SELECTED PAPER

NASDA'S PROMOTION ACTIVITIES AND RELATED EXPERIMENTS FOR i-SPACE PROJECT

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ABSTRACT

NASDA recently launched a new integrated space project called "i-Space Project", which mainly consists of three(3) satellite projects: The Engineering Test Satellite-VIII (ETS-VIII) and Ka-band Wideband InterNetworking engineering test and Demonstration Satellite (WINDS) project, and quasi-Zenith satellite project. The Satellite Mission Research Center of NASDA is a responsible organization for conducting a survey and also planning/performing a promising and innovative application experiment(s) for the "i-Space Project". The Center is actively involved in promotion activities and is acting as a window for domestic and overseas partners who are eager to perform a pilot experiment(s) in cooperation with NASDA. This paper introduces a total of nine(9) pilot experiments that NASDA conducted in the 2001 fiscal year, along with the role of the Satellite Mission Research Center of NASDA.

INTRODUCTION

NASDA and CRL have been cooperating closely for the development of new satellite missions and the bus technologies in the past. However, as seen in a recent rapid development of Information Technology including the Internet, progress of technology itself and user demand is changing dramatically so that it is not easy to set a clear development target without understanding those innovative and emerging technologies.

Taking those factors into account, NASDA intends to explore, plan, and perform new and innovative application experiments in a promising field of communications, broadcasting and navigation when developing a new engineering and test satellite. That process is initiated by promoting satellite missions utilization and by strengthening the relationships with external parties. NASDA believes that offering those opportunities to external parties will bring them a great chance to challenge and test a new space-based application(s) and that it may create a new and attractive satellite mission(s). As a result, NASDA hopes that the result of those new space missions are returned to general public in the end and that the ideas or requirements for new satellite mission could emerge and materialize in the future.

ROLE OF SATTELLITE MISSION RESERCH CENTER

NASDA newly established a "Satellite Mission Research Center" in the Office of Satellite Systems in order to strengthen NASDA's activities on conducting numerous promising mission experiments in the fields of communications, broadcasting and navigation. The primary objective of the Center is to survey, plan, and conduct a promising satellite mission experiment(s) in as many fields as possible, thereby promoting strongly the utilization of the space-based technologies on the ETS-VIII and the WINDS spacecrafts. Those experiments are called as "pilot experiments" and the results of those experiments are to be reflected in the satellite design.

To achieve those objectives, NASDA is playing more active roles than before, and is presently promoting the following activities:

1) Conducting survey to explore various experiment ideas from various external parties such as research institute(s), university(s), and industry(s) in order to utilize experiments of ETS-VIII and the WINDS spacecrafts,
2) Selecting a promising experiment(s) by opening a hearing session(s) and by asking a wide range of opinions from external authorities,
3) Planning and performing a pilot experiment(s) in promising fields through the use of existing commercial satellites, and
4) Organizing the co-experiment community to actively discuss promising topic/candidate(s) on satellite communications.

It should be noted that no successful implementation of the satellite utilization experiments is possible without active participation from various fields and

organizations. Therefore, NASDA continues its close cooperation with domestic and overseas institutions, hoping that it provides useful opportunities of satellite utilization promotion experiments. For this purpose, NASDA is pleased to invite any ideas for the "pilot experiments" utilizing the ETS-VIII and WINDS satellites. The Satellite Mission Research Center acts a window to bridge a possible experiment partner(s) and NASDA and coordinate a planning for a satellite application testing(s) with the partner(s).[1]

The i-SPACE PROJECT

The Japanese Government announced in January 2001 that Japan becomes one of the most advanced countries in the world in the field of Information Technology (IT). They also set a ambitious target to launch an ultra-high speed internet satellite (i.e. WINDS) by 2005 and completes verification testing of its function.

Recognizing the importance of this commitment toward an advanced information society and in response to a growing social demand to realize broadband communications environment and advanced mobile communications, NASDA proposes a new space project named "i-Space Project". The i-Space Project intends to make contribution to a revolutionized information society, and is accomplished by developing new space-based communication capabilities effectively integrated with ground communication infrastructure. It is also promoted by demonstrating an experiment(s) to prove its effectiveness in as many space-based application areas as possible.

One important objective of the "i-Space Project" is to effectively utilize a newly-developing satellite communication technology(s) including a fixed satellite-based Internet system and mobile communications system, in an effort to cope with important issues in a nation level such as an Earth environment preservation, education, medical treatment, and security management etc. If NASDA can demonstrate the usefulness and/or advantage over terrestrial communications, the "i-Space project" will serve as a bridge to connect a present demand and the future need. A possible examples of space communications are illustrated in Figure 1.

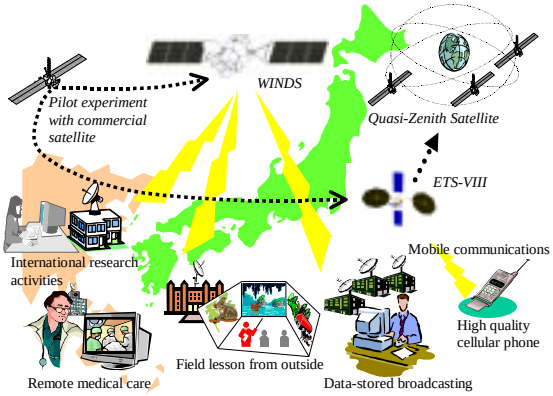

Figure 1 Examples of Space Communications

The outline of the Engineering Test Satellite-VIII (ETS-VIII) and the Wideband InterNetworking engineering test and Demonstration Satellite (WINDS) are as follows:

THE ETS-VIII SATELLITE

The Engineering Test Satellite - VIII (ETS-VIII) is one of the world's largest class of geostationary satellite for mobile communications, having three(3) year mission life, approx. 2,900kg of on-station weight at BOL, approx. 7,500watts of solar generation power at EOL (i.e. BOL+3years), and a large-scale deployable reflector (LDR) with approx. 19x17meters in size. The LDR enables a use of S-band handheld terminals at ground and high speed packet communications testing for multimedia information such as images to mobile users. The ETS-VIII satellite also carries a high precision atomic clock system for satellite positioning experiments (L-band and S-band).[2]

The satellite is being developed by both NASDA and CRL for a slated launch in 2004 fiscal year by H-IIA rocket. Figure 2 shows on-orbit configuration (deployed) of the ETS-VIII satellite.

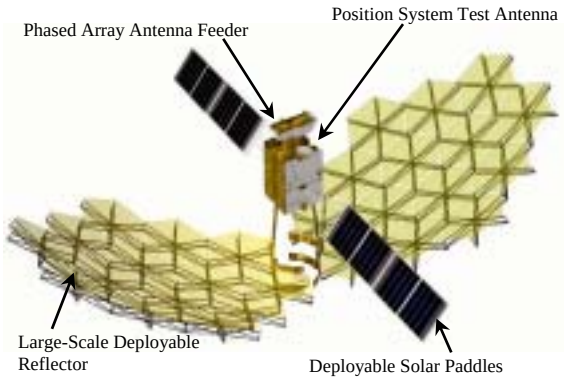

Figure 2 On-orbit configuration (deployed) of the ETS-VIII satellite

Fundamental experiments are scheduled to be conducted once the ETS-VIII satellite is launched. Utilization experiments are conducted and they are continued for several years after the fundamental experiments are complete. Although the S-band mission antenna of the ETS-VIII is primarily designed to cover the Japanese islands for mobile communications test purpose, CRL and NASDA are now considering to extend its usable coverage by controlling the satellite's attitude and on-board beam forming network (BFN) to extend its coverage so that countries such as Philippines, Vietnam, and China are able to participate a mobile communications experiment jointly with NASDA and CRL.

THE WINDS SATELLITE

The Wideband InterNetworking engineering test and Demonstration Satellite (WINDS) is a Ka-band experimental satellite, aiming at establishing a fixed satellite network for the Internet. It is consistent with the "e-Japan Plan" that Japanese Government is committed to realize by the year 2005.

The WINDS satellite is being developed by both NASDA and CRL to incorporate advanced satellite communications technologies such as Ka-band Multi-Port Amplifiers (MPAs), Ka-band Active Phased Array Antennas (APAAs), and on-board Asynchronous Transfer Mode (ATM) switching / routing function. The satellite is slated for a launch in 2005 by H-IIA rocket. Although the following parameters are still "tentative", the main features of the WINDS are as follows: Five(5) year mission life, approx. 2,500kg of on-station weight at BOL, and approx. 7,500watts of solar generation power at EOL(i.e. BOL+5years).

The WINDS satellite will demonstrate the applicability of satellite-based Internet services. The satellite is capable of providing IP services as fiber-like Gbps trunking connection and 155Mbps class, ATM-based multimedia access by a small-aperture ground terminal(s) throughout the Asia-Pacific region. Figure 3 shows on-orbit configuration (deployed) of the WINDS satellite.

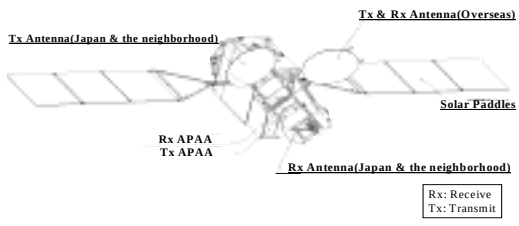

Figure 3 On-Orbit Configuration (deployed) of the WINDS satellite

QUASI-ZENITH SATELLITE SYSTEM

In addition to these two(2) satellite systems, CRL and NASDA are investigating a feasibility on Quasi -Zenith Satellite System as a promising candidate for next generation's mobile communications satellite system.

The idea of the Quasi-Zenith Satellite System is to place three(3) satellites in inclined orbits (typical inclination of orbit is 45degrees), having the same size as the geostationary orbit and the same separation angle among the three(3) satellites. The constellation of those satellites provides users with excellent advantage to establish communications link: A mobile user(s) can expect excellent accessibility to one of the satellites with high elevation angle (typically greater than 70degrees, depending on the location of interest.). Adding a position sensing function to the Quasi-Zenith Satellite System is also under investigation.

Because of this unique feature, the Quasi-Zenith Satellite System is considered suitable for mobile communications users not only in urban areas where geographical difficulty is an issue but also in big cities where an RF blockage by tall buildings and a multipath problem are issues. Since the system itself is under investigation, no pilot experiment was done at NASDA for the Quasi-Zenith Satellite System.

PILOT EXPERIMENTS

NASDA is now promoting "pilot experiments" as precursor testings for the ETS-VIII and the WINDS satellites. Utilizing commercial communications satellite, the first two(2) pilot experiments (Medical and Education) started in 2000 fiscal year to promote the use of the ETS-VIII. The following fiscal year of 2001, a total of nine(9) tests were selected as promising pilot experiments for the ETS-VIII and WINDS satellites. The two(2) tests were among the nine(9) experiments. The selection was made from a total of thirty five(35) testing candidates, by asking a wide range of useful opinions from external authorities and by a subsequent voting.

In selecting promising experiment, careful evaluation is made primarily on the content of experiment itself, qualification of potential collaboration partner, and significance of the experiment (such as social contribution to domestic and regional demands) as well as feasibility including cost and partner's resources.

The following paragraphs describe the nine(9) pilot experiments NASDA conducted in 2001 fiscal year.

1. MOBILE HOSPITAL EXPERIMENT

In an effort to realize a diagnosis from a remote area, the following two(2) remote medical experiments have been performed, using a commercial satellite and VSAT technology. See figure 4 for overall experiment setup.

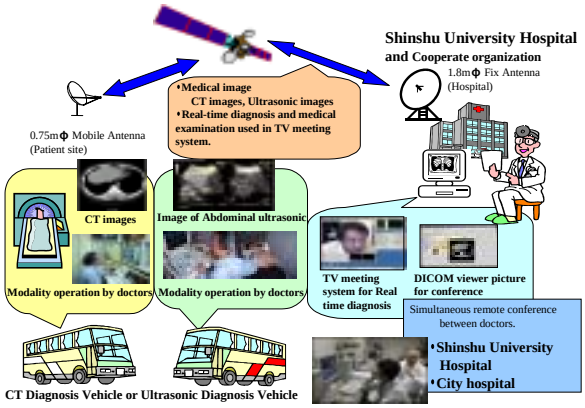

Figure 4 Mobile Hospital Experiment

CT DIAGNOSIS TEST

By placing a vehicle equipped with Computerized Tomography (CT) scanning equipment and an operation technician(s) in an isolated area, three(3) doctors who have been a way from the area have been able to check a realtime CT picture(s) of the potential patients at the isolated area.

Satellite multicasting technique has been used to transmit the CT pictures. A 1.5Mbps, Ku-band satellite communications link has been used from the isolated site (75cm diameter antenna was used) to three(3) medical hospitals (1.8meter diameter antenna was used at each hospital). For diagnosis purpose, the doctors could talk with each other and exchange their comments on the pictures via a terrestrial TV conference system. The testing was successful and the CT quality turned out "above satisfactory" when received at the remote hospitals.

ULTRASONIC DIAGNOSIS TEST

A similar testing on Ultrasonic mass examination was conducted, using satellite communications as a diagnosis tool. Satellite communications data rate and VSAT antennas were the same as in the CT Diagnosis. However, since an Ultrasonic moving picture contains more information than a CT picture, it turned out that it needs more study to establish better system for an early detection of disease.

2. MOBILE TELEMEDICINE EXPERIMENT

The ultimate goal of this Mobile Telemedicine experiment is to establish comfortable medical environment for the doctors who try to visit a patient home with a handy satellite communications tool and make a remote diagnosis in close collaboration with his / her hospital at any time. For the purpose, the doctors need to keep good medical network with his/her hospital as it usually keeps disease history and other important medical database of the patient. In this sense, this Mobile Telemedicine testing is apparently an example of mobile communications as represented by the ETS-VIII satellite.

Actual experiment was carried out by establishing a satellite communications link (1.5Mbps, Ku-band) between a patient home and two(2) hospitals, Tottori University Hospital and Hino Hospital in Tottori Prefecture. Satellite unicasting technique was used to exchange a digital camera picture(s) of patient as well as digitalized databese of medical images such as CT, MRI, and Chest XP etc. between the patient home and the hospitals. In addition, a high definition picture equipment having pointing capability was installed to make diagnosis. Use of DICOM server of hospital allows the person concerned to see most of medical pictures at three(3) sites. See figure 5 for overall experiment setup.

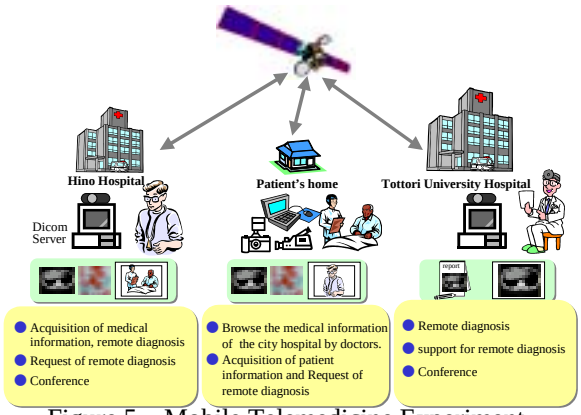

Figure 5 Mobile Telemedicine Experiment

3. FIELD EDUCATION EXPERIMENT

NASDA is now promoting the use of mobile satellite communications as a promising tool to expand interest and experience of the students who are eager to learn more on many academic topics. Typical examples were: An astronomy lesson hearing live comments from astronomer, a social study lesson on a river pollution utilizing a satellite remote sensing data, and a biology lesson on the living creatures in the sea sharing a live report from a deep sea submarine. This concept is called as "Field Education".

In all of those experiments, a school classroom is directly connected via satellite with a teacher or a reporter on outside field where no communication infrastructure is available except satellite. In addition, extensive use of mobile, satellite-based conference system allows the teacher and student to discuss any environmental problems by sharing a live picture taken at the outside field. NASDA believes that, through the use of advanced technology of satellite mobile communications, students are able to obtain a more vivid and real picture of the topics of interest without going out of classroom. See figure 6 for overall experiment.

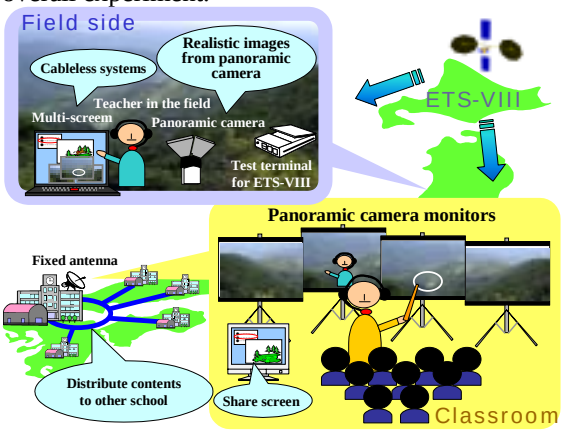

Figure 6 Field Education Experiment

4. MULTICAST EXPERIMENT

Several, basic multicast transmission experiments using a next generation IPv6 protocol and associated simulation were performed in 2001 fiscal year with respect to multicast scalability, operationability, and reliable multicast etc. Those experiments were conducted jointly with JSAT Corporation and through close cooperation with WIDE Project. See figure 7 for overall experiment.

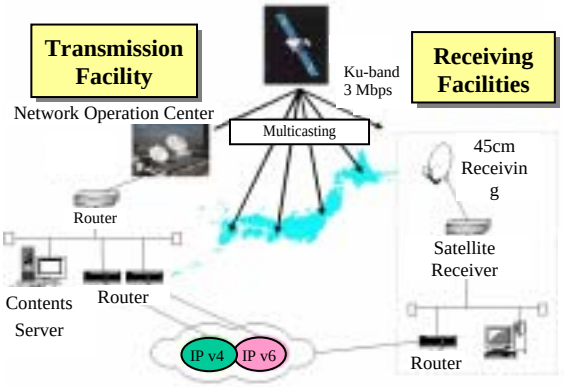

Figure 7 Multicast Experiment

5. DISASTER MANAGEMENT EXPERIMENT

Disaster management is placed as one of the important applications of the "i-Space Project". As satellite can cover very wide area, a disaster information collection system is apparently one of the suitable application of satellite communications utilization. Disaster management pilot experiment was conducted at the skirt of Mt. Usu in Hokkaido (north of Japan) in cooperation with Asian Disaster Reduction Center (ADRC). The mountain erupted in January, 2000. In this pilot experiment, a live picture(s) was taken near Mt.Usu and was distributed via commercial satellite to one(1) headquarter near by and three(3) remote sites for the diagnosis of a simulated disaster environment. GPS data was utilized simultaneously to identify the position information of a disaster location. Realtime communications was arranged among the four(4) sites. The overall experiment turned out very successful and effective, and NASDA plans to continue and upgrade the testing next fiscal year. See figure 8 for overall experiment.

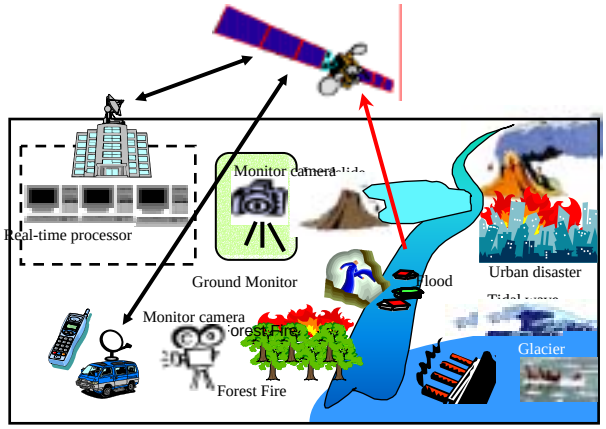

Figure 8 Disaster Management Experiment

6. Ka-BAND PLATFORM EXPERIMENT

The purpose of this testing is to build a high speed Ka-band testing environment and evaluate its operationability and performance. In 2001 fiscal year, several experiments were conducted on this platform: A streaming distribution of HDTV, file transfer via MFTP, and HDTV transmission testing. Those tests were conducted jointly with SCC. Figure 9 shows the experiment.

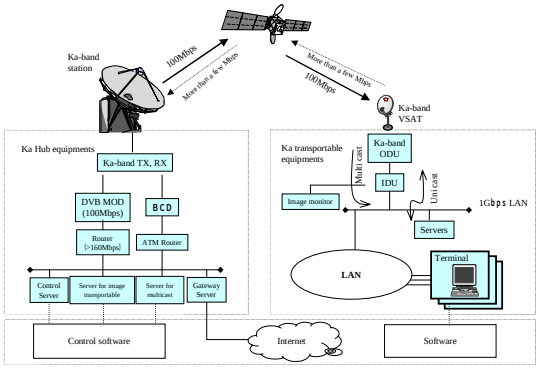

Figure 9 Ka-band Platform Experiment

7. DIGITAL DIVIDE TESTING

Most people living in urban districts and nearby cities are (or will soon be) able to access broadband communications such as ADSL, CATV, and wireless LAN. But this is not a case for rural areas (i.e. remote islands and mountainous places etc) where they are not necessarily equipped with adequate means of communications because of a cost issue. As a result, it is generally believed that the communications environment difference is expanding between those two places due to a rapid progress of terrestrial communications. The phenomenon is called as "Digital Divide". The Japanese Government estimates that approximately eight(8) million households will remain in the category of "Digital Divide" in the year of 2005.

NASDA started experiment in the fiscal year 2001 in an effort to resolve the issue of "Digital Divide" through the use of satellite communications and the development of "Satellite Dynamic Resource Assignment Technology" with JSAT Corporation. This pilot experiment was to check satellite Internet operationability of the whole system having asymmetric communications link (i.e. mobile phone for an Internet access and satellite downlink as a return link) and a small diameter R.O. (receive only) antenna at rural area. TCP/IP accelerator was used in satellite link to enhance throughput of the system. NASDA and JSAT have successfully demonstrated its effectiveness and usefulness in several fields. Figure 10 shows the experiment.

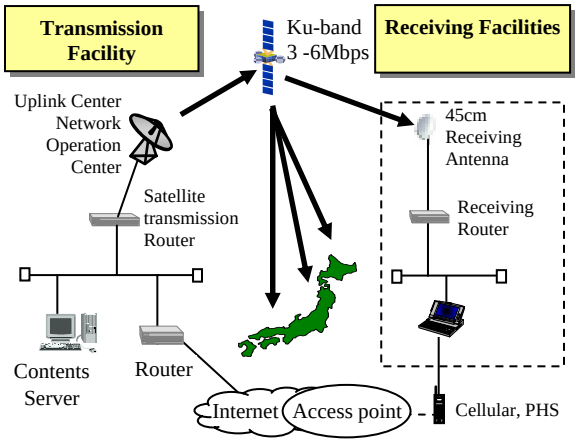

Figure 10 Digital Divide Testing

8. AIRCRAFT AND SHIP COMMUNICATIONS EXPERIMENT

Those two(2) experiments are explained below.

8. 1 AIRCRAFT TO/FROM GROUND

First experiment is between a small aircraft and ground and is intended to use for disaster monitoring such as fires and earthquakes. Combining and processing both GPS position information and realtime picture image taken by the on-board camera of the aircraft, overall data is transmitted from the aircraft to ground via Ka-band commercial satellite for further data processing. In 2001 fiscal year, the processing software was developed in cooperation with CRL and Diamond Air Service (DAS) so that a flight testing is planned in 2002 fiscal year. Figure 11 shows the experiment setup.

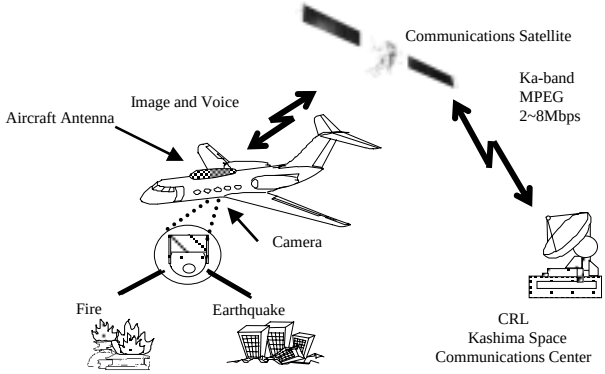

Figure 11 Aircraft and Ground Experiment

8. 2 SHIP TO/FROM GROUND

Second testing is between ship and ground. In this experiment, a digital HDTV picture(s) was taken at the deep sea floor or at the sea floor (approx. 650m deep) by a remotely operated vehicle and research vessel (ROV "Hyper Dolphin" and R/V "KAIYO", owned by JAMSTEC: the Japan Marine Science and Technology Center) and approx. 45Mbps realtime transmission experiment was carried out between navigating R/V KAIYO and ground via commercial communications satellite. The testing was a great success in that it demonstrated a most sophisticated marine data is quickly obtained by satellite communications technology. It also gives marine researcher(s) and ground researcher(s) an opportunity to cooperate toward a joint analysis and research work in realtime. Figure 12 shows the experiment.

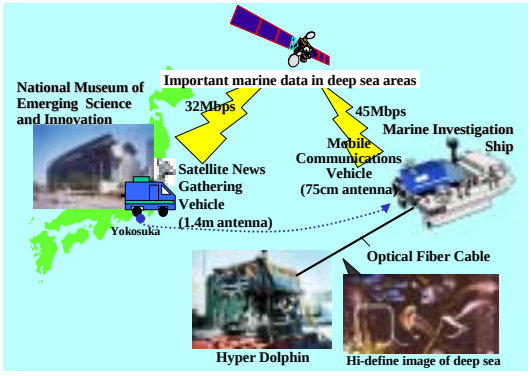

Figure 12 Ship and Ground Experiment

CONCLUSION

In this paper, "i-Space Project" proposed by NASDA is introduced and explained that it has three(3), integrated, space-based projects: S-band ETS-VIII project, Ka-band WINDS project, and Quasi-Zenith Satellite project. The Satellite Mission Research Center of NASDA is a responsible organization for conducting a survey and also planning/performing a promising and innovative application experiment(s) for the "i-Space Project". The Center is actively involved in promotion activities and is acting as a window for a domestic and overseas partner(s) who is eager to perform a pilot experiment(s) in cooperation with NASDA.

This paper introduced nine(9), domestic pilot experiments that NASDA conducted in 2001 fiscal year. The experiment fields ranges from telemedicine (mobile and home), education, and disaster management to communications infrastructure such as a satellite-based Internet multicasting testing, a satellite dynamic resource assignment testing via small VSAT terminal (i.e. Digital Divide testing) , a Ka-band high speed data transmission testing, and a communications testing between aircraft/ship and ground.

It should be noted that active participation from various application fields as well as many user communities is extremely important for the successful implementation of satellite utilization experiments. The Satellite Mission Research Center of NASDA will continue to promote a similar pilot experiment(s) next fiscal year through its close cooperation with domestic and overseas institutions, research laboratories, and industries in Asia-Pacific Region, hoping NASDA provides appropriate opportunities of satellite utilization experiment and thereby a need for satellite communications grows in the future.

ACKNOWLEDGEMENT

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