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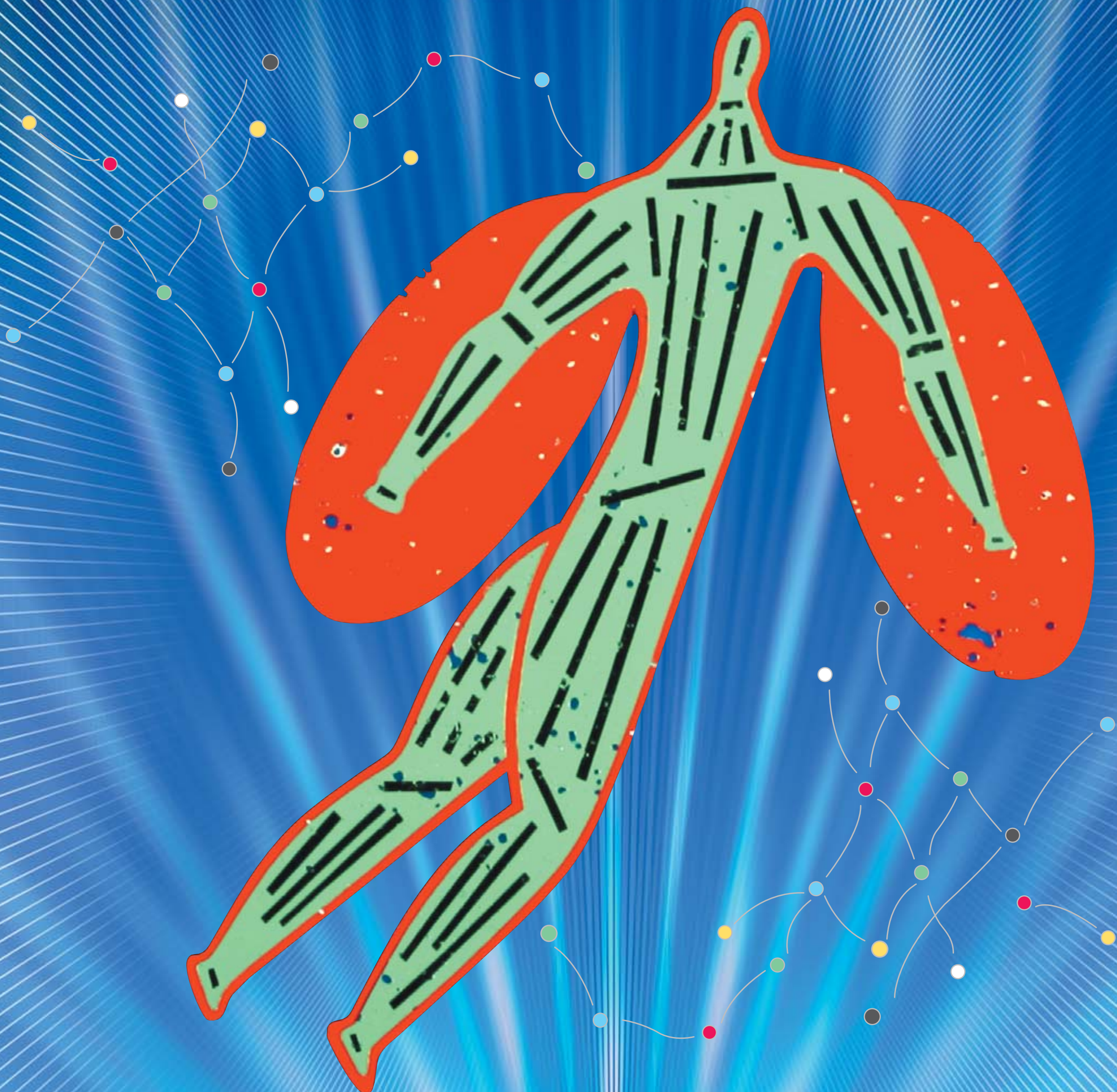
# NICT NEWS

National Institute of Information and Communications Technology



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# Development of Arctic Environment Measurement Technology Using Next-Generation High-Speed Network


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Joined Communications Research Laboratory (currently NICT) in 1993 and has since been engaged in the Alaska Project. Specializes in development of environment measurement technology for the middle atmosphere.

## Introduction

NICT develops remote-sensing technologies for environment measurement utilizing light and radio waves as advanced applications of electromagnetic waves. As part of this endeavor, the International Arctic Environment Research Project Group has undertaken the "Alaska Project" in partnership with the University of Alaska Fairbanks (UAF), beginning in 1993. This project is designed to enable the development of measurement technology for the middle atmosphere in the Arctic region.

Project activities are carried out mainly at the UAF's Poker Flat Research Range, located 50 km north of Fairbanks, Alaska. Although Poker Flat is at a high latitude (65 degrees north), comparable to the Showa Station in the Antarctic, it offers a number of advantages as a site for international research projects, such as easy access to nearby cities and an international airport open even in the middle of winter, in addition to the necessary IT infrastructure for next-generation Internet experiments. Furthermore, the university is renowned for its research activities on the Arctic environment, including auroral observations.

## Main objective of Alaska Project

The objective of this project is to develop nine types of remote-sensing instruments for the observation of physical phenomena in a wide range of altitudes between the troposphere and the thermosphere, which range includes the flight altitudes of airplanes and space shuttles alike. Figure 1 shows the scope of observation and the remote-sensing instruments developed under the auspices of this project. Measurement altitudes and capacities differ according to the instrument. Observed phenomena include atmospheric constituents of the ozone layer, temperatures, winds, and auroras. As an example, we'll describe the measurement of air pollutants in the troposphere (altitude range of zero to ten kilometers) using a Fourier transform infrared spectroscope (FTIR), a remote-sensing instrument employed in the analysis of optical spectra.

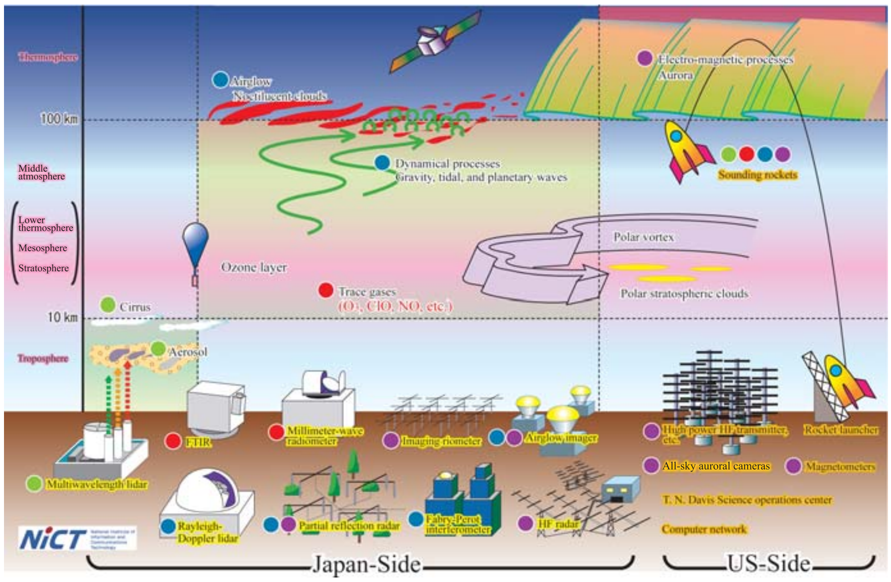
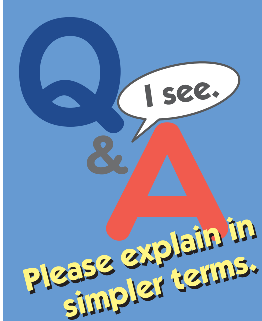



Figure 1: Observation units for Alaska Project



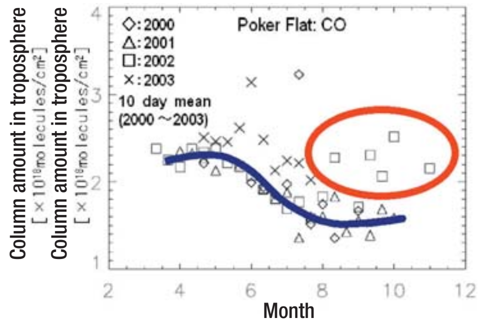

**Q** What are the nine types of remote-sensing instruments?

**A** These instruments include an imaging riometer, a millimeter-wave radiometer, a Rayleigh-Doppler lidar, Fabry-Perot interferometers, a partial reflection radar, an FTIR, a multiwavelength lidar, a Super DARN HF radar, and airglow imagers. Observation targets (e.g., horizontal or vertical distributions) and times (day, night, or round the clock) differ depending on the instrument. These instruments are used to observe trace atmospheric constituents, wind direction and velocity, and temperatures at various altitudes between the troposphere (10 km) and the thermosphere (250 km).

**Q** What's SALMON?

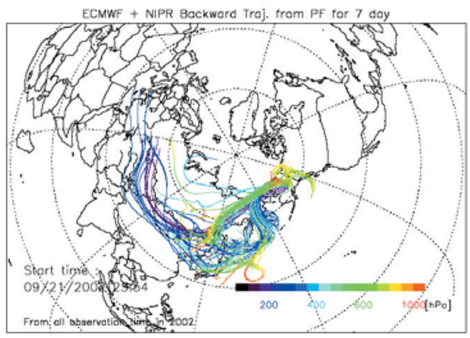
**A** SALMON is an acronym for the System for Alaskan Middle Atmosphere Observation data Network. Using a high-speed network, this system sends data obtained at observation points within Alaska to NICT in real time for analysis and display on the web and on other systems. We have established the requisite high-speed connections between Japan and the United States in collaboration with two separate international network initiatives.

Figure 2:
The amount of carbon monoxide in the air over Alaska measured by FTIR (total amount per unit area below an altitude of 10 km). The blue line shows seasonal changes from 2000 to 2002, and the red circle indicates an increase in the winter of 2002.



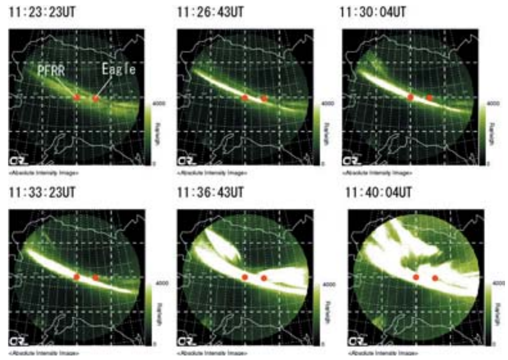

We used FTIR to observe seasonal changes in the amount of carbon monoxide (CO) per unit area below an altitude of 10 km, as shown in Figure 2. As you can see, this amount clearly increased between September and December 2002 (an increase indicated by the squares "□" within the red circle). Further, we performed a trajectory analysis of the atmosphere with a focus on the numerous wildfires in Siberia during the same period, as shown in Figure 3. Based on the results of this study, we concluded that the CO generated by these fires was probably carried over Japan to Alaska, resulting in the observed increase in CO amounts.

Figure 3:
Analysis of weather maps in a time series to determine the origin of carbon monoxide increase over Alaska. Differences in altitudes are color-coded.




In this project, we have developed a remote-sensing instrument to study the effect of solar activity on the Earth's environment. A Fabry-Perot interferometer can determine wind velocity and temperatures at altitudes between 100 km and 250 km through spectroscopy of aurora's light. We placed this instrument at two observation points, both in Alaska: one at the Poker Flat Research Range and the other at the Eagle Observatory. By remotely controlling these instruments from Japan through an ultrahigh-speed network, we can observe auroras simultaneously at these two points. We are also able to observe the horizontal extent of auroras over the sky using an all-sky imager. Examining these results, we made the unprecedented observation that upper atmospheric winds blowing along a long strip of aurora were distributed in the same manner at two points separated by a horizontal distance of 300 km (Figure 4).

Figure 4:
Auroral distribution in the skies over Alaska, observed using an all-sky imager. The two red circles indicate the locations of the Poker Flat Research Range and the Eagle Observatory. Fabry-Perot interferometers were used at these two points to measure wind velocity and temperature in the upper atmosphere.




### SALMON test network for high-capacity data transmission

Apart from the development of remote-sensing technologies and the observation of phenomena in the atmosphere, an important task of the Alaska Project is to carry out high-capacity transmission experiments via high-speed test network lines. This data network system is referred to by the acronym SALMON (http://salmon.nict.go.jp/). SALMON remotely and automatically controls most of the observation instruments placed in Alaska, and transfers a large amount of the resultant observation data to NICT's Koganei Headquarters for processing, analysis, and display on the web. We are currently operating SALMON in collaboration with two high-speed network experiment initiatives: APAN (Asia Pacific Advanced Network; http://www.apan.net/) and TransPAC (http://www.transpac.org/).

This is the first global-scale data network experiment involving the collection and transmission of environmental information in real time, based on multiple network connections and long-distance communications.

**Life & Technology**

## ● Use the web to observe auroras at home

By incorporating a live aurora camera within SALMON, we have enabled live viewing of auroral phenomena on the project's website (http://salmon.nict.go.jp/awc/contents/index.php). We began broadcasting these auroras "live" from Alaska using a digital SLR camera on an experimental basis in order to research whether the presentation of NICT content with an adequate user interface will attract public interest. And in fact, after we began operation of the live aurora camera, traffic on the SALMON website increased sharply, with the number of monthly hits reaching two million in December 2004. In addition to the numerous requests from websites in Japan and abroad for approval to link to this page, we have received a substantial number of inquiries from journals and major search engine companies.

# R&D of Technology for Tracking and Control of Stratospheric Platform

## Mitaka Stratospheric Platform Research Center

Kazuo Ohashi

Expert Researcher (Project Sub Leader)
Mitaka Stratospheric Platform Research Center
Collaborative Research Management Department

We finally made it… A commemorative photo of staff members (tracking/control and mission groups) taken in the control room. The author is at farthest left.

## Introduction

A "stratospheric platform" is built on a large unmanned airship that remains in the stratosphere at an altitude of about 20 km, serving as a base for communications, broadcasting, and Earth observation (Figure 1). In terms of communications and broadcasting, this platform can cover a wide service area, as if it were a relay antenna installed on a 20-km-tall tower. Moreover, due to a shorter transmission distance relative to those of satellites, the platform can send and receive data using lower intensity radio waves and more compact antennas & communication units.

Figure 1:
Conceptual drawing of stratospheric platform

The Mitaka Stratospheric Platform Research Center conducts research on technology used in this type of platform for tracking and control of airships.

## Features of stratospheric platform airships

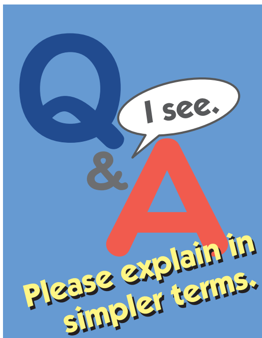
To ensure continuous communications and broadcasting operations and to improve operational efficiency, a stratospheric platform airship must be able to continue an unmanned stationary flight for several years with no external replenishment of energy. Therefore, we had no choice but to use solar power (solar arrays) as an energy source for flight. We also adopted the lightweight and efficient energy source referred to as a "regenerative fuel cell (RFC)" for use at night. In the day, the airship drives its propellers with the solar arrays and uses the surplus power to electrolyze water into hydrogen and oxygen. At night, the RFCs generate power through the reaction of these gases.

If there are clouds above the airship, stable power generation cannot be ensured. An airship can carry fairly heavy equipment and remain in a fixed location for a long time, but it is vulnerable to weather conditions such as rain, snow, and typhoons (especially high winds). Unlike ordinary airplanes, they cannot evade such weather conditions, given the aim of stationary flight.

A stratospheric zone at an altitude of about 20 km is suitable for a platform airship's stationary flight. Since this zone is located well above jet streams (10 km) and clouds, there is no risk of rain or snow, and wind velocity is stable at about 25 m/s. To obtain adequate buoyancy for flight in an atmosphere with 1/15 to 1/20 the density of air on the ground, it is necessary to increase the volume or overall length of the airship (to as large as 200 m). Although this seems large, this length is not out of the question; the overall lengths of Zeppelin airships were over 200 m. In Japan, the Japan Aerospace Exploration Agency (JAXA) and NICT are jointly working on development of these stratospheric platform airships, applying many of the latest technologies. As part of these efforts, the Mitaka Stratospheric Platform Research Center is currently pursuing R&D of technology for airship tracking and control.

## System for tracking and control of stratospheric platform airships

"Tracking and control" specifically involves tracking the locations and flight conditions of unmanned airships, which are controlled from the ground using radio waves. To ensure safe and reliable operation, we developed a special system for tracking and control of airships particularly vulnerable to bad weather conditions, especially winds. This system is referred to as ITACS (Integrated Tracking and Control System). Figure 2 shows the structure of this system.



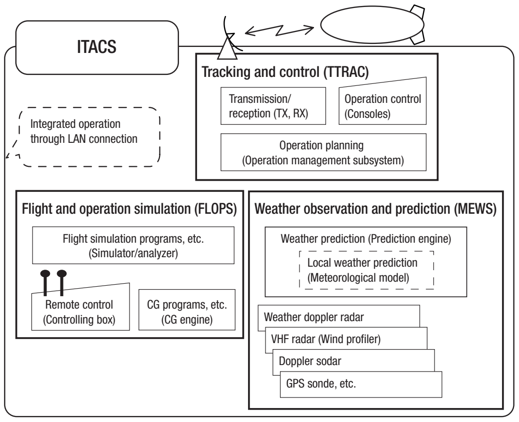

**Q** What type of a system is MEWS?

**A** MEWS includes the following instruments for wind observation: a meteorological Doppler radar (observation range: 100-km radius), a VHF radar (observation range: 8 km; directly vertical), a Doppler sodar (observation range: 400 m; directly vertical), and a GPS sonde (used in observation even at altitudes exceeding 20 km). This system also includes a local weather prediction instrument with a prediction range of 200 km (east-west) x 200 km (north-south) x 25 km (height). These instruments are extremely useful in airship operation.

**Q** What are the specific groundbreaking achievements in stationary flight tests?

**A** For the first time anywhere, we have succeeded in enabling an unmanned airship to rise to an altitude of 4,000 m, where it performed fully automated stationary flight. In terms of communications and broadcasting, we tested digital broadcasting functions and succeeded in receiving radio waves sent from the airship. Further, we executed optical tracking at a distance of 4,000 m, through the installation of optical tracking antennas both on the airship and the ground.

Figure 2: Structure of the Integrated Tracking and Control System (ITACS)




ITACS consists of three subsystems:

(1) Meteorological subsystems; in particular the Wind Observation and Prediction Subsystem (MEWS)

MEWS observes weather conditions in the area of the test flight facility (within an approx. 100-km radius of the facility) with its weather radar and calculates weather predictions for the following 40 hours.

(2) Flight and Operation Simulator (FLOPS)

Based on the future weather conditions calculated by MEWS, FLOPS performs airship flight simulation for the formulation of flight plans and verification of safety. FLOPS is connected to an airship flight controller and provides flight training similar to that of an airplane flight simulator (Figure 3).

Figure 3:
Airship flight controller (CG screens are created by FLOPS)

(3) Telemetry, Tracking, and Command Subsystem (TTRAC)

In addition to its telemetry and command functions for tracking and control of airships by radio waves from the ground, TTRAC establishes a network connecting itself with MEWS and FLOPS, enabling operation as an integrated system (ITACS).

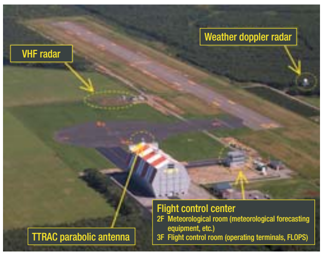



Figure 4:
Stratospheric platform test facility in Taiki, Hokkaido

Construction of these subsystems began in FY 2002 at a test facility in Taiki, Hokkaido (Figure 4), and they were used in a "Stationary Flight Test" at this facility in FY 2004.

## Stationary flight test

JAXA and NICT jointly carried out a stationary flight test using a test-model stratospheric platform airship with an overall length of approximately 70 m (Figure 5). While the airship performed stationary flight autonomously using its onboard computer at an altitude of 4 km, we verified the technologies used in the airship's flight control system. We also conducted testing relating to communications, broadcasting, and Earth observation using equipment mounted on the airship.

Figure 5:
Stationary flight test model being removed from the hangar (TTRAC parabolic antenna is installed on top of the hangar.)

This flight test took place in the airspace above the Taiki Multi-Purpose Aerospace Park, Hokkaido. Using ITACS's three subsystems in combination, we achieved the final goal of stationary flight at a height of 4 km and conducted successful communication/broadcasting testing on November 22, 2004. These tests of a stratospheric platform airship test model were the first of their kind anywhere in the world.

Figure 6:
Stationary flight of the airship 4 km directly above the test facility (Under the airship is a spiral staircase to the roof of the flight control center.)

Figure 6 shows a photo of the airship taken from below, showing accurate stationary flight at a height of 4 km directly above the flight control center. Thanks to ITACS and the constituent MEWS, FLOPS, and TTRAC subsystems, we were able to carry out the precise flight as planned on time, despite harsh weather conditions.

## Conclusion

Due to the success of the stationary flight test, the Stratospheric Platform Project in Japan achieved its goals for FY 2004 with highly satisfactory results. This project will now proceed to the next phase, in which we will evaluate the results of R&D to date and formulate plans for the future. I am hopeful that the airship tracking and control technology developed by NICT will also be helpful in the next phase in ensuring safe and reliable flight.

**Life & Technology**

### ● Airships in the stratosphere to form new infrastructure for information and communications

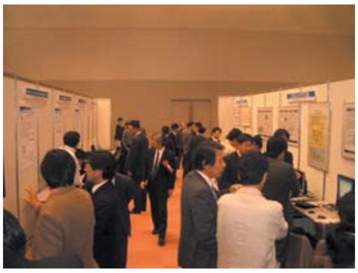
Due to a shorter transmission distance relative to those of satellites, a stratospheric platform will send and receive data using lower-intensity radio waves and more compact antennas. These features will also be particularly useful in mobile communications. In this way stratospheric platforms will form a new type of infrastructure for information and communications.

In addition to communications and broadcasting, stratospheric platforms have the potential for use in other applications, such as the detection of illegal radio through location of wireless stations, observations of vegetation, or traffic monitoring.

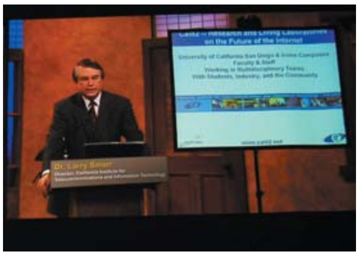
Hiroyuki Aoyama
Director, Network Test-bed Management Division
Collaborative Research Management Department

# Report on JGN II Symposium 2005 in Osaka

Opening address by President Nagao



Exhibits



Special remote speech by Professor Smarr (Seattle, US)


Special remote speech by Professor Murai (Keio University Shonan Fujisawa Campus)

Panel discussion 2; "Global Middleware (Backend for u-Japan)"

NICT held the first symposium on the R&D test-bed of "JGN II" from 17 to 19 January 2005 at the Osaka International Convention Center and other locations. This symposium had various programs, panels, and demonstrative exhibitions whose themes were JGN II research activities, JGN II regional use, and possible directions for international cooperation, consisting of sessions which included speeches, panel discussions, and reports on a number of topics.

Dr. Nagao (President of NICT) made the opening address. This was followed by speeches by guests of honor Mr. Kito (Councilor for General Technical Affairs, Ministry of International Affairs and Communications) and Dr. Miyahara (Professor at Osaka University). Subsequent to them, Dr. Saito (Professor Emeritus at the University of Tokyo) gave a keynote speech entitled "Expectations for JGN II," in which he suggested changes in the JGN II environment and the development of a variety of network services.

Mr. Akiyama (President of Panasonic System Solutions Company, Matsushita Electric Industrial Co., Ltd.) spoke on the prospects for a ubiquitous network society from various angles, including efforts in the area of information application appliances and so forth. In his captivating speech, Mr. Akiyama presented a vivid description of future lifestyles.

A subsequent speech by Dr. Murai (Professor at Keio University) and a speech by Dr. Larry Smarr (Professor at the University of California in San Diego) on the next day were delivered remotely via high definition transmission. The audience showed a great deal of interest in the sharp images of the speakers on the HD (High Definition) screen. Meanwhile, at the exhibition site, spectators enjoyed a demonstration of 4K digital cinema technology, in which the JGN II ultra-wideband network (20 Gbps) uniquely provided an impressive digital cinema experience.

With regard to international cooperation, the primary subject of this symposium, two sessions were recognized: one was a session involving a remote lecture by Dr. Larry Smarr, and the other was a panel discussion entitled "International Cooperation in the Test-Beds for R&D." The panelists had an engaging discussion which involved the whole audience. Both sessions suggested the potential for international cooperation in JGN II, and many participants voiced expectations for increased promotion of international joint research.

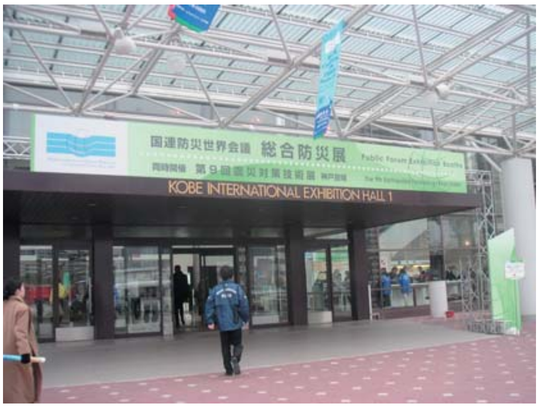
Additionally, panelists from various fields had energetic discussions on other topics, such as technology for cooperative resource-sharing among business locations, education, broadband issues, wearable computers, network use in the Kansai region, global middleware, etc.

This symposium drew roughly 750 people over the course of two days (17 and 18 January 2005). The final day (19 January 2005) was set aside for technical committee meetings of the co-hosting institutes, such as the IEICE (Institute of Electronics, Information and Communication Engineers) Technical Committee on Internet Architecture. The meetings were well-attended and lively.

We would like to express our deepest gratitude to the many people involved in organizing this event for their assistance in hosting this successful symposium.

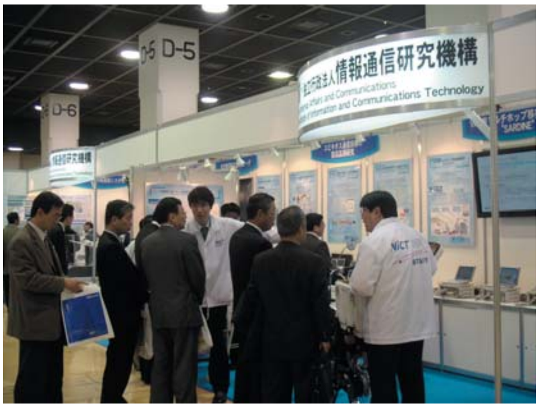
Toshiyuki Okuyama
Expert, Public Relations Division
General Affairs Department

# Report on Exhibition at the United Nations World Conference on Disaster Reduction




Entrance of exhibition site


Ribbon-cutting ceremony
(Third from right is Mr. Egeland, UN Undersecretary General)




Exhibition site

Based on the determination of the 58th United Nations General Assembly, the United Nations (UN) World Conference on Disaster Reduction took place in Kobe, Hyogo Prefecture from January 18 to 22, 2005, exactly ten years after the Great Hanshin Earthquake, with the Japanese government and the UN working together as one. In addition to UN member countries, a number of international organizations and NGOs attended this conference, the aim of which was to formulate new disaster prevention guidelines and mitigation measures for the 21st century. On December 26, 2004, the Sumatra Earthquake and the resultant huge tsunamis caused an unprecedented number of casualties in the coastal countries on the Indian Ocean; a “Special Session on the Indian Ocean Disasters” was thus added to the conference.

The conference consisted of intergovernmental meetings, theme-specific meetings, and public forums such as symposiums, exhibitions, and poster sessions. NICT manned an exhibition booth (Comprehensive Disaster Reduction Exhibition) in collaboration with the Ministry of Internal Affairs and Communications, at which we displayed actual equipment and display panels presenting the results of R&D on disaster-relief, communications, and disaster prevention using ICT and electromagnetic wave measurement. Specifically, we addressed (1) Disaster Prevention using Ubiquitous Telecommunications Technology; (2) “SARDINE”: Multi-Hop Communication Terminal on VHF Band; (3) Helicopter-Satellite Communication System for Transmission of Disaster and Warning Information; and (4) Pi-SAR: Airbome Dual-Frequency Polarimetric and Interferometric Synthetic Aperture Radar. In addition, we used videos and panels to provide an overview of the NICT organization. Meanwhile, the Ministry presented an overview of the “Emergency Communications Council” entrusted with ensuring communications routes in the event of disaster. The Ministry also displayed actual equipment and display panels to describe two disaster prevention communications systems: one involving digital broadcasting and another dealing with digital mobile communications.

Although the exhibition site was somewhat far from the main venue of the conference, the exhibitions drew a large number of people, including conference participants, local government officials involved in disaster prevention, and ordinary visitors. This is partly because the conference was situated in a former disaster site, Kobe, and took place just after the Sumatra Earthquake; there was thus a high public awareness of the importance of disaster prevention. In fact over 40,000 visitors attended a range of public forums, including these exhibitions and symposiums. Many of these visitors showed great interest in the NICT exhibits, and our researchers assiduously responded to their inquiries. For any questions we couldn’t answer immediately, we sent explanatory materials to those visitors at a later date.

Personally, through participation in this exhibition I became keenly aware that a disaster could happen at any time and that any measures we can take in advance that might help reduce damage are worth the effort.

# "Women in Business, Science, and Technology" conference at the Canadian Embassy

Akiyo Nadamoto
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To celebrate the 75th anniversary of the establishment of diplomatic relations between Japan and Canada, the Canadian Embassy hosted a conference entitled "Women in Business, Science, and Technology" from November 29 to December 1, 2004.

This conference mainly consisted of speeches and panel discussions by 16 women from both countries who worked in various areas of business and technology. On behalf of NICT, I attended the speech and panel discussion sessions on November 30 and December 1.


I delivered a speech entitled "Future Television: an Attractive Blending of Internet and Television" in which I presented NICT's research on "Web2TV." This technology converts web content into broadcast type content, enabling even children and elderly people to obtain information from the Internet easily. I also discussed a "Comparative Web Browser" that allows you to view and compare several websites simultaneously.

At an open forum entitled "The Road to Success as Women" held on the final day, I talked to a group of university students about my career as a female researcher and the research environment of NICT from a woman's viewpoint. I attempted to convey my basic philosophy to these young women as they prepare to embark on their careers: hold long-term, ambitious goals; never regard yourself as inferior; believe in what you're doing; and never give up. Finally, I attended a panel discussion in which we discussed how to cultivate a societal environment in which women can pursue a greater range of possibilities.

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