UNITED
NATIONS

A

General Assembly

Distr.
GENERAL

A/AC.105/614/Add.1
22 December 1995

ORIGINAL: ENGLISH

COMMITTEE ON THE PEACEFUL
USES OF OUTER SPACE

IMPLEMENTATION OF THE RECOMMENDATIONS OF THE SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

International cooperation in the peaceful uses of outer space: activities of Member States

CONTENTS

V.95-60510T

INTRODUCTION

1. In accordance with a recommendation of the Committee on the Peaceful Uses of Outer Space at its thirty-eighth session, Member States have submitted information on the following topics:[1]

(a) Those space activities that were or could be the subject of greater international cooperation, with particular emphasis on the needs of developing countries;

(b) Spin-off benefits of space activities.

2. The information on those topics submitted by Member States as of 31 October 1995 is contained in document A/AC.105/614.

3. The present document contains information on those topics submitted by Member States between 1 November and 15 December 1995.

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[1] *Official Record of the General Assembly, Fiftieth Session, Supplement No. 20* (A/50/20), para. 27.

REPLIES RECEIVED FROM MEMBER STATES

A. Canada

[Original: English]

1. Canadian Space Programme

4. The Canadian Space Agency (CSA) and other Canadian government departments and agencies involved in space are continuing efforts to implement the new Canadian Space Programme (CSP) announced in 1994. In all sectors, work in progress to define and implement programmes in priority areas for Canada in the fields of human space flight, Earth observation, satellite communications, space science and space technology development. Activities undertaken by Canada in those areas guarantee a Canadian contribution to the global knowledge base and help to achieve socio-economic benefits for all Canadians.

5. In order to better accomplish those ends, the President of CSA has recently begun a process of reorganizing the Agency. The reorganization process has involved extensive consultation with the employees of CSA and all the major Canadian stakeholders in space activities. The objectives of the reorganization are to produce an organizational structure that better fulfils the mandate of CSA, makes better use of the skills of its employees, responds more effectively to a changing environment, and plans better for the future.

6. The major orientations and objectives of CSP remain as follows:

(a) To focus on the commercial and technological strengths of Canada to meet its ongoing needs in space science, automation and robotics, Earth observation and communications;

(b) To promote economic growth and employment;

(c) To enhance Canadian industrial competitiveness and export capability;

(d) To foster the advancement of knowledge.

7. Like all federal government programmes, CSP underwent budgetary reductions in early 1995. Funding for the Second Long-term Space Plan for the period from 1994/95 to 2003/04, approved in June 1994, was reduced by 15 per cent in the budget provisions of February 1995. The guiding principles to be observed in carrying out the reductions in Canadian space activities are fivefold: first, that space remains a key priority of the Government of Canada, despite the reductions; second, that the reductions are to be achieved while preserving the funding balance between the major components of CSP identified in June 1994; third, that Canada will meet its commitments to its international partners on the International Space Station Alpha; and fourth, that the timetable for implementing the Second Long-term Space Plan will not be significantly affected.

(a) Some Canadian accomplishments in space in 1995

8. The most significant event of 1995 was the launch of RADARSAT-I, the first Canadian Earth observation satellite, on 4 November 1995. RADARSAT-I will use synthetic aperture radar (SAR) to observe the Earth, even in darkness and through clouds, providing data essential to a variety of applications for resource management and environmental monitoring. Work will soon start on the follow-up satellite, RADARSAT-II, which will be ready for launch around the year 2000.

9. Canadian astronaut C. Hadfield took part in the Shuttle Mission STS-74 that docked with the MIR station of the Russian Federation, and operated the Canadarm system used to put into place the docking adaptor that will allow

repeated shuttle missions to MIR. C. Hadfield was the first Canadian to orbit in a spacecraft of the Russian Federation and the first Canadian mission specialist.

10. In the area of space science and research into global change, Canada is continuing to develop the instrument called Measurements of Pollution in the Troposphere, its contribution to the Earth Observing System of the United States of America, destined for launch on a polar platform in 1998. This mission, developed in collaboration with scientists of the United Kingdom of Great Britain and Northern Ireland and the United States, will measure the amount of carbon monoxide and methane in the Earth atmosphere in order to determine the effects of human activity on the atmospheric environment of the planet.

11. CSA, in collaboration with the United States National Aeronautics and Space Administration (NASA) and the Centre national d'études spatiales (CNES) (the French National Centre for Space Studies), has recently made important discoveries with the Wind Imaging Interferometer (WINDII). Data from this instrument show planetary scale disturbances in upper atmospheric weather corresponding to one or two waves around the globe. These disturbances resemble weather patterns, but clearly demonstrate that the upper atmosphere responds to processes arising at the surface of the Earth. WINDII also discovered a gap in atomic oxygen at the equator, thought to be due to the action of atmospheric tides and associated winds.

12. Canadian scientists participated with scientists from France, Germany, Japan, the European Space Agency (ESA) and NASA in the second International Microgravity Laboratory mission launched in July 1995. Approximately 80 studies were conducted on the effects produced by microgravity on astronauts, including back pain and changes in nerve conduction and in the cardiovascular system.

13. Canada recently became a partner in a multinational cooperative endeavour to support research into semiconductor and oxide materials using the floating zone process. The Commercial Float Zone Furnace will fly on the SPACELAB 04 mission to process 12 sample materials being investigated by researchers from Canada, Germany and the United States.

14. Also important is the ongoing COSPAS-SARSAT programme (the International Satellite System for Search and Rescue), of which Canada is one of the four original member States along with France, Russian Federation and the United States. The System currently features 6 satellites, 28 ground stations and 15 control centres in 16 countries. To date it has saved 4,535 lives.

15. Canada is continuing work on the development of the Mobile Servicing System (MSS), its contribution to the largest international science project in history, the International Space Station Alpha. MSS is a sophisticated robotics system that will play a predominant role in the assembly, maintenance and operation of the Space Station, in which Canada is a partner with Japan, Russian Federation, the United States and participating member States of ESA.

(b) Key events in the Canadian Space Programme in 1996

16. In early 1996, Canada is to launch MSAT, an advanced communications satellite that will provide people in rural areas in Canada and the United States with the same satellite communications as those enjoyed in metropolitan centres. This project is a cooperative venture involving Canadian and United States partners in the private sector, and will provide voice, data transmission and paging services to users.

17. Also important in 1996 will be the activities of three Canadian astronauts. D. Williams was selected by NASA as part of the 1994 class of mission specialist trainees. Dr. B. Thirsk was also selected as a payload specialist for space shuttle flight STS-78, following a rigorous international selection process involving astronauts from several countries. STS-78 will be a Life and Microgravity Sciences Space Lab Mission. To complete the group, M. Garneau, the first Canadian astronaut in space, was selected for a second space shuttle mission. M. Garneau will fly as a mission specialist aboard Endeavour flight STS-77, on a nine-day mission scheduled for April 1996.

18. Finally, work is in progress on the definition of two small scientific missions, as well as on the collaboration between Government and industry in the Advanced SatCom and the International Mobile Research programmes.

2. Space activities that were or could be the subject of greater cooperation, with particular emphasis on the needs of developing countries

19. In June 1994, the Government of Canada approved the new CSP, which calls for investments of 2.4 billion Canadian dollars over 10 years, and is the result of over two years of intensive consultations between CSA and all stakeholders in Canada.

20. The new CSP calls for investments in several sectors, in particular the following:

(a) Earth observation (completion of RADARSAT I, initiation of RADARSAT II, advanced radar technology development, ground segment upgrades, applications development and technology transfer);

(b) Satellite communications (launch of MSAT, a programme for advanced satellite communications development, a programme for development of technologies for mobile communications);

(c) Space science (activities in solar-terrestrial physics, atmospheric sciences, astronomy and microgravity life and materials sciences, a space science enhancement programme and the possibility of two small satellites for science missions);

(d) Space technology (ongoing in-house projects and contracting out development, a new strategic space technology development programme, and contributions to new ESA programmes);

(e) Flights for Canadian astronauts (opportunities on the United States space shuttle and preparation of related experiments);

(f) A new space awareness programme to encourage Canadian youth to undertake careers in science and technology.

21. Also in June 1994, the Government announced that, following the successful conclusion of discussions with NASA, Canada would remain a full partner in the context of the International Space Station project, albeit at a reduced cost. The new CSP also mentions that space activities are of strategic importance to the transition of Canada to a knowledge-based economy, and identifies CSA as the lead coordinator for all policies and programmes of the Government in civil space-related research, science and technology, industrial development and international cooperation.

22. Cooperation is essential to the implementation of CSP, as it promotes the sharing of costs and risk in carrying out programmes and activities. The time for cooperation has never been so good, with the new opportunities resulting from such major events as the end of the cold war and the increased realization around the globe of the important uses of space technologies, systems and science for sustainable development. Clearly, issues affecting the common welfare call for common solutions, and international space cooperation therefore becomes a chosen instrument.

23. In that context, and also because most Canadian space activities have always been undertaken in collaboration with foreign partners, it is expected that significant opportunities for enhanced international cooperation will arise in the future, especially in the context of the new CSP. The possibilities for cooperation are expected to be found in most of the sectors identified above in the description of the new CSP, and more specifically in space science research (including microgravity research), space technology development, radar technology and systems development and applications of RADARSAT data and of communications satellites.

24. Several of the opportunities for cooperation could be very helpful in furthering the process of sustainable development, where possible. In particular, Canada (mainly through the efforts of the Canada Centre for Remote Sensing and the Canadian International Development Agency) has been working closely with developing countries in all regions in addressing the potential uses of RADARSAT data for a variety of applications, such as geology and geomorphology, the identification and monitoring of primary forest clearing for agricultural land use, ice monitoring, the monitoring of changes in shorelines and mangrove forests, hydrology, soil erosion and disaster monitoring. Technical training and data analysis workshops have been held, assistance in the provision of relevant equipment has been provided, and other such opportunities could be considered.

25. Furthermore, there could be interesting opportunities in the use of satellite communications services for tele-education and telemedicine, as well as for research into global change. In the latter case, such cooperation could be facilitated on the American continent through the new Inter-American Institute for Global Change Research.

26. CSA and its partners in the implementation of CSP would welcome any suggestions from existing or potential new partners regarding possibilities for increased cooperation.

B. India

[Original: English]

1. Space activities

27. In 1995, as in past years, India continued to make significant progress in the development and application of space technology to promote rapid socio-economic development. The Indian space programme also continued to further international cooperation in the exploration and peaceful uses of outer space.

(a) Performance of INSAT

28. The two Indian-built multi-purpose satellites, INSAT-2A and INSAT-2B, respectively launched in July 1992 and July 1993, together with INSAT-1D, launched in 1990, provided uninterrupted services in the areas of telecommunication, television broadcasting, meteorology, disaster warning and distress alerts.

29. Development and fabrication of more advanced satellites in the INSAT-2 series, in particular INSAT-2C and INSAT-2D, have made good progress. INSAT-2C, which was successfully launched on 6 December 1995, will provide additional services, including mobile and business communications. INSAT-2D, identical to INSAT-2C is to be launched in 1996. INSAT-2E, with advanced meteorological payloads in addition to communication payloads, is also being developed. A few transponders on board INSAT-2E will be made available to INTELSAT. The launch of INSAT-2E is planned for 1997 or 1998.

30. New demonstrations and experiments designed to extend and enhance the INSAT services for various purposes, especially for new classes of telecommunication services and tele-education, are being conducted. Several experiments and demonstrations involving satellite-based communication for interactive education and training have been successfully conducted for universities, village administration (panchayat raj) officials, special social groups and personnel from the industrial and commercial sector. A channel of INSAT is exclusively used for interactive training and education. This channel can be used for intensive, interactive training courses of long duration for special interest groups, without the usual constraints on the length and timing of the broadcast.

(b) IRS satellites for natural resource management

31. The two Indian remote sensing satellites, IRS-1A and IRS-1B, respectively launched in March 1988 and August 1991, together with IRS-P2, launched by India with its own polar satellite launch vehicle (PSLV), known as PSLV-

D2, in October 1994, have become the mainstays of the national system for the management of natural resources. The data from the IRS satellites are being put to use in important applications such as estimating agricultural crop acreage and yield, drought monitoring and assessment, flood mapping, land-use and land-cover mapping, wasteland management, survey and management of ocean and marine resources and of forest resources, urban planning and mineral prospecting.

32. Satellite-based remote sensing services, will be further enhanced through the launch of more advanced satellites, IRS-1C and IRS-1D, currently being developed. These satellites will have better spatial and spectral resolutions than the present IRS satellites, stereo viewing capability and on-board recording facilities. The launch of IRS-1C is planned for the first quarter of 1996.

33. India has planned the launch of an IRS-P series of satellites on board its PSLV launch vehicle. The series would be designed to test and demonstrate new and advanced technologies and applications of space-based remote sensing such as those for ocean resources monitoring and cartography. India will provide opportunities for flying payloads from other countries on the IRS-P series of satellites. IRS-P3, carrying a modular opto-electronic scanner, for ocean remote sensing, of the German space agency, in addition to a wide field sensor and an X-ray astronomy payload, is scheduled for launch in the first quarter of 1996 on board the PSLV-D3 launch vehicle.

(c) Integrated mission on sustainable development

34. The implementation of locale-specific action plans generated under the Integrated Mission for Sustainable Development (IMSD), which mainly uses IRS data and collateral socio-economic data, is progressing well in 21 districts of India. Action plans for the development of other areas in 174 districts all over the country, identified under IMSD, are being generated. Priority has been given to 92 specific areas for generating action plans for integrated land and water resources development using IRS data. The initial results of implementing the action plans generated under IMSD have been encouraging. For example, in Ananthapur district in southern India, construction of water-harvesting structures have resulted in a substantial rise in the ground-water levels, enabling farmers there to grow two crops per year, a commendable achievement for an area with the second-lowest rainfall in the country.

(d) Launch vehicle technology

35. Having established INSAT and IRS satellite systems to provide uninterrupted space services in the areas of telecommunication, television broadcasting, meteorology, disaster warning and natural resources survey and management, India achieved a significant milestone on 15 October 1994 in developing the capability to launch those satellites through the success of the second developmental launch of its polar satellite launch vehicle, PSLV-D2. PSLV-D2 placed the Indian remote sensing satellite, IRS-P2, weighing 804 kilograms, into a polar sun-synchronous orbit at a height of about 817 kilometres. The third developmental launch of PSLV (PSLV-D3) is planned for the first quarter of 1996. The Government of India has already approved the launch of three more continuation flights, PSLV-C1, PSLV-C2 and PSLV-C3, over the next three years. Those flights will be used to prove the reliability of PSLV, to increase its payload capability towards operationalization of the vehicle, and to launch satellites for Earth observation and scientific missions.

36. PSLV has also proved, in flight, many of the systems that go into the Indian geosynchronous satellite launch vehicle (GSLV), intended for launching the Indian INSAT class of communication satellites into geosynchronous transfer orbit. Development of GSLV is progressing well. As a result of the suspension of transfer of cryogenic technology by Glavkosmos of the Russian Federation, India is developing its own cryogenic stage. The first few flights of GSLV will, however, use the cryogenic stage supplied by Glavkosmos.

(e) Pursuits in space science

37. India continues to pursue research in space science. The SROSS-C2 satellite, put into orbit using the Indian launch vehicle ASLV-D4, on 4 May 1994, is providing valuable scientific data in astronomy and aeronomy from

its two payloads, one for conducting the gamma ray burst experiment and the other consisting of a Retarding Potential Analyser (RPA). Several gamma ray bursts of potential celestial origin have been detected in the energy range of 20 to 3,000 kilo-electron-volts. RPA has so far collected a few hundred sets of useful orbital ionospheric data over the Indian subcontinent, and interesting observations on the variation of electron and ion temperatures have been made.

38. The National Mesosphere-Stratosphere-Troposphere Radar Facility set up near Tirupati in southern India is helping atmospheric researchers. The facility is also being used by international scientists to conduct experiments.

2. International cooperation

39. India continues to pursue cooperation in space with several countries. Recent agreements include those signed with the Russian Federation on 30 June 1994 and with Ukraine on 16 September 1994. India hosted the fifteenth Asian Conference on Remote Sensing, held at Bangalore from 17 to 23 November 1994, and attended by 320 participants, including 83 representatives of 26 countries. India is to serve as host to a Centre for Space Science and Technology Education for the Asia-Pacific region, which is being established as a United Nations initiative.

40. Under the sharing of experience in space (SHARES) programme, several participants, specifically from developing countries, are being trained in the various aspects of space science and applications.

41. India is also playing an active role in the Committee on Earth Observation Satellites. Data from IRS-1B and IRS-P2 are now available to users all over the world.

3. Conclusion

42. With the satellites designed and built by India in the INSAT and IRS series performing to specification, the country has started to reap the benefits of space technology for developmental applications, specifically in the areas of communication, broadcasting, meteorology, disaster management and the survey and management of resources. The planned launches of more powerful satellites in the two series will further enhance and extend the benefits of space technology. The successful launch of PSLV and the progress made in the development of GSLV have inspired confidence in the capability of India to launch the IRS and INSAT class of satellites from its own soil. Thus, India today has a well-integrated and self-supporting space programme which is providing important services to society.

C. Jamaica

[Original: English]

43. Jamaica reports that it has not yet established a national space programme.

D. Japan

[Original: English]

1. National organizations for space activities

(a) Space Activities Commission

44. The Space Activities Commission (SAC) was established within the Office of the Prime Minister in 1968 under the Law for the Establishment of the Space Activities Commission as the body to succeed to, and carry on the work of, the National Space Activities Council, which had been functioning since 1960. Its purpose was to unify the space activities of various government agencies and actively promote them.

45. SAC formulates plans, deliberates and takes decisions on the matters listed below, and submits its opinions to the Prime Minister, whose decision is guided by the opinion of SAC thus submitted. The matters dealt with by SAC are as follows:

(a) Important policy matters relating to space activities;

(b) Important matters bearing on the coordination of space-related work among the government agencies concerned;

(c) Estimates of space activity expenses of the government agencies concerned;

(d) Matters relating to the development and training of space researchers and engineers (excluding instruction and research at universities or colleges);

(e) Other important matters concerning space activities.

46. SAC consists of five persons noted for their learning, nominated by the Prime Minister following approval by the Diet, and including the Minister of State for Science and Technology serving as Chairman. Its secretariat functions are performed by the Space Policy Division of the Research and Development Bureau of the Science and Technology Agency (STA).

(b) Science and Technology Agency

47. STA established the Space Science and Technology Preparation Office in May 1960, thereby starting space activities for the first time through an organization of the Government of Japan. In July 1964, STA set up the National Space Development Centre to serve as the primary promoter of space activities in Japan.

48. Attracting able personnel from industry, the academic world and Government and maintaining flexible budgetary and organizational procedures and mechanisms are necessary to ensure the full and effective implementation of space activities. To that end, STA reorganized the National Space Development Centre into the National Space Development Agency (NASDA) of Japan, a special entity under the law, in operation since 1969.

49. STA now plans and promotes basic space-related policy and the overall coordination of space activities among government agencies, and conducts research and development activities through the National Aerospace Laboratory (NAL), a research organization attached to it, and NASDA. It thereby plays the central role in the space activities of Japan.

50. As the secretariat of SAC, STA also maintains liaison and conducts negotiations between various government agencies, thereby allowing smooth and effective development and utilization of space science and technology.

(c) National Aerospace Laboratory

51. NAL, formerly called the National Aeronautical Laboratory, was established in July 1955 as a subsidiary organization of the Office of the Prime Minister to expedite the development of aeronautical technology in Japan. After the establishment of STA in 1956, NAL was placed under its administration. In 1963, NAL was charged with the additional task of conducting research in space technology and renamed National Aerospace Laboratory.

52. NAL established its Rocket Division in 1963 and its Kakuda Research Centre in 1966 to allow research on a broader scale. The Rocket Division was reorganized into the Space Technology Research Group in October 1969 to encourage progress in space research within a stronger, more fully structured organization. Since then, the Space Technology Research Group and the Kakuda Research Centre have played a dominant role in the development of space technology in NAL, although close cooperation with other divisions is occasionally required. Most NAL

divisions are conducting research on key technologies for winged systems of space transport, which NAL considers essential to the pursuit of autonomous space activities by Japan in the coming century.

53. NAL has strong connections with NASDA, with which it jointly conducts various experiments required for the development of space technology. NAL offers its research data to other organizations to promote further progress in that area, and undertakes basic as well as advanced studies which are considered to be essential to future development. The liquid oxygen turbopump developed at the Kakuda Research Centre is installed in the LE-7 engine.

54. The principal activities of NAL in the field of space technology are as follows:

(a) Research on basic technologies for spaceplanes, with the focus on aerodynamics, advanced composite structures, flight control, propulsion systems, manned space flight and orbiter manoeuvring engines;

(b) Joint research with NASDA on the aerodynamics, guidance and control, and structure of the H-II Orbiting Plane (HOPE);

(c) Research on oxygen-hydrogen rocket engine components;

(d) Research on satellite systems and utilization of the space environment.

(d) National Space Development Agency of Japan

55. NASDA was established by law in October 1969 as the central body responsible for the development of space technology in Japan and the promotion of space activities solely for peaceful purposes.

56. The main tasks of NASDA are to develop satellites and their launching vehicles; to launch and track the satellites and promote the utilization of space technology; and to devise methods, facilities and organizations for those purposes in accordance with the Space Development Programme. To perform its tasks, NASDA has facilities in various parts of the country.

57. NASDA has orbited various satellites by means of N-I, N-II, H-I and H-II launch vehicles. It has launched a total of seven satellites with the N-I vehicle, the first, the Engineering Test Satellite I (ETS-I), in September 1975. Since 1981, eight meteorological, telecommunications and broadcasting satellites have been launched with the N-II, and the H-I made a record 9 successful launches after its maiden flight in 1986.

58. To meet the demand for launching large-scale satellites in the 1990s, NASDA developed the H-II launch vehicle with 100 per cent Japanese technology, and its first flight was successfully made in February 1994.

59. NASDA is also striving, from a long-range, system-based perspective, to promote research and development in materials processing through test projects, and to implement the space station programme involving the United States Space Shuttle, thereby further expanding the scope of space activities in Japan.

(i) Tanegashima Space Centre

60. The Tanegashima Space Centre has a total land area of 8.6 million square metres. The site has launch pads for H-II, J-1 and TR-IA rockets, communication and test facilities and optical and radio wave systems. There are also ground combustion test facilities for checking the reliability of liquid-propelled rocket engines and their parts as well as their performance within the launch site. To track and support the rockets launched, two radar stations are located on Tanegashima Island.

(ii) Yoshinobu Launch Complex

61. The Yoshinobu Launch Complex for launching the H-II launch vehicle was completed in September 1991. Major facilities and equipment include a vehicle assembly building, a mobile launcher, a pad service tower, propellant storage and supply facilities, a launch control building (blockhouse) and a range control centre.

62. Static firing tests of the first-stage rocket engine of the H-II are conducted adjacent to the Yoshinobu Launch Complex. Storage and supply facilities (for liquid hydrogen, liquid oxygen, helium and nitrogen) and facilities to supply water and electricity are designed for common use by the Complex and adjacent installations.

(iii) Tsukuba Space Centre

63. The construction of the Tsukuba Space Centre began in 1970 in Tsukuba Science City, Ibaraki Prefecture, and many new facilities have been added to the area, which covers 530,000 square metres. Furnished with up-to-date test facilities and equipment comparable to those of major laboratories throughout the world, it conducts research and development in space technology and engineering tests of satellites and launch vehicles.

64. It also plays an important role as the nucleus for tracking and control of satellites in Japan. A large-capacity computing system facilitates various types of analyses and real-time data processing during launch and initial orbit phases.

65. Other roles of the Centre include collecting and maintaining data on developments in space technology, as well as providing training and education and implementing joint studies with other organizations.

(iv) Kakuda Propulsion Centre

66. The Kakuda Propulsion Centre is responsible for research on and development of constituent parts of rockets.

(v) Earth Observation Centre

67. The Earth Observation Centre receives and processes remote sensing data by means of satellites. It now receives and processes data from the Marine Observation Satellites 1 and 1b (MOS-1/1b) of Japan, the United States Land Remote Sensing Satellite (LANDSAT), the satellite système probatoire d'observation de la terre (SPOT) (the French remote sensing satellite), the European Remote Sensing Satellite-1 (ERS-1) and the Japanese Earth Resource Satellite (JERS-1).

(e) Institute of Space and Astronautical Science

68. Directly under the auspices of the Ministry of Education, Science, Sports and Culture is the Institute of Space and Astronautical Science (ISAS), a central institute for space and astronautical science in Japan. ISAS conducts scientific research using space vehicles. For this purpose, it develops and operates sounding rockets, satellite launchers, scientific satellites, planetary probes and scientific balloons. As of February 1995, 21 scientific and test spacecraft had been launched, including Suisei and Sakigake, which explored Halley's comet in 1986.

69. ISAS was founded in April 1981 as a result of the reorganization of the Institute of Space and Aeronautical Science, University of Tokyo, which was the core of space research in Japan from 1964 to 1981. It launched the first Japanese satellite Ohsumi in 1970. As one of the inter-university research institutes run with the cooperation of researchers in universities, ISAS takes part in graduate education. Some of its students are from the University of Tokyo, where a number of ISAS faculty members have positions as professors or associate professors. Other students from various universities receive part of their education at ISAS by working under the guidance of ISAS staff.

70. The main ISAS campus is at Sagamihara, about 20 kilometres west of metropolitan Tokyo. Several ISAS centres are set up around the country.

(i) Kagoshima Space Centre

71. The Kagoshima Space Centre (KSC) is located in a mostly hilly area of Uchinoura-cho, on the east coast of Ohsumi Peninsula, Kagoshima Prefecture. Covering a total of 71 hectares, the area of KSC includes various facilities for launching rockets, telemetry and tracking, command stations for rockets and satellites and optical observation posts, at sites developed by flattening the tops of several hills. Buildings in KSC have a total floor space of 12,755 square metres.

72. Between 1962, when the use of KSC began, and February 1994, a total of 336 rockets (24 Mu, 25 Lambda, 119 Kappa and 172 S and test rockets) were launched.

(ii) Noshiro Testing Centre

73. The Noshiro Testing Centre (NTC) was established in 1962 at Asanai Beach, Noshiro City, Akita Prefecture. The ground firing test stand, workshop, measurement centre, optical observatory and other facilities are provided for ground-based test firing of large-scale solid motors. Basic research on liquid-hydrogen and liquid-oxygen engines was started in 1975, and several research facilities have been constructed. ISAS, which began studies on the development of the air turboramjet engine in 1976, tested the engine at NTC from 1990 to 1992 under sea-level static conditions using a quarter-scale model. With a total floor space of 2,788 square metres as of February 1993, NTC stands facing the Sea of Japan, far from towns and highways to ensure the safety of its firing range.

(iii) Usuda Deep Space Centre

74. Surrounded by mountains that block out city noise, the Usuda Deep Space Centre is located 1,450 metres above sea level at Usuda-machi, Nagano Prefecture. It started operating in October 1984. A large parabolic antenna 64 metres in diameter, a receiver, a transmitter and a ranging system in S-band are provided at the Centre to serve as a deep space tracking, telemetry and command station. The facilities can be controlled by the Deep Space Operation Centre at the ISAS main campus at Sagamihara, Kanagawa.

(iv) Sanriku Balloon Centre

75. The Sanriku Balloon Centre is located at Sanriku-cho, on the east coast of Iwate Prefecture, facing the Pacific Ocean. The balloon launch site is on a hill 230 metres above sea level. The control centre stands beside the launch site, where launch control and assembly of the balloon and its payload are conducted. On a hill about 700 metres south-west of the launch site is the telemetry centre, where balloon tracking, telemetry receiving and telecommanding are conducted. In May 1987, a new telemetry centre was constructed at the top of Mount Ohkubo, 4.1 kilometres west of the launch site.

(v) Collaboration of ISAS and NASA in space experiments with particle accelerators and Geotail

76. ISAS conducted space experiments with particle accelerator (SEPAC) jointly with NASA in 1983 and 1992. In SEPAC, accelerated ion and electron beams were ejected from the space shuttle. In 1992, the Geotail satellite developed by ISAS was launched by NASA using a Delta II launch vehicle. The Geotail satellite carries scientific instruments developed by both ISAS and NASA.

(f) Ministry of Transport

77. The space-related organizations under the Ministry of Transport are the Transport Policy Bureau acting as a headquarters, the Electronic Navigation Research Institute as a subsidiary organization, and the Maritime Safety Agency and the Japan Meteorological Agency as affiliated agencies. Those bodies have been using meteorological, geodetic and aeronautical satellites, and accumulating knowledge about their use.

78. Recently, the importance of space technology and its use in the field of transport has increased, as reflected in such areas as meteorological and maritime observation, maritime geodetic control, search and rescue of ships and aircraft, air traffic control and operational control of ships, aircraft and land vehicles. In addition, space technology, such as large-scale geostationary satellite technology, has been steadily progressing.

79. It is now believed that it would be much more economical and effective to launch a large, multi-purpose satellite instead of launching several kinds of satellites separately in order to conduct meteorological observations and air traffic control. As a result, the Ministry of Transport has been investigating the possibility of establishing a multi-purpose satellite system to cover all its needs.

80. The Ministry plans to conduct a search and rescue experiment to relay ship distress signals using the geostationary meteorological satellite-5 (GMS-5), launched in March 1995. The Ministry also supervises NASDA, a quasi-governmental agency, thus exercising control over satellite development. Important projects under way include the following:

(a) The Electronic Navigation Research Institute is conducting research and development work on satellite-based technologies for air navigation and air traffic control. Major research and development projects undertaken in those areas are as follows: automatic dependence surveillance, a system that gives pseudo-radar images to air traffic controllers by using aircraft-derived position data transmitted through a satellite data link; and the wide area augmentation system, a system that improves the integrity, accuracy and availability of the Global Positioning System (GPS) for civil aviation in Japan;

(b) Development of a GPS overlay, a system that recovers the accuracy degradation of the GPS system by using GPS signals transmitted by a geostationary satellite;

(c) Development of a satellite data link, a system that improves the communication quality and surveillance capability of air traffic control for the safety of transoceanic flights.

(i) Maritime Safety Agency

81. To establish Japanese territorial waters, the positions of the mainland and the off-lying islands must be registered with the World Geodetic System (WGS). The Maritime Safety Agency has therefore been participating in a joint international observation plan using the United States laser geodynamics satellite (LAGEOS) since 1982 to fix the precise positions of the mainland based on WGS. The Agency has been conducting a maritime geodetic survey to determine, to a high degree of accuracy, the positions of the mainland and its off-lying islands and the distances between them, using the geodetic satellite of Japan, AJISAI, launched in August 1986.

(ii) Japan Meteorological Agency

82. The Japan Meteorological Agency conducts space-based meteorological observations using GMS and meteorological rockets as part of the World Weather Watch programme of the World Meteorological Organization (WMO).

83. GMS observes cloud coverage and temperatures of sea surface and cloud top, and collects meteorological data from aircraft, buoys and meteorological observation stations in remote areas. It also distributes by facsimile the cloud image charts thus obtained.

84. As the ground facility to operate GMS, the Agency has the Meteorological Satellite Centre, which comprises the Data Processing Centre for image data processing and the Command and Data Acquisition Station for communication between the Data Processing Centre and GMS.

85. The satellite data serve to improve weather forecasting on an operational basis, and are used in the International Satellite Cloud Climatology Project (ISCCP) and the Global Precipitation Climatology Project (GPCP) of WMO. In addition, the Data Processing Centre receives and analyses data from the polar-orbiting meteorological satellites of the United States National Oceanic and Atmospheric Administration.

86. The meteorological rockets observe temperature, atmospheric pressure, wind etc. at altitudes of between 30 and 60 kilometres. Launching of the meteorological rockets are carried out by the Meteorological Rocket Observation Station, the sole facility capable of meteorological rocket observation in East Asia and the western Pacific.

87. The Meteorological Research Institute develops techniques for the more effective use of meteorological satellite data, and conducts studies on sensors for the next generation of meteorological satellites.

(g) Ministry of Posts and Telecommunications

88. The Ministry of Posts and Telecommunications plans and promotes policies governing the use of radio waves and space-related research and development in the same field. The Communications Research Laboratory is attached to the Ministry, which also supervises Kokusai Denshin Denwa, Japan Broadcasting Corporation (NHK), NASDA, Nippon Telegraph and Telephone and the Telecommunications Advancement Organization (TAO) of Japan. The main activities of the Ministry include research on and development of long-range space communication concepts, complex satellite systems and a pilot plan for promoting satellite utilization and advanced satellite communication systems.

(i) Communications Research Laboratory

89. The Communications Research Laboratory is conducting research and development work on various kinds of space technologies to meet diversified communications needs in an era of advanced information technology and manned space flight. Specific activities of the Laboratory include the following:

(a) Research on and development of small, low Earth-orbiting satellite communication systems;

(b) Research on cluster satellite communications;

(c) Research on and development of intersatellite communications with S-band, millimetre-wave and optical frequencies using ETS-VI;

(d) Research on and development of advanced mobile satellite communications using Ka-band and millimetre-wave and advanced satellite broadcasting using the communications and broadcasting technology satellite (COMETS);

(e) Research on and development of mobile satellite communications and satellite sound broadcasting using the technology of large deployable antennas operating in the S-band;

(f) Research on high-data-rate satellite communications systems using optical and millimetre-wave techniques;

(g) Research on geostationary servicing satellite systems and technology for detecting space debris;

(h) Research on and development of space environment forecasting systems for predicting sun flares;

(i) Research on and development of an airborne, two-frequency Doppler radar and a space-borne radar for the tropical rainfall measuring mission (TRMM) to observe global rainfall from outer space;

(j) Experiments for the precise measurement of crustal movement and rotation of the Earth using the very long baseline interferometer (VLBI) and satellite laser ranging systems.

(ii) Telecommunications Advancement Organization of Japan

90. The Telecommunications Satellite Corporation of Japan was renewed as TAO in 1992. The Corporation was established in 1979 to develop radio communications and seek effective utilization of radio waves in space by controlling the location, attitude etc. of communications and broadcasting satellites and efficiently using the telecommunications facilities installed on those satellites. The main tasks of TAO are as follows:

(a) Controlling the location, attitude etc. of communications and broadcasting satellites;

(b) Ensuring that radio systems on communications and broadcasting satellites are used by operators of radio stations.

91. The Kimitsu Satellite Control Centre tracks and controls satellites. CS-3, N-STAR, and BS-3 are currently tracked and controlled using six antennas (in the 10 to 18 diameter class). To promote the spread of high-vision satellite broadcasting (high-definition television), TAO owns one of the transponders aboard BS-3b, and leases it to NHK and commercial broadcasting companies.

(h) Other organizations

92. In addition to the above-mentioned organizations, the Ministry of International Trade and Industry, the National Police Agency, the Geographical Survey Institute of the Ministry of Construction and the Fire Defence Agency of the Ministry of Home Affairs have made space-related budgetary appropriations.

2. Development of Space Science and Technology in Japan

(a) Lunar and planetary exploration

(i) LUNAR-A Project (Moon Penetrator Mission)

93. ISAS plans to send a spacecraft called LUNAR-A to the Moon in 1997. It will be the second flight of the M-V vehicle being developed by ISAS. LUNAR-A will drop three penetrators into the Moon. The penetrators are supposed to penetrate the lunar surface, and form a network that will explore the internal structure of the Moon using on-board seismometers and heat flow meters.

(ii) PLANET-B Project (Mars Atmosphere/Plasma Mission)

94. PLANET-B is the first Japanese Mars mission and is scheduled for launch in 1998 by the M-V-3 vehicle. It will be injected into orbit around Mars, and will study the Martian upper atmosphere, especially its interaction with the solar wind.

(iii) Projects under discussion

95. The following are among the lunar and planetary missions under discussion by ISAS: Comet Coma Sample Return Mission; Mars Rover Mission; and Venus Aerocapture/Balloon Mission.

(b) Astrophysics

(i) Project in the ASTRO series (satellites for astronomical observations)

96. The fifth X-ray astronomy satellite (ASTRO-E) and an infrared astronomy satellite are being studied for launch in the late 1990s. In infrared astronomy, observations from stratospheric balloons and sounding rockets have been conducted. Observations from the Space Flyer Unit that was launched in March 1995 are being executed.

(ii) VLBI Space Observatory Programme

97. A satellite for very long baseline interferometry from space, called MUSES-B, will be launched by ISAS in 1996. It will be the first flight of the M-V vehicle being developed by ISAS.

(c) Communications

98. The N-STAR communications satellite (N-STARa) being procured from the United States by Nippon Telegraph and Telephone was launched by an Ariane rocket in August 1995 to maintain the satellite communication services being provided by CS-3.

(d) Broadcasting

99. In order to increase the reliability of the satellite broadcasting system, a back-up broadcasting satellite (BS-3N) is being procured from the United States by NHK and Japan Satellite Broadcasting (JSB). This satellite is scheduled to be launched by an Ariane rocket. The BSAT broadcasting satellites (BSAT-la and BSAT-lb) are also being procured by NHK, JSB etc., and are scheduled to be launched in 1997 and 1998 to maintain the satellite broadcasting services currently being provided by BS-3.

(e) Research and development satellites for communications and broadcasting technology

(i) Communications and broadcasting technology satellite

100. The objectives of COMETS are to develop and experimentally demonstrate new technologies of advanced satellite mobile communication, interorbit communication and advanced satellite broadcasting. The satellite weighs about 2,000 kilograms at the beginning of its life in orbit, and its design life is three years. The satellite is scheduled to be launched by an H-II rocket in the middle of 1997, and to be injected into a geostationary orbit at 112 degrees east longitude.

(ii) Advanced satellite mobile communication technology

101. An advanced system of L- and S-band satellite mobile communications will be developed to provide Ka-band and millimetre-wave satellite mobile communications systems with demodulator/modulator on-board satellite switches.

(iii) Inter-orbit communication technology

102. To provide a large-capacity data communications link from the Advanced Earth Observation Satellite (ADEOS), interorbit communication technology will be developed.

(iv) Advanced satellite broadcasting technology

103. For future satellite broadcasting services, such as high-definition television, integrated service digital broadcasting and provincial satellite broadcasting, a satellite broadcasting system operating in the 21 gigahertz band with a multibeam antenna will be developed. The Optical Inter-Orbit Communications Engineering Test Satellite will be launched into low Earth orbit aboard a J-1 rocket in the middle of 1998 to conduct, in cooperation with ESA, on-orbit demonstrations of pointing, acquisition and tracking technology and other key technological elements for optical interorbit communications, which will be important for future space activities. The on-orbit demonstrations will be conducted using the ARTEMIS geostationary satellite of ESA.

(f) Earth observation

104. GMS-5 was launched in March 1995 as a successor to the GMS-4. The functions of the Visible and Infrared Spin Scan Radiometer (VISSR) of the GMS-5 have been enhanced compared with those of the GMS-4. For example, in addition to the visible channel and the infrared channel, a water vapour channel has been newly introduced. Moreover, the infrared windows have been divided into two channels. The former provides information on the water vapour distribution in the atmosphere, and the latter enables more accurate determination of the sea surface temperature. Those innovations are expected to improve short- and long-range weather forecasting services. Furthermore, the GMS-5 has been newly equipped with search and rescue instrumentation for relay of distress signals on an experimental basis.

(i) Advanced Earth Observation Satellite

105. ADEOS will continue the Earth observation tests of MOS-l/1b and JERS-1. The main objectives of ADEOS are as follows:

(a) To develop advanced Earth observation sensors;

(b) To develop a modular satellite that will be the key technology of the future platform;

(c) To conduct experiments on the relay of Earth observation data using data relay satellites to form a global observation network;

(d) To contribute to domestic and international cooperation by carrying announcement-of-opportunity sensors developed by domestic and foreign organizations.

106. ADEOS will carry two core sensors, the Ocean Colour and Temperature Scanner (OCTS) and the Advanced Visible and Near Infrared Radiometer (AVNIR). The following six announcement-of-opportunity sensors are also installed on ADEOS:

(a) NASA scatterometer (NSCAT) by the NASA Jet Propulsion Laboratory;

(b) Total ozone mapping spectrometer (TOMS) by the Goddard Space Flight Center of NASA;

(c) Polarization and directionality of the Earth's reflectances instrument (POLDER) by CNES;

(d) Interferometric monitoring of greenhouse gases (IMG) by MITI of Japan;

(e) Improved limb atmospheric spectrometer (ILAS) by the Environment Agency of Japan;

(f) Retroreflector in space (RIS) by the Environment Agency of Japan.

107. The interorbit link with COMETS is another important mission of ADEOS. ADEOS will be launched from Tanegashima in mid-1996 by an H-II rocket.

(ii) Tropical rainfall measuring mission

108. TRMM is being jointly conducted by Japan and the United States to measure tropical rainfall. Over two thirds of global rainfall occurs in tropical areas, producing one of the main sources of global climate change. TRMM will be the first mission carrying a precipitation radar to monitor tropical rainfall from space.

109. The precipitation radar on board TRMM will be provided by NASDA on the basis of studies carried out by the Communications Research Laboratory, which has collaborated with NASA through experiments on precipitation observation from airplanes. NASA will provide the other sensors and spacecraft for TRMM.

110. The results of the joint programme are expected to contribute to scientific research in various fields, and to facilitate the understanding of mechanisms of global climate change. TRMM will be launched in mid-1997 on the H-II launch vehicle being developed by NASDA.

(iii) Advanced Earth Observation Satellite II

111. ADEOS-II, the successor to ADEOS, will be launched by an H-II launch vehicle around February 1999. The objectives of ADEOS-II are to observe global environmental change, to contribute to international science

programmes such as the International Geosphere-Biosphere Programme, and to follow the ADEOS mission. The satellite is of a modular type with a flexible solar array paddle. ADEOS-II will have two core sensors developed by NASDA, namely the advanced microwave scanning radiometer (AMSR) and the Global Imager (GLI).

112. AMSR is a microwave radiometer with six channels, from 6.6 to 89 gigahertz. Its observation targets are precipitation, cloud water, water vapour, sea surface temperature, ice distribution etc., all of which are concerned with water mutation. The physical values associated with them are observed with high accuracy during night and day.

113. GLI is an advanced type of the OCTS carried on ADEOS. GLI has been developed as a multi-purpose observing spectrometer using more spectral bands and narrower spectral bandwidths than OCTS in order to satisfy various mission requirements in terms not only of the ocean but also of vegetation and atmosphere.

114. ADEOS-II also carries several sensors from other agencies. The final configuration of sensors on ADEOS-II will be defined in the near future.

(g) Development of engineering test satellites

115. The objective of the ETS programme is to develop the high-level technologies required for the practical utilization of satellites (for Earth observation, broadcasting, communications etc.), thereby fostering Japanese technology.

116. ETS-VI is a satellite in the 2-tonne class satellite with a bipropellant apogee engine and the following additional features: an ion engine for controlling the north-south orbit; a high-precision attitude control system; a light structural body; a light solar battery paddle; and a system of high heat prevention and heat control in the satellite bus part to ensure an excellent performance. The purpose of ETS-VI is to confirm the capabilities of the H-II launch vehicle, to establish the technology of the 2-tonne geostationary three-axis satellite bus, and to test advanced satellite communications equipment.

117. ETS-VII, following the current phase of research and development, is to be dual-launched with TRMM from the Tanegashima Space Centre. The purpose of ETS-VII is to acquire the basic technologies of rendezvous-docking and space robotics that are essential to future space activities. ETS-VII consists of a chaser satellite and a target satellite. After launching, ETS-VII detaches the target satellite in orbit, and then the chaser satellite conducts rendezvous-docking experiments with the target satellite. It also conducts space robotics experiments by using the robot arm installed on the chaser satellite. ETS-VIII is undergoing research and development, with the focus on mobile satellite communications and satellite sound broadcasting using the technology of large deployable antennas operating in the S-band.

(h) Space transportation system

(i) H-II launch vehicle

118. The H-II launch vehicle is the main system developed by Japan for space transportation in the 1990s, and meets the demand for large satellite launches maintaining a high degree of reliability. It is a two-stage vehicle, augmented by a pair of solid rocket boosters (SRBs). It is 4 metres in diameter and 50 metres in height, with a lift-off weight of 260 tonnes. The H-II launch vehicle is capable of launching a satellite in the 2-tonne class to geostationary orbit and a satellite of about 10 tonnes with supply materials to space station orbit. It will be able to send an exploration spaceship of about 2 to 3 tonnes to Venus or Mars.

119. The first stage is powered by the LB-7, a staged combustion-cycle liquid-oxygen and liquid hydrogen engine, which delivers a thrust of 110 tonnes in vacuum. In order to supplement the thrust of the first stage, two SRBs with a thrust of 160 tonnes each are installed. Thrust direction control of the SRBs is performed through a movable nozzle. The second stage uses the LE-5A engine, an improved version of the LE-5 engine of the H-I launch vehicle.

The standard payload fairing measures 4.1 metres in diameter and 12 metres in length. Its large version, produced in September 1991, measures 5 metres in diameter. The construction of the new Yoshinobu launch site for the H-II vehicle was finished in 1991.

120. The first test flight was carried out successfully in February 1994, and the second was used to launch ETS-VI in August 1994. The capability and characteristics of the H-II launch vehicle were verified through those flights. The third test flight was used to launch GMS-5 and the Space Flyer Unit (SFU) in March 1995. The use of the H-II launch vehicle for launching various other satellites is also being studied.

(ii) J-I launch vehicle

121. NASDA, in cooperation with ISAS, is developing the three-stage solid rocket called J-I, to launch small satellites. The intention is to develop J-I at low cost in a short time by using the components of two existing vehicles, the SRB of the NASDA H-II launch vehicle and the upper stages of the M-3SII launch vehicle. J-I is intended to be a time-saving launch system with minimum operation time at the launch site. J-I uses the Osaki launch facilities at the Tanegashima Space Centre, which was equipped for the H-I launch vehicle. The first test flight, scheduled for February 1996, is to carry a hypersonic flight experiment vehicle.

(iii) Launch vehicles in the M or Mu series

122. ISAS has started to develop the M-V launch vehicle to provide larger launch capability to meet the requirements of space science in the late 1990s and the twenty-first century. M-V will be 2.5 metres in diameter and 30 metres in length, and will weigh 130 tonnes. It will be able to launch a payload of 2,000 kilograms into low Earth orbit or 400 kilograms beyond the Earth gravitation region. The first M-V flight is scheduled for 1996. Three spacecraft, MUSES-B for the space VLBI (1996), Lunar-A for the Moon Penetrator Mission (1997) and PLANET-B for the Mars Orbiter (1998), have already been approved for launching by M-V.

123. The use of M-V launch vehicles is being discussed for the pursuit of a variety of space science projects and fields of study in the near future, including the following: X-ray astronomy; the Comet Coma Sample Return Mission; the Lunar/Mars Rover; the Venus Aerocapture/Balloon Mission; the Asteroid Sample Return Mission; infrared astronomy; solar physics; and atmospheric science.

(i) Space experiments and utilization of the space environment

(i) Space Flyer Unit

124. SFU is an unmanned, multi-purpose, reusable free-flying platform that has been developed since 1987 by ISAS, MITI and the Science and Technology Agency (through NASDA). It was launched by the H-II launch vehicle in March 1995, and retrieved by the space shuttle in January 1996. The experiments carried out during the SFU mission are as follows:

(a) Advanced technology experiments and space observations;

(b) Verification of a partial model of the exposed facility in the Japanese Experiment Module (JEM) attached to the International Space Station;

(c) Flight tests of advanced industrial technologies.

(ii) Space station programme

a. Outline of the Japanese Experiment Module

125. Japan decided to participate in the International Space Station Programme by developing JEM. The major objectives of JEM are to contribute to the development and utilization, to the fullest possible extent, of space science and Earth observation; to foster the use of the space environment; to promote the general progress of science and technology; and thereby to enhance the quality of life for all. Japan has committed itself to the development of the new technologies required to achieve those ends, including the technology for supporting and ensuring the safety of manned space flight, as well as the extension of the technology already accumulated in launching rockets and satellites.

126. The needs of prospective users must be fully ascertained and reflected in the design and development of JEM, which must also be carried out with due regard to international norms relating to safety, the interaction of humans and machinery in complex systems, user interfaces etc. JEM, which is being designed in accordance with those requirements, will consist of a pressurized module, an exposed facility and an experiment logistics module. Together they will constitute a space laboratory allowing experiments in extensive areas. JEM is designed to be attached to the core of the space station, on which it will depend for meeting such needs as electric power, heat dissipation, living quarters for on-board engineers, air and communications.

b. Pressurized module

127. The pressurized module will provide an environment of one atmospheric pressure. Crew members will be able to conduct microgravity experiments in materials and life science in a shirt-sleeve environment. It will also have systems to control JEM operation, the exposed facility and its manipulators, as well as the airlock and other equipment. The outer surface of the pressurized module will be covered with a bumper to guard against space debris. There will be about 20 racks within, 10 of them to be equipped with experimental payloads.

c. Exposed facility

128. Crew members will use the exposed facility to conduct materials experiments, scientific Earth observation and communications and engineering tests in an extravehicular environment. The exposed facility is designed to be connected to the pressurized module. The JEM manipulator will be used to exchange experimental equipment or samples between the exposed section of the experiment logistics module and, through the airlock, the pressurized module.

d. Experiment logistics module

129. The experiment logistics module will be used to transport experimental equipment, samples, various gases and supplies. It consists of a pressurized section and an exposed section. The pressurized section is designed to be attached to the pressurized module and to carry and store the payload required for intravehicular activity. The exposed section will be attached to the exposed facility, and will be used for transporting and accommodating extravehicular experimental equipment and supplies.

e. Operation and utilization of the space station

130. The operation and utilization functions of the space station are expected to continue and evolve for many years. In its initial stage of utilization, industrial, academic and governmental users will conduct tests using mainly common experimental equipment. With growing experience, users are expected to develop and utilize experimental equipment of their own design, thereby paving the way for the development of advanced technology and industrialization.

(j) Start of basic and pioneering space technology research

(i) Spaceplane

131. Since 1986, NAL has been engaged in research on and development of a horizontal take-off spaceplane capable of flying into space and landing with a degree of safety similar to that of an ordinary airplane. Important fields of research on the basic technology for such a plane include those concerned with atmospheric forces, structures, guidance control and engines. Another important field is that of systems research, which is needed to clarify conceptual aspects of the spaceplane. Research and development will be continued to overcome the problems involved.

(ii) Basic research on winged launch vehicles

132. To conduct a basic study on winged space vehicles, a multidisciplinary working group of researchers from all over the country has been organized at ISAS. The group has worked to identify the following major areas of study relevant to winged vehicles: aerodynamics and flight dynamics; navigation; guidance and control; development of recovery and automated landing systems; scientific experiments with the test vehicle; microgravity experiments with the test vehicle; and development of an advanced hydrogen rocket engine.

133. As a first step, a gliding test of a small-scale model was carried out in June 1986, with follow-up flights in October 1987. Useful data for further studies was obtained in the first two areas of study referred to above. In 1992, a solid-propellant rocket launched a winged vehicle into the upper atmosphere from a balloon floating at high altitude. It performed the first Japanese controlled aerodynamic re-entry flight.

(iii) H-II Orbiting Plane

134. HOPE is a winged unmanned space vehicle designed to be launched on the H-II launch vehicle. The objective of the HOPE project is to recover objects from orbit and establish the basic technology for completely reusable space transport vehicles of the future. Test flights of the planned space vehicle are to take place after the turn of the century.

135. The main conceptual features of HOPE at the present stage are as follows:

(a) It will be mounted on and launched by the two-stage H-II launch vehicle;

(b) It will be an unmanned vehicle;

(c) It will return to the landing grounds through winged gliding flight;

(d) It will land on the runway automatically;

(e) It will allow subsequent addition of the rendezvous-docking functions for space activities.

136. HOPE is being studied by NASDA and NAL on the basis of those design concepts.

3. International cooperation

137. In accordance with the basic principles of its space development policy, Japan attaches great importance to international cooperation in its space activities.

(a) Cooperation with the United States of America

(i) Tropical Rainfall Measuring Mission

138. TRMM will be developed by Japan and the United States to observe tropical rainfall. Such observations are necessary to determine the mechanism of energy consumption on a worldwide scale. Japan will develop the precipitation radar to be carried by the satellite, which it will launch using an H-II rocket. The United States is developing the satellite bus. Research and development started in 1991, with the goal of launching the satellite in 1997.

(ii) Cooperation in the introduction of technology and space equipment

139. On the basis of an agreement of July 1969 between Japan and the United States concerning the field of space development and notes verbales of December 1976 and December 1980, Japan has incorporated United States equipment and technology into the N-II launch vehicle, the H-I launch vehicle and various artificial satellites.

(iii) Senior Standing Liaison Group

140. On the basis of an exchange of letters by NASA and SAC in July 1979, meetings of the Senior Standing Liaison Group have been held between those two bodies to promote cooperative projects between Japan and the United States in the fields of Earth observation, space sciences, life science and microgravity sciences, and to study new collaborative projects.

(iv) Receiving LANDSAT satellite data

141. Since January 1979, Japan has been receiving LANDSAT observation data about Japan and its vicinity.

(b) Cooperation with Europe

(i) Cooperation between Japan and the European Space Agency

142. In accordance with an agreement concluded between Japan and the European Space Research Organization, the predecessor of ESA, in December 1972, information and specialists are being exchanged, and administrative-level meetings held. In connection with the administrative-level meetings, administrative officials and specialists attend meetings of bodies dealing with Earth observation, space transportation, International Space Station, space science, microgravity experiments, quality reliability etc.

(ii) Support of the European Space Agency for satellite tracking and control

143. NASDA received ESA support for the tracking and control of MOS-1 launched in February 1987 and MOS-1b launched in February 1990.

(iii) Cooperation with Germany in microgravity investigations

144. Germany and Japan cooperate in conducting various experiments and life science investigations utilizing microgravity, one of the properties of the space environment, under the Japan-German Technological Cooperation Agreement. At the level of private industry, Japanese companies are scheduled to participate in the D-2 programme of Germany, a plan for microgravity experiments using the Spacelab.

(c) Cooperation with the Russian Federation

(i) Agreement on Space Cooperation

145. Japan and the Russian Federation concluded an Agreement on Space Cooperation on 13 October 1993.

(d) Space station programme

146. The International Space Station is an international collaborative project involving Canada, Europe (ESA), Japan, Russian Federation and United States. Japan will provide JEM to the project.

(e) International cooperation in the field of Earth observation

147. Japan has been cooperating by directly receiving data from MOS 1 and lb, launched in February 1987 and February 1990, respectively, and plans to promote collaboration through ERS-l, ADEOS etc.

(i) Cooperation through MOS-1

148. MOS 1 and lb data will be received directly in Australia, Canada and Thailand and by ESA. Japan and countries of the Association of South-East Asian Nations have several joint research programmes utilizing the data received.

(ii) Cooperation through ERS-1

149. NASA and NASDA have agreed that the NASA Fairbanks Station will receive ERS-1 data. ESA and NASDA have agreed to grant mutual access to data from JERS-1 and ERS-1. Several other countries are also paying attention to ERS-1 data, so that international cooperation in their utilization is expected to grow even further.

(iii) Cooperation through ADEOS

150. To promote international cooperation in the field of Earth observation, NASDA published an announcement of opportunity to the international community to provide sensors to carry on board ADEOS. Six sensor proposals, including those of CNES and NASA, have been selected.

(iv) Cooperation through the Tropical Rainfall Measuring Mission

151. The TRMM programme is being jointly promoted by Japan and the United States. Japan will provide the precipitation radar and launch the satellite by H-II rocket, and the United States will provide the satellite bus and other sensors.

(v) Cooperation through ASTER

152. NASA plans to develop and operate an Earth observing system-AM1 (EOS-AM1) polar orbiting platform, thereby creating an integrated scientific observation system through international cooperation. The advanced resources searching sensor of MITI will be mounted on EOS-AM1.

(vi) Inter-Agency Consultative Group for Space Science

153. In 1981, when preparations for missions to encounter Halley's comet were about to begin, four space agencies - ESA, Intercosmos of the Academy of Sciences of the former Union of Soviet Socialist Republics, ISAS and NASA - formed the Inter-Agency Consultative Group for Space Science (IACG). The task of IACG was to informally coordinate all matters relating to the space missions to Halley's comet and the observations of the comet from space.

154. The collaboration of IACG proved to be invaluable for the success of the cometary mission. Vital information was exchanged on the cometary path, the cometary dust environment and experiment design. Hence, when the encounter ended, all delegations recognized the advantages of the close cooperation that had occurred, and agreed to continue IACG.

155. As its next project, IACG adopted the Solar-Terrestrial Science Programme at its meeting held at Padua, Italy, in 1986. The Solar-Terrestrial Science Programme addresses the effects of solar ultraviolet and plasma emissions on the atmosphere and the magnetic field of the Earth. Beginning with AKEBONO in 1989, about 20 missions were approved or planned for the period from 1989 to 1996. ISAS collaborates in the AKEBONO, Geotail and SOLAR-A missions.

(vii) Multilateral cooperation

156. Japan has been attending sessions of the United Nations Committee on the Peaceful Uses of Outer Space and its Legal Subcommittee and Scientific and Technical Subcommittee, and actively participating in their discussions since 1962. Japan has also been exchanging information and opinions with various countries.

E. Jordan

[Original: English]

157. Jordan has submitted a proposal to host the Centre for Space Science and Technology Education to be established in western Asia. The Royal Jordanian Geographic Centre (RJGC) and Al Al-Beit University have expressed their commitment to provide the permanent facilities required to manage the Centre. In view of the need for the participation of academic institutions in order to ensure the success and sustainability of the Centre, the Higher Council for Science and Technology held a workshop that was attended by all the concerned institutions, in particular the following: the Higher Council for Science and Technology, the Royal Jordanian Geographic Centre (RJGC), Al Al-Beit University, the University of Jordan and the Department of Meteorology and the Department of Space Telecommunications of Jordan.

158. RJGC conducts regular training programmes as well as a three-year diploma course in surveying and cartography through its community college, which is being considered for upgrading to a university college in collaboration with the University of Jordan. It is planned that the proposed university college will offer a five-year programme of courses involving three years of general education and two years of specialized education in cartography, photogrammetry, geographic information systems (GIS) and remote sensing. RJGC is engaged in a number of projects of national importance involving remote sensing and GIS applications.

1. Projects involving the application of space science and technology

(a) Hydrological projects

(i) Economic and Social Commission for Western Asia

159. A project has been undertaken by the Economic and Social Commission for Western Asia to evaluate water resources (surface and ground water) in the region of south-western Asia. RJGC has prepared studies of the area using satellite images, GIS and remote sensing techniques to produce regional hydrological and hydrogeological maps.

(ii) Selection of sites for dams

160. A project has been undertaken to select seven sites for potential dam construction in different areas in Jordan in collaboration with the Jordan Valley Authority. The selection will be based on the topography and storage capacity of the sites, which are located at Wadi Al-Shalalah, Karak, Ajiloun, Tafileh and Wadi Shuaib.

(iii) Study of flood effects in Petra

161. In a study of flood effects in Petra, satellite images and GIS are used to establish a model for flood hazard zoning.

(iv) Studying the Dead Sea recession

162. A study has been undertaken to delineate the water body of the Dead Sea by using satellite images and aerial photography taken between 1945 and 1994.

(b) Land use and desertification

163. Land use applications using radar satellite imagery for the areas of Madaba and Azraq are being studied, and comparisons have been made using satellite imagery. The deterioration of land use as a result of human activity and the extent of urban development in the Amman Greater Area is being investigated for the period between 1945 and 1994, using satellite imagery and aerial photography.

164. The role of satellite data and GIS techniques in land use is exemplified by a study undertaken to establish optimum land use in the Irbid area by investigating the geomorphological, topographical, land-cover and agricultural aspects of the area.

165. A project on the desertification of Al-Azraq wetlands monitors environmental pollution in the Al-Azraq area using multi-temporal analysis for the period between 1975 and 1994 to show the diminishing of the natural plant cover as a result of irrigated vegetation and the consequent depletion of water reserves in the area.

(c) Other projects

166. Using aerial photographs, remote sensing and GIS, landslide hazard detection is being performed on the Amman-Jerash motorway in order to suggest an alternative route. Another project involves landslide mapping using SAR in the Al-Zarqa river basin. Landslide hazards in the Wadi Al-Karak basin are also being studied using GIS and SPOT images to delineate areas of existing landslides and of probable landslides.

167. The Department of Meteorology of Jordan conducts space activities through its two satellite stations, one of which is installed at the old airport, the other at the Queen Alia International Airport. The latter station is used for receiving pictures from Meteosat satellites two or three times daily, especially for cloud cover and plantation coverage. The cloud pictures are mainly used for aviation forecasting, and there is a weather radar. The Department operates 13 meteorological stations. There are two more stations used exclusively for monitoring pollution and a network of solar radiation recording stations. Since 1986, a programme for enhancing rainfall through cloud-seeding from the ground with silver iodide has been implemented. According to some estimates, there has been a 19 per cent increase in precipitation. There is also a programme to monitor surface temperatures of the Mediterranean Sea and to compare them with actual on-site measurements in ships. At Aqaba, temperature accuracy by the two methods has been noted to be of the order of 1.5 degrees centigrade.

2. Multilateral cooperation and national telecommunications policy

168. Jordan is a member of the International Telecommunications Satellite Organization (INTELSAT). The Department of Space Telecommunications in the Ministry of Communications of Jordan is in charge of international

telephone and television traffic and the promotion of satellite communications for the public and private sectors, utilizing the satellites of INTELSAT and the Arab Satellite Communications Organization. Jordan has three ground receiving stations which are used in the exchange of television programmes all over the world, and in retransmission from the Atlantic to the Indian Ocean and vice versa. Jordan has direct dial services with 140 countries. Direct dial services are established not only via satellite but also via submarine cables routed through the territory of the Syrian Arab Republic. Regular telephone lines are used for fax services, and require approval in accordance with international standards.

169. Since 1986, the Government of Jordan has reconsidered the role of its postal, telephone and telegraph services in national development by extending narrow- and wide-band services of the Integrated Services Digital Network. Offering incentives to attract private investors to the telecommunications sector and assigning them a definite role in expanding and upgrading the system have also been considered. The Government has already completed the first phase of implementation of a restructured telecommunications policy permitting private sector involvement in the sector through the provision of services such as cellular telephony and data transmission.

F. South Africa

[Original: English]

170. The following is a compilation of summary reports of space-related activities of South Africa during the past year.

1. South African Astronomical Observatory

171. Unquestionably the highlight of 1994 was the collision of Comet Shoemaker-Levy 9 with Jupiter. All four telescopes at the Sutherland observatory were scheduled to observe the event. The most spectacular results were obtained with the infrared camera on the 0.75-metre telescope, which showed the development of the fireball resulting from the impact of each fragment. The public interest and media coverage were phenomenal, and included live coverage of the largest fragment, Q1. Sutherland was extremely well-placed to observe seven of the impacts, the weather was favourable, and all were recorded.

172. In addition to the "the great crash of 1994", research at the South African Astronomical Observatory (SAAO) has been carried out over a wide range of astronomical topics, frequently involving international collaboration. SAAO participated in ground-based, multiwavelength observations of sources detected by space observatories and in concerted campaigns focused on individual targets as determined by the time-critical nature of the observations. The input of data from an observatory in the southern hemisphere at the longitude of SAAO is essential to the success of the campaigns.

173. Cosmological studies at SAAO have continued primarily by measuring the line-of-sight velocities of galaxies. This has contributed to determining the correlation length of X-ray emitting clusters of galaxies, the distribution of galaxies in the southern hemisphere and the mapping of large-scale structures behind the Milky Way.

174. Contributions to the understanding of the Galaxy have been based principally on infrared observations. From SiO maser sources towards the galactic centre, the average rotation period of the galactic bulge was found to be 8.5 x 10^7 years. Infrared astronomical satellite (IRAS) sources in the Sagittarius-I field were studied and their properties compared to those in the Large Magellanic Cloud and solar neighbourhood. An infrared survey of the galactic centre for variables has been initiated using a wide-format infrared array camera. A study of IRAS sources in the south galactic cap has shown that they are mostly non-Mira M or S stars, probably a mixed population and similar to those of the inner bulge of the Galaxy.

175. As a result of the follow-up of Röntgen Satellite X-ray sources, a number of interesting magnetic cataclysmic variables have been discovered. These interacting binary systems reveal a remarkable variety of astrophysical

phenomena depending upon the strength of the magnetic field of the white dwarf. Spectroscopic, photometric and polarimetric observations are essential to interpret the physical properties of the systems.

176. Substantial progress has been made in the study of pulsating stars, with SAAO participating frequently in multisite campaigns, which are necessary to elucidate the nature of some variables. Discoveries have been made of new pulsating stars, including members of rare classes, and a new class of pulsating F-type star has been established. The radii of galactic Cepheids, which are fundamental distance calibrators, have been determined more accurately than hitherto by using extensive infrared, optical and radial velocity data.

177. In 1994, the results of research by SAAO staff and other astronomers using the facilities of SAAO were published in 146 papers in astronomical journals and in conference proceedings. The publications that included SAAO authors exceeded those of previous years. Over 60 per cent of the papers appeared in referred journals. The number of papers published in 1995 was not available at the time of writing the present report, but it is expected to exceed that of 1994.

178. A comprehensive document on the funding of the Southern African Large Telescope has been completed and distributed to scientists, decision makers and potential international partners. An international working group to promote the project, involving representatives from Germany, Namibia and South Africa, was established, and held two meetings during 1994, one in Germany and one in Namibia.

179. On the technological side, the large-format platinum-silicon infrared camera (the outcome of collaboration between SAAO and Japan) was improved, the optical charge-coupled device (CCD) was developed further, and a highly successful CCD autoguider was commissioned on the 1.9 metre telescope. Software techniques have been developed for the automatic reduction and analysis of differential CCD photometry. An SAAO Differential Image Motion Monitor (DIMM) to measure seeing has been commissioned and tested at Sutherland, and compared with a European Southern Observatory DIMM on the Gamsberg in Namibia. The quality of the dome seeing in the building with the 1.0-metre telescope has been substantially improved as a result.

180. An important development has been the SAAO education initiative, which is aimed at stimulating an interest in basic science among young people through contact with astronomy. A resource centre has been created for teachers, courses for teacher training are being developed, and there are plans to include astronomy in the physical science syllabus of schools. Astronomy has a natural appeal to the young, and can have a very positive effect in stimulating an interest in science and technology. Such an interest is vital to the future development of South Africa.

181. In 1994, SAAO organized the Annual Review of South African Astronomy and Astrophysics, which included participants from overseas and from nine South African universities and institutes. A month-long Summer School in Astronomy was held at Cape Town for selected third-year physics and mathematics students from South African universities.

2. Department of Posts and Telecommunications

182. South Africa has been a member of the INTELSAT since its establishment and of the International Mobile Satellite Organization (Inmarsat) since 1994. South Africa makes use of the satellites of INTELSAT for its public traffic with foreign countries (including some countries in Africa) and for the distribution of broadcasting signals in South Africa. For communication between fixed points and vehicles or between fixed points and areas where telecommunication infrastructure does not exist, the satellites of Inmarsat are used. In addition to the INTELSAT system, broadcasters started using the satellite service of PANAMSAT during 1995. This system will also be used by Transnet, the communications unit of the public railway utility, for its own communications.

183. Towards the end of 1993, so-called Ku-band INTELSAT services became available for South Africa, enabling Telkom SA Ltd., the public telecommunications operator of South Africa, to provide dedicated, small satellite terminals to clients whose volume of traffic justifies a dedicated satellite service.

184. A lively commercial interest in the provision of telecommunication service by means of satellites continues. South Africa was recently requested by a United States/South African consortium to register frequencies for a new satellite system with the International Telecommunication Union (ITU). This satellite system is expected to become operational in 1998. It is proposed to provide space segment capacity to countries in the southern African subregion.

3. University of Stellenbosh

185. SUNSAT is a 60-kilogram microsatellite being developed by a team of 27 graduate students at the University of Stellenbosh. Its prime research role is to test a 15-metre-resolution, tricolour pushbroom imager with a 45-kilometre swath on a microsatellite of that size. Is also carries an amateur radio communications package for international and national use.

186. This satellite, the first developed by a South African university, is a significant research project for the Department of Electrical and Electronic Engineering at the University. A schools project is being run in association with the South African Amateur Radio Satellite Organization (SA-AMSAT).

187. SUNSAT is gravity-gradient-stabilized for minimum energy consumption, but includes magnetictorquers, small reaction wheels and precision horizon sensors for attitude control to miliradian accuracy. It uses a system concept that can be realized without the need for conventional space-reliability components.

188. NASA agreed to launch SUNSAT as a secondary payload on the Delta II Argos/P91-1 mission. In exchange, SUNSAT was increased to a height of 62 centimeters to fly laser reflectors and a NASA precision GPS receiver for research in gravity recovery and atmospheric tomography as part of the NASA Mission to Planet Earth. Modal survey tests and other structural evaluations have shown SUNSAT to be satisfactory for carriage on the Delta II.

189. SUNSAT will also carry a scientific magnetometer. Together with data from the Danish Oersted satellite, which will be released in the same orbit as SUNSAT, it can provide valuable magnetic research information.

190. The mission, originally scheduled for January 1996, has been delayed to March 1997. A launch in May 1996 on another mission is being investigated by NASA. Construction of the flight model of SUNSAT has started, and will be accelerated to meet the May 1996 launch date, if required.

191. The project is funded at a minimal level by a group of electronics companies in South Africa and by the Foundation for Research Development. It relies on the goodwill of other companies to perform environmental tests, to manufacture various structural components, and to obtain donations of components from a number of suppliers. The project has developed some subsystems for use by other satellites, and is seeking partners. A number of international student exchanges have already occurred.

192. Further information on SUNSAT is available on the Internet WWW at http://esl.ee.sun.ac.za and arnsat.orq.

4. University of the Witwatersrand

193. Professor David Block, of the Department of Computational and Applied Mathematics at the University of the Witwatersrand, at Johannesburg, is the leader of an international team of astronomers that has achieved a breakthrough in the imaging of intergalactic cold dust. An International Conference of Astronomers will be held at the University of the Witwatersrand from 22 to 26 January 1996 to focus on changing perceptions of the morphology, dust content and dust-to-gas ratios of galaxies. This will probably be the largest astronomical conference ever held in South Africa.

5. Satellite Applications Centre

194. The Satellite Applications Centre of the South African Council for Scientific and Industrial Research (CSIR) is located at Hartebeesthoek, in the vicinity of Johannesburg. It has business interests in remote sensing and satellite tracking services.

195. Remote sensing as a business is based on the reception, processing and distribution of resource data from the polar orbiting satellites of the National Oceanic and Atmospheric Administration (NOAA), the LANDSAT thematic mapper sensor, the French SPOT series (panchromatic and multispectral data) and the SAR sensors of ESA ERS-1 and ERS-2. Digital archives are maintained; in some cases the records date from 1972. Thanks to the geographic position of the Centre at Hartebeesthoek, its data acquisition programmes cover the entire southern African region up to the equator, including also Madagascar.

196. Data products conforming to international standards are being supplied to users worldwide, and are increasingly being supplemented by value-added products in map format, for use in GIS.

197. The Centre has its second area of business in the provision of tracking, telemetry and command services, 24 hours per day, all year round. The facility is part of the CNES 2-gigahertz network.

6. Hartebeesthoek Radio Astronomy Observatory

198. Within the same complex as the Satellite Applications Centre, South Africa operates the Hartebeesthoek Radio Astronomy Observatory (HARTRAO). Although primarily used for astronomical research, the 26-metre radio telescope is actively involved in space geodesy, using VLBI techniques to measure plate tectonic motions of all continents with respect to Africa. HARTRAO also makes supporting radio observations of objects currently being investigated by the Compton Gamma Ray Observatory.

199. HARTRAO will make its facilities available as a ground support VLBI station for the Japanese MUSES-B satellite in 1996 and for the Radioastron satellite of the Russian Federation when it is launched.

7. Other ongoing research

200. South African Universities have, during 1995, been involved in a number of other projects, as exemplified by the work done by the Space Physics Research Institute at the Durban campus of the University of Natal. The research programme of the Institute includes research in magnetospheric and atmospheric physics. The major programmes are Antarctic Magnetosphere-Ionosphere Ground-base Observations (AMIGO), Southern Hemisphere Auroral Radar Experiment (SHARE) and General Magnetospheric Studies and Ozone Studies. SHARE and AMIGO form part of the South African National Antarctic Research Programme, which is carried out at Sanae Base in the Antarctic in collaboration with other research institutions in South Africa and other countries.

G. Thailand

[Original: English]

201. The outer space activities of Thailand are focused on two areas: remote sensing and communications.

1. Remote sensing

(a) Background

202. The Thailand Remote Sensing Centre (TRSC), under the auspices of the National Research Council of Thailand (NRCT), is the national centre for remote sensing activities. TRSC was established in 1971, and its activities are directed by the National Remote Sensing Coordinating Committee, whose members are representatives of relevant agencies. In 1981, the ground receiving station was completely constructed, enabling it to receive

LANDSAT signals with the radius of data reception extending approximately 2,800 kilometres from Bangkok. The Thailand Ground Receiving Station currently has the capability to receive data from a variety of satellites, including LANDSAT, SPOT, ERS-1 SAR imagery, and MOS, JERS and NOAA advanced very high resolution radiometer data. Remote sensing activities conducted in fiscal year 1995 are reviewed below.

(b) Data reception, production and distribution

203. Planning for data acquisition is carried out daily by the Satellite Operations Centre. The receiving station routinely acquires and stores data in the digital tape archives. Satellite data are supplied via computer compatible tapes (CCTs), paper print and film, in accordance with user requirements. In 1995, TRSC provided domestic and international customers with a total of 1,067 photographs and 508 CCTs containing satellite data.

(c) Data applications

204. Satellite data have been utilized in many fields, including agriculture, forestry, land use and land cover mapping, geology, map updating, natural disaster monitoring and environmental studies. In the field of agriculture, satellite images have been used for crop acreage surveys and mapping as well as agricultural planning. Forest applications include forest area estimation and mapping, forest monitoring, forest fire assessment and forest management. Other applications include flood disaster monitoring and assessment and the application of remote sensing and GIS in matters of national security. Besides TRSC, other government units are involved in remote sensing applications, including the Department of Agricultural Extension, the Department of Agriculture, the Department of Forestry, the Department of Land Development and the Office of Agricultural Economics.

(d) Education, training and research

205. Most of the universities in Thailand, such as Chulalongkhon University, Kasetsart University, Thammasart University, Chiangmai University and Khon Kaen University, have included remote sensing in their regular syllabus. TRSC has organized both training in and seminars on remote sensing and GIS, and has so far trained nearly 500 participants from various agencies, including civil service departments, military offices and educational institutions.

206. Each year, TRSC has granted 3 million baht to remote sensing projects proposed by Thai researchers as a means of promoting applications of the technology in Thailand. In 1995, nine research projects were funded under the grant.

(e) Regional remote sensing centres

207. In 1994, TRSC established regional remote sensing centres in three regions, with the objective of promoting the utilization of satellite data and transferring remote sensing and GIS technologies to the regional level. Three educational institutions, well endowed with the necessary facilities and resource persons have been appointed as regional centres, namely Chiangmai University in the northern region, Prince of Songkhla University in the southern region and Khon Kaen University in the north-eastern region. In 1995, TRSC supported the regional centres in terms of both the budget and resource persons for the promotion of remote sensing applications and the transfer of technology to local users and students in the regions through seminars, training, workshops, university courses and research projects. The three regional centres organized three seminars, which were attended by a total of 367 participants from 182 agencies.

(f) Publications

208. TRSC publishes two quarterly newsletters for dissemination of information to users, one version in Thai and the other in English. It also publishes an annual report in Thai summarizing the activities of the centre over the past year. Most research work is reported in Thai, except when conducted in cooperation with international organizations.

(g) International cooperation

209. Besides working with the relevant agencies in Thailand, TRSC has also cooperated with agencies in other countries and with international organizations. Cooperative projects conducted in 1995 include: the Regional Remote Sensing ERS-1 Project of the European Communities and ASEAN; the GlobeSAR Project; the Global Research Network System Project; Joint Research on Enhancement of Remote Sensing Technology in Tropical Environment Monitoring; Joint Research on the Changes of Tropical Forest and their Influence; and the Asian JERS-1 Project.

210. TRSC also initiated cooperation with the Lao People's Democratic Republic. The first cooperative activity was the Workshop on Application of Remote Sensing and GIS for Natural Resources Management, held at Vientiane.

(h) Seawatch Thailand Programme

211. The Seawatch Thailand Programme is a marine surveillance and information system consisting of a network of moored data buoys in the Gulf of Thailand collecting meteorological and oceanographical data for the database at NRCT. Authorized users can transfer data through the Oceaninfo system or receive monthly plots by mail. Seven buoys have thus far been deployed.

(i) Smallsat Programme

212. An Earth observation small satellite mission has been approved in principle by the Government of Thailand. The Ministry of Science, Technology and Environment, through its technical authority in NRCT and in cooperation with the Canadian Space Agency, will own and operate the satellite system. The satellite is scheduled to be launched in 1998, with the parameters indicated in the table below.

Parameters of the projected small satellite mission

Parameter	*Value*
Mission life	5 years
Orbit type	73 orbits per 5 days, multi-sun-synchronous
Orbital period	96.66 minutes
Orbital inclination	28.394 degrees
Orbital altitude	611.75 kilometres
Coverage repeat	Every 5 days
Illumination repeat	49 days
Command uplink	S-Band: 2 kilobits per second
Telemetry downlink	S-Band: Direct 2/4 kilobits per second Playback 32/128 kilobits per second
Data downlink	X-Band: <85 megabits per second

2. Space activities and projects of the Ministry of Transport and Communications

(a) Asia-Pacific multilateral cooperation on space technology and applications

213. Originally, China, Pakistan and Thailand signed a memorandum of understanding to organize workshops and conferences in each country concerned. The Republic of Korea subsequently joined the arrangement and the four countries agreed on the following two space projects: the Small Multi-Mission Satellite (SMMS) and the Satellite Disaster Mitigation System (SDMS).

214. The SMMS project has been progressing, and details of cooperation were discussed during conferences held at Bangkok in 1994 and Islamabad in 1995. China prepared a memorandum of understanding on the project, which was to be signed by the four countries concerned by the end of 1995.

(b) Coordination of geostationary satellite orbital positions

215. Thailand has been using one position at 78.5 degrees east, which co-located Thaicom 1 and 2. More positions are needed ranging from 84.5 degrees east to 153.5 degrees east for the national communications satellite series A, B and C. The third, larger Thaicom-3 satellite is to be launched into orbit at 120 degrees east. Thailand is seeking to achieve coordination and cooperation through the project

(c) National communications satellite (Thaicom)

216. To cope with the increasing demands of communication by satellite, the Government of Thailand and the Shinawatra Company have signed an agreement on domestic satellite communications allowing the Company to provide satellite communications under a 30-year concession. The specifications for the first two satellites are as follows:

(a) Thaicom-1 and -2 are identical. Each satellite has 10 C-band transponders and two Ku-band transponders;

(b) The effective isotropically radiated power (EIRP) for the coverage of Thailand on C-Band is at 37 decibels above 1 watt, with a bandwidth of 36 megahertz. The EIRP for the Ku-Band is 50 decibels above 1 watt, and its bandwidth is 54 megahertz.

(d) Membership of international organizations

217. Thailand has been a member of INTELSAT since its inception, and it recently became a member of Inmarsat, thus enabling it to provide international telecommunication services all over the world. Since other facilities, such as mobile telephones, are usually provided through private international dealings, the possibility of allowing private firms in Thailand to join the Iridium programme and provide services is being considered.

H. United Kingdom of Great Britain and Northern Ireland

[Original: English]

218. The annual report of the United Kingdom is contained in the brochure entitled *UK space activities 1994-1995*, distributed to the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space at its thirty-third session.