Result of 5 (five) Subcommittees meetings

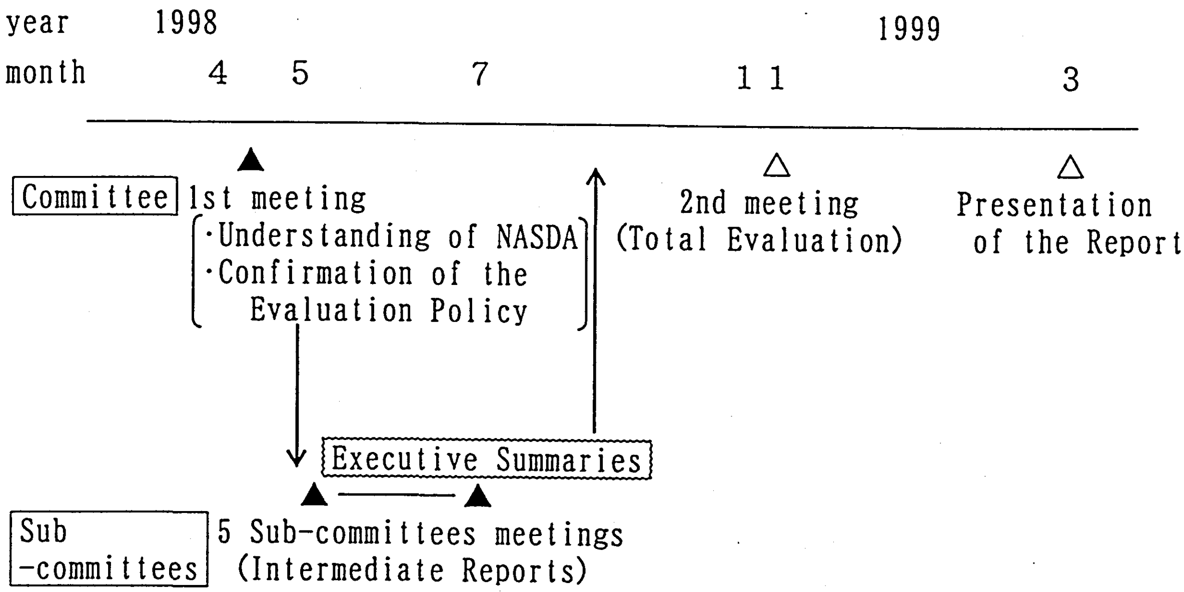
In accordance with the result of the first meeting of the Committee for NASDA Evaluation held in April of this year, 5 (five) Subcommittee's meetings have been held as following schedule to evaluate NASDA's programs and projects. Subcommittees made summaries at the end of each meetings as intermediate proceeding report. Based on these reports, their editorial works to complete final reports are in process and the reports will be submitted to the Committee. With these reports, the Committee will organize the second meeting in this November, and will discuss for the final NASDA evaluation report.

Subcommittees	meeting term
Subcommittee for Space Utilization	May 19 (Tue.)- 21(Thu.), 1998
Subcommittee for Satellite Engineering	June 9 (Tue.) - 12 (Fri.), 1998
Subcommittee for Research & Development	June 22 (Mon.) - 24 (Wed), 1998
Subcommittee for Space Transportation	June 29 (Mon.) - July 3 (Fri.), 1998
Subcommittee for Earth Observation	July 6 (Mon.) - 9 (Thu.), 1998

August 28 , 1998
National Space Development Agency of Japan

Attached:
1. Committee schedule
2. List of the Subcommittee membership
3. Subcommittees' Executive Summaries

Committee Schedule



Sub-committees Members List: Sub-committee for Space Utilization

	Name
Co-Chairman	Hideo OHASHI (President of the Kogakuin Univ. , Chairman of the fifth Division of Science Council of Japan) Wilbur C. TRAFTON (Executive Vice President of the International Launch Services)
Member	Isao KURODA (former Prof. of the Waseda University) Yasunori MATOGAWA (Prof. of the Institute of Space and Astronautical Science) Takuo SUGANO (President of the Toyo University) Shun TAKEDA (Chief executive officer of the Aerospace Technology Promotion Foundation) Teruko TAMURA (Prof. of the Bunka Women's University) Tamito YOSHIDA (Prof. of the Chuo University)
	Klaus D. BERGE (Director of Space Project of the German Aerospace Center, Germany) Karl H. DOETSCH (President of the International Space University, Canada) David J. LARSON (Prof. of the State University of New York, USA) J. Wayne LITTLES (Consultant, former Director of the Marshall Space Flight Center, USA) Valerie POLYAKOV (Deputy Director of the Institute for Biomedical Problems (Cosmonaut), Russia)

Sub-committees Members List: Sub-committee for Satellite Engineering

	Name
Co-Chairman	Nobuyoshi FUGONO (President of the Support Center for Advanced Telecommunications Technology Research Foundation)
	Joseph N. PELTON (Prof. of the Telecommunications University of Colorado, USA)
Member	Fumio HARASHIMA (President of the Tokyo Metropolitan Institute of Technology)
	Kazuhiko HASHIMOTO (Chief Engineer of the System Engineering Dept. of the Perfec TV Corporation)
	Risao HAYASHI (Prof. of the Faculty of Engineering of the Kagoshima University)
	Yoshiaki OHKAMI (Prof. of the Dept. of Mechano-Aerospace Engineering Faculty of Engineering of the Tokyo Institute of Technology)
	Yasuhiko YASUDA (Prof. of the Dept. of Electronics and Communication Eng. School of Science and Engineering of the Waseda University)
	Stephen Z. GUNTER (Technical Manager of the Mission Information Systems Engineering of the Jet Propulsion Laboratory, USA)
	James B. HAMILTON (Manager of the Satellite Communications Applications Program of the Communications Research Centre, Canada)
	Vinod J. MODI (Prof. Emeritus of the Dept. of Mechanical Engineering of the University of British Columbia, Canada)

Sub-committees Members List: Sub-committee for Space Transportation

	Name
Co-Chairman	Hideo NAGASU (former Director General of the National Aerospace Laboratory) John M. LOGSDON (Director of the Space Policy Institute of the George Washington Univ., USA)
Member	Hiroshi ENDOH (Japan Air System Co.) Eiichi ITOH (KDD Network Planning Dept.) Kumiko MIYAZAKI (Associate Prof. of the Dept. of Industrial Engineering and Management of the Tokyo Institute of Technology) Nobuhiro TANATSUGU (Prof. of the Institute of Space and Astronautical Science) Susumu TODA (Deputy Director-General of the National Aerospace Laboratory
	William R. CLAYBAUGH II (Business Advisor/Alliance Development Office, Office of Aeronautics and Space Transportation Technology NASA HQ, USA) Dietrich E. KOELLE (Trans Cost Systems, Germany) Chester L. WHITEHAIR (used to work for Aerospace Co., USA)

Sub-committees Members List: Sub-committee for Earth Observation

	Name
Co-Chairman	Tomio ASAI (Research Supervisor of the Japan Science and Technology Corporation) Gordon A. MCBEAN (Assistant Deputy Minister, Environment Canada, Canada)
Member	Shukuro MANABE (Program Director of the Frontier Research Program for Global Change) Mikio TAKAGI (Prof. of the Science Univ. of Tokyo) Atsushi TAKEDA (Advisor of the Asia Air Survey Research Institute)
	Charles F. KENNEL (Director of the Scripps Institute of Oceanography, UC San Diego, USA) Pierre MOREL (Acting Director of the Science Division of the Office of Earth Science, NASA (Science Advisor of the Office of Earth Science, NASA), France) Vibulsresth Subit (Deputy Permanent Secretary of the Ministry of the Science Technology & Environment, Thailand)

Sub-committees Members List: Sub-committee for Research and Development

	Name
Co-Chairman	Hirotoshi KUBOTA (Prof. of the Tokyo University) Samuel L. VENNERI (NASA Chief Technologist, USA)
Member	Nobuyoshi FUGONO (President of the Support Center for Advanced Telecommunications Technology Research Foundation) Yoshiaki OHKAMI (Prof. of the Dept. of Mechano-Aerospace Engineering Faculty of Engineering of the Tokyo Institute of Technology) Mikio TAKAGI (Prof. of the Science Univ. of Tokyo) Shun TAKEDA (Chief executive officer of the Aerospace Technology Promotion Foundation) Susumu TODA (Deputy Director-General of the National Aerospace Laboratory)

Attachment-3

Sub-committees' Executive Summaries

REFERENTIAL CONTENTS

Evaluation Report of the NASDA Space Utilization Program

Executive Summary

Introduction

The Utilization Subcommittee (enclosure 1) met at Tsukuba, Japan on May 18 through May 21, 1998 (enclosure 2) to evaluate the NASDA Space Utilization Program. The subcommittee considered the ten project areas and ten evaluation criteria reflected in the Trafton/Ohashi letter (enclosure 3). To conduct this evaluation, the subcommittee had been provided the "Material for Submission to the Subcommittee for Space Utilization". NASDA personnel also provided presentations on the International Space Station Program in Japan and an outline of NASDA's space utilization activities which were considered in the subcommittee's deliberations.

Overview of Evaluation

NASDA has established a very broad-based utilization program consisting of projects, which provide key on-orbit capabilities(JEM and Centrifuge), JEM operations, logistics re-supply (HTV), space research, supporting experiment facilities, experiment development activities, astronaut training and health management, and space medical research. NASDA is to be congratulated on the progress made to date, particularly in achieving an advanced state of JEM and ground facilities development, and planning for the whole range of projects undertaken.

A summary evaluation of the individual projects according to the suggested criteria is presented in the following section. However, during the course of the evaluation, the subcommittee requested NASDA provide an overall assessment of its own program. The result is captured in "NASDA's Space Utilization Program including ISS Participation" (enclosure 4). In view of this assessment and review of the other reports and material provided, the following overarching observations, which relate to several or all of the projects, are made:

1. Space Station will be a major advance in human endeavors. It symbolizes international cooperation, and advances the frontiers of knowledge, as well as the human spirit and experience. As such, we need to share the results of this endeavor with all nations and all people. Japan can play a leading role in realizing this vision.
2. Restructuring of the ISS program and schedule delays have impacted the NASDA program. NASDA has been successful in accommodating the delays, but impacts have occurred to NASDA budgets and in some areas little margin remains. In particular, NASDA can ill-afford problems in software development, integration and testing. Any further delays could have serious consequences with regard to the overall NASDA utilization program.
3. NASDA is currently undertaking the HTV and Centrifuge projects, while completing JEM development and transitioning to JEM operations planning. In the opinion of this subcommittee, NASDA requires additional personnel to accomplish these tasks within their currently defined areas of responsibility. While adding contractors can mitigate this deficiency, the subcommittee believe that an augmentation of NASDA personnel should be seriously considered. NASDA also needs to consider developing the next generation.
4. Space utilization is much more than simply operating a space station and conducting scientific experiments in space. It involves the expansion of the human race beyond planet Earth. We recommend NASDA expand public awareness/ outreach of its activities through education, humanization (e.g., crew presentations, daily images via TVs, websites); include spiritual connection, global relevance, etc.; expand ISS mission to include all of mankind; emphasize other intangible values (non-scientific results, etc.)
5. In reviewing the definition of requirements for each of the ten areas of NASDA's space utilization activities (i.e., projects), it was observed that some requirements were provided without corresponding evaluation criteria. We recommend that each requirement have a corresponding evaluation criteria associated with it to enable the construction of meaningful performance metrics, which are needed to conduct quantitative evaluation of the activities.

Project Evaluation

I. JEM Development Project

- JEM development has been managed well and has coped with changes introduced by International Partners.
- However, little margin exists to accommodate problems in software development, integration and testing.
- Ensure appropriate transition from development phase to operation / sustain engineering, including required personnel and budget.

II. HTV Development Project

- Well structured program, but international agreement on traffic model is needed to ensure that Japan receives the expected benefits from developing HTV.

III. Centrifuge Development Project

- Centrifuge is critically important to the ISS user community.
- Development schedule is very aggressive, considering the high level of critical-path international involvement, and international hardware procurement.

IV. Operation of JEM

- Establish a plan for the required transition of workforce from development to operations phase in conjunction with newly established centrifuge project and HTV.
- Highlight need for emergency/contingency response planning.

V. Research and Promotion of Space Utilization

- Well developed program that could be further enhanced by additional funding.
- Consider expanding objectives to include commercial research and development.
- Enhance coordination of ground-based research with on-orbit research by consolidating long range planning, integrating the planning process into the Space Utilization Research

Committee, and minimizing redundancies by building multinational teams (i.e., internationalize AO process).

- Suggest forging associations with various external organizations to enhance credibility and develop collaborative programs and projects.

VI. Development of JEM Multi-user Experiment Facilities and EF Payloads

- A well developed program that should generate a strong Japanese utilization.
- Potential use of JEM experiment facility by other countries by co-investigation or barter of utilization rights is appropriate.

VII. Space Experiment

- A well conceived program that needs to consider introducing additional flight opportunities until JEM is operational.
- Cooperation with ISAS, and other agencies, should be emphasized.
- NASDA should develop an evolutionary plan for space experiments for the ISS during its 10 year operational life.

VIII. Crew Training

- A well designed program.
- Future activities and plans look reasonable. Continue to place emphasis on public speaking and other PR skills, and also include increased emphasis of non-scientific fields in future selection and training of astronauts. Consider potential for training non-scientists (e.g., artists, poets, et. al.) for space flights.

IX. Health Care for the Japanese Astronauts and Research on Space Medicine

- Continue to develop techniques to achieve maximum crew performance, beyond just physical health, such as sociological and psychological performance.
- Establish a post-flight rehabilitation plan.
- Provide adequate reinforcement of medical support and research organization at operations control center.

- Take maximum advantage of existing knowledge base of space medicine in other nations, which possess long duration space flight experience in medical support and experiment verification.

X. Safety & Product Assurance Activities of Manned System

- Well established program. Risk management, including failure modes and effects analysis, should be covered by S&PA. Develop a comprehensive risk management process.
- Pay close attention to software safety for both ground and flight software.
- Consider broadening safety expertise by utilizing knowledge base available in the nuclear power, aeronautical fields, etc.
- Astronauts/cosmonauts with wide range of previous flight experience should be members of safety review teams, to maximize the breadth of coverage.

Evaluation Report of
NASDA Satellite Engineering

Executive Summary

1. Introduction

The Satellite Engineering Subcommittee (enclosure 1) met at Tokyo, Japan on June 10 through June 12, 1998 to evaluate NASDA Satellite Engineering activities. The subcommittee considered past, on-going and future projects. To conduct this evaluation, the subcommittee was provided the "Material for Submission to The Subcommittee for Satellite Engineering" (enclosure 2) and "NASDA's View of the Items to be Evaluated" (enclosure 3).

Since its founding in 1969, the NASDA's satellite systems efforts have been conducted to introduce practical communications, broadcasting, meteorological satellite systems, and to develop advanced R&D in parallel. Influenced by the trade agreement between the Japanese and American Governments, caused by imbalance of international trade, NASDA's activities for satellite development have been limited to R&D areas since the 1990s. NASDA has made significant achievements in the areas of satellite communications, broadcasting and satellite technology development in its many programs. The future challenge is expected to be in moving towards the "Faster, Better, Cheaper" concept promoted recently in the US and other countries.

1.1 Project Planning and Quality Assurance

As to current planning for satellites projects, it has been largely accomplished by negotiation among particular organizations or simply within NASDA. It is recommended that this process be broadened to include members from other communities such as scientists, university researchers, representatives of mass communications providers and user organizations, and to establish future plans by including their full consideration. Japan's technology development has been conducted based on introducing foreign technologies in order to catch up, but has now moved to develop its own technology. The recent troubles of NASDA seem to be related to this transition to independent technology. In the development of new technology for satellites, it is recommended to establish a well balanced planning system in considering the appropriate way to maintain the technical reliability, as well as reconsidering an optimal approach to reliability assurance within overall cost efficiency.

1.2 Japan's Space Activities in Comparison to Rest of the World

A comparison of space activities to other space faring nations around the world is presented in Annex 1. In general this confirms that Japan's activities are highly productive in a financial and economic sense.

2.0 Program Evaluation

2.1 Overview of All Current and Future Programs Reviewed

Figure 1 presents an overview summary of all programs considered in this report.

2.2. Review and Evaluation of Current Programs

ETS-VI: This mission was very ambitious and included a number of complex new technologies, especially in millimeter wave, and optical systems. Although the launch of this satellite into GEO orbit failed, the maximum usage of the satellite functions from elliptical orbit was accomplished, including highly innovative space-to-earth and earth-to-space optical experiments.

The research and technology experiments and overall mission which ETS-VI did not verify on orbit should be included as soon as possible in future NASDA missions.

OICETS: This project represents a key technology experiment for future satellite communications with inter-satellite optical links. It is expected to achieve cost reductions in the OICETS program based on the products of NASDA's past satellites. It is also possible that GEO-GEO, GEO-LEO, GEO-interplanetary satellite data links will be established. This will be, in part, accomplished with international collaboration with ESA, with regard to the SILEX package on board the Spot 4, and the ARTEMIS project.

MDS-1: "MDS" is a series of shorter manufacturing time, cost-effective small satellites with a common bus technology concept. Double launch of (MDS-1) on the H-II or the use of the J-1 rocket will result in a less costly launch. The spin-stabilized MDS-1 is used to verify functions of commercially available electrical or electronic parts which are selected by the Mission Selection Committee from (1) the components or parts to be used in NASDA applications satellites in the immediate future or (2) those parts proposed by private companies. It is noted that the flight tested parts are valuable assets, and more importantly, the ground testing procedures are equally verified. The verification procedures will be applied to other commercially available parts or components, thereby reducing the hardware cost of medium class satellites.

MDS-2: MDS-2, a three axis stabilized version, will be launched into a sun synchronous orbit to verify the function of LIDAR (Light Detection and Ranging) and to examine three-dimensional cloud distribution. It is reasonable to use such a cost-effective satellite in a timely manner to identify unknown factors before the LIDAR equipment is mounted on a future complex remote sensing satellite.

ETS-VII: This carries remotely controlled, highly sophisticated experiments for rendezvous and docking and for space robotics. It is the first attempt at remote servicing of a satellite ever reported and hence is a commendable initiative. This valuable experience (development of technology) should be applied in future missions aimed at revival of a disabled satellite, construction of large platforms, etc.

There are several areas of challenging future evolution including use of redundancy for more efficient operation, obstacle avoidance, operation in presence of a joint failure, robust control, etc. The ultimate challenge would be the achievement of autonomous operation, maintenance and/or repair.

COMETS: The COMETS was intended to be launched into GEO, and to participate with other satellites in a number of trials and experiments. Due to a launcher problem, unrelated to the satellite, it failed to reach the planned orbit. NASDA is to be complimented on salvaging the satellite so that several of the new technologies (about 30% to 40%) can be verified, and some experiments can still be completed. One major concern is that the Ka-band inter-orbit link, originally planned for verification on ETS-VI, and now unable to be proven on COMETS, is planned to be an essential element of DRTS.

DRTS: DRTS combines new RF technology with a new 1-ton satellite bus. ETS-VI and COMETS failure to confirm some technologies should be considered in risk assessment/mitigation planning. The ground system is equally critical and risky but no description of requirements, design, implementation, status, etc. were provided. Thus, NASDA needs to apply extraordinary measures to assure success.

ETS-VIII: This is a remarkable development aimed at extending the frontiers of communications, structural dynamics and control technologies.

The S-band mobile communication payload using a large antenna (18x19 meters), on-board processor and packet exchanger will demonstrate a more efficient network than other global mobile systems. As S-band mobile broadcasting is planned for commercialization, ETS-VIII experiments should emphasize advanced mobile broadcasting technology.

Use of modular truss-type structure for the antenna is a logical way to proceed and the OSS decision is quite appropriate. The planned experiment using the H-IIA will assist in assessing the integrity of the deployment mechanism and the dynamic behavior of the antenna. There is concern about the satellite design with respect to the antenna and its phased array feed system as well as the overall control, pointing and stabilization.

2.3 Review and Evaluation of Future Programs

Gigabit Satellite: The estimated global market for broadband multi-media services (including broadband internet and enterprise network access) is estimated to exceed $700 billion by 2005. Satellite systems are being designed to capture a 10% to 20 % of this market. Thus the development of a new gigabit/second data stream satellite technology is extremely important. Also this technology is important because earth observation systems will relay up to 10,000 terra-bytes of data over the next decade. Key Issues are: (i) cost & scheduling; (ii) addressing issue of latency; (iii) the need for low cost micro satellite user antennas operating at 1-2Gbps; and (iv) whether to add Q/V (48/38 GHz) or W (60 GHz) band antennas to Ka band payloads.

2.4. Key Technologies

TT&C: TT&C planned modernization with increased geographical coverage and automation is necessary. The addition of DRTS will increase scheduling and operations complexity. The overall infrastructure of TACC needs the ongoing redesign for station consolidation around Japan and for provided services. Flight dynamics analysis and spacecraft attitude dynamics analysis should be considered as a new separate department within OSS. It should be noted that while NASDA is planning increased dependence on data relay satellites for remote sensing missions, NASA is depending on an expanded ground network in place of TDRSS after EOS-AM1.

Basic Technology Development Program: The development of bus subsystem technology is of importance for NASDA to pursue for Japanese space development. It is equally important to maintain, re-design and up-grade the subsystem functions as well as performance, with attention to reduced cost. It is recommended that NASDA utilize MDS missions to verify the on-orbit performance and environmental compatibility. Special attention should be given to technology transfer.

General Technology Development: The proposed plan aims at development of a wide spectrum of technologies in the areas of communications, broadcast and navigation; ground and space networks; on-orbit services; space debris observation, and others. Attention to the multi-body tethered systems for Earth environment study (as proposed in the "Mission to Planet Earth") is likely to be rewarding.

3.0 Key Findings

The section below makes some suggestions about how future programs might achieve even more successful results.

a. Broad Based Mission Planning: Planning should be guided by the Space Activity Commission long term vision with mission selection determined by inputs from the general public. Advisory groups can speak in favor of different space related investigations, to assure fund authorizing politicians, that good use will be made of the taxes paid. Representative groups of the Japanese community should include: scientists and educators; research laboratories; and government agencies. International collaborative missions should continue.

b. Improved Security For Satellites; Protection and Disposition of Data: The expenditures by NASDA to design, build and deploy space applications satellite systems and to obtain useful test data from these systems is quite large. Over a decade these investments exceed billions of dollars or hundreds of billions of yen. Further efforts should be considered to protect these investments. Improved methods for protection, backup and disposition of data should be undertaken, especially as data base increase in size.

c. Contingency Planning: Advanced planning for mission contingencies is a formidable task. At best, one can minimize its adverse effects through filings with the ITU for operation of satellites in transfer or circular orbits in the event that optimal orbital deployment is not achieved. Alternatively, experiments that could be carried out through re-pointing of satellite antennas may be designed into the spacecraft

d. International and Industry-Based Cooperation: In light of the limited funds available for space applications tests and demonstrations, future planning should encourage further enlargement of outside participation. This could involve cooperation with other countries in terms of launch opportunities, experiments, instrumentation, tracking, etc. For example, cooperation with southern hemispheric countries to carry out experiments of the COMETS program.

e. **Mission Objectives for Telecommunications, Broadcasting and Navigation:** NASDA's long term mission plan has progressive evolutionary objectives that depend on continuous mission success. Based on recent history, the plan should be amenable to re-adjustment as significant objectives may not be realized due to unexpected accidents. NASDA should assess the impact of missed objectives and propose a recovery plan. In future planning, priorities of mission objectives should be established and critical objectives that have impact on subsequent missions should be clearly identified. This would assist in evolving an adaptive approach to help recover the essence of the missed objectives.

f. **Process to Evaluate AO Mission Proposals and Ways to Include Representative of the Press, Users, and Aerospace Industry:** In developing a process for selection of missions for piggy-back payloads it is important that scientists, educators, satellite system users and the press be actively included in the selection process. This is so that social and cultural objectives can be included and NASDA's public support base can be broadened.

g. **Effectiveness of Technology Transfer to Industry and the User Community:** The development of new space technology should be transferred to industry and the user communities as effectively as possible. NASDA might undertake a new approach. The approach would license technology developed under contract to industry on a for fee basis. Consideration should be given for industry input in project selection.

h. **Choice of R &D Projects that are Sufficiently Ahead of Commercial Markets:**

NASDA should select longer term R&D projects that would be of interest to industry 5 to 10 years in the future. The timing and level of technology selected for NASDA projects should be chosen to be relevant to industry.

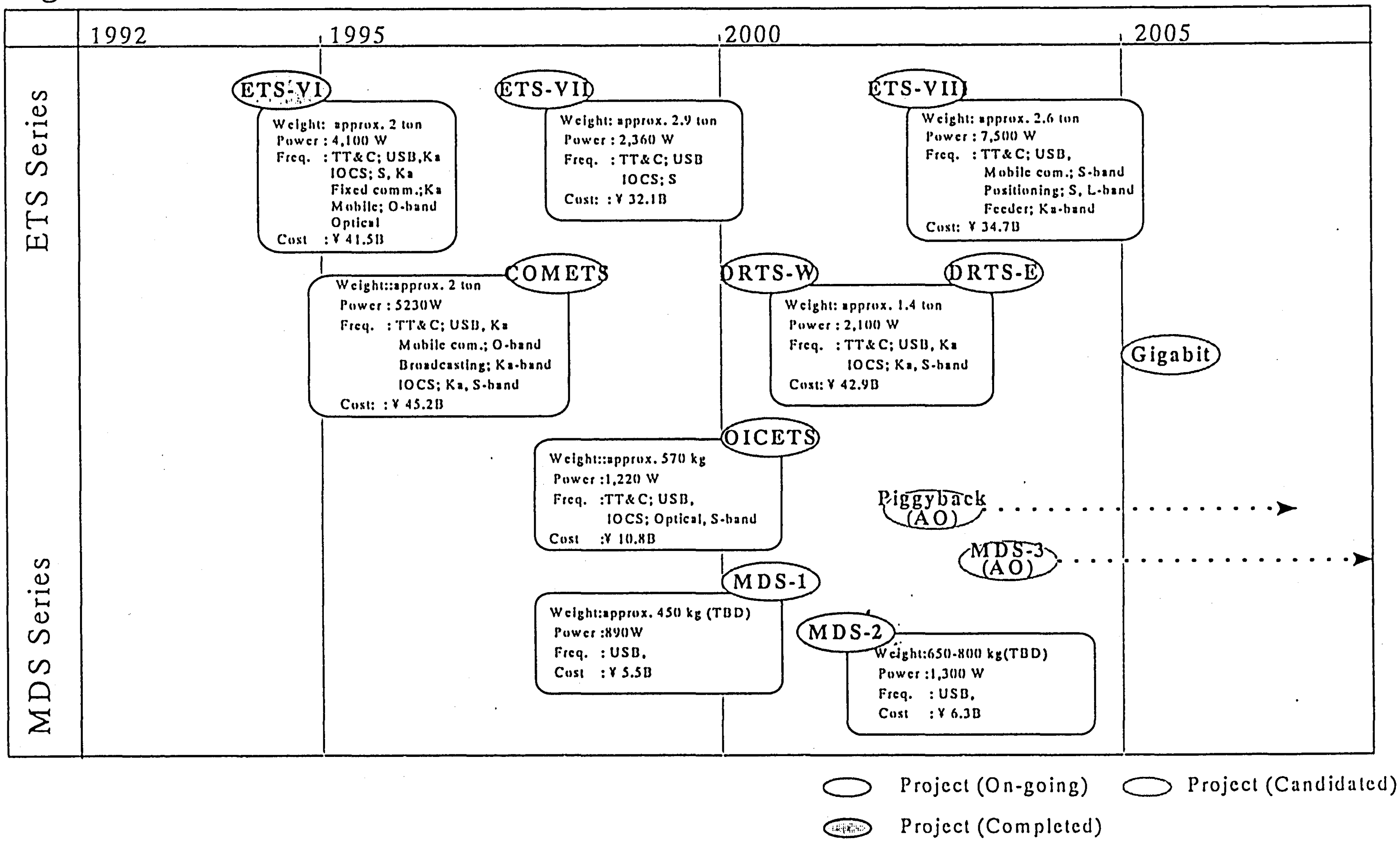
i. **Organization, Structure and Independence of Reliability Assurance Unit:** Within NASDA each Project Manager has full authority for all aspects, including quality control. The subcommittee recommends that an independent quality assurance unit be established. This unit would oversee quality control for all NASDA projects.

j. **Setting of Key Planning Guidelines:** The following elements should be considered during each project planning phase:

- Decisions for optimal resource division among Overhead, Program Planning, Satellite Control and Project Implementation
- Decisions as to whether contract allocation should be national or open to international participation;
- Adoption of success parameters for each mission, such as whether technology is adopted by industry or spin-off products or services created
- Broad participation by government agencies, the user community, industry, the media, etc. in setting objectives
- The trade-off between a single complex project or a number of simpler, smaller projects
- Best relative emphasis on technology or applications demonstrations
- Whether or not to seek international partnership.

k. **Public Outreach and Educational Programs:** Methods to inform the public and programs for education should be included in all mission proposals and must be critically evaluated as part of mission selection. The intent is to involve the public and students in NASDA activities with all types of multi-media materials, lectures and participation in missions via real-time internet web sites for significant mission events. Materials should be prepared especially for school use and small satellite projects should be made available for student experiments and participation in operations.

Figure. 1



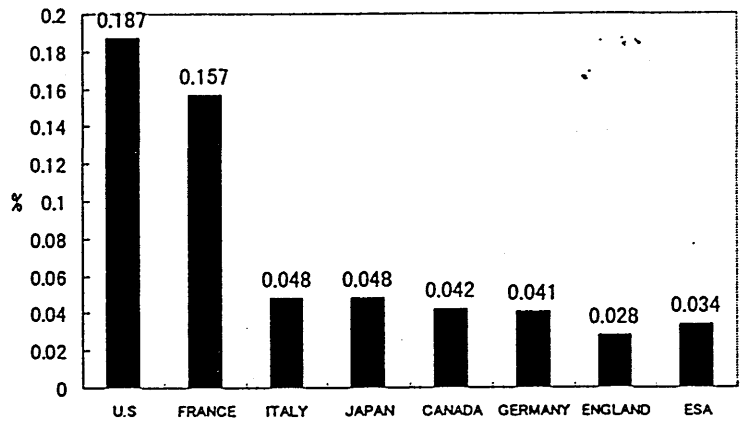
1992
1995
2000
2005
ETS Series
MDS Series
ETS-VI
Weight: approx. 2 ton
Power : 4,100 W
Freq. : TT&C; USB,Ka
IOCS; S, Ka
Fixed comm.;Ka
Mobile; O-band
Optical
Cost : ¥ 41.5B
ETS-VII
Weight: approx. 2.9 ton
Power : 2,360 W
Freq. : TT&C; USB
IOCS; S
Cost: : ¥ 32.1B
ETS-VIII
Weight: approx. 2.6 ton
Power : 7,500 W
Freq. : TT&C; USB,
Mobile com.; S-band
Positioning; S, L-band
Feeder; Ka-band
Cost: ¥ 34.7B
COMETS
Weight::approx. 2 ton
Power : 5230W
Freq. : TT&C; USB, Ka
Mobile com.; O-band
Broadcasting; Ka-band
IOCS; Ka, S-band
Cost: : ¥ 45.2B
DRTS-W
DRTS-E
Weight: approx. 1.4 ton
Power : 2,100 W
Freq. : TT&C; USB, Ka
IOCS; Ka, S-band
Cost: ¥ 42.9B
Gigabit
OICETS
Weight::approx. 570 kg
Power :1,220 W
Freq. :TT&C; USB,
IOCS; Optical, S-band
Cost :¥ 10.8B
Piggyback (AO)
MDS-3 (AO)
MDS-1
Weight:approx. 450 kg (TBD)
Power :890W
Freq. : USB,
Cost : ¥ 5.5B
MDS-2
Weight:650-800 kg(TBD)
Power :1,300 W
Freq. : USB,
Cost : ¥ 6.3B
Project (On-going)
Project (Candidated)
Project (Completed)

Japan's Space Activities in Comparison to Rest of the World

Figure A-1 provides a comparative analysis of Japan's space expenditures in comparison to other space faring nations. Figure A-2 shows that Japan's expenditure in the areas of communications, broadcasting, navigation and space systems engineering is generally in accord with the rest of the world although the US is currently spending much less. When one considers US defense-related expenditures in this area, as well as its spending on data relay satellites, these figures also seem comparable.

Figure A-1

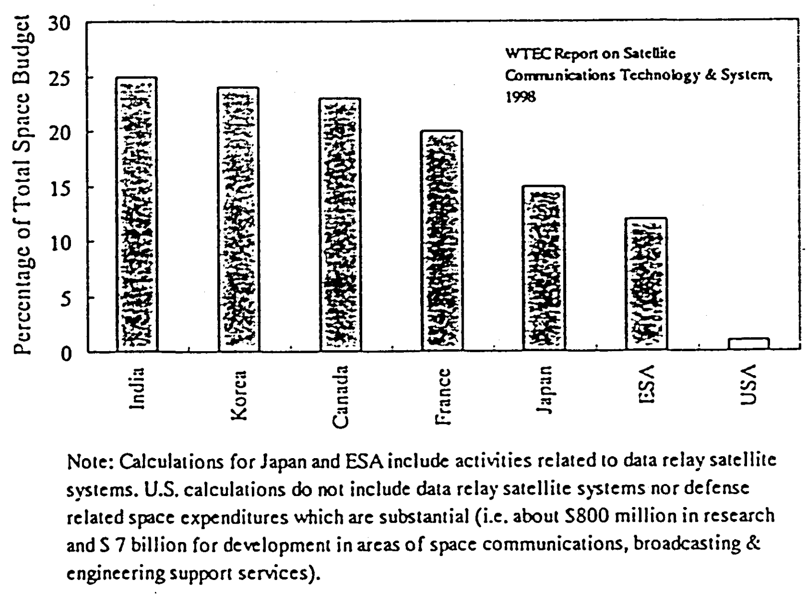
COMPARISON OF NATIONAL CIVILIAN SPACE DEVELOPMENT BUDGETS ON BASIS OF SPENDING / GDP



NOTE1: Budget of Each European Countries and CANADA Including Investment toward ESA.
ESA Population is Total Number of 14 Member Nations
NOTE2: Caluculations do not Include Defense Related Space Activities

Figure A-1

Comparison of National Space Activities in Communications, Broadcasting & Engineering Support Services



Note: Calculations for Japan and ESA include activities related to data relay satellite systems. U.S. calculations do not include data relay satellite systems nor defense related space expenditures which are substantial (i.e. about $800 million in research and $ 7 billion for development in areas of space communications, broadcasting & engineering support services).

Evaluation Report of NASDA Research and Development

Executive Summary

1. Introduction

The Research and Development Subcommittee met at Tsukuba, Japan from June 22 through 24, 1998 to evaluate the activities of research and development of NASDA (National Space Development Agency of Japan). The Subcommittee discussed and evaluated (a) achievement of research and development, (b) research and development activities, (c) SELENE Project, and (d) future directions and issues, mainly focusing on activities of the Office of Research and Development (hereinafter referred to as "the Office") in connection with the overall NASDA research and development, on the basis of ten criteria described in "Guideline for Implementation of Evaluation by Subcommittee" by the NASDA Evaluation Committee. To conduct this evaluation, the Subcommittee had been provided with the "Presentation to the Subcommittee for Research and Development", "Material for Subcommittee for Research and Development (Summary) and (Detail)".

2. Overview of evaluation

NASDA does research for practical applications. From the past to the present, NASDA, especially the Office has tried to extend its principle from "introduction of foreign technology" to "accomplishment by its own technology". It seems to be successful, but critical issues are addressed and presented in the following evaluation and recommendation.

3. Evaluation of achievement

3-1. Mission project

- The Office in some of the previous mission projects (ETS, JERS, etc.) has had significant impacts on mission success. This has encompassed the concept design, technical support and new technology development.
- Experiences and lessons learned including failed missions from past mission

projects should not be forgotten and have to be reinvented for future programs.

3-2. Fundamental technology

- The Office of Research and Development has developed the spacecraft components such as solar cells, batteries and sensors, which have been widely used by the space industry.
- NASDA research and development has developed criteria and test procedures for acceptance testing of parts specified in the Qualified Products Lists (QPL).
- Unique facilities for combined space environment test simulation and evaluation of mechanical systems under realistic loading environment have been implemented.

4. Evaluation of research and development activities

4-1. Overall evaluation

- We endorse research and development conducted by the Office is to develop practical technology and exploit fundamental research that comes from universities and national research institutions. Also we endorse that the researchers in the Office on a selected case can make a bottom-up research proposal if they want.
- We recommend the balance between in-house and out-of-house research and development be improved. Having a balanced in-house and out-of-house system will result in gathering various kinds of knowledge in cooperation with external organizations.
- The concept of risk management and total life-cycle cost assessment should be taken into the process of research plan determination.
- Open system during the early formulation of new diverse concepts and ideas is required.

4-2. Specified research and development activities of the Office

(1) Piggy-back satellite

- We endorse the concept of piggy-back satellite that enables broad spectrum of participation in the space programs.
- We understand that piggy-back satellite provides opportunities for low-

cost space experiments.

- We recommend that a solicitation process be established that enables broad-based participation in this program.

(2) Ultra-small/High Functional Satellite (Hypersat)

- We endorse this ambitious and challenging spacecraft concept.
- However, the Office needs a better clarification in order to be understood, since the concept and objectives are different from piggy-back satellites.
- The Office needs to focus on both the reduced size of satellite bus and the payload as a total satellite system.

(3) Space Systems Design/Analyses Support System

- We understand the need to establish a design and analysis space system.
- However, the Office should develop a detailed implementation plan to define needs and milestones for phased approach.
- Common use with external organizations including industry should be evaluated.

5. Evaluation of SELENE Project

- We understand the SELENE Project is an ambitious project, which will bring a new aspect of originality to lunar science.
- In this Project, it is aimed that after the scientific observation mission in lunar orbit of one year, the engineering mission of lunar landing is executed. We have noted that there is a high probability of problems on mission arrangement and the various unexpected troubles, because the two missions can not help being carried out in series in spite that they are essentially independent. We recommend that such concerns should be dissolved by quick and flexible response based on the reasonable risk management system and procedure.
- This Project is a pathfinder to bring NASDA and ISAS together in a new approach. Therefore, we recommend that this Project will be successful and transmit its experience and results to future by well communication and proper decision-making with both organizations through execution plan including a process of documentation of appropriate size on the expected problems, such as modulation of the various experimental items, trade-off of

many choices and selection of the complicated systems process.

- The Center for Lunar Mission Operation and Research is important for the auxiliary role of operation and data analysis of the SELENE Project.
- We recommend the use of the Internet to establish effective data utilization by external public and scientists.

6. Future directions and issues

- The vision and prioritization of future research and development activities were not clear and we require better clarification with identifiable goals and milestones.
- The number of staff and budget should be augmented to enable the continued growth in new space activities and technology products for the Office.
- The evaluation of the quality of research programs should be subject to external reviews.
- An action program to maintain and upgrade critical capabilities and skills of researchers and technicians should be implemented.
- Cooperation and/or partnership with universities, other national laboratories and industries should be expanded.

7. Conclusions and recommendation

- The Office of Research and Development has contributed to the achievement of the goal of establishment of a world-class space program in Japan.
- More investments in space research and development are necessary to achieve lower cost and higher reliability and insert advanced technology into future space missions.
- The Office of Research and Development should have a vision to be open and receptive to new ideas and concepts, establishment of partnerships with external organizations, and effectively communicate the impacts of new technology and activities to the general public.
- NASDA should recognize that the future of NASDA is dependent on this Office, therefore enforce its capabilities.

Executive Summary of
The NASDA Space Transportation System Subcommittee
External Evaluation Report

(Ver. 3.4; 13:00, 03/07/98)

1. Introduction

The Space Transportation Systems Subcommittee (Appendix) met from June 29 to July 3, 1998. Most of the meeting was held in Tokyo, but the subcommittee also traveled to Nagoya on June 30 and July 1 to visit the Mitsubishi Heavy Industry (MHI) plants involved in the H-II and H-IIA programs. After the formal subcommittee meeting concluded, most of the committee members visited the Tanegashima launch site. Results from that visit are not reflected in this report. To conduct this evaluation, the subcommittee had available to it the "Materials for Submission to the Space Transportation Systems Subcommittee."

The subcommittee also received a summary report of the SAC Planning Subcommittee on Space Transportation Systems Evaluation. Emphasis of that activity seemed to be the evaluation of actual projects. Therefore, this NASDA Subcommittee concluded that its evaluation should be concentrated on future NASDA program activities.

The subcommittee also heard a series of presentations from NASDA personnel and received responses from NASDA to a number of its questions posed during the meeting. The subcommittee thanks NASDA for all the substantive and logistics support provided during its meeting.

2. General Comments

The subcommittee commends NASDA for achieving the goal set out in past statements of Japan's fundamental space policy of achieving world-class, autonomous space transportation capabilities for Japan. The H-II launcher is technically the equivalent of, in some ways superior to, any other expendable launch vehicles (ELV) in the world. The failure of the fifth flight of the H-II in no way diminishes this accomplishment. All of the world's launch vehicles have failed at some point; launching payloads into space is one of the most demanding technological endeavors, and failures of some kind are almost inevitable. The appropriate response to the H-II failure is to learn from it how best to minimize the risks of future problems.

The subcommittee was also very favorably impressed by the comprehensive and ambitious activities and plans of NASDA's Office of Space Transportation Systems. Equally, it recognized that the planned program could not be carried out with the level of budget resources currently available to the office. If no future budget increases are realistically possible, either NASDA will have to scale down or stretch out its current plans, or place increased emphasis on international cooperation (including firm-to-firm cooperation) in the space transportation area.

NASDA clearly recognizes its role as a research and development organization, but appears to be receiving unclear guidance from the Japanese Government with respect to the relative priority between serving Japanese public interests and supporting Japanese competitiveness in the global space transportation market. The emphasis on cost reduction in future space transportation systems (including the H-IIA) is quite appropriate. However, whether the major reason for this emphasis is to allow Japan to carry out more public space missions within a level budget or to allow Japan to capture a share of the space launch market is not clear. The subcommittee believes that it is the first of these two objectives that should be the primary goal for NASDA. Commercial competition is more properly the role of the private sector, and NASDA should put increased emphasis on the rapid transfer of its technology to Rocket Systems Corporation and other private sector entities, rather than become itself a more commercially oriented organization.

The current fundamental space policy recognizes that the importance of optimal collaboration on a global basis should be also taken into account in addition to a reasonable level of the autonomous capabilities in the Japanese space program. NASDA has recognized this by including a small percent of imported components in its H-IIA design and in its plans for the upgraded J-1 program. This trend toward taking advantage of the best available technology in the world rather than a total focus on autonomy should continue in the planning of future transportation systems, while retaining in Japan the basic capabilities required to develop autonomous technologies when necessary.

3. Evaluations of Current and Future Programs

(3-A) *Large Space Launch Vehicles* (H-II/IIA Family of Launch Vehicles)

In large part because of success of the N series of launch vehicles through the H-II development, Japan has become a leading space-faring nation. NASDA led research and development of these systems in acquiring the necessary technologies, production, maintenance/operations and management expertise, which are recognized as contributing greatly to Japan meeting national goals for space.

With the successful development completion and maturing of initial operation of the H-II launch vehicle, Japan has autonomously developed the necessary technologies and industrial base to produce launch vehicles to the highest international technology standard. The high payload to launch mass ratio makes it the world's best launch vehicle from a performance efficiency standpoint.

The H-II flight 5 failure appears to have been an undetected flaw on a single LE-5A engine and not a generic or systematic process flaw. NASDA should review its internal processes to take advantage of all lessons learned from this failure and consider additional and perhaps broader internal but independent review/oversight to attempt to preclude future incidents.

Visits to the Nagoya engine and airframe factories of MHI revealed excellent manufacturing capabilities, high quality hardware in production and know how and progress toward H-IIA design and production simplification. This gives the subcommittee confidence that the cost and production goals for the approved programs can be met.

Based on the information presented to the subcommittee, necessary upgrades to Tanegashima launch facilities appear well planned for the H-IIA family of launch vehicles.

By a successful H-IIA development with essential cost reductions in vehicle fabrication and operations, and by expected higher production and launch rates, Japan may also become a fully competitive launch service provider. As the first step, the Rocket Systems Corporation (RSC) has been created and the initial relationships with NASDA have been established for the production, integration and launch preparation of the H-IIA family of launch vehicles.

The worldwide trend towards commercial/industrial launch vehicle development and operations rather than government sponsorship may lead to a review of the NASDA/industry relationship. Industry should be encouraged to invest its own funds in commercially viable projects, project areas or product improvements. This could let NASDA invest more in advanced technology and future projects.

(3-B) *Small-Mid Size Launch Vehicles* (J-1 & J-1 Upgrade)

The subcommittee was made aware of critical reviews of the J-1 program by other groups in Japan, and felt that it had little to add to these assessments. At any rate, only one more J-1 launch is planned. Even before recent criticisms, NASDA had developed plans to upgrade the J-1 vehicle in ways that would increase its performance and reduce its costs, while also developing some new technologies. The subcommittee found that the current study efforts on the J-1 Upgrade launch vehicle were interesting and should be continued. It hopes to have an opportunity to review the program again before it moves to the development phase.

That being said, the subcommittee did raise some concerns about the program. It noted a mixed rationale for the program. One rationale is developing a lower cost launcher than the H-IIA for small and medium satellites and as a testbed for new technologies. It is also intended to capture a portion of the global launch market for such satellites. The subcommittee believes that the first rationale for the program should be stressed. Although an upgraded J-1 might be able to attract some commercial users depending on the cost per launch actually achieved, the emergence of reusable and other launch vehicles with prices that are likely to be substantially lower than the upgraded J-1 makes it unlikely that it can be a significant commercial success. In addition, if lowering the cost per launch was the primary objective for upgrading the J-1, it probably would make sense to use only proven technologies. NASDA has included the development of interesting new technologies in its plans for the J-1 Upgrade; yet developing new technology is seldom compatible with achieving the lowest possible cost.

This means that the primary rationale for deciding whether to invest in a J-1 Upgrade effort should be that Japan does intend to continue to develop and launch small and medium satellites several times a year. The subcommittee notes that of the ten satellites suggested as potential payloads for an upgraded J-1, only one (MDS-2) is an approved program. Certainly, Japan does not want to repeat its experience with the J-1, where only two launches several years apart actually received approvals.

(3-C) *Re-entry Vehicles* (HOPE-X, HOPE-X Flight Demonstrators)

HOPE-X appears to be a very interesting technical project, which promises to significantly enhance NASDA's technology base. However, the similar Hermes project of ESA was budgeted at ten times as much money. NASDA has historically demonstrated the ability to complete development projects at one-half to one-third the cost of similar efforts in the USA or Europe, but it seems unlikely that HOPE-X can be completed on such a limited budget. Additional funds may be required to complete the HOPE-X program.

The relation of the HOPE-X project to RLV studies is not quite clear; a comprehensive analysis of that relationship appears to be needed. The proposed delay of the first flight of HOPE-X by three years will make it difficult to use flight test results as design inputs for RLV development. It seems that the HOPE-X project is intended both as a technology testbed and as the prototype for a cargo transfer vehicle to the International Space Station. Development of such a "HOPE-XA" vehicle for this purpose is likely to severely restrict the funds available to begin development of a RLV on the currently proposed schedule.

The subcommittee also recognizes that both reusable reentry vehicle technology and RLV technology are areas that offer the opportunities for international cooperation. NASDA may wish to consider approaching other nations regarding the purchase, license, or cooperative development of technology for reusable reentry vehicles and related RLV technology. This approach may also offer the opportunity to lower the cost of developing such technology.

(3-D) *Reusable Launch Vehicles* (Rocket-SSTO & Space Planes)

It has been widely recognized that a major reduction of space transportation cost (a factor of 10) is only feasible by reusable launch vehicles. Accordingly, essential activities have been started in the USA to design reusable launch vehicles to develop advanced technology and to build and test demonstrator flight vehicles (NASA X-33, X-34). The goal is to have a reusable vehicle operational by the year 2005.

In Europe, the SAENGER reusable winged vehicle concept has been used as a reference for comprehensive design work and technology experimental studies (1987-1994). This work has been continued in a broader scale in the ESA Future European Space Transportation Investigation Program (FESTIP). A number of different vehicle concepts is being analyzed with respect to technical problems/merits and cost.

The planned NASDA budget for RLV studies in 1998/99 as well as the following four years is minimal. A budget increase is essential if Japan will not experience a large time gap compared to the other countries in developing the next generation of launch vehicles. It is also recommended to extend the cooperation with industry (own investments), universities, ISAS and NAL.

Different RLV concepts should be studied and compared with the same basic requirements and technologies. Only this approach will lead to the selection of the optimum vehicle under cost engineering aspects with affordable development costs.

4. Recommendations

(a) The subcommittee believes that, particularly since NASDA's budget is unlikely to increase anytime soon, considerations of cost should be introduced from the very start of the study and design process for future space transportation (and other) projects. To that end, NASDA should establish a "cost engineering" group or capability within its own staff, given the NASDA lead role in systems design. This is especially important for the definition of a future reusable launch vehicle.

(b) In addition, NASDA needs to include life cycle cost estimates in its program and project planning processes. The subcommittee did not receive any such estimates from NASDA OSTS during its meeting, and thus assumes that such estimates are currently not prepared. They seem to the subcommittee to be an essential element in the decision to begin the development of a new project. For next year's review, it is recommended to show some kind of life-cycle cost and long term planning in budget terms for the HOPE-X program and the RLV studies.

(c) It was not clear to the subcommittee that NASDA internal processes offer adequate opportunity for self-examination and even self-criticism of on-going projects to minimize the risks of technological obstacles, cost overruns, and even failures. Also, the lessons from past failures should be well integrated into these processes. The subcommittee suggests that NASDA examine its internal review processes to make sure they include, within the organization, independent review/oversight adequate to achieve these objectives.

(d) NASDA should put more emphasis on technology transfer to the private sector, which should be encouraged to invest its own funds in commercially viable projects. This would lead NASDA to focus more on leading edge new technological developments.

Appendix

Member List of Space Transportation System Evaluation Subcommittee

Evaluation Report of
NASDA Earth Observation Program

Executive Summary

1. Introduction

The Earth Observation Subcommittee met in Tokyo July 6-9,1998 in Tokyo. The Subcommittee visited the Earth Observation Center and the Earth Observation Research Center on July 7,1998. The Subcommittee heard a series of presentations from NASDA personnel and received detailed, formal responses to every one of its questions. The subcommittee wishes to thank NASDA for the outstanding and prompt staff work and the excellent logistical support throughout the meeting. The discussions at the meeting were open and candid and the subcommittee believes it got as good a view of NASDA's earth observation program as was possible in four short days.

2. Overview of Programs and General Issues

The Office of Earth Observation Systems has three strategic goals, namely, to contribute to earth science, to promote the practical use of earth observation (EO) data, and to advance technology development. To undertake these activities, the Office has an annual budget of about 37 billion Yen, or about US$ 280 M, 21% of the budget of NASA's Office of Earth Science, and 20% of the total NASDA budget. NASDA's authorized staff amounts to 94 persons, or 8.9% of the NASDA total.

Like NASDA as a whole, NASDA's earth observation program has evolved considerably since the founding of the Agency in 1969. In October of 1978, NASDA took its first step towards establishing and developing the technologies of Earth Observing satellites by receiving Landsat 2 data at the Earth Observing Center. Since then, NASDA has continued to receive and distribute data from successor Landsats, the French SPOT series, and ESA's Earth Remote Sensing Satellites, ERS-1 and ERS-2, which employ Synthetic Aperture radar (SAR) technology. Of course, NASDA also set out to create its own independent capability. It worked with the Japan Meteorological Agency (JMA) to develop a series of Geostationary Meteorological Satellites (GMS), it developed Marine Observation Satellites (MOS-1, 1b), and it undertook its own SAR mission, JERS-1, in 1992. Up to this point, NASDA had focused on the development of launch systems, flight hardware, and the associated ground systems. However, the importance of promoting the utilization of EO data soon became apparent, and the Office of Earth Observation Systems was created in FY 1993 in order to integrate development, operations, and data utilization. The Earth Observation Research Center (EORC) was established in FY 1995 to create and validate useful data products from the basic data received at the EOC, as well as to promote a closer two-way relationship with users.

NASDA continues to advance the development of the full range of land surface imagers: SARs, moderate resolution imagers (such as GLI), Landsat equivalent imagers, stereo mappers (PRISM),and high-resolution imagers. The successful development of the Advanced Land Observing Satellite (ALOS) would further emphasize that NASDA is fully competitive at the international level in land remote sensing. The subcommittee has been impressed by the diversity of achievement in this and other areas, and is pleased to confirm NASDA's own analysis of the Agency's rise to maturity. The subcommittee is convinced that NASDA can be technically competitive in any area of applications remote sensing that Japanese national policy requires. The question now becomes, do Japan and NASDA choose to commit permanently in ALL the areas of applications remote sensing in which it has demonstrated its capability? On the one hand, these are becoming stable technologies and may require a reduced rate of investment to remain effective in the future; on the other, maintaining so many imaging technologies in the face of growing international capabilities may prove to limit NASDA's flexibility to pursue the new area it and Japan have recently chosen to enter.

NASDA has recently crossed the threshold into the more sophisticated arena of climate science. The ADEOS spacecraft, though it only lasted 10 months, did show that NASDA could make useful comprehensive climate science measurements and collaborate with the international community. Continued reduction of the ADEOS data will produce useful scientific and engineering information, and the flight of ADEOS-II will make Japan a full partner in the International Earth Observing System. The Tropical Rainfall Measurement Mission (TRMM), a collaboration with NASA, is of an entirely different order of scientific ambition. TRMM is measuring a quantity never before measured from space, precipitation, and Japan built the key instrument, the precipitation radar. The experience of constructing and validating entirely new data products and then judging their value by their contributions to the scientific understanding of climate will bring NASDA, and the Japanese climate science community, to a new level of achievement and maturity.

Recently, the Science and Technology Agency (STA) has committed Japan to the most ambitious course possible in contemporary global climate and environmental science. STA has initiated a unified interagency program of research to create an advanced computational capability, apply it to climate modeling, improve model content and architecture with process studies, and drive the models with comprehensive, global, and multidisciplinary observations. These are Japan's Frontier Research and Earth Simulator Programs.

The observations needed will necessarily be a blend of space-based and in situ measurements, and are so comprehensive that they can only be made in international collaboration. Thus, NASDA will have to participate in formulation of an international Integrated Global Observing Strategy. Since the science of climate has major unknowns, that strategy will not be clearcut in every area, will have to evolve as new understanding emerges, and will demand technological and conceptual innovation. At the same time, the climate processes of research interest have time scales of decades so a simultaneous commitment to continuous observations and continual innovation will have to be maintained by the international community for decades. Clearly the traditional distinctions between research and operations will be blurred, as will the traditional definitions of various agencies' roles.

NASDA's climate research programs will need a new organizational philosophy to be successful. To see this, we contrast classical remote sensing with climate science. In the applications arena, NASDA concern is to provide high quality data in a timely fashion to a wide variety of largely practical users, who are downstream recipients of data. While the users inform NASDA of their needs, they typically do not participate in the design and development of the observing instruments. NASDA does rely on its users to create higher order data products and largely leaves the innovation of new applications to users. The users need not have any direct contact with NASDA to benefit from its data products, and NASDA is probably not aware of all the uses to which its applications data is put. By contrast, in the scientific arena, the relationship between technological innovation and knowledge development is circular and iterative. The end-to end involvement of (usually) a multidisciplinary scientific community in all aspects of the program-research strategy, detector design, algorithm development and validation, data production, data analysis, and knowledge creation is necessary for success in climate studies. The payoff for Japan is very large. Success in global environmental science will confirm Japan's respected status at the table in the climate and other environmental negotiations that will be at the center of the international policy agenda in the next century.

Once NASDA has developed a more integral relationship with the climate science community, it will be in a better position to deal with an important strategic issue: How should NASDA contribute to the Integrated Global Observing Strategy for climate? In what areas does Japan want to be a good climate citizen, by helping to maintain the continuity of important but relatively standard measurements? In what areas should Japan become a leading citizen, by focusing NASDA on new discoveries, new understanding?

All in all, the most pressing question presently facing the Earth observation program of NASDA is: how will it find the conceptual, social, and financial resources to meet international climate and environmental research standards while maintaining a program in applications remote sensing that meets the nation's needs? The record of accomplishment thus far makes us optimistic that, once it is given adequate financial resources, NASDA can do the rest.

3. Specific Issues and Findings

3.1 Applications and the ALOS Mission

As the principal national agency for space development activities, NASDA is bound to fulfill the strategic expectation of the Japanese government as expressed by the many ministries and governmental agencies that have interests in earth observations from space. These expectations are mainly for mapping the earth's surface with a range of high-resolution imaging systems of progressively more advanced technical performance.

The Subcommittee finds that NASDA's current activities and plans are well suited to carry out a continuing program of earth remote sensing and for delivering, through EOC and EORC, well-established remote sensing products to a broad range of users.

NASDA's role in the applications domain is that of a data producer serving a diverse community of users. This implementation philosophy allows NASDA to concentrate on developing and operating high-technology satellite systems together with an effective data acquisition, processing and distribution system. It relies on the ability of users to subsequently develop higher-level processing and information retrieval methods in their respective fields of application.

The question remains: to what extent should NASDA get involved in developing or helping users develop such application-specific products.

ALOS has been endorsed by the United Nations as a demonstration project on disaster monitoring mission for the IDNDR.

3.2 Scientific Program

Another major component of NASDA's activity is its contribution to the international scientific effort to understand the scope and the causes of changes in the earth climate and the global environment using systematic observation of essential earth system parameters and experimental investigations of critical processes.

The first kind of activity includes the observation of the atmosphere and ocean with a series of optical sensors (ocean color, temperature, aerosol and atmospheric composition) as well as passive and active microwave sensors (atmospheric water vapor and precipitation, snow and sea ice, ocean surface wind.)

Activities of the second kind includes the observation of storm systems and precipitation with a range of active and passive sensors on the highly successful and innovative Tropical Rain Measurement Mission (TRMM).

Both kinds of scientific investigations make use of satellite sensors to acquire raw data and both require strong involvement of scientific partners to extract the full scientific benefit of the observations for the advancement of earth system and climate science.

3.3 The ADEOS Series

ADEOS's 10 month life time was long enough for a reliable assessment of the performance and variety of many sensors mounted on ADEOS. In order to insure the success of ADEOS series of satellites, it is desirable to continue NASDA's effort to develop algorithms for data analysis and in-depth evaluation of the analysis products. Although the specific funding for ADEOS data analysis is going to be terminated in the next fiscal year, we recommend that the analysis and critical evaluation of ADEOS data. Be continued. It is possible to transform the ADEOS crisis into great success.

ADEOS-II, a natural extension of the ADEOS mission, is well suited to continue the major contribution of Japan to the International Earth Observing System. In the future NASDA should seek to optimize the complementarity of the ADEOS program with the measurements carried out by partner agencies, as well as look for opportunities to evolve toward smaller payloads and spacecraft.

NASDA's AMSR instrument will be mounted on NASA's EOS-PM1 and ADEOS-II. ADEOS-II is designed for data acquisition in the morning, and EOS-PM1 for data acquisition in the afternoon. The combination will make enable data on daily changes to be collected. In other words, changes of cloud water volume will be available within a day. If achieved, this will be a clearcut result of international cooperation.

3.4 The Earth Observation Research Center (EORC)

The establishment of EORC in 1995 is a very important step towards successful usage of the data from remote sensing of the Earth. It has begun to produce a wide variety of products for both applications and the study of the temporal variation of the coupled ocean- atmosphere- land surface system. However, the current capability and number of staff members at EORC appear insufficient for the development of the algorithms needed for the analysis of the massive data obtained from current and future satellites.

3.5 Cooperation with Earth Observation Application Users

NASDA has developed its EO technologies in cooperation with users of various levels of earth observation products for both scientific and practical use. NASDA's first goal in the field of EO was the development of the geostationary meteorological satellite, GMS. It was noted that JMA is now fully responsible for the GMS series of satellites.

In addition, NASDA has made efforts to develop application techniques for practical use of EO data in various public application domains, such as agriculture, forestry, maritime safety, fishery, land management, disaster mitigation and international affairs under cooperation with governmental agencies in charge.

Coordination with the external user community for all of Japan is done through the Satellite Remote Sensing Program Committee (about 130 members) and the Earth Science and Technology Forum (about 540 members). Committee members act in their individual capacity as scientists or specialists. Within the context of the Japanese situation, this may be the best way to reflect users requirements with respect to NASDA's satellite projects

3.6 EOC and data distribution system

We endorse the plan for reconstructing the EOC and renewal of its system. More automated and simplified operations are desirable. Although the reception and demodulation systems are different for each satellite, the data in digital form are the same. Therefore, an integrated common data processing and archiving and database management and distribution systems are highly recommended. nevertheless SAR may need a special system. The EOC should pay more attention to users regarding data accessibility and efficient data delivery.

The scientific instruments on ADEOS offered the first experience for NASDA to generate datasets from observed values to physical parameters. The first products from ADEOS data were not to an appropriate level of satisfaction. In this respect, the enhancement of EORC and EOC is necessary to fulfill NASDA's responsibility to offer the level 2 and 3 datasets to scientists all over the world.

3.7 Human resources

As a general rule, it appeared that NASDA project teams were significantly smaller than the staff appointed to perform similar oversight tasks in foreign space agencies. The Subcommittee suggested that NASDA consider whether sufficient human resources are devoted to technical oversight of flight project implementation, quality control and failure mode analysis.

It was also questioned whether the traditional rotation of staff and the emphasis on general rather than specialized professional competence is optimal for the implementation of such technologically-advanced systems.

4. Specific Recommendations

Resource Strategy.

The subcommittee noted that the breadth of flight projects implemented by NASDA stretches the agency's resources thin, leaving little to support an end-to-end program of earth science research and practical applications of remote sensing, and recommends that NASDA re-examine the balance of resource allocations.

Interagency and international cooperation

The Subcommittee recommended that NASDA explore the possibilities for deploying sensors developed in Japan on flight missions sponsored by other space agencies and vice versa as part of its contribution to the Integrated Global Observing Strategy.

Strengthening EORC

The Subcommittee recommends strengthening EORC by placing special emphasis upon the recruitment of additional excellent group leaders from diverse disciplines.

Scientist Participation

End-to-end participation of scientific investigators in the design, development and exploitation of those earth observation programs is an outstanding issue that needs to be addressed by the agency and the Japanese government.

The involvement of scientific partners in the conception and implementation of satellite projects would require re-examination of the allocation of resources (between flight systems and data processing development on the one hand, and relevant algorithm development and broad-based scientific research on the other), as well as a re-examination of the inter-agency consultative and mission selection process (in order to allow the examination of competing scientific objectives and projects, and the selection of discrete domains of scientific excellence).

Overall, the number of Japanese scientists currently using data from remote sensing is too small to fully exploit the excellent opportunity provided by current and future NASDA satellites. It is ,therefore, very desirable that NASDA increase its financial support of satellite-related research on global change and climate variability at both private and public institutions in Japan.

Asian Pacific leadership

NASDA is the clear leader of Asia in space activities, especially in the area of Earth observation. This gives NASDA a leading role and a special responsibility in Asian Pacific region. In recent years, NASDA has played an increasingly important role in supporting the activities of the ESCAP RESAP program in terms of human resources development and the provision of remote sensing data from Japan Earth observation satellites. Many countries in Asia, especially South East Asia, have benefited greatly from cooperation with NASDA. With the improved capabilities of its future Earth observation missions, NASDA should enhance these cooperative activities, including research on applications of common interest, global change, deforestation and oceanography.

In particular, ALOS will have important applications for Asian Pacific region. In order to optimize these benefits, NASDA may have to stimulate the development of appropriate infrastructure to provide information services in the region, including training, etc.

ALOS

ALOS will incorporate a unique combination of advanced land surface sensors that hold promises of important practical applications, especially in the Asian Pacific region, and will make significant new contributions to the study of terrestrial ecosystems and other fields of environmental sciences. In order to optimize the benefits of ALOS, NASDA may want to stimulate developments of practical use of high resolution images for all-weather observations applied to cartography, disaster monitoring and other applications.

The Subcommittee also recommends that the abilities of ALOS to contribute to ecological and other scientific issues be studied.

Interaction with Applications User communities

In the applications arena, while NASDA's first priority is to the public interest, it should also respond to the views and requirements of private industry users.

Enhancement of EOC

The EOC should be a world-wide center. The present infrastructure for domestic and international access to EOC data is insufficient and should be improved. Wide-band access to the EOC database to promote the use of NASDA's data should be implemented as soon as possible.

Small Satellites

There is a worldwide tendency to seek more effective implementation of earth observation from space through more focused missions, dedicated to a narrower range of scientific goals and allowing use of smaller spacecraft and instrument payloads. This calls into question the optimization of the relation of spacecraft design to launch vehicle capabilities. NASDA should examine the various scientific, technical, and programmatic aspects of the trade-off of large and small spacecraft and report on this matter in one year's time.