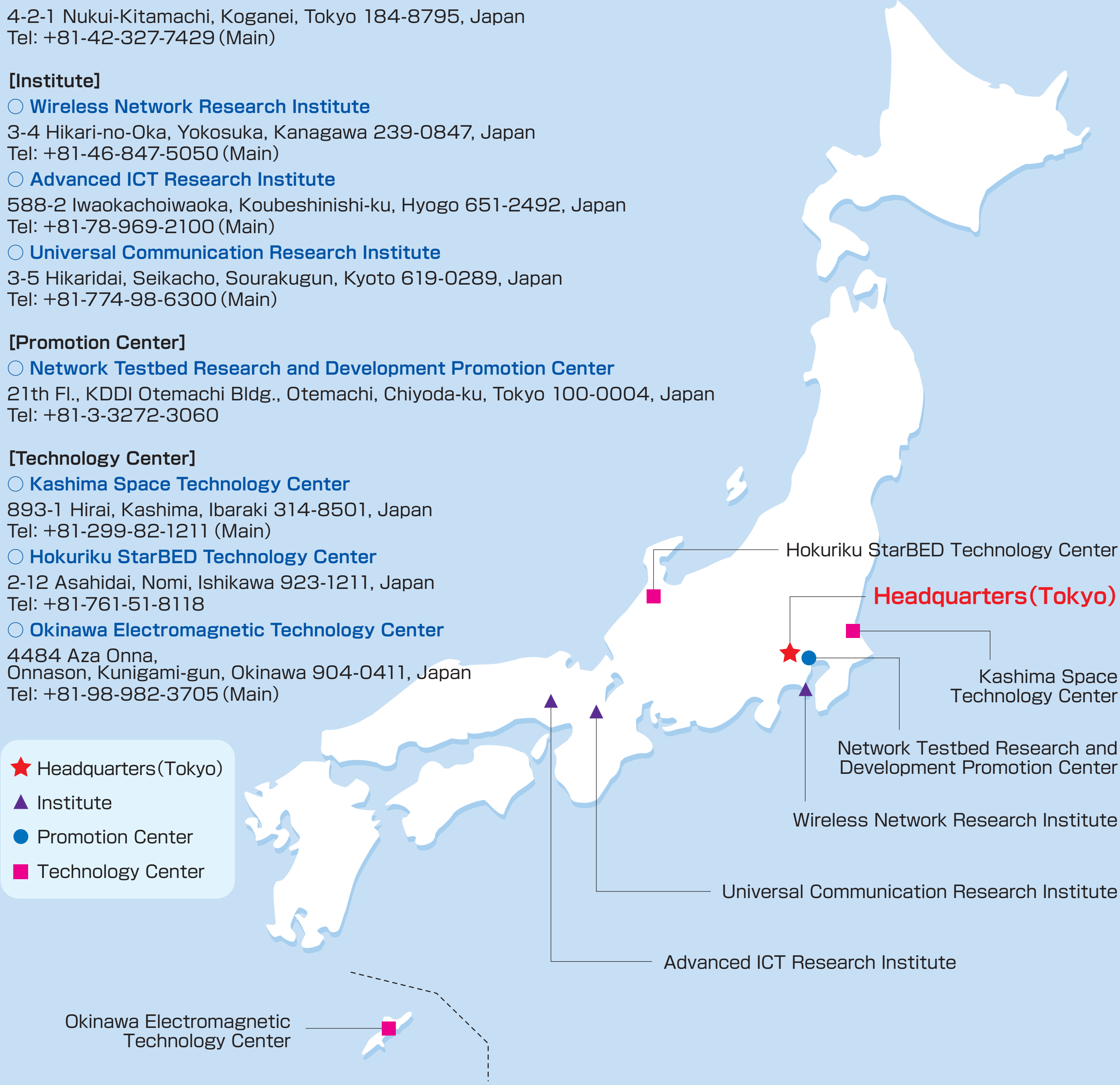
○ **Network Testbed Research and Development Promotion Center**
21th Fl., KDDI Otemachi Bldg., Otemachi, Chiyoda-ku, Tokyo 100-0004, Japan
Tel: +81-3-3272-3060

[Technology Center]

○ **Kashima Space Technology Center**
893-1 Hirai, Kashima, Ibaraki 314-8501, Japan
Tel: +81-299-82-1211 (Main)

○ **Hokuriku StarBED Technology Center**
2-12 Asahidai, Nomi, Ishikawa 923-1211, Japan
Tel: +81-761-51-8118

○ **Okinawa Electromagnetic Technology Center**
4484 Aza Onna,
Onnason, Kunigami-gun, Okinawa 904-0411, Japan
Tel: +81-98-982-3705 (Main)



Information for Readers

The next issue will introduce the standardization activities for next-generation networks in ITU and report on our exhibit at Interop.

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