Office for Outer Space Affairs
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WORKSHOP ON

EXPANDING THE USER COMMUNITY OF SPACE TECHNOLOGY APPLICATIONS IN DEVELOPING COUNTRIES

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Introduction

INTRODUCTION

Background and Objectives

The United Nations Office from Office for Outer Space Affairs (OOSA) organizes several regional and international conferences and workshops on various aspects of space science and applications of space technology. Participants in these activities have made recommendations concerning the establishment of space related infrastructure and the potential of accelerating the social and economic development of developing countries through the expansion of the user community of space technology applications. In this context, the United Nations and the International Astronautical Federation (IAF) agreed to continue a successful series of meetings with the eighth UN/IAF Workshop focussing on the theme „Expanding the User Community of Space Technology Applications in Developing Countries".

The Workshop was included in the 1998 activities of Space Applications Programme of the United Nations Office for Outer Space Affairs and was held from 24-27 September 1998 in the Victoria Vista Hotel in Melbourne, Australia. The meeting was hosted by the Government of Australia and co-sponsored by the Centre National d'Études Spatiales (CNES).

The objectives of the Workshop were to assist developing countries in establishing and strengthening national capabilities in space technologies and applications and to provide developing countries with a general plan to expand the user community in space affairs.

The observations of participants and the conclusions reached by the Workshop will also provide inputs and ideas to the Third United Nations Conference on the Exploration and the Peaceful Uses of Outer Space (UNISPACE III), which will be held at Vienna from 19 to 30 July 1999.

A report on the meeting was submitted to Committee on the Peaceful Uses of Outer Space at its forty-second session and to its Scientific and Technical Subcommittee at its thirty-sixth session. The participants will report to the appropriate authorities in their own countries.

Programme and Participants of the Workshop

Many successful examples for the expansion of the user community in space technology applications in developing countries were presented during the course of the Workshop. The aim was to demonstrate how developing countries could benefit from space technology for economic and social development. The Workshop was structured around seven sessions, in which twenty-six papers were presented. A vigorous exchange of information, comments, questions, recommendations and suggestions occurred. In addition, brief presentations by participants from developing countries provided an insight into the status of space technology applications in their countries. Afternoon sessions concluded with panel discussions, followed by an open exchange of views.

The Workshop programme (Annex I to the present report) was industrialized by OOSA in collaboration with the IAF and the international programme committee.

The United Nations, on behalf of the co-sponsors, invited developing countries to nominate candidates for participation in the Workshop. Selected participants were required to have university degrees in remote sensing, communications, engineering, physics, biological or medical sciences or other fields related to this workshop. Additionally, participants were selected based on their professional background and their working experience with programmes, projects or enterprises in which space technology is or could be used. The participation of specialists at a decision-making level from both national and international entities was specifically encouraged.

Funds allocated by the United Nations, IAF and the Centre National d'Études Spatiales (CNES) for the organization of the Workshop were used to cover international air travel and per diem expenses of more than thirty participants from developing countries. Registration fees for the Congress, room and board expenses for participants from developing countries were also covered by the sponsors of the Workshop.

The Workshop was attended by more than one hundred participants, including funded participants from Argentina, Azerbaijan, Bangladesh, Brazil, Cambodia, China, India, Indonesia, Islamic Republic of Iran, Kenya, the Lao People's Democratic Republic. Malaysia, Mongolia, Morocco, Nigeria, Pakistan, Philippines, Republic of Korea, Sri Lanka, Sudan, Tunisia, Uzbekistan, Zambia and Zimbabwe.

Lectures were delivered by representatives of the Office for Outer Space Affairs, Arthur C. Clarke Institute of Modern Technologies (Sri Lanka), the Bangladesh Space Research And Remote Sensing Organisation (SPARRSO), the Brazilian Space Agency (AEB), the Chinese Academy of Space Technology (CAST), China National Space Administration (CNSA), the Centre Royal de Télédétection Spatiale of Morocco (Royal Centre for Remote Sensing), THE European Space Agency (ESA), the Indian Space Research Organisation (ISRO), National Space Development Agency (NASDA), National Aerospace Laboratory (NLR), National Aeronautics and Space Administration of the United States (NASA), the International Space University (ISU) and the University of New South Wales (Australia).

Presentations by space industry and commercial ventures were given by representatives of the Aerospace Corporation (United States), Alcatel France, Alcatel Australia, AUSSPACE (Australia), BRAZSAT (Brazil), Geomatic Technologies/ SpaceImaging (Australia, United States), Northrop Grumman Corporation (United States), Surrey Satellite Technology Ltd. (SSTL, United Kingdom), Telstra (Australia), SPACEHAB (United States) and WorldSpace (India).

PRESENTATIONS AND DISCUSSIONS DURING THE WORKSHOP

The Director of the Office for Outer Space Affairs, in his introductory address, referred to the growing economic importance of space technology applications in the world and to the still existing large gap between industrialized countries and developing countries. The main objective of the Workshop series was to identify the obstacles that prevented developing countries from obtaining benefits from these technologies. Solutions should be industrialized to address and to surmount obstacles by means of increased national commitment and by strengthening international cooperation. In that context, the participants were also briefed about the latest developments with regard to UNISPACE III which is seen as a major potential milestone towards preparing and coordinating space activities in the early twenty-first century.

The Executive Director of the Cooperative Research Centre for Satellite Systems reviewed the status and role of space technology applications in the world. In the past, space technology had been industrialized and used by the wealthy, industrialized countries, often driven by military objectives. The high cost of space technology, the strong political differences and the lack of technology prevented the developing countries from benefiting from space technology. Fortunately, this situation had changed in recent years. He predicted the gradual expansion of the space technology user community based upon the availability of more affordable, more accurate, more diverse and accessible solutions. Not only the industrialized but also the developing countries can now greatly benefit from using space technology applications, expanding the user community of space technology applications.

In his keynote address, the chairman of the Indian Space Research Organization (ISRO) discussed the benefits of space technology to society. In our days, the global space industry had become one of the largest industries in the world, with an annual revenue of about 80 billion US$ and more than 800,000 employees worldwide. Developing countries were still facing constraints in terms of resources, policies and awareness at different levels, which had to be removed through appropriate adjustments in policies, human resources development, institutional frameworks and international support, coupled with balanced commercial mechanisms. There are great challenges for expanding space applications. Four billion people, nearly two thirds of the total global population, are inhabitants of developing countries. But they only possessed three per cent of all telephones and ten per cent of all TV sets. There was a growing demand for mobile communications in developing countries. Other applications included the use of geographic information systems (GIS) and remote sensing data for agricultural applications. Because of the population growth, it is necessary to increase the grain productivity from the current level of one to two tons per hectare to about four to five tons per hectare. Additionally, remote sensing data could help to safe drinking water and to facilitate disaster management. Space communication was also of growing importance for spreading education rapidly to illiterate populations in rural areas as the literacy rate in developing countries is only between fifty and seventy per cent while we have reached an amount of ninety-eight per cent in industrialized countries.

Establishing and enhancing the use of space applications in developing countries

First, the outcome of the previous UN/IAF Workshops and an overview of current activities were presented. The purpose of the Workshops has always been to provide developing countries with a forum to discuss concepts for the development and use of space technology and space applications tailored to their needs. Some of the recommendations had already been addressed and partially resolved. But others had continued to require attention, including the need to convince government officials and decision makers about the benefits of applications of space technology. It was pointed out that other recurring concerns regarding funding, data, equipment and software acquisition, education and training, as well as end-user and private sector investment, had been and would continue to be addressed in future workshops and discussions.

It was necessary to raise and increase the awareness of policy and decision makers as experience had taught that successful introduction of space technology applications required their support. The Director-General of the Brazilian Space Agency underscored the benefits that could be gained from space technology applications, particularly through improving the daily lives of people. The presentation covered the space activities of Brazil and highlighted the multidisciplinary requirements and the multitechnology approach to space activities. Cost-sharing of some space activities between Government and industry were also discussed. In addition, he stressed the importance of fiscal incentives and funding support for education, research and development. Brazil was currently working in a programme that would result in giving the country an independent capability for space access. International cooperation with partner institutions had been a good strategy for Brazil to reduce the cost and risk of its programmes.

The director of the Arthur C. Clarke Institute of Modern Technologies recommended that special space policy plans should be drafted for developing countries in order to coordinate their use of space applications. The space policy of a country depended on its technological and financial capabilities as well as its maturity in mastering space technology applications. His presentation emphasized the need for considering the ramifications of various space technology applications as well as the essential elements that should be embodied in the space science and technology policy of a developing country such as Sri Lanka. That included accepting space science and technology as an integral part of the broad area of science and technology, which had the following aims: to achieve economic development and human well-being; to give priority to areas of space applications in which direct results could be achieved and benefits accrued to the common people; to utilize the knowledge and technology gained by other advanced countries rather than trying to reinvent the wheel; to provide education and training in space science and technology to develop some self-reliance in the field, and to ensure that space policy would not be easily thrown off course from political expediency by changing Governments.

Training users of space applications

One precondition for the effective implementation of space policy plans was the availability of experienced and trained staff. Training opportunities for space experts as well as the education of users of space technology application has been a major concern raised in previous UN/IAF Workshops.

The inauguration of thee regional Centre for Space Science and Technology Education in Asia and the Pacific in 1995 was an important milestone in addressing the training and education needs of that region. The Scientific Secretary of ISRO introduced the work of the Centre, seated in India. The main goals are increasing knowledge and understanding in space science and technology and enhancing national and regional capabilities. In the future, the Centre should become a centre of excellence by expanding its outreach and offering activities other than education, such as research and consulting services.

The International Space University (ISU) was offering programmes in interdisciplinary space education. An ISU representative described the changes in the global political environment and the resulting changes in the space sector. Space education must strive to meet the new needs and challenges of a changing world. Multidisciplinary professionals are necessary because of the international character of space activities.

Education is a key for a better future of humankind. Distance education using satellite technology offered the possibility of high-quality education to anybody on the globe, also for those in rural areas. The General Manager of WorldSpace, India, described the WorldSpace digital sound broadcasting system, consisting of three geostationary satellites, for distance education and applications to address current needs for distance education in rural areas. It was expected that prices would further come down. The WorldSpace system will mainly provide educational programming targeted towards adult education.

The marketing and business manager of Northrop Grumman Corporation provided an overview of the major activities of the company in space technology applications that could be of interest to developing countries. Their radar system could provide all-weather data of special interest to equatorial regions that were frequently hidden under cloud cover. The company was also providing training in image processing at its Spectral Imagery Training Center on a commercial basis. It was promoting real-time GIS that would allow the linking of real- and near-real-time data sources directly into GIS to enable better decision-making for environmental and agricultural applications, for the sustainable use of natural resources, and for transportation, hydrology, tracking and tagging and defence matters. In the future, the aim was to combine such GIS with real-time or near-real-time data acquired from Earth Observation satellites. Such an application would be an important step towards the operational use of high-resolution remote sensing data beyond what was already currently possible with data acquired from meteorological satellites or advanced very high-resolution radiometer data at low resolution (in the 1-km-range), and would allow the use of such data in new application fields, contributing to expanding the user community for space technology applications. However, because of technical constraints in the space and ground segment and in computing power, it would still take some time until such real-time GIS using remote sensing data acquired by satellites would be commercially available.

The Earth Science programme of NASA included many activities of relevance to the region of Asia and the Pacific and offered several opportunities for international participation. Data were collected for agencies and universities in Australia, Brunei Darussalam, Cambodia, Malaysia, New Zealand, Papua New Guinea, the Philippines and Thailand. Applications included the study of cultural resources, land-use studies, natural hazards, geology and mining and urban studies. Earth imaging radar materials could be obtained from the Worldwide Web at http://southport.jpl.nasa.gov/.

Global Learning and Observations to Benefit the Environment (GLOBE) was an international science and education programme bringing together students, teachers and scientists to enhance the environmental awareness of people throughout the world, to contribute to the scientific understanding of Earth and to support improved student achievement in science and mathematics. The initiative was launched on 22 April 1995, on the occasion of Earth Day. Internationally; GLOBE was being implemented through bilateral agreements between the Government of the United States and Governments of partner States. More than 120 States had expressed interest in GLOBE, and over 70 had signed GLOBE agreements. GLOBE measurements had been selected by the international science community and were used in ongoing research. The measurements included data for atmospheric and climate studies, hydrology studies, soils studies, land cover and biology studies. Further information could be obtained from GLOBE at http://www.globe.gov/.

During the first panel discussion on the theme "Expanding the user community of space technology applications: opportunities and constraints", panelists noted the changing geopolitical situation in the world and its impact on the development of space technology. The changing economic and political environment, the growth of commercial space activities, the deregulation of the telecommunications and trade sectors, the integration of the global market and the information society, had led to an increasing demand for applications of space technology. However, in some countries, those changes had not brought about the expected easier access to space benefits. They had rather resulted in constraints that prevented potential users from benefiting from those opportunities. One reason was that national policies sometimes did not keep pace with the swift technology changes and required updating. Participants concluded that Governments should provide incentives and encourage competition in the private sector, but should still continue with funding and carrying out space-related activities needed for the well-being of society (e.g., in the fields of education and environment), but which could not yet be conducted on a commercial basis.

Participants suggested that the Office for Outer Space Affairs should establish a programme specifically designed for educating politicians and legislators on space applications and their derived benefits. The language barrier between decision makers or potential users and space experts was identified as a major hurdle. The hope was expressed that a programme taking that issue into account would help to accelerate the formulation of space policy plans and increase the commitment of a country to the implementation and operational use of space applications. It was noted that the Office had already been charged with organizing UNISPACE III, which would be held at the ministerial level. In preparation for the Conference, a package of twelfth background papers had been prepared, each containing a summary of the state of and the benefits from space technology applications in a non-technical language. Participants agreed that awareness should start at the national level.

A major issue for developing countries was the operationaliziation of remote sensing applications. A comparison was made between the remote sensing field and satellite communications. The remote sensing market had not been growing as quickly as the satellite communications market. Remote sensing projects had mostly been limited to pre-operational applications. The problem was that remote sensing applications must sell information, not data, as was the case with telecommunications. However, it had proven to be difficult to extract the kind of information that was relevant and useful to the decision makers using that information. In other cases, the information was extracted, but it was difficult to convince decision makers of its actual use.

Small satellite and microsatellite systems for promoting space capabilities and applications

The Secretary-General of the Chinese Academy of Space Technologies presented the development history of the Chinese small satellite programme. China was following the worldwide trend of developing small satellites that had shorter project times from conceptualization to operation and lower costs of development as well as launching. Several projects were in the engineering development stage or in the conceptual study phase. The Practice5 (SJ-5) satellite would conduct scientific and technical experiments and demonstrate the platform technology. The first application satellite using the small satellite platform operationally would be Oceansat-l (HY-l). It would be used mainly for the observation of sea fish distribution, marine-life breeding resources and the distribution of mud and sand in river mouths and ports. A project in the conceptual study phase was the Asia-Pacific Small Multi-Mission Satellite (SMMS), developed in cooperation with other Asian countries. SMMS would be based on the SJ-5 satellite bus platform and mainly carry remote sensing instruments. Ka-band communication and space environment experiments, as well as a constellation of satellites for environment and disaster monitoring, were also under study. The latter would be based on a constellation of six low-Earth-orbit satellites, four operating in the optical regime and two SAR satellites providing an all-weather capability. China had realized the need for radar-based observation systems because of the flood disasters experienced by the country in 1998. Such a small satellite constellation would achieve short-time resolution and reasonable spatial resolution while keeping within an acceptable cost limit.

The Deputy Director-General of the Department of Foreign Affairs of the China National Space Administration highlighted the role of space technology in planning, monitoring and managing resources. He gave a detailed description of the operation and objectives of the SMMS project, which was initiated during the Asia-Pacific Multilateral Cooperation in Space Technology and Applications Conference series. In that connection, a memorandum of understanding on cooperation in the SMMS project was signed on 22 April 1998 in Bangkok by China, Iran (Islamic Republic of), Mongolia, Pakistan, the Republic of Korea and Thailand. The Government of China was also welcoming further bilateral and multilateral cooperation with other States, with special emphasis on small satellite development, to share the benefits of such technology sustainable development.

The Chief Executive Officer of Surrey Satellite Technology Ltd. (SSTL) described the small satellite projects developed by SSTL and the Surrey Space Centre in cooperation with other countries and the technology transfer achieved through them. SSTL was well known for its small satellite programmes, which offered developing countries the opportunity to build up a domestic capability for developing national satellite programmes within a relative short period of time ant within a realistic cost range. He also discussed future programmes, including development of a constellation of small satellites disaster warning, monitoring and mitigation applications, as well as the possibility of lunar and interplanetary missions. The Surrey Space Club, a forum of emerging spacefaring States with experience in small satellite projects, was established with the aim of increasing international cooperation and eventually embarking on international joint small satellite projects.

A representative of Alcatel Space, described the light-weight Proteus satellite bus and its technical details. The bus could be adapted to a wide range of space missions. Fields of application included telecommuniations, navigation, Earth Observation and science. With a payload capacity of 300 kilograms and a power capacity of 300 watts, the Proteus platform was designed to meet the requirements of space missions too large for small satellites (in the 100-kilogram range) and too small for large, full-scale satellites (in the above-1,000-kilogram range). Possibilities for cooperation and participation ranged from delivery of the standard service module delivery of a complete satellite and in-flight reception the complete system. The Proteus platform could also be used as a generic base for the development of dedicated satellite buses in the 300- to 1,000-kilogram range. The platform would be used for the JASON-1 satellite, an oceanography mission involving the cooperation Alcatel, CNES and the NASA Jet Propulsion Laboratory, replacing the Topex-Poseidon satellite, and in the scientific COROT satellite, a mission for studying the in structure of stars and for the detection of planets beyond the solar system.

Space technology for disaster management

Natural and human-made disasters created many problems in developing countries, which often lacked the infrastructure to react efficiently to such disasters. Each year, the result was an unacceptably high economic and human loss. Space technology, in the form of Earth Observation or telecommunication satellites, could alleviate many of those problems and help stabilize the situation in the aftermath of disasters more quickly. Certain space applications could also be used to introduce effective preventive measures and to implement a disaster early-warning capability to reduce the expected economic and human loss when disasters struck.

The application of telecommunications systems for disaster management was illustrated by a representative of Telstra, an Australian provider that had recently introduced a new telecommunications service. The new service was based on the International Mobile Satellite Organization (Inmarsat) mini-M system using a laptop mobile terminal. The system compared favourably with other global mobile personal communication systems in terms of its data rate and operational costs, and would be especially useful in situations where the terrestrial telecommunications infrastructure was unavailable or inoperative. Terminals based on earlier versions of that system had been successfully used in crisis situations all over the world.

In the second panel discussion on the theme "International and regional cooperation: small satellites and disaster warning projects", panellists stressed that critical factors for disaster monitoring and mitigation applications were not only spatial and spectral resolution, but also temporal resolution. For some types of disasters, for instance, floods, Synthetic Aperture Radar (SAR) systems had advantages over optical systems, such as all-weather imaging. However, SAR systems were still costly in terms of both acquiring and processing the image data when compared with optical systems. It was suggested that a gradual development from the use of optical data to data obtained by near-infrared sensors, and then to SAR data, might be a viable approach for emergency response offices with little or no remote sensing experience.

Disaster monitoring applications were a good means of convincing Governments of the benefits of space technology. For example, the Government of Indonesia had increased its support for remote sensing applications after the huge damages and economic losses caused by forest fires in 1997. A major effort was required to slowly acquaint the management responsible for mitigation actions with the new technology. The implementation of space technology in disaster management applications was often met with resistance, since management was not always ready to accept the new technology. Well-structured education and training programmes were therefore a precondition for introducing space technology.

For the development of a national satellite programme, an inventory of national technology and manpower resources should first be taken and long-term plans be made before starting such an activity. A long-term commitment was necessary for a national satellite technology programme to maintain momentum. Participants also discussed the idea of sharing the development, cost and benefits of a constellation of small satellites. A cost-benefit analysis would help to establish the cost of such a project and to better inform decision makers. Participants concluded that regional multilateral or bilateral cooperation in small satellite projects should be promoted and would provide a synergy resulting in greater benefits than the independent pursuit of development programmes in each country.

Satellite communications and applications: mobile systems and Very Small Aperture Terminals

In late 1998, the first operational telecommunication satellite constellations had been fully deployed. The IRIDIUM and Orbcomm satellite systems had entered into service. Several other projects were in the design or testing stage. The advantage of satellite constellations is their worldwide or near worldwide coverage regardless of the nature of the local telecommunications infrastructure. The IRIDIUM system could provide voice communication between any two points on the planet.

While the current personal mobile satellite communication systems are designed to provide data rates sufficient for messaging services and voice data; future systems are designed to support broadband applications. The Skybridge system was a proposed constellation of approximately 80 satellites and will provide global access to interactive, multimedia communications starting in late 2001 to address the growing demand for high-speed data communications and broadband applications. The system will be integrated with existing terrestrial broad-band networks and use satellite links only when they were essential to bring down the overall cost.

Very Small Aperture Terminal (VSAT) networks are providing a variety of services suitable for business communications in India. VSAT technology is an ideal solution to provide telecommunication services to users in developing countries, especially in rural areas with insufficiently industrialized telecommunications infrastructures or at remote sites of geographically dispersed organizations. In the later case, a central, larger hub station connected via the space segment to the various remote sites, which are equipped with small, simple and relatively cheap satellite antennas. Applications range from stock market and news broadcasting, distance education and training, pricing databases, audio broadcasting and
relay advertising in one-way VSAT networks to interactive computer transactions, database enquiries, videoconferencing, bank and automated-teller-machine transactions, reservation

systems, voice communications and email in two-way VSAT networks. The Indian VSAT networks are based on the domestic Indian National Satellite series of satellites. Currently, there are four operational satellites providing telecommunications, broadcasting and meteorological services. In the not-too distant future, Ka-band satellites will be able to provide connectivity with a data rate of up to 2 megabytes per second between ground stations equipped with antennae dishes having a diameter as small as 75 centimetres. VSATs have a major role to play in the concept of a global village.

Earth Observation applications

Remote sensing from space could provide essential information for policy-making, land use and land cover, environmental and agricultural applications and planning of resource utilization. When combined in GIS with data from other sources, for example, with socio-economic and population data, it could become an essential tool for the implementation of national and local development strategies. For such a system to be successfully applied in implementing programmes of major importance for the country, the following was necessary: to have the support of high-level policy and decision makers; to train a critical number of well-qualified specialists to supervise the system; to establish effective mechanisms to transfer the information extracted from the data to the application specialists and to train the latter in using the data to assist in practical decision-making; and finally, to ensure access to the information by the user community on a regular and timely basis.

The Royal Centre for Remote Sensing of Morocco was using GIS for the location and sustainable exploitation of resources. The use of GIS was dictated by the increasing constraints on the exploitation of resources and by the complexity of natural phenomena. The need for the identification of long-term trends in the evolution of natural resources and phenomena could best be tagged by GIS combining data from different sources that could capture interaction on different scales (global, regional and local). GIS for sustainable development made possible the integration of all components involved in resources management by using a systems approach aimed at t optimal use of resources. The availability and continuity of data, problems in data exchange standards, copyright issues and the lack of expertise were among the hurdles implementing such GIS. They had to be overcome by improving education, training, technology transfer and access to data. Several professional organizations were promoting the use of GIS and working towards solving the known problems. However, users in developing countries were sometimes unaware of those organizations, or many cases could not afford to subscribe to the relevant publications.

The National Space Development Agency of Japan (NASDA) is conducting a number of activities in the region of Asia and the Pacific. The activities consisted in education and training programmes, pilot projects, satellite data reception agreements, data utilization agreements, cooperative experiments and data network programmes. Within the Asia-Pacific Pilot Project, NASDA had been working with Indonesia and Thailand in the operational use of satellite data for rice field classification and acreage assessment and for pest disease detection and identification. For that purpose, ground receiving stations and processing facilities for the JERS-1 satellite and the Advanced Earth Observation Satellite had been established in those countries. In addition, the Global Research Network System (GRNS) was designed to establish a human network and to develop standardized data sets for desertification, forest cover, hydrological management and the coastal environment. Participants in GRNS were Australia, China, Indonesia and Thailand.

Spatial information technologies of remote sensing, the Global Positioning System and GIS would facilitate the manipulation of environmental data to provide better or more appropriate information for decision-making and resource management than had previously been available. Experience showed that the success of any technology transfer programme depended on the provision of trained personnel. To sustain remote sensing applications, two forms of assistance were necessary, namely, financial and technical assistance. The financial commitment to the successful implementation of remote sensing had been limited in the past, lacking an overall strategy at the Government, industry or institution level. Few Governments had committed sufficient funds to allow remote sensing and GIS technologies to become fully operational, let alone sufficient money for the necessary training and personnel. It was therefore necessary that the developers of remote sensing technology and agencies committed to technology transfer should support and fund the establishment and maintenance of training programmes in remote sensing, until a sufficient number of potential users had adopted the technology and thereby created a demand for trained and capable personnel.

Local decision makers often chose not to use Earth Observation data because of the perceived high cost and the fact that in many cases information was not available in the local context. To find a solution to such problems, the National Aerospace Laboratory of the Netherlands had industrialized RAPIDS, a personal-computer-based local ground station for the reception of optical and radar data. Through the ground station, satellite data could be received directly and locally by the user organization in a relatively cheap and straightforward manner. It had been industrialized to operate automatically and to be managed without excessive technical support and with the ability to collect data for the principal area around the user (plus or minus 45 degrees elevation). The ground station was flexible enough to receive data from a range of satellites (European Remote Sensing Satellite (ERS-1 and ERS-2), Japanese Earth Resources Satellite (JERS) and Systéme Pour l'Observation de la Terre (SPOT 1-4) (French Earth observation satellite)), allowing for a multimission and multisensor approach. For ease of transportation, it had been designed to keep within the minimum physical size. The system will be further tested during the monsoon season (March-October) in Bangladesh in 1999 to deliver timely information on floods. It was anticipated that the more timely, cost-effective access to less expensive high-resolution data would lead to an explosive growth in the transfer and utilization of applications using remote sensing data. The focus needed to be on operational activities and the use of appropriate technology to sustain operational remote sensing. RAPIDS was an example of such an appropriate technology. It made it possible to obtain vast amounts of data in a regular and cost-effective manner. Further information on RAPIDS can be obtained from http://www.neonet.nl/rapids/.

Space Imaging would start to commercially distribute l-metre panchromatic and 4-metre multispectral images in mid-l999. The data would be acquired by a new generation of remote sensing satellites, Ikonos-l and Ikonos-2. The image resolution provided by those satellites would be the highest available in the civilian remote sensing data market. The short maximum revisiting time of three days would make possible new applications in infrastructure development, transportation, urban planning and development, environmental management and engineering, disaster assessment, management of natural resources and national and global security.

In the panel discussion on the theme "Matching developing country needs and commercial space applications", needs of the developing countries with regard to satellite communications and satellite remote sensing applications and the relevant commercialization aspects in both areas were discussed. While satellite communications were used on a personal level, remote sensing applications were mainly used by institutions or organizations and were not directly linked to personal needs. The broad base of users was one reason why satellite communications had industrialized into a strong market, while the remote sensing data market was still in a somewhat developmental stage, although slowly growing. To address that problem, the focus for remote sensing applications should be placed on the generation of value added information that was relevant to users on a personal level. Five factors were needed for the remote sensing data market to succeed, namely, affordability, accessibility, availability and timeliness of data, as well as user awareness.

Changes in the commercial remote sensing sector, such as the increasing number of data providers arising from the deregulation of image products after the end of the cold war could also benefit users. The need for a balance between the interests of users who preferred to receive data free of charge and those of the commercial sector that had to work on a profit basis was also discussed. It remained a challenge to match the needs of developing countries and commercial data providers. However, there was a potential for both sides to benefit and to create a win-win situation, if data providers succeeded in demonstrating the cost-benefit advantage of using remote sensing data.

The way forward

With the launch of the first components of the International Space Station (ISS), there would soon be long-term research opportunities for researchers to operate their experiments under microgravity and space environment conditions on ISS. Various initiatives were already under way to commercialize ISS. One of the first private companies providing services for the resupply of ISS, was SpaceHab Inc. The company was selling space on its logistical carriers and pressurized payload modules, and also acting as a consultant for researchers to fly their experiments on ISS. Several institutions in developing countries, e.g., universities in South America, were already participating in various experiments. The high cost of delivering payloads into space and in operating experiments on ISS were still major hurdles to overcome for both industrialized and developing countries in performing such experiments on a routine basis. However, reusable launch vehicles currently under development might one day help to considerably reduce the cost of space access. It was therefore important to inform institutions in developing countries, about opportunities to engage in microgravity research, which, e.g., could help to develop drugs for major illnesses that caused considerable economic and human losses in those countries.

A representative of BRAZSAT, a commercial space company in Brazil and a major player within the Brazilian space programme, discussed the issue of matching developing country needs and commercial space applications. Brazil did not intend to reinvent the wheel, and its space programmes were therefore designed to engage in active global cooperation. The success of the Brazilian space programme and efforts towards commercialization illustrated once more the importance of convincing politicians and decision makers of the benefits of space technology applications.

OBSERVATIONS AND CONCLUSION

Considering that the expansion of the user community of space technology applications in developing countries has been demonstrated in several application domains for improving infrastructures, the participants were aware that cooperative efforts should be made by international organizations and by national entities to promote the use of space technologies. By international cooperation, the risk that the lack of national resources in developing countries will lead to a negative situation in which space technology cannot be used to help the development of these countries.

A crucial point is that the awareness of decision makers in the so called third world must be sustainable increased. Space technologies and space applications must find a considerable place in the policy and economy of developing countries. Some participants have already recognized a good progress since the first UN/IAF Workshop but there is still a long way to go in persuading the policy and decision makers to take a more active role within space affairs.

Participants from developing countries often counted on the United Nations to implement and spearhead programmes. However, the United Nations has limited resources and the Office is limited in the activities it should pursue the following the directives provided by the Committee. It is therefore up to Workshop participants and experts in developing countries in general to approach the politicians and decision makers in their countries and to persuade them to take a more active role within the Committee. UNISPACE III would be an ideal forum for presenting the needs of emerging spacefaring States and development countries and charting the way forward for cooperation in the near future.

The need for regional space agencies to make possible the regional sharing of solutions was stressed by several participants. Especially in the field of small satellite projects, e.g., the development of a constellation of remote sensing satellites to provide disaster warning and management services. Several organizations and committees already existed to coordinate activities in remote sensing and space applications, and developing countries should use the occasion of UNISPACE III to establish links with such entities and to voice their opinions. Participants were called upon to approach their national delegations to UNISPACE III so that proper contact could be established with policy and decision makers in their countries who would in turn make and support proposals to the United Nations.

It was furthermore stressed that a national commitment and a long-term plan were necessary for continued development of space activities and use of space applications. Space policies should be formed in harmony with other existing national policies, striving for balance with the commercial sector in order to be successful. Existing programmes and frameworks for international cooperation must be utilized and promoted. Regional organizations should be established to promote space applications through international cooperation. The education of the young generation of future space managers and professionals was a precondition for the continuity and successful development in space activities in emerging spacefaring States and developing countries.

With respect to microgravity research programmes, it was recommended that future Workshops and conferences organized by the United Nations should continue to inform emerging spacefaring States and developing countries about opportunities to participate in such projects.

There is an enormous potential in the communication sector. The expansion of the user community gives the possibility, that people in developing countries will use communication facilities as Satellite TV and telecommunication (phone and internet) in close future like people in the industrialized world already do.

Space technology can enable a sustainable development. New technologies can be shared world wide in order to reduce the gap between the industrialized and the developing countries. For this it is necessary, that the user community of space technology applications expands in developing countries.

ACKNOWLEDGEMENT

We would like to thank the Government of Australia and the Centre National d'Études Spatiales (CNES) for co-sponsoring this Workshop.

The excellent cooperation with Ms. Annie Moulin, Mr. Karl Doetsch and Mr. Claude Gourdet of the International Astronautical Federation (IAF) and with Mr. Brian Embleton and Mr. Chris Graham of the Cooperative Research Centre for Satellite Systems of Australia is greatly acknowledged.

Particular thanks go to Ms. Karen Doull and Ms. Ruth Lancaster of the Cooperative Research Centre for Satellite Systems, and to Ms. Teresa Crowley, Ms. Yen Lai and Mr. Augustine Arthur for the excellent support given during the Workshop.

We thank Mr. Seorim Lee from the Satellite Technology Research Center of the Korea Advanced Institute of Science and Technology who acted as Rapporteur General of the meeting and who prepared a summary report of the Workshop (A/AC.105/714).

Finally we would like to thank Mr. Jochen Elsen for editing and assembling the Workshop proceedings.

Office for Outer Space Affairs
United Nations Office at Vienna

United Nations Address

N. Jasentuliyana
Deputy to the Director-General,
United Nations Office at Vienna, and
Director, United Nations Office for Outer Space Affairs

Ladies and gentlemen,

On behalf of the United Nations, I would like to welcome you all to this Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries". This Workshop is organized by the United Nations and the International Astronautical Federation and co-sponsored by the Government of Australia and the Centre National d'Études Spatiales (CNES) of France.

This Workshop is one of the many activities organized each year by the United Nations Office for Outer Space Affairs as part of its Programme on Space Applications. The primary mandate of the Programme is to assist developing countries in establishing and strengthening national capabilities in space technologies and applications. This Workshop forms part of the effort of the entire United Nations system to meet this objective.

WORKSHOP OBJECTIVES AND ORGANIZATION

The Workshop this week is the eighth in an on-going series of United Nations activities held in conjunction with the IAF Congresses. Previous workshops have taken place in Montreal, Washington D.C., Graz, Jerusalem, Oslo, Beijing and Turin, Italy. All these activities share the common thread of providing developing countries with a general plan for establishing cost-effective industrial and institutional enterprises in selected fields of space science and technology.

The major question that we will be dealing with this week is how can developing countries, in implementing strategic plans and policies designed to utilize space technology to its fullest extent, expand the user community of space applications. This theme has many implications but the programme we have devised for this Workshop will aim to examine the various reasons why in some cases the use of space applications is still restricted to a relatively small user community. We will also focus on potential solutions to this situation.

Through presentations and panel discussions, we will identify the obstacles that currently exist to keep the user community from growing in many countries and other factors that might, in the future, possibly impede the widespread use of space applications. The different topics for your consideration have been selected to stimulate possibilities for increased scientific and technical cooperation between industrialized and developed countries as well as among developing countries themselves. Additionally, we will consider some insight into areas that are ripe for cooperative ventures between space industry and developing countries.

Presentations on increasing the awareness of decision makers of the advantages of space technology and on drafting a plan for determining a space policy will serve as the foundation for our deliberations this week. In addition, we will examine the training and education of space applications users and the various sectors of space activities that are conducive for increasing the number of users.

EXPANDING THE USER COMMUNITY IN SPACE TECHNOLOGY APPLICATIONS: OPPORTUNITIES FOR COOPERATION

Ladies and gentlemen,

You are all well aware of the growing prevalence of space technology applications in our daily lives. The jet airliners that brought you here were guided by satellite navigation systems. The television programmes that we enjoy are broadcast via satellites. And the mobile telephones that we find so convenient today utilize the latest in satellite communications technology. Yet the vast majority of the world's population has no access to or is not able to take advantage of these seemingly basic tools, which we take for granted today.

For instance, according to a series of articles in the *International Herald Tribune* on telecommunications emerging markets, for services other than basic access to a telephone, 84 percent of all mobile cellular subscribers, 91 percent of all fax machines and 97 percent of all Internet host computers are located in developed countries. By the year 2000, the telecommunications industry is expected to be worth more than $1 trillion annually. This despite half the world's population having never made a phone call. These statistics obviously show an alarming disparity between the developed and developing worlds.

Asia and the Pacific has long been an important region for the space community. Several countries have become avid developers, users and promoters of space technology applications and in many cases, space science and technology have contributed heavily to sustainable development programmes. However, the financial difficulties that have struck this region underscore once again just how interdependent the world's economies have become. Thus, it is even more apparent today that in space-related activities greater regional and international cooperation between countries as well as partnerships with private industry should be further encouraged, especially here in the Pacific Rim.

Until recently, governments had been the driving force behind new developments in space technology. Now industry and private ventures have become important players in their own right and they should also be encouraged to play a more prominent role in development activities. This is one reason why the United Nations is placing new emphasis on its role as promoter and facilitator of international cooperation at all levels in order to benefit the greatest number of people. You will note that the programme of this Workshop was developed to include industry participation as a means to examine opportunities for increased cooperation and to promote initiatives to expand the community of space technology application users.

Let us hope the presentations during the course of the Workshop will provide an opportunity for individuals from both sectors to meet, discuss complementary strategies and ultimately embark on projects that will benefit all parties.

Ladies and gentlemen,

The United Nations will be concentrating much of our efforts over the next few months on the organization of the Third United Nations Global Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III). The Conference will take place in Vienna from 19 to 30 July 1999 and shall add to the experience gained from the last two UNISPACE Conferences, held in 1968 and 1982, also in Vienna.

With one of the aims of the Conference being to further strengthen the capability of countries, particularly developing ones, in the use of space-related technologies for various developmental purposes, our discussions here at this Workshop on how to expand the user community of space technology applications will be contributing to that objective. Please take the opportunity at this Workshop to provide input and ideas to UNISPACE III. I encourage you to consider the agenda of the Conference within the context of this Workshop. Indeed, in the conclusions and recommendations of the Asia-Pacific Regional Preparatory Conference for the UNISPACE III Global Conference held in May in Kuala Lumpur, Malaysia, international cooperation was a continuous theme throughout the final report.

Undoubtedly, the ideas resulting from these discussions here in Melbourne will be included in the report of this Workshop and will also be considered in the discussions of the Preparatory Committee for UNISPACE III. Of course, I would also like to invite all of you to be actively engaged in the preparations of your countries and agencies for the UNISPACE III, and to attend the Conference in Vienna next year.

CONCLUSION

Ladies and gentlemen,

Over the next four days, you will hear a substantial amount of information on how best to expand the user community in space technology applications and other news that will be of particular relevance to your development goals. I would implore you not to miss the chance to talk with all the participants, invited guests and presenters so that a comprehensive understanding may be reached on the final recommendations and decisions to be included in the report of the Workshop, which will be disseminated to high-level policy and decision makers. Additionally, the contacts you make here will be a vital part of the knowledge gained through the Workshop and facilitate future cooperation with your counterparts in other parts of the world.

I would like to express the appreciation of the United Nations to the experts and specialists who will be participating as speakers in this Workshop, many of whom have travelled great distances to be here. I would especially like to thank the IAF, CNES and the Government of Australia for their generous support to make this Workshop possible. I would also like to thank the local Organizing Committee for the Congress, particularly Chris Graham and his colleagues, for their support in locating the facilities and services for this Workshop.

Ladies and gentlemen,

Building on the successes of previous Workshops in this series, the United Nations views these activities as a means to promote sustainable development with as wide a spectrum of participation as possible from the world community while at the same time remaining true to its ideals and objectives of enhancing cooperation and peaceful relations among nations and I would express the hope that this Workshop facilitates this goal.

Welcome once again and please accept my best wishes for a pleasant and productive Workshop.

Expanding the Use of Space Technology Applications-Opportunities and Constraints in Making it Happen*

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*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

ABSTRACT

International space agencies, national space systems, private sectors, research and application institutions have stimulated the development of technological capabilities and industrial infrastructures, along with growing user/consumer markets all over the world. Today, the global space industry has become one of the largest industries in the world with annual revenue of about US $ 80 billion and more than 800,000 people employed world wide. While in developed countries, space benefits have been touching to almost all social segments, industries and academic institutions, space technology, though a powerful tool to accelerate the pace of development, has not been fully tapped to address the developmental issues in developing countries. There are constraints in terms of resources, policies and awareness at different levels, which have to be removed through appropriate adjustments in policies, human resources development, institutional framework, international support.

Since last four decades, Space has proved to be of crucial strategic, political, socio-economic and scientific importance. The coupled with balanced commercial mechanisms.

INTRODUCTION

Applications of space technology over the years have grown manifold and in several dimensions, leading to a wide spectrum of benefits to the human society. The applications which originated in terms of using the synoptic perspective and the vantage point of space such as telecommunications or remote sensing of earth resources have rapidly expanded and diversified, thanks to the continuous developments in related technologies. These developments not only enabled considerable increase in the performance and cost effectiveness of space systems, but also pushed this technology to emerge as a unique tool for several new applications such as positioning, distance education, mobile communications and disaster management as well. This scenario of expanding applications of space has further widened by the growth of commercial sector, which has gained a new momentum in the recent times by the new economic and policy environment in different parts of the globe .

Rapid growth of population, particularly in developing countries, has increased the pressure on the use of their limited resources including the natural resources like land and water. Several urgent needs such as expansion of infrastructures for communications, transportation and education on the one hand and combating recurring natural disasters on the other are the priority requirements for these countries. Space technology, being a powerful tool to accelerate the development in these areas, can be fully tapped to provide the maximum benefit.

Thus, while the opportunities are constantly unfolding for expansion of use of space technology to achieve further social, cultural and economic development, there are constraints in terms of resources, policies and awareness at the right levels. These have to be removed through appropriate adjustments in policies, human resources development, institutional systems, international cooperation and by providing a balanced role for commercial sector.

SPACE BENEFITS TO SOCIETY

Application of space technology has resulted in innumerable benefits to society in terms of providing better capabilities for weather predictions, for expansion of communications particularly to remote and rural areas, generating information relevant for the optimum management of natural resources, for television broadcasting and monitoring of environment. Space activities support one of the largest industries at global level with annual revenue of about US$ 80 billion. Satellites have also been of immense value for providing timely warnings on natural disasters and in assessing the damages. Several new applications involving space systems such as mobile communication services, digital sound broadcasting and direct-to-home television services are emerging to grow. The advent of high resolution remote sensing satellite systems have enabled a wide range of mapping applications which are of immense value to urban planning and generation of information at cadestral level.

OPPORTUNITIES FOR EXPANSION OF APPLICATIONS IN DEVELOPING COUNTRIES

Nearly two thirds of the total global population of 6 billion people live in developing countries. Together they offer a tremendous potential user base for expanding space applications such as communications and broadcasting. They possess less than 3% of the number of telephones and 10% of the number of television sets possessed by developing countries. Their potential demand for new services such as mobile communications are also equally large. For example, the proportion of mobile telephone subscribers as a percentage of total telephone subscribers in several developing countries are comparable to that in developed countries, which indicates the strong preference for this newly emerging service by the customers in developing countries.

The overall space communications capacity which is used for both communications and broadcasting, has been steadily growing over the past years. Nearly 180 satellites are operating in the geostationary orbit and the transponder capacity (in 36 MHz equivalent units) is poised to grow from about 4500 in 1997 to over 10000 (in C, Ku and Ka-bands) by the year 2007. A significant portion of this growth is expected due to the market potential in developing countries. The potential for growth of television, telephone and internet services is at least 4 to 10 times of the present level in developing countries as their economies grow further.

Another major area of space application which has tremendous implications for development is the use of remote sensing data for management of earth resources, particularly the land and water resources, which play an important role in increasing agricultural productivity. The increasing level of populations, in developing countries has dictated the need for enhancing food grain productivity from the present level of 1-2 tons per hectare to 4-5 tones per hectare progressively.

Satellite remote sensing data, in combination with other collateral data and in conjunction with the use of modem tools like GIS could play a vital role in achieving sustainable development. It is estimated that an area of 1.2 billions hectares has degraded in the last 45 years. The monitoring through satellites could be of immense help in arresting land degradation and also in efficiently harvesting water resources. Space technology has effectively been used for locating ground water for drinking and irrigation purposes in a cost effective way in rural areas. Noting that still only 50-80% of the population alone have access to safe drinking water in developing nations, the scope for expansion of this application is high.

Education is a basic need for human development and there is a strong correlation between the level of illiteracy and the socio-economic backwardness. While the industrialised countries with literacy rate of greater than 98% have a per capita annual income of greater than US $ 8000, the developing countries with 50-70% literacy have annual per capita gross income of about US $ 600. The space communications can effectively be used to spread education rapidly to illiterate populations spread in rural areas.

All over the globe, natural disasters have been recurrently causing severe hardships and loss of valuable lives and property. The developing countries have been severely affected by a variety of natural disasters and their consequences. The damage caused during 1990-1994 in developing countries amounted to 60 billion, which is 75% of the total damage caused world wide. Meteorological satellites, land remote sensing satellites and communication satellites can all play several roles which are important in the context of disaster management. They can assist in establishing an efficient disaster warning system, monitoring areas affected by disasters such as floods and drought, deliver timely information and provide objective assessment of damages.

Satellites also enable establishment of rapid communications capability and location services in disaster affected areas.

EXPANDING SPACE APPLICATIONS - VARIOUS MODELS

The experience of space agencies and industries in expanding space applications can be generalised along several models. The space communications services which support a vibrant global commercial market of above 15 billion $ per year, has initially expanded through the role of international satellite systems. As the demands for these services grow in several countries, many national systems have emerged leading to operational services at a national level. With the advent of new technologies, space communications are diversifying from the traditional fixed satellite services and broadcasting services to mobile services and digital broadcast services. One can see a trend of these national systems contributing to the evolution of regional service systems.

On the other hand, there is also an alternate model of systems which originally evolved as regional systems, but later spun off national systems in their participating countries. Deregulation of markets and emergence of new applications are propelling greater private sector role and investments in expanding the space communications. Several global and regional systems in private sector are significant y contributing to these expansion.

In the case of earth observation systems, the development of applications are enabled by the continuity of space segment maintained by a few space faring nations. The earth observations systems, world over, have initially emerged as national system supporting basically the requirement of a particular nation or group of nations. Today we see the transitioning of these national systems into commercial programmes which benefit a wider community of users spread all over the globe and providing varied types of value added services. If we look at a full fledged national system, the drivers for such a system have been the capability perceived need of a country to develop various technology elements required for building a satellite, its payloads, an operational ground system and finally application services to different users. The developmental requirements of the country provide the rationale, both political and technical, to justify strongly for a national earth observation system. At the same time, cooperation and learning from international participation is yet another driver which helps the nation to plan and develop front end capabilities.

The benefit from establishing such national system are directly felt at the societal level because the data supports national resources management, disaster management, generation of wide variety thematic maps and environmental monitoring. Once the societal role of the national user system is well established, the scope for commercial sector development comes into focus and this provides the thrust for transition towards commercial and global earth observation programme. Establishing a system for marketing the data world wide and also providing the value added services for global market would provide the means for enhancing the scope of earth observations programmes. This way of evolution of earth observations programme can mirror the model adopted by many countries which have operational systems today. This model relies on the learning of the total process and focussing of applications towards the developmental activities through national systems and later expand to commercial processes. Alternate mode s involving reliance on commercial space systems for obtaining data and building up of value added activities nationally through private as well as public enterprises could also be more suitable for several countries.

ENHANCING THE APPLICATIONS - APPROACH LONG TERM

Central to the expansion of space technology applications at a national level is the development of a strong user base. Commitment at appropriate political level to develop and expand applications in the areas relevant to national priorities are often a pre-requisite to establish and sustain a national programme. Sustainability of such a programme on a long term basis demands the development of an indigenous technological base coupled with an institutional frame work. Often, implementation of operational services to users on a timely, cost effective and reliable basis call for an initial phase of a pilot scale/experimental system which demonstrates efficacy of applications to users. Synergy among various institutions including the space agency, academia and the national R&D laboratories and networking their capabilities can result in benefits of savings in cost and time. In al these efforts, the key factor for success is the availability of qualified and trained human resources. They play a crucial role in both expanding the space applications and creating the desirable impact on society. As a nation goes through several of these steps, appropriate policies should be evolved not only to fructify the government sponsored programmes but also enable industries to develop a commercial sector that can contribute to the rapid expansion of space technology applications. For example, appropriate evolution in policies regarding distribution of maps can enhance the market for applications. Similarly, policies aimed at developing private sector industry for value added services can enhance rapid expansion of applications in pace with growth in developing national activities.

ROLE OF INTER-NATIONAL COOPERATION

Committee on Peaceful Uses of Outer Space (COPUOS) has been playing a key role in promoting International cooperation has been serving as one of the important means for several countries for expanding the space technology applications. Several countries, after developing certain level of national capabilities in space technology applications, look forward to alliances with others which can extend the synergy of markets, investments and technological resources. International cooperation can play a crucial role in meeting this need. Other areas where international cooperation assume vital importance are the human resource development and cooperation in global scientific programmes aimed at the development of knowledge on earth's environment and its protection. Cooperative approach in addressing humanitarian activities such as search and rescue and disaster management can facilitate sharing in efforts and savings in costs. United Nations international cooperation in the peaceful uses of space through its activities. The United Nations General Assembly decided to hold the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE-III) in Vienna from 1930 July 1999 as a special session of COPUOS, open to all Member States of the United Nations. This conference aims to promote effective means of using space technology to assist in the solution of problems of regional or global significance and to strengthen capabilities of the Member States of the UN, in particular developing countries, to use the applications of space research for economic and cultural development. This provides a unique opportunity for all countries to deliberate on the ways and means for expanding the use of space technology applications for the benefit of all.

OVERCOMING CONSTRAINTS

The major constraints in the expansion of use of space technology applications are posed by the availability resources both in terms of trained human resources and financial resources. All applications of space technology are not commercially viable, even though a significant level of activities are commercialised. Government funding and investment are essential to promote several social applications which are of vital value to the society. This would demand evolution of national institutions and extension of governments' support which in turn need creation of greater awareness among the decision and policy makers. Another constraint to be noted in the context of expanding space technology applications is the high risk/high investment nature of space systems, which inherently favours concentration and integration of industries for space segment development at global level in view of high costs of advancing technologies. Given the current scenario of constraints on the international technology transfer, in this field, appropriate policies are to be evolved, reconciling the role of national industries vis-à-vis global corporations and the private sectors role vis-à-vis that of the government agencies, to meet both social and economic growth objectives.

In the expansion of space technology applications, institutions play a crucial role. Institutionalisation of interface with users offers a challenging task, in view of the dual nature of strategies of "Technology Push" and "Applications Pull" adopted in the context of space applications. Finally, international cooperation is an essential element to expand use of space technology applications, as space activities are inherently amenable for global coverage and cooperation.

Expanding the User Community of Space Technology Applications: New Applications and New Users*

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*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

Expanding the User Community of Space Technology Applications: New Applications and New Users.

presented by Dr Brian J.J. Embleton

Prepared by

Roger L. Franzen

General Manager

Auspace Limited

Where did it begin?

- V2
- Sputnik 1957
- Telstar 1962
- Earlybird 1965

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What Applications Were Developed?

- Communications
- Planetary Science
- Astro Physics
- Launch Vehicles
- Human Biology
- Military

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Who Developed Them?

- The wealthy Industrialised nations (USA, Europe, the then USSR, China)
- Nations who saw no alternative

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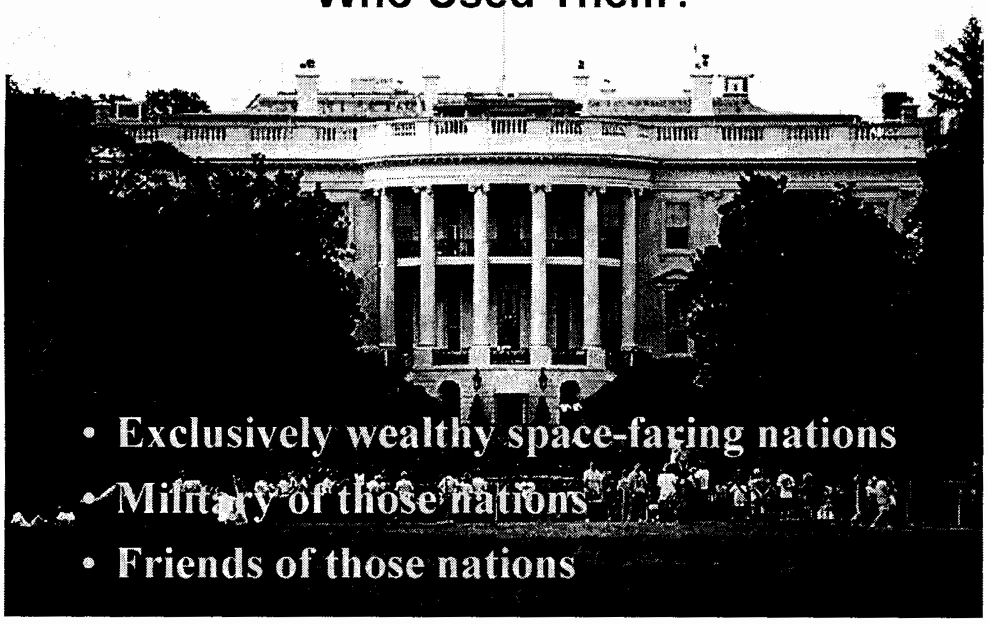
Who Used Them?



Why Could No-one Else Use Them?

- Cost of missions
- Strong political differences
- Lack of Technology
- No access to the Technology Needed
- No assessed NEED

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What Has Changed?

- Global politics no longer assures global destruction
  - however, still unstable
  - however, still unable to attain global unity
  - politics strongly influenced by trade, power & religion
- Space technology is more accessible & affordable
- Space technology is now more Efficient
  - more powerful "tools"
  - new applications of space technology
  - more ways to use space technology

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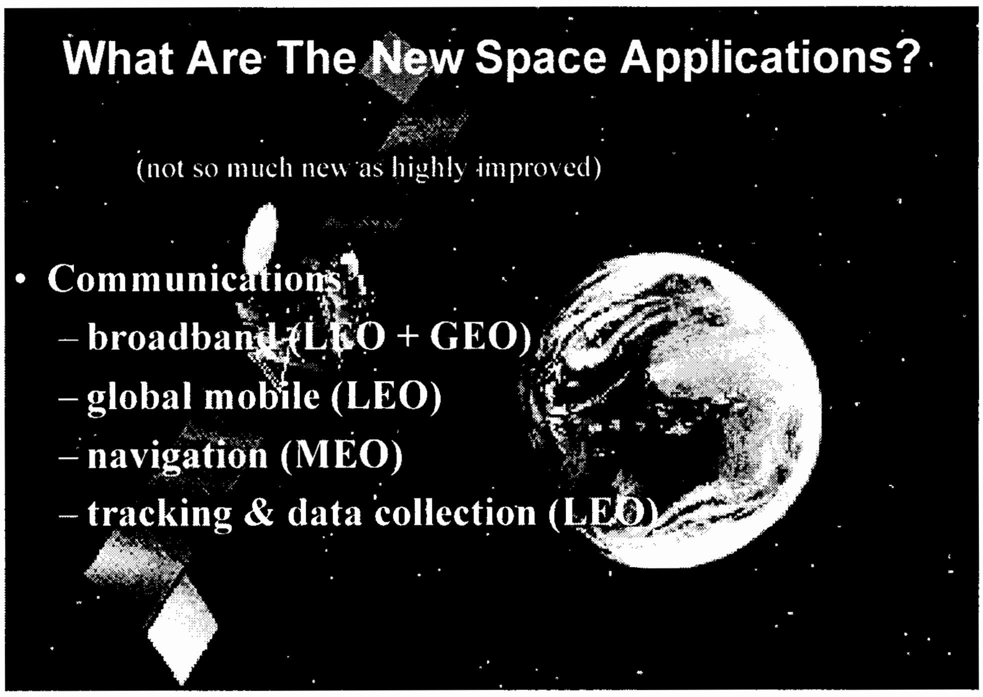
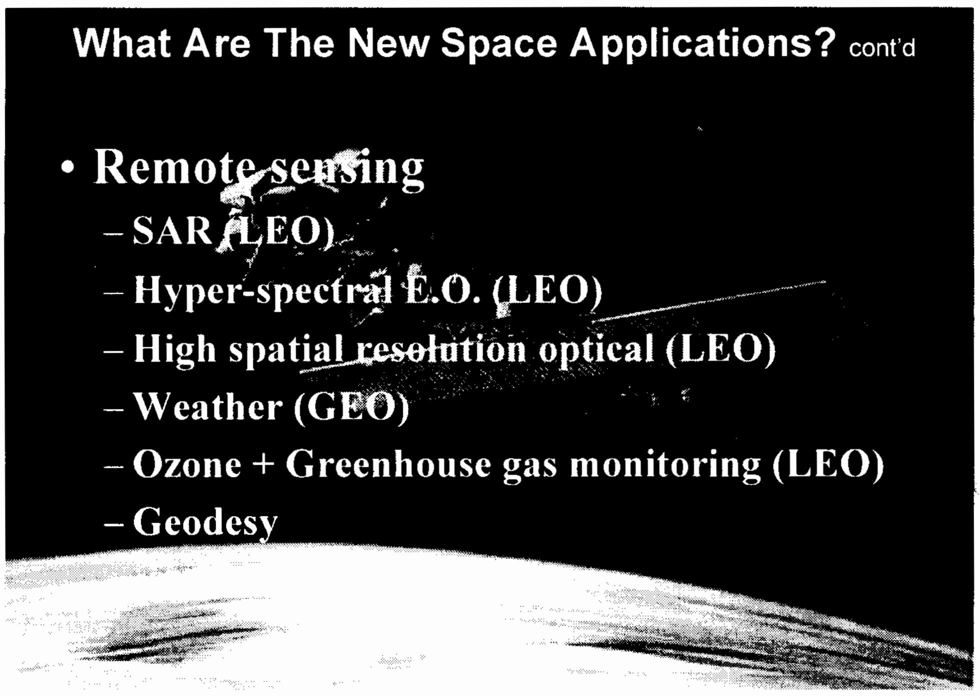

What Are The New Space Applications?
(not so much new as highly improved)
• Communications
– broadband (LEO + GEO)
– global mobile (LEO)
– navigation (MEO)
– tracking & data collection (LEO)


What Are The New Space Applications? cont'd
• Remote sensing
– SAR (LEO)
– Hyper-spectral E.O. (LEO)
– High spatial resolution optical (LEO)
– Weather (GEO)
– Ozone + Greenhouse gas monitoring (LEO)
– Geodesy

What Are The New Space Applications? cont'd

- Science
  - astronomy
  - astrophysics
  - interplanetary
  - magnetosphere
  - lunar
  - comets and asteroids

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What's New About Communications?

- **Widespread Fixed Satellite Coverage in C and Ku Bands now.**
  - **National & International Trunking**
  - **Regional TV and Radio Broadcast via Satellite**
  - **Internet via VSAT networks and DTH**
  - **Village Local Cell Phones to PSTN via VSAT**
  - **VSAT based Point to Multi-Point (MP) & MP to MP**
  - **Integrated Satellite and Optical Fibre Networks**
  - **Copper almost obsolete**

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What's New About Communications?
cont'd

- **Global Mobile Communications (Handheld Voice, fax, Data)**
  - Iridium, Globalstar, ICO, Ellipso
  - Providing Global handheld Mobile Phone Coverage ANYWHERE!
  - Dual Satellite Cellular Modes into PSTN
  - Civilian, Law Enforcement and Military Applications

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What's New About Communications?
cont'd

- **Navigation (Global Positioning System)**
  - "Where am I" to <100m precision handheld Globally
  - "Where are you" automatically to same precision
  - Precise Geodesy for Plate Tectonics and Earthquake Prediction
  - Combined Navigation & Communications Systems (EPIRB's etc)
  - Used in Taxis, Yachts, Ships, Aircraft, Bushwalkers
  - Many Civilian & Military Uses

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What's New About Communications?
cont'd

- **Tracking and Remote Data Collection**
  - Little LEO Constellations Orbcomm, Kitcomm, Others
  - Low Cost Terminals
  - Low Data Rates
  - Low Operational Costs
  - Remote Monitoring of:
    - containers
    - trucks/trailers
    - gas/water/electricity meters
    - pipelines
    - assets + personnel (children,CEOs convicts, etc)
    - security systems
  - Many other low level applications

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What's New About Remote Sensing?

- ISSUES Benefiting from Remote Sensing
  - Land Use
  - Land Cover (vegetation, salination, erosion, flooding)
  - Land Management + Crop Prediction
    - the commercial "edge" in commodities
  - Environmental Engineering
  - Mineral Exploration
  - Weather Monitoring & Prediction
  - Ozone & Greenhouse Gas Monitoring

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What's New About Remote Sensing? cont'd

- Satellite Based Remote Sensing Tools
  - **Synthetic Aperture Radar (SAR)** - all weather day & night
  - **Hyperspectral Sensing in EO**
    - discrete mineral/vegetation identification in single pass
  - **Commercial High Spatial Resolution Imaging (1m to 3m)**
    - object detection
    - data for GIS
  - **Weather Monitoring Instruments** with Global/Regional Perspective
  - **Ozone & Greenhouse Gas Spectrometers**
    - monitoring concentrations, sources and degradation rates
  - **Laser Ranging Systems** for precision Geodesy and Space Object Tracking
  - **Ground Based Data Fusion Techniques**

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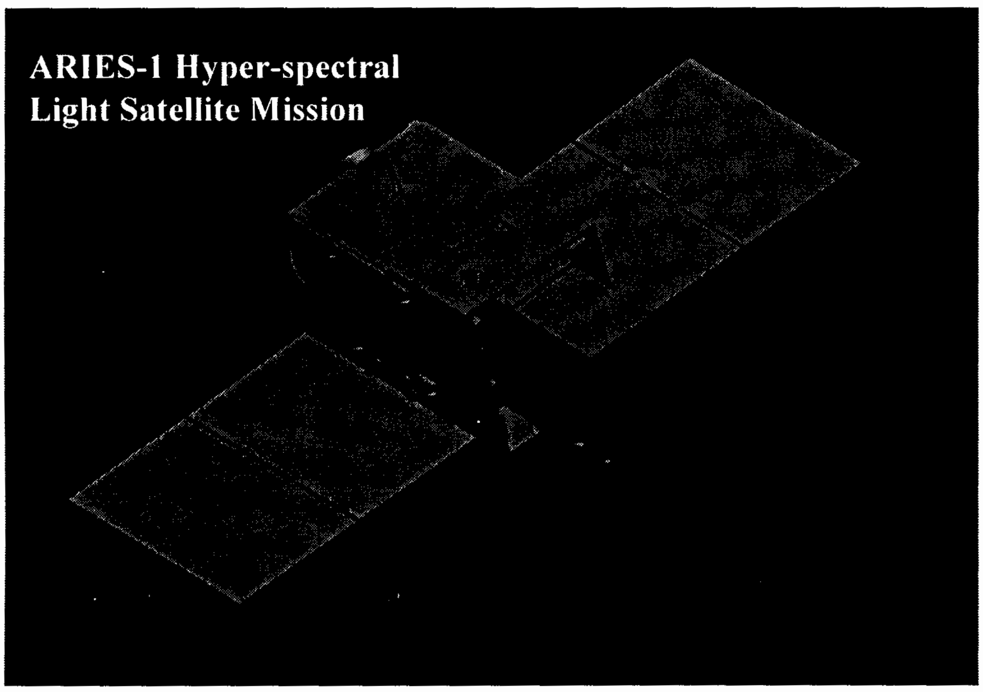


What's New About Science?
• New Scientific Instruments
– Inform Us About the Universe (Hubble Space Telescope & others)
– Measure our near Earth Environments
– Precisely Map the Stars (Hipparcos)
– Observe & Analyse our Planet Neighbours (Mars Explorer & others)
– Observe Our Sun (Ulysses)
– Encounter & Analyse Comets and Astroids (NEAR, others)


CONCLUSION
• New Space Technology Applications Are:
– More Affordable
– More Accessible
– More Accurate
– More Diverse
• All Nations can NOW Use Space Technology Applications in Some Way
• All Nations Means Many New Users

Review of Recommendations of Previous UN/IAF Workshops*

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* This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

REVIEW

The Secretariat of the Committee on the Peaceful Uses of Outer Space (COPUOS) provided in their General Assembly document A/AC 105/692, dated 12 January 1998, a list of the activities sponsored by the United Nations Program on Space Applications from 1971-1997. This reference document provided a summary of 143 activities organized during the last 26 years. These activities included seminars, training courses, expert meetings, conferences and workshops. Since 1982 there had been an increase in the number of training courses and workshops with a concurrent decrease in the number of seminars, expert meetings and conferences.

This focus was necessary to emphasize the need to increase public awareness and training to stimulate indigenous capabilities in space science and technology for application to developing countries needs.

The United Nations Office for Outer Space Affairs and the International Astronautical Federation (IAF) initiated workshops, designed specifically for developing nations. Their purpose was to provide developing countries with a forum to discuss concepts for the application of space science and technology to their needs. This workshop in Melbourne with the theme "Expanding the User Community of Space Technology Applications in Developing Countries" is the eighth in a series, starting in 1991, held in conjunction with the IAF Congresses.

The locations and themes of the previous Workshops were:

- 1991 Montreal, Canada-Space Technologies for Development.
- 1992 Washington, DC USA-Space Technology for Developing Countries-Making it Happen!
- 1993 Graz, Austria-Organizing Space Activities in Developing Countries-Resources and Mechanisms.
- 1994 Jerusalem, Israel-Benefits of Space Technology for the Developing world from Economic Growth to Environmental Protection.
- 1995 Oslo, Norway-Space Technology for Health Care and Environmental Monitoring in the Developing World.
- 1996 Beijing, China-Education and Awareness: Space Technology and Applications in the Developing World.
- 1997 Turin, Italy-Space Technology as a cost-effective tool to Improve Infrastructures in Developing Countries.

The past workshops included a broad spectrum of topics such as sustainable development, food production, education, health care, environmental monitoring, communication, disaster management, agrometeorology and hydrology. Our goal was to address the needs of developing countries providing applicable solutions from space science and technology.

Over 700 participants from 65 developing countries have participated in these workshops. Additionally, these participants were afforded the opportunity to attend the concurrent IAF Space Congresses. They were afforded the opportunity to attend plenaries, technical sessions and industrial exhibits. This provided them with the additional opportunity to meet space experts and industry representatives from both the developed and developing world.

In this paper I will provide a synopsis of the workshops together with a summary of recommendations. It is important that we review these recommendations to assess our progress and to incorporate them in our planning process for future workshops.

Montreal

Our first workshop held in Montreal, Canada concentrated on the areas of remote sensing, resource management, space communications and planning of space programs. In the area of planning, agricultural development papers were presented on using remote sensing for crop information systems and for developing rural water supplies. The session on communications and education included presentations on using communication satellites for education and development, organizing an educational satellite system and a description of space applications for rural and remote health services. Additional papers were presented on industrial and commercial opportunities for developing countries.

Several participants from developing nations also made presentations on the application of space technologies in their countries. An important result of the workshop was the gaining of an understanding of the variety of developing nations needs and the recognition that space technology could provide a means of addressing them.

Key recommendations included:

- Financial resources limit developing countries in the exploitation of space technology for socio-economic development therefore; developed nations should support them by, for example, reducing the cost of remote sensing data.

- Demonstration projects with UN assistance should be established. For example, a cost effective space technology application for land and water resource development and maintenance.

- The UN should continue to provide training and education on the application of space technology to their needs and assist them in the acquisition of modern equipment and facilities.

- To reduce cost, cooperation between developing countries was emphasized. This could lead to joint facility construction and the sharing of remote sensing data. It was suggested that the formation of a space agency for developing countries would enhance cooperation.

- The value of space programs must be clearly enunciated and value added demonstrated before developing countries would fund projects using scarce resources.

- Policy makers, planners and political decision-makers should be invited to future workshops.

- Case studies of the successful application of space technology were requested to be incorporated in future workshops.

- Topics suggested for future consideration were, providing education to remote and rural communities and the use of space technology for natural disaster and emergency preparedness.

Washington

The planning for the second workshop, held in conjunction with the IAF/COSPAR World Congress, included the consideration of the recommendations from the Montreal workshop. The program was divided into two sessions, "Sustainable Development of Natural Resources" and "Modernization through Communication".

Presentations included; agriculture and crop information systems, water resources management and operational agrometeorological programs, monitoring cover and change of forest resources, satellite communication programs for rural education, remote health and safety services, satellite communications for disaster relief and developing an industrial capability in space communication.

The workshop's program not only addresses the above issues but also was designed with the goal in mind to "making them happen".

In the session on Sustainable Development of Natural Resources the following was recommended:

- Developing countries should make maximum use of remote sensing technology as a viable tool in the sustainable development process. Some of the specific programs recommended were; crop and land use monitoring including vegetation, surface water and forests, potential ground water identification, flood management, the identification of potential mineral and oil exploitation, the identification of schools of fish, urban planning, infrastructure planning to include potential sites for dams and reservoirs.

In the session on Modernization through Communication the following was recommended:

- There should be increased study and analysis and the preparation of plans for the development of adequate telecommunications infrastructure.

- Since private companies are more interested in urban telecommunication development, governments should address the rural telecommunication needs.

Recommendations, which resulted from discussions in joint sessions, included:

- To "make things happen" a partnership between the government, industry and the academic community is required to plan and implement recommended programs/projects. Specifically, the government is needed to ensure long term commitment and funding; industry to provide technical expertise and investment in the operational phases; academic institutions to conduct research and assist in the planning of programs, the preparation of feasibility studies and the evaluation of results; the user community, for example farmers, to translate the results into practice.

- Suggest the establishment of regional institutions to foster the exchange of information, the sharing of remote sensing data cost and the development of solutions addressing regional needs.

- There is an urgent requirement to sensitize and educate policy and decision makers on the value of using space technology for sustainable development.

- To obtain acceptance and funding of programs, there is a need for pilot projects and case studies. Development organizations, regional bankers and industry must be brought together to assure adequate funding and development of programs.

Graz

An important recommendation coming from the first two workshops was the need to convince decision -makers on the value of applying space and research technology to the needs of their constituents. The third workshop, held in Graz, Austria, therefore concentrated on the resources and mechanisms for organizing projects in developing countries. Emphasis was placed on case studies.

Presentation subjects included; establishing organizational and institutional infrastructure for a national space program, a case study of a telecommunication project in the Cape Verde Islands, a case study for managing water resources in the Sahel areas, the development and application of satellite technologies in China, introducing and establishing the VSAT technology in Thailand, remote sensing for national development and implementing results achieved in the national Indian satellite program.

Recommendations included:

- More cooperation between developing countries should be encouraged. The Asia-Pacific Multilateral Cooperation in Space Technology and Application (MCSTAD) initiative was used as an excellent example.

- Decision- makers in developing countries need to be shown the value and cost effectiveness of space technology programs in solving their critical problems. They must also be convinced that they can be realistically achieved.

- Developed countries need to ensure that developing countries are not placed at a disadvantage in the allocation of frequency bands and orbital slots for satcoms.

- Intelsat, Inmarsat and other satcom operators should provide satcom capacity to developing nations for the development of communication services such as TV for education to rural areas.

- Satellite data should be made available in a timely manner at an affordable cost unhindered by unnecessary bureaucratic complications and free of external influences. To this end space agencies should make space data available to developing countries in the user-friendliest form.

- Earth observation space techniques should be systematically incorporated into educational curricula not just for the training of space specialists but of equal importance to make other professionals space literate. This would lead to increased public awareness on the value of space.

- Remote sensing institutes should avoid becoming isolated and should actively seek cooperation and even co-location with other institutes such as agriculture, geology etc.

Israel

At our fourth workshop the focus was on highlighting the benefits of space technology to the developing world. The focus on using remote sensing and space communication to address the issues of environmental protection and economic and social development was very appropriate considering the venue of the congress in an arid land location. Presentations included; use of space technology for food security, using space technology in the protection of the earth environment, space education and training in developing countries, remote sensing for monitoring desertification and drought, delivery of mobile satellite services to rural areas and satellite communication for mass education.

Recommendations included:

- Policy makers should be shown that the use of space technology can constitute an important element in the overall development policy of their countries.

- National and international space agencies should take into account the needs of developing countries when defining their programs.

- The involvement of local industries is an essential requirement for expanding the use of space technology and applications in developing countries. This can create the momentum needed to stimulate the development and continuation of programs, leading to the creation of the necessary infrastructure for fostering technology development and utilization.

- Programs for the promotion of economic growth through the use of space technology should be accompanied by parallel action plans to protect the environment and for reducing the impact of natural disasters.

- Remote sensing should be used to identify wetlands for reclamation, the delineation of underground water supplies, to monitor surface water and soil conditions, to provide timely information on crops and to assist in the management of natural disasters such as floods and droughts.

- National and international space agencies should, in cooperation with developing countries, develop pilot projects to demonstrate to decision-makers the value of earth observation satellites.

- Users should be involved from the early stages of space application development leading to the effective implementation and operationalization of applications that are relevant to needs and priorities.

Oslo

At the fifth workshop in Oslo, Norway concentration was placed on the importance of merging space technology with other conventional techniques. Again, the planning considered recommendations from the previous workshops and resulted in Healthcare and Environmental Monitoring as the main themes of the workshop with more emphasis placed on presentations by the participants from the developing countries.

Presentations included; satellite technology in health care, using satellite data in environmental monitoring and planning of national development, national and regional space competence-arriving at an appropriate mix of space and non space technology, global access to the Tele-health and education system (the GATES), a case study on providing health care between countries by Tele-medicine, satellite systems in support of health care services in remote areas, global tropical forest monitoring using remote sensing data, the role of space technology in establishing and implementing disaster preparedness and response policies and the role of satellite systems in meeting the telecommunication needs of developing countries.

Recommendations included:

- It was reiterated that the problems associated with the use of space technology in implementing programs to solve the needs of developing countries was not with the technology, but more regulatory, legal, political, institutional, financial and educational. It was recommended that future workshops focus on these issues, making recommendations to reduce these inhibitors.

- There being a continuing requirement for extensive education on the benefits of space technology, it was recommended that school children in the developing countries be taught subjects related to space science and technology which were most relevant to their countries future needs.

- Noting the ever-increasing cost of participating in space technology programs it was strongly recommended that there be added emphasis placed on international cooperation in space science and technology.

- Developing countries should place a higher priority on the active participation in application of space technology in the field of health care and education.

- The United Nations and other international organizations should play a proactive role in influencing policies that result in the development of telehealth, distance education systems and communication networks.

- Since relatively few countries had the resources to operationally utilize space technology for hazard management, increased access to space technology for such uses should be promoted through international coordination and cooperation.

- Space science should continue to play a vital role, as even a modest investment would pay large dividends.

- A cadre of ambassadors, comprised of successful space technology managers, be organized to increase the awareness of developing nation's political leaders and decision makers of the value of using space technology to provide solutions for their needs.

- Although there was a largé market in developing countries for space technology products it was recommended that more emphasis should be placed on building the required infrastructure to successfully implement space programs.

- Better access to the internet services should be made available for developing nations.

- Comprehensive cost-benefit analyses must be prepared for each program to convince decision-makers in developing countries that expenditures of limited resources on space programs would substantially contribute to social stability and economic growth.

- Involvement of the private sector at future workshops was recommended.

- Government and agencies should be encouraged to reduce prices of remote sensing data and to reduce copyright restrictions.

- Mobile satellite systems should be used for disaster management.

- Satellite remote sensing should be used to help areas affected by land mines.

- Centers should be established that provided for both remote sensing and GIS training. Training should be provided for staff from a variety of agencies thereby fostering information sharing and reducing duplication.

Beijing

The sixth workshop held in Beijing, China concentrated on the areas of sustainable development, the educational aspects of space applications and the improvement of infrastructures through space systems. Presentations included; satellite remote sensing to study and monitor the environment, the contribution of satellite remote sensing data to food and agricultural policy making in drought affected areas, the current status and future perspective of international cooperation in applying space technology for sustainable development, satellite remote sensing to provide information on rural development, motivating teachers and educators to increase the awareness of the benefits of space to the user community, providing medical education to remote and rural areas through space systems, indigenous education and training services in the application of space technology for national and regional development in Africa, space systems in support of increasing the awareness of environmental pollution, and space systems in support of improving infrastructures in remote and rural areas.

Recommendations included:

- Since most space programs and projects require substantial initial investment it is essential to convince policy and decision makers of the value of providing resources to these programs.

- The exchange of data and information on a bilateral or regional basis is important for sharing experiences in preventing or mitigating transboundary and global problems such as environmental pollution and natural disasters.

- There needs to be increased effective education programs on the value of space to gain continuous public support for national space policies and programs. Awareness training is more effective when given by user specialists such as agricultural or water resource managers versus remote sensing specialists.

- Before projects are defined the needs of the user community should be clearly established. Additionally, once the project has been initiated ongoing evaluations should be conducted to ensure program objectives.

- The most sustainable way to encourage the use of space technology is through increasing space curricula at universities.

- There is a need to train university teachers to make the best use of materials available to them, for as wide a variety of local applications of earth observation techniques as possible.

- Schools should start the process of raising environmental awareness through introducing earth observation techniques to their students.

- Demonstration models of space technology applications should be introduced to the public using CDs for display and manipulation of remote sensing satellite imagery.

Turin

Last year's workshop, the seventh in our series, concentrated on four areas which were selected as being critical to the successful application of space technology to developing country needs. They were; enhancing the cost-effectiveness of space technology applications; benefits of international cooperation in space activities; operationalization of remote sensing application; space spin-offs and future applications and for the first time we dedicated an entire session for space industry presentations. The presentations included; Space Technology for infrastructure improvement in developing countries, training of end users for the operationalization of space technology applications, cost-benefit analysis of space projects-an essential need to achieve commitment to provide resources, the role of space systems for creating environmental awareness, GIS based resources management-operational applications at the village level, space systems for disaster warning, affordable access to space for developing countries, telemedicine for applications in developing countries, space flight opportunities-future applications for developing countries.

As can be seen by the content of last year's workshop the planning had included many of the recommendations from previous workshops. Of particular interest are the resultant recommendations, many of which were repeats from our previous workshops. As documented in the report presented to this year's COPUOS meeting they include the following excellent summary.

To trigger long term sustainable development and to support the building of indigenous capacity in developing countries, international cooperation has to materialize in the form of:

- The effective transfer of know-how to developing countries through education, on the job training, opportunities to attend meetings, networking, and increased access to information.

- Coordinated and targeted funding of application projects of high relevance to developing countries, based on a committed partnership by the developing countries in terms of human, technical and financial resources.

- The provision of business opportunities for local industry through joint ventures with companies from more developed countries.

- The creation of an international advisory body on space technology was recommended. Its main task would be to act as reference contact for developing countries that were committed to incorporate the use of space technology for development. This body would be asked to:

  - Ensure the availability of simple but effective executive brochures on the cost-benefit results that could be expected from space application projects.

  - Provide developing countries with easy access to integrated information on results achieved through the use of space technology.

  - Assist institutions from developing countries to define their specific needs and assist them in the preparation of cost- effective analyses of using space technology in local application projects.

  - Assist developing country institutions in the preparation of space technology application projects to attract international cooperation and funding opportunities.

As can be seen from the content and recommendations from the previous workshops, our planning takes into consideration the in-put of the participants. I have included many of these that were reported by the Office of Outer Space Affairs in their reports to COPUOS. In addition there have been other recommendations which addressed the participants views on improving the workshops. They come primarily from previous workshop participants.

Drs. Kami Muninov, Abdulla Khodajaev and Olga Rasuleva from the Uzbekistan State Space Agency, having participated at last year's workshop made the following recommendations:

To speed up the implementation of space technology applications in developing countries, special attention should be paid to creating pilot centers for training local staff on methods of using satellite information. The requirements for these centers include:

- Making necessary equipment available.

- Promoting the free transfer of software for computer processing of satellite information.

- The training of local staff by experts from developed countries.

- Educating and training local staff working in foreign centers, with the objective of transferring the skills and lessons learned to the local centers.

A recommendation for future workshops was to include reports of successful space technology pilot projects. These could be used to convince government and decision making authorities to fund local projects.

Another participant, Dr. Sandra Mejia Mendoza from Nicaragua provided the following recommendations for themes for future workshops:

- How space technology can play a role in alleviating poverty.

- Approaches to making decision-makers aware of the capabilities of space technology in programs associated with the assessment and management of natural resources.

- Marketing techniques to increase the awareness of the value of space related technologies.

- Lessons learned from forest fire emergencies throughout the world specifically addressing such subjects as using space technology for early detection and lightning monitoring.

- There should be more time made available for dialogue/sharing among participants.

Last year we reported some recommendations made by Dr. Salim Mehmud, Chief Scientist and Scientific Advisor, Pakistan. I have selected some which are certainly relevant to the future planning of our workshops.

- We should prepare a compendium of problems faced by developing countries. Prioritize these problems and relate them with the specific space technology techniques, which can be used to solve them.

- Invite, as far as possible, only those speakers who are fully familiar with the conditions and constraints of developing countries.

- Sharp-tune the workshops to respond to the specific needs of the developing countries. The selection of themes and sub-themes should have as a goal the launching of space technology applications projects in the developing countries.

- We should compile a computer database on workshop participants. This data should include information on their activities relevant to the aims and objectives of the workshops.

CONCLUSION

As was so eloquently stated at a previous workshop:

" The problem with adopting space technology in developing countries is not with the technology itself, which exists and is readily available.
The problems are regulatory, legal, political, institutional, financial and educational".

I have enumerated many of the recommendations from our previous workshops that addressed these areas. There are several, which have become ubiquitous. They are:

- The requirement of convincing government officials and decision-makers to spend resources on the application of space technology to the needs of their constituents.

- The need for continuing training and education on the application of space technology.

- The need for a concerted effort to reduce the cost of remote sensing data.

- To reduce the high cost of space application there is the need for more cooperation and sharing between developing countries.

- There should be increased involvement of industry, both local and international in the application of space technology to the needs of developing countries.

If we have achieved one thing during the last seven workshops it is the highlighting of the impediments that have to be overcome. They are funding, data, equipment and software acquisition, education and training, communication for exchange of information and end user and private sector involvement.

We have addressed these and the reports presented by the participants from the developing countries indicate that there has been great advancement over the last seven years. However, there is still much progress to be made.

I can assure you that we will continue to incorporate the recommendations from this and from our previous workshops in the planning of our future endeavors. Our goal has not changed- to assist our friends in the developing world with the application of space technology in order to derive solutions for their needs, thereby improving the living standards of their citizens.

Introducing Space Technology in Developing Countries: How to Increase the Awareness of Policy and Decision Makers*

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*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

INTRODUCTION

Following a global trend, Brazilian policies and national programs regarding space and its uses emphasize the fulfillment of public needs and the strengthening of the country's technological and productive sector. Social welfare is a national priority, and space applications are evaluated for their ability to improve Brazilian people's life quality and standards.

In pursuit of its goals, Brazilian government has identified international cooperation as a powerful strategy to achieve faster and better results, while investments and risks are shared and therefore reduced. For the establishment of partnerships, both public and private sectors are considered.

The transborder, multinational or even global coverage that characterizes space systems represent a highly positive factor favouring international cooperation. In order to optimize the performance of Earth-observing systems, global information exchange efforts and satellite telecommunications networks, it is fundamental that administrations join the international community, thus contributing to the global picture build-up and global information gathering effort.

Worldwide integrated space systems will enable societies to measure, understand and manage Earth's resources, thus learning how to make better and sustainable use of them. The world need to be aware that most of the times the interactions between men and nature may have global side effects, and that environment and climate phenomena may be detected in their early phases in a given region of the world, and impact other areas some time later. We just had a good example of this, with the El Niño Southern Oscillation.

In addition to the above reasoning, the post cold war environment has improved significantly the relations among many countries. Under these new conditions scenario, it is now possible to extend the benefits of space systems to developing countries, that would be otherwise unable to afford the high costs of space systems and applications.

Now, in order to present to you a more complete picture of Brazilian space program and the benefits already achieved or expected, I will briefly describe the guidelines and goals that presently orient the work of the Brazilian Space Agency.

GUIDELINES AND HOALS OF THE BRAZILIAN SPACE AGENCY

Brazilian goals and projects in space faring represent today one of the most suitable instruments to promote the country's progress and growth, since it is well known that space activities are extremely effective in fostering the multidisciplinary and multisectorial cooperation among science, technology and industry.

Since the beginning of the 80's, following another world trend, and recognizing the major role played by some areas like Biotechnology, New Materials, Information Technology (networks), High Precision Mechanics and Chemistry in the elaboration of new products and processes, Brazilian government selected these areas as priorities. At this point, we observe that all these disciplines are present and interactive in space technology.

Brazilian government has systematically allocated financial resources to the research institutions to improve their framework, stimulated industries through fiscal incentives, and funded scientific and technological projects in these areas.

Awarding grants and scholarships to students and scientists, the states' authorities have joined the federal effort, and this has accounted for about 90% of the whole Brazilian contribution to the national development of the R&D sector.

The scientific cooperation in space and correlated areas between Brazilian institutions and scientists and international research centers are submitted to bilateral or multilateral agreements, treaties and other instruments, where the cooperation for the peaceful use of outer space is the outstanding rule.

In order to illustrate the importance that Brazil attaches to the cooperation within the international community, the table below briefly presents some initiatives presently in progress between Brazil and other countries:

Table: International Space Corporation with Brazil

COUNTRY	ACRONYM	FULL NAME	DESCRIPTION
Argentina	SAC-C	Argentinean Teledetection Satellite	Designed and built in Argentina, the SAC-C will be tested at INPE's Lab for Integration and Testing - LIT.
	Sabia	Satellite for Information on Food, Water and Environment	Remote Sensing satellite to be designed and built in a cooperative effort by Brazil and Argentina. Ground stations in both countries will receive the imaging data generated by the spacecraft sensors.
China	CBERS	China-Brazil Earth Resources Satellite	Joint Program for the construction and launching of two (plus two) state-of-the art remote sensing satellites (first launch to take place early next year).

COUNTRY	ACRONYM	FULL NAME	DESCRIPTION
France	Argos	Data Collecting System	Through this program, Brazilian Data Collecting Platforms can send data to the Mission Control Center, using the French Spaceborne Argos Data Collecting System
USA	Balloon	Stratospheric Gases Measurements Campaign	In the context of the "Mission to Planet Earth", the Brazilian INPE and the American NASA conduct atmospheric and stratospheric gases measurements, in an effort to determine present and predict future environmental conditions.
	CIMEX	CCD Imaging Instrument Experiment	Brazilian CCD Camera, designed to fly on board a National Remote Sensing satellite, will undergo tests on NASA's Space Shuttle, before being commissioned for a real mission.
	HSB	Humidity Sensor Brazil	Brazilian-built sensor that will fly on a NASA's Remote Sensing satellite.
	ISS	International Space Station	Brazil will participate in the ISS program, providing parts, sending Mission Specialists to space and having access to the Station facilities, to conduct experiments and research of National interest.
	TRMM	Tropical Rainfall Measuring Mission	Brazil participates in the NASA's TRMM Ground Validation Program, which will ensure the accuracy of the measurements to be accomplished by the satellite in the tropical regions.

To those who study and analyse scientific and technological development, it is clear that space activities are essential, they constitute one of the major sources of high value-added jobs and research & development achievements in the field of new discoveries.

We live in an era that can be labeled as "Technological Revolution" and, among all other alternatives that can be identified as being important or vital for the national development process, space-related sciences are those that have most influenced human life on Earth, being at the heart of many dramatic changes that occurred over the last three decades. These changes were originated by a fast growing obsolescence process that hit a whole set of former values and rules, all of them being now continuously replaced by what is new, better and more efficient.

The development achieved in space faring is not limited to sciences and engineering. Impressive progress has been made in new techniques, as well as new procedures in multiple-variable project management. In these aspects the technological revolution found solutions for many socioeconomic problems like housing, pollution, transportation, medicine, agriculture and other modern diseases that are characteristic of the human society.

The benefits already obtained are many, and they are difficult to list. What is most astonishing, however, is that the future will bring many more, and to predict what they will be is a challenge to our imagination. The economic outcomes of space program, looking at those nations that invested most in the field are obvious but many times underestimated.

The return on investment made in space faring has been measured only in terms of salaries paid and profits earned by all organizations participating in the projects. This is not sufficient, however, to make one realize the outstanding contribution the space sector has made to human progress and development.

It is amazing to notice that space programs are enormously expensive and in spite of the huge investments made in space activities, results measured show that in fact, those nations that have spent much money in space faring became stronger than never before, through the knowledge of their land, agriculture, weather and other parameters that improved their citizens life standards.

Space technology has brought about new boundaries in education; a true revolution in electronics; in medicine, it has produced achievements within time frames never wondered of before; in telecommunications, it allowed for a globalization that would be impossible otherwise; meteorology and agriculture have benefited from remote sensing and productivity increased dramatically in the fields.

All those that somehow depend on geographic localization around the world know the Global Positioning system. GPS terminals are becoming standard equipment on aircraft, boats and trucks. The precision in navigation and position determination provided by GPS is allowing for significant savings in air, sea and ground transportation systems.

It would be very difficult to identify and measure to what extent space technology has changed our lives. We could say that almost all fields of human knowledge were influenced somehow. In short, it is possible to state that without it, the world would be different: less efficient and less capable.

In Brazil, although the efforts in space faring have been much smaller than in more advanced countries, the results can be seen in every segment of our society. Always struggling against budgetary constraints, Brazil could never afford a space program with targets like fly to the moon or deep space research; instead, the country's investments were concentrated in space applications aimed at the solution of national problems, like telecommunications, remote sensing for agriculture improvement and forest fire monitoring.

As a potential major user of space applications, Brazil currently invests in a program that will lead to the installation in the country of a complete capability in space: development of a launch vehicle, design and construction of satellites and satellite-based sensors, and construction of a launch site. As I mentioned in the beginning, international cooperation and partnership has been a good strategy to reduce costs and risks, and Brazilian Space Agency is always looking forward to identify potential partners, countries with similar problems to solve, with whom we can share a solution.

Drafting Space Policy Plans for Developing Countries – A necessity to effectively Co-ordinate and Enhance the Use of Space Technology Applications*

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*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

INTRODUCTION

A space policy for a country is a prerequisite for co-ordinated use of space applications for its development. However, there is hardly a country that we know of which had started all its space activities after the establishment of a Space Policy. Many a nation has used space science and technology initially more in an ad-hoc manner until a state is reached where a policy became a necessity. Once a policy is decided on, it is also not considered as something sacrosanct but the policy has to be updated in line with developments in space technology and with time.

The space policy of a country naturally will depend on its technological and financial ability and the state of maturity reached in space technology applications. To a lesser extent it also depends on the prestige of a nation when it comes to major players.

The space policy of the U.S had a major transformation after the launching of a manned space flight by the Soviet Union in 1961 which prompted President John F. Kennedy to declare as a part of the space policy of the U.S to put a man on the moon and bring him back before the end of the decade, which they were able to accomplish in 1969.

The space policy of President Ronald Reagan in 1982 was more demanding. He emphasised that the basic goals of the U.S space policy are to :

- strengthen the Security of the U.S.,
- maintain U.S Space leadership,
- obtain economic and scientific benefits through the exploitation of space,
- expand U.S private sector investment and involvement in civil space related activities,
- promote international co-operative activities in the national interest, and
- co-operate with other nations in maintaining the freedom activities which enhance the security and welfare of mankind.

In this policy, Security of the U.S, supremacy of the U.S and national interest came first. U.S was able to accomplish this policy in view of its technological capability, its financial capability and the maturity of the U.S in space technology applications.

SPACE POLICY FOR DEVELOPING COUNTRIES

Developing countries cannot adopt the space policies of advanced countries such as U.S and the former Soviet Union. They have neither the technological capability nor the financial capability to adopt space policies of advanced countries. Developing countries will have to develop their policies in their own milieu, constrained by limited technological capability, financial ability and availability of human resources.

The Space Policy of such nations has to be drawn up to meet their own national needs and priorities and must complement and be in consonance with other national policies such as in education, communications, agriculture and water resources, forestry, coastal management etc. In developing such a policy we have to recognize the differential abilities of the many developing countries and a policy which is suitable for India for example will not be suitable for Sri Lanka. The reason for this is that different countries which are described as developing countries have varied states of maturity in space technology and varied technological and financial capabilities.

For instance, India and China have achieved very high levels of capability in space science and technology so much so that their abilities are in some aspects equal to those of some developed countries and sometimes surpassing some of them. Quoting from Prof. Rao's book on Space Technology for Sustainable Development, with reference to India he says "The ultimate success of a space program in meeting the requirements of a nation, depends as much on the basic policy of the country as on its implementation". "The major reason for significant achievements made by India in the development and application of space technology is due to its long term commitment to an integrated approach with a well defined goal of using space technology for national development to tackle identified national tasks".

"The Indian space programme forged an excellent co-operation with other user departments such as agriculture, water resources, minerals, ocean development, rural development, communication and education, through appropriate structural adjustments, to ensure that the benefits from space do not merely remain in research domain but are well integrated into the national developmental plans".

These are statements worth dwelling on in trying to draft a national space policy. The national needs no doubt are not similar and if the policy is to satisfy the national needs, the national policies will certainly have quite a diversity even among the developing countries.

For a country like Sri Lanka, even the term "space science & technology applications" is rather new. It is recently, certainly after the Ministerial Conference on Space Applications in 1994, that the term "Space Application" from our country's point of view could be interpreted as earth observation from space or space science and technology relating to near space not beyond the synchronous orbit. Interstellar space or even interplanetary space is too much for us to be involved with.

A result oriented space science and technology policy and plan, that has direct and immediate results which will benefit the bulk of the people are more the concern of countries like Sri Lanka. Such a policy only will have public and governmental support despite the fact that the areas of applications will naturally be very limited.

Satellite communications, satellite TV broadcasts (conventional and direct broadcasts) satellite meteorology, satellite earth observations are of much importance to us than design and launching of satellites or rocketry. The latter are ill affordable by way of technology human resources and financial resources.

Even in the former areas of space applications, international and regional co-operation and technical assistance have been prerequisites. This is the reason why Sri Lanka as a member of the Intelsat has contributed funds for using the system for international communications. Fortunately, in satellite meteorology, due to the magnanimity of the organizations that control meteorological satellites, the financial burdens are less and the dependence is for hardware and software which have become more economical, and sometimes the data have been made available even on the internet for a small fee or free. Earth observations data, unfortunately, is much controlled by the satellite operators and either the current data is not being made available or it will be at an exorbitant price. Even the operators in the region peg their prices at international level.

All these ramifications must be taken into consideration in developing a space science and technology policy for small developing countries which I prefer to call fourth world" countries.

RECOMMENDATIONS

With these as the background, it is my view that a country specific space science and technology policy should embody the following aspects:

- To use space science and technology as an integral part within the broad area of science and technology to achieve economic development and human well-being.

- To involve scientists and engineers proficient in space science and technology and such professionals from departments using space applications in the formulation of policy and plans.

- The priority areas of space applications selected to be country specific and should be areas where direct results are assured and the benefits accrue to bulk of the people. While not decrying R & D in any of these areas, emphasis must be on the utilization of the already gained knowledge and technology by other advanced countries rather than trying to re-invent the wheel, so to say.

- To foster a strong cooperation both regionally and internationally in the utilization of space science & technology in view of the limited technological and financial capacity of a country.

- To seek assistance from UN and other international and national organizations to develop the capacity of the country in space science and technology.

- To provide education and training in space science and technology within the appropriate educational institutions of a country with a view to develop some sort of self-reliance in the field at least at a distant date.

- To allocate reasonable and adequate funds for space application activities to enable the fruits of space science and technology to be brought within easy reach of the common folks.

- To provide all facilities to those engaged in space applications in the country to interact with counterparts in other countries in order to advance their knowledge in the face of the ever increasing knowledge and sophistication in space science and technology.

- Once the policy is decided on, it is to be ensured that this will not be thrown of course for political expediency by changing governments.

UN Centre for Space Science and Technology Education in Asia-Pacific (CSSTE-AP) – Committed to Capacity Building*

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*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

INTRODUCTION

The countries of the Asia and Pacific region have several links in political, cultural, commercial, academic and religious fields. It is hence appropriate that we strengthen this historic linkage in the field of generating knowledge that could assist in meeting the present and future challenges. The Asia Pacific region with around 27% of the global landmass, accounts for about two-thirds of the world's population. The rapid increase in population places a heavy burden on the limited resources available in the region. A corollary to the exploding population growth is increasing pollution and the disturbance of the fragile eco-systems. Large-scale deforestation has resulted in increased soil erosion and frequency of disasters like flood. Waterlogging and salinity, desertification, drought etc are the related phenomena often affecting the region. Besides the above, the other sectors overloaded are education, health care, food, energy, housing, communication and other services of importance to the quality of life of the peoples. Parallely, the region has attracted worldwide attention due to the high economic growth and increased developmental activities. Balancing these developmental activities for improving the quality of life with the need for conservation and preservation of natural resources and environment calls for adopting appropriate strategies for sustainable development.

Benefits of harnessing the new developments in high technology areas like space technology, information technology and biotechnology for sustainable development have been well recognised and many countries in the region have started looking towards assimilating these technologies as part of their developmental plans. Space technology, particularly satellite remote sensing, satellite communications, satellite meteorology and space sciences provide powerful means of appropriately addressing the above issues of relevance to the quality of life and sustainable development. For effective assimilation and adaptation of space technology and its applications, efforts are needed for appropriate capability building in high technology knowledge and expertise.

NEED FOR EDUCATION OPPORTUNITIES IN SPACE TECHNOLOGY APPLICATIONS

The benefits of space technology, both direct and indirect, have introduced new dimensions into the study and understanding of Earth's processes and in improving the quality of life for the people living on it. All countries should have access to space technology and must share the benefits. An essential prerequisite to partaking in these opportunities is the building of various indigenous capacities for the development and utilisation of space science and technology.

In recognition of such a prerequisite, a consensus has emerged within the international community that if effective assimilation and appropriate application of space technology are to succeed in the developing countries, dedicated efforts must be made at the local level for the development of necessary high-level knowledge and expertise in space technology fields.

To this end, the United Nations General Assembly, in its resolution 45/72 of 11 December 1990, endorsed the recommendations of the Committee on Peaceful Uses of Outer Space (COPUOS) that "the United Nations should lead, with the active support of its specialised agencies and other international organisations, an international effort to establish regional centres for space science and technology education in existing national/regional educational institutions in the developing countries". Based on this recommendation, the United Nations initiated the process of establishing Centres of Space Science and Technology Education at the regional level in the developing countries.

THE CENTRE FOR ASIA PACIFIC REGION

Based on the report of the UN Evaluation Mission, India was selected as host country for the Centre in Asia and Pacific region. The Centre was established in India on November 1, 1995 when the Agreement of the Centre was opened for signature by countries in the region. As of now 13 countries of the region have signed the Agreement for the Centre's establishment. These 13 countries are - Democratic People's Republic of Korea, India, Indonesia, Kazakstan, Kyrghysztan, Malaysia, Mongolia, Nepal, Nauru, Phillipines, Republic of Korea. Sri Lanka and Uzbekistan.

The Centre's Campus is situated in Dehradun, India around the infrastructure available at the Indian Institute of Remote Sensing (IIRS), Dehradun, which is a part of the National Remote Sensing Agency, Department of Space, Government of India. For fulfilling its programmes, the Centre has arrangements with Space Applications Centre, Ahmedabad - playing as host institution for programmes related to Satellite Communications and Satellite Meteorology and with Physical Research Laboratory, Ahmedabad for programmes related to Space Sciences.

Governance of the Centre

The Governing Board (GB), represented by the signatory countries, is the principal policy-making organ of the Centre. The Governing Board determines the policy of the Centre, approves its long-range plans and annual programmes. Presently, India serves as the Chairman of the Governing Board.

An Advisory Committee provides technical support to the GB and serves as the technical arm of the GB. The Advisory Committee is being formed with experts from different countries.

The Centre is headed by a Director who guides the overall programme of the Centre. A full-fledged Director of the Centre is already functioning as of now.

Linkage to UN bodies

The Centre has maintained close working relationships with the United Nations, particularly the Office for Outer Space Affairs (OOSA) and Economic and Social Commission for Asia and the Pacific (ESCAP).

The Centre has entered into a Cooperation Agreement with the United Nations that defines the affiliation of the Centre to United Nations and also the working relationships between the two agencies in terms of technical assistance, support etc.

UN has provided travel support for the scholars to attend the courses and has also assisted in finalising the curriculum for the courses of the Centre.

Goals of the Centre

The Centre is an education and research institution that is capable of high attainment in the development and transmission of knowledge in the field of space science and technology. The Centre's programmes aim at development of indigenous capability of participating countries in designing and implementing space-based research & applications programmes. The Centre also fosters continuing education programmes for its scholars and awareness programmes for policy and decision-makers and the general public.

The principal goal of the Centre is the development of skills and knowledge of a specific "target group" (as of now, the target group includes university educators, research & applications scientists) through rigorous theory, research, applications, field exercises and pilot-projects in various aspects of space science and technology that can enhance the capabilities of countries in the Asia Pacific region to maximise the benefits from space. Indirectly, the Centre aims to contribute in the overall social and economic development in countries of the region by the optimum use of space technology.

HOST COUNTRY AGREEMENT

The Government of India has concluded a Host Country Agreement with the Centre by which according it specific privileges and status. The host country is providing all necessary support and facilities to the Centre - in terms of fellowships, technical facilities, administrative support, faculty and experts. With almost more than US$ 6 million investment and a recurring of about US$ 700000/year being provided by the host country, the Centre has obtained a good foundation and has emerged as a regional institution. At this stage, the thrust is to further the next stage of the Centre by establishing full-fledged facilities and faculty/fellowship prourammes for the Centre.

Support Obtained from UN Agencies

The United Nations offices, particularly UN-OOSA and UN-ESCAP, have provided support to the Centre's education programme. The support has been mainly in the form of travel grant for the students of the first course.

UN-OOSA provided a grant of about USD 75,000 to the Centre - mainly for the purpose of supporting the travel of students for the different courses of the Centre. UN-ESCAP has also supported the travel of 4 students from the Asia Pacific region to attend the first course on Remote Sensing and GIS of the Centre.

CENTRE'S EDUCATIONAL ACTIVITIES

The initial emphasis of the Centre is to concentrate on in-depth education, research and applications programmes, linkages to the global programmes/databases, execution of pilot projects, continuing education and awareness and appraisal programmes. Scholars and professionals who will contribute to the educational programme will be renowned experts in their respective fields from both within and outside the region. The educational activities of the Centre include:

- Natural Resources Management (RS and GIS) with emphasis on the utilisation of Remote Sensing and GIS for efficient natural resource utilisation/monitoring and generating sustainable plans of development. This module is a 21-months programme, including 9 months of course work in India and 12 months project work in the candidate's country.

- Satellite Communications (SATCOM), with emphasis on the understanding of communications technology and its applications for providing services for education, health care, rural communication etc. This module is also a 21-months programme, including 9 months of course work in India and 12 months project work in the candidate's country.

- Satellite Meteorology and Global Climate, towards research and study of regional climate and weather modelling with a view to understanding and managing the phenomenon of cyclones, rain-storms, cloud-dynamics etc. This module is a 21-months programme, including 9 months of course work in India and 12 months project work in the candidate's country.

- Space Science, with emphasis on the understanding of the basic aspects of Space and Atmospheric Sciences. This module is a 1 2-months programme, including 6 months of course work in India and 6 months project work in the candidate's country.

On the successful completion of the course, MSc (Tech) - for the 12 months course of Space Science and MTech - for 21 months course of RS and GIS, SATCOM and SATMET is awarded from a reputed Indian University.

The Curriculum of the courses have been based on the UN Experts Groups recommendation and is as per the guidelines laid down by UN-OOSA. The common module is oriented more towards the thematic subjects, as the case may be.

EDUCATIONAL ACTIVITIES - A REPORT

The Centre has been conducting the educational activities - mainly the PG courses and the short-term workshops.

The increasing interest by the countries of the Asia-Pacific region in the Centre and its education programme is reflected in the large number of students that have attended the course and also the wide spread of countries benefiting from the Centre's educational activities.

Post Graduate Course in RS/GIS-1996

The first phase PG course in RS/GIS was conducted between April 1St and December 31St, 1996 at the Indian Institute of Remote Sensing, Dehradun. 25 participants from 14 countries attended. The faculty for the course were experts in the field of Remote Sensing and GIS and was conducted using the state of the art facilities at IIRS, Dehradun. The Governing Board also had an opportunity to interact with the course participants during the visit by them in September, 1996. As part of the first phase, a project concerning the specialization of each candidate was conceived and completed. On return to home country, the participants started working on the second phase of the course by way of taking up a follow up project with active guidance from scientists assigned by the Centre.

As of now, a third of the participants are completing the follow up projects and are in the process of submission of reports to the Centre by the middle of this year. The Centre has already received reports from four of them. One third of the participants have indicated their ability to submit the reports only by the second half of 1998. However, the remaining third of the participants have made slow progress and are hoped to submit reports only in 1999. The Centre is periodically following up on the progress of the project work of all the participants. As the reports have started coming in, the evaluation procedure is being worked out with Andhra University.

Post Graduate course in SATCOM-1997

The first phase of first post graduate course in SATCOM was conducted between 1St January and 30th September 1997 at the Space Applications Centre, Ahmedabad. 13 participants from 9 countries attended the course. The first phase ended with the completion of a module dedicated for project work of interest and specialization of the candidates. The scholars have returned to their respective organizations and are working on the second phase 1-year projects.

Post Graduate course in RS/GIS-1997-98

The second PG course in RS/GIS has started on October 1St, 1997 at the Indian Institute of Remote Sensing, Dehradun has also been completed. 23 participants from 14 countries attended the course. Some modifications to the course have been brought in as part of an attempt of improvisation. Significant amongst them are, reduction of overlap of subjects between the first two modules, reduction of emphasis on theoretical aspects, increase of practicals pertaining to DIP & GIS, reduction of number of lectures in the first two modules and increase in emphasis on specialized subjects in second module in comparison to general topics.

Post Graduate course in RS/GIS-1998-99

The first phase of the third PG course in RS/GIS is slated to start on the 5th October 1998. 21 students from 13 countries have been selected for this course. The stress this time will be on the projects and more hands-on learning.

Post Graduate course in SATMET

The first phase of the first PG course in satellite meteorology has begun on the 1St March 1998 at Space Applications Centre, Ahmedabad. 15 participants from 10 countries have been offered admissions.

Post Graduate course in Space Sciences

The first PG course in Space Sciences has begun on 1St June 1998 in the Physical Research Laboratory, Ahmedabad. 11 students from 7 countries are attending the course.

Short-duration workshops

An international workshop in Satellite Communications was conducted in January, 1997 coinciding with the commencement of the PG course in SATCOM. All the 13 participants of the PG course in SATCOM and an additional 9 persons attended the workshop.

An international workshop, in memory of the famed meteorologist - Prof. Verner Soumi, on "Emerging trends in satellite meteorology" is planned to be conducted at Space Applications Centre, Ahmedabad between March 9th and 12th, 1998.

Impact of the Courses conducted by the Centre in the region

The Centre has already completed two post graduate courses and one awareness workshop. One course is currently running and two courses and a workshop are planned to be conducted during this year. From the courses and workshops conducted so far, 70 participants representing 20 countries have passed out of the Centre. This number in itself is indicative of the Centre's outreach and beginning of a regional impact. Further, the post graduate courses have offered an excellent opportunity for the participants from the region to pursue a project of high relevance to their respective country. Subsequent to their return, the participants have taken up those projects that address a significant social context.

Linkages with other institutions

The Centre has established and benefited from linkages with several esteemed national and international organizations. Linkages with IIRS, SAC and PRL are of umbilical in nature. The ICIMOD, UN-OOSA, MEA/GOI and UN-ESCAP have offered fellowships to the course participants and have advised the Centre in various contexts. The Third World Academy of Sciences (TWAS) has offered to consider recognizing the Centre as an associate centre of excellence, enabling us to receive the benefit of receiving research scientists as lecturers. The Videsh Sanchar Nigam Ltd (VSNL) has indicated that it can substantially support the Centre with fellowships for SATCOM course. These leads are being vigorously pursued. Recently, a proposal to obtain support for fellowship, facility, faculty and consultancy services has been submitted to the Government of the Netherlands

Publications

The Centre has decided to issue a newsletter periodically once every three/four months. The newsletter would portray the Centre's progressive philosophy, report on activities, help being in touch with the alumni. The very first issue has just been prepared and is released on this occasion. The Centre has initiated action on preparation of a digital publication encompassing all the earlier hardcopy publications. This publication is planned to be prepared in HTML format, so that it can be made available on Internet if needed. The Centre has also initiated action on preparation of a promotional Video.

Future schedule of educational programmes

Apart from the already conducted courses, the future plan of the Centre is to conduct education programmes as per the following schedule.

- Remote Sensing and GIS course (1 year and 9 months)
  - October, 1999 onwards

- Satellite Communication course (1 year and 9 months)
  - early, 1999 onwards

- Space Meteorology course (1 year 9 months)
  - early 2000.

Subsequent to these courses, another cycle of courses would start and almost 4 courses per year (in the 4 disciplines) is planned to be conducted after 1 999-2000.

AFFILIATION TO UNIVERSITIES

Presently the Centre's educational programmes are affiliated to Andhra University, Visakhapatanma which is awarding M.Tech degrees in Remote Sensing and GIS, Satellite Communications and Satellite Meteorology. For the Space Science courses, the university will award M.Sc (Tech) degree.

BENEFIT TO ASIA PACIFIC COUNTRIES

90 students from 22 countries have benefited from the education courses of the Centre. These students have been exposed to the frontier of space technology and will do a project in their home country. They will also act as catalysts to spread the technology in their own countries - for which the Centre will provide all assistance and support. About 130 students from about 25 countries in the region have benefited from the Centre.

CONCLUSION

Though the concept of Regional centres was first proposed in 1980s, this Centre in the Asia pacific region is just about 2 1/2 years old - and the Centre is already into its fourth educational course today. The vision of the United Nations that the Centre would enable the Member States to build indigenous capabilities in the development and utilisation of space science and technology and offer opportunities to them to partake in the benefits of this high technology is already taking shape. To each one of us associated with the Centre, it is a deep sense of satisfaction that what the United Nations initiated almost 10 years back has shaped into a major international institution in the region.

The Centre has been established by UN to provide space education to AP countries. The Centre in the Asia Pacific region has been operational for the past 3 years and is providing operational courses in 4 areas - RS and GIS, Satcom, Satmet and Space Science. Presently mainly support by India and the UN, the Centre envisages to emerge into a Centre for excellence. With 7 courses already completed/on-going and about 130 students having undergone the courses, it is perceived that the Centre will impact national level activities at various levels.

In the coming days, the Centre would expand its scope of activities through the various educational programmes, short term training programmes, research programmes and faculty exchange programmes. A vision for the Centre has been set out - that it will become the nerve-centre for coordinated research and projects in the area of space technology and applications in the region - specially considering the fact that there is no such single agency concentrating on education, research and projects in the region. These research and project endeavors would provide the countries in the region to initiate larger national level programmes which incorporate space based inputs and enhance their ability to utilise the technology for their own developmental programmes. The Centre would hopefully bring to fruition the goals and visions that the United Nations had set out for the regional Centres, including this one for the Asia-Pacific region.

ACKNOWLEDGEMENT

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The WorldSpace Digital Sound Broadcasting System for Education and Applications in Rural Areas*

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*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

" Children ought to be educated, not for the present but for a possibly improved condition of man in the future; that is, in a manner which is adapted to the idea of humanity and the whole destiny of man".

- Immanuel Kant

WORLDSPACE

"The present day world is marked by a population explosion, the imperative requirements of economic development and the fight against hunger, the scientific and technological revolution, the multiplication of knowledge, the rise of the masses, the consequences and new expressions of the democratic idea, the extension and proliferation of information and communication media, this world is making and will make many new demands on education".

- International Commission on the Development of Education.

WORLDSPACE

The Global Paradox

- Education is accepted as an inevitable element of improved quality of life.
- Liberates the mind... empowers the individual... improves the quality of life... benefits the society.
- Universal declaration of human rights, proclaiming that everyone has the right to education was adopted in 1948 by U.N.
  - At least 1 billion, including 300 million children are unable to exercise or have never exercised this "right".
  - Less than 68% of eligible children are enrolled in school.
  - Number of students in tertiary level - A meagre 6% of primary enrollment, in developing countries.

WORLDSPACE

The Explosion!

- "l' explosion scolaire" or pupil explosion
  - 2.5 billion in the age group of 5-24 by 2000 A.D.
  - UNESCO Recommends a minimum of 4% of GNP as educational expenditure; currently varies from 0.5% to 12%.
- Knowledge Explosion or technological revolution
  - New frontiers, new vistas, new applications
  - Space technology, Information technology, Biotechnology.

WORLDSPACE

The Issues

- Conversion of rapidly growing population into Human Resource
- Access to education
- Poorly trained trainers
- Unfavorable student - teacher ratio
- Insufficient capacity
- Inability to handle extensive needs of adult & continuing education students.

WORLDSPACE

The Barriers

- Distance
  Many, especially in rural areas are too far from educational facilities.
- Time
  Educational opportunities may not be available at the time a person needs them
- Age
  Many adults feel that they are not able to take advantage of learning opportunities as adults
- Circumstance
  Geopolitical, Linguistic, Financial, Individual constraints, Different Intelligence levels
- Adaptability
  Curriculum constraints and the formality of educational system that does not allow for much adaptation.

WORLDSPACE

Distance Education: The Roles

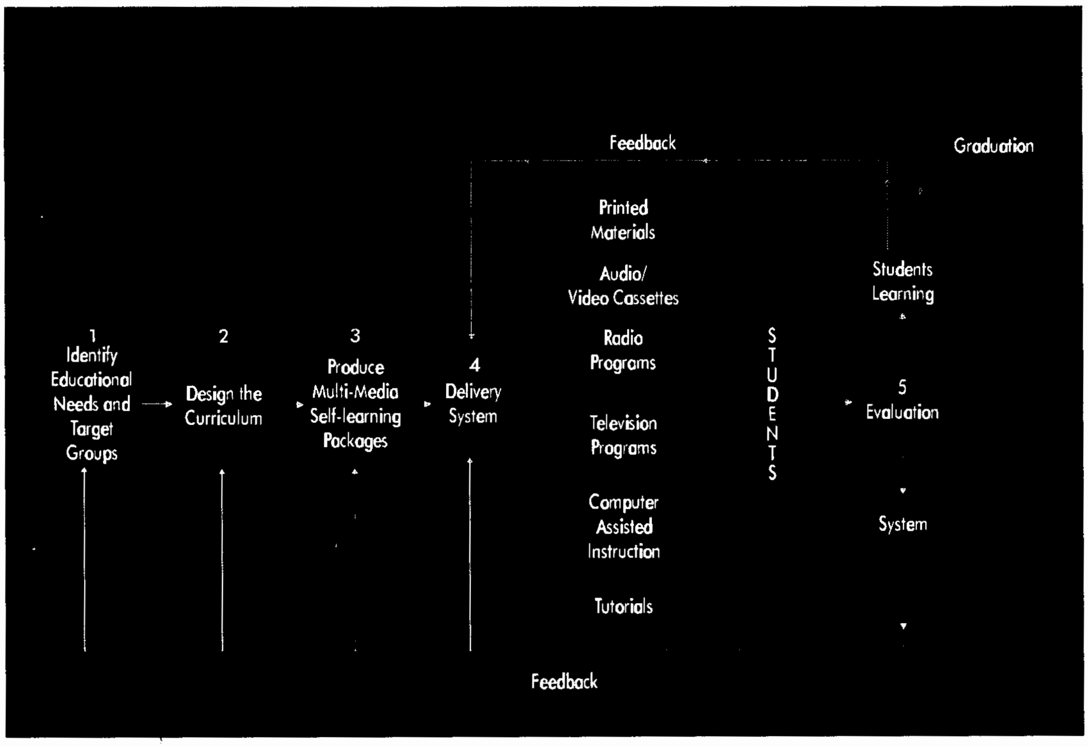
- Balancing inequalities between age groups
- Offering second chance upgrading
- Organizing information & education campaigns for large audiences
- Training key target groups, speedily & efficiently
- Educating otherwise neglected targeted groups
- Expanding the capacity for education in new areas
- Extending geographical access to education
- Offering combination of education with work and family life
- Developing multiple competencies
- Offering trans-national programs

WORLDSPACE

In Short...

- Removes time, space & Socio-Economic barriers to learning
- Broadens the access by students to a variety of learning sources
- Up-to-date information from sources that come from any part of world.
- Interactivity, variety & superior trainers through innovative technologies.

WORLDSPACE



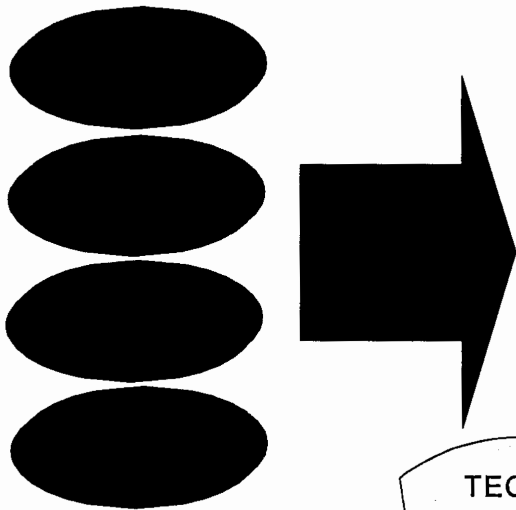
Space Options

- Satellite based distance education
- Developmental communication
- Interactive training programs
- Community education for better resource management

Television
Digital audio

WORLDSPACE

The Worldspace Offering



- Reliability
- Geographical Independence
- Flexibility in Methodology
- Greater variety in teaching content
- Greater variety of educational settings

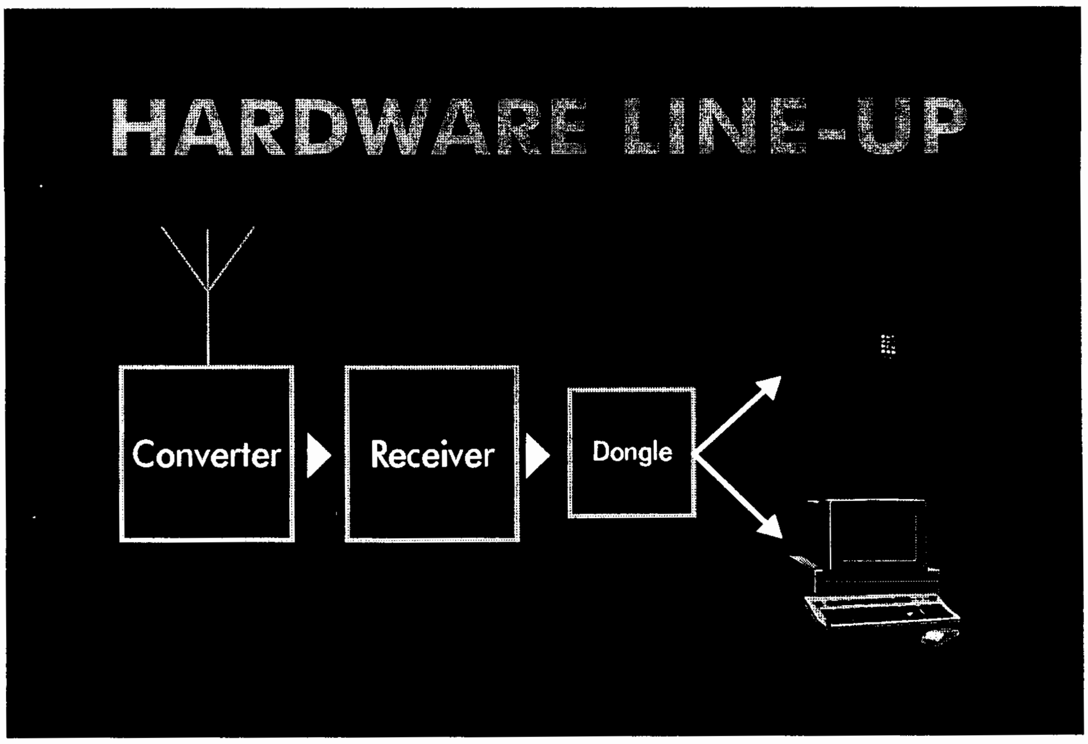
TECHNOLOGICAL EDGE
GLOBAL (AD)VANTAGE

WORLDSPACE

The Multimedia service

- It's not the Internet !
- More focused
- Infinitely faster
- Structured content
- Lower costs to the consumer
- Perfect complement to the new generation audio service
- The final integration of information, entertainment and education
- And.. You don't have to worry what your kid gets to experience!

WORLDSPACE



"Our first wish is that all men should be educated to full humanity; not any one individual, nor a few nor even many, but all men together and singly, young and old, rich and poor, of high and lowly birth, men and women - In a world all those whose fate it is to be born human beings; so that at last the whole of the human race may become educated, men of all ages, all conditions, both sexes and all nations. Our second wish is that every man should be wholly educated, rightly formed not only in one single matter or in a few or even in many but in all things which affect human nature".

- Comenius

WORLDSPACE

Educating Future Space Managers and Space Professionals*

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*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

INTRODUCTION

Education in Space is a key issue for expanding the user community of Space Technologies, particularly regarding
- Space Managers and Professionals
- Educators and Teachers in space related activities

In order to be efficient, this education should
- take into account the important changes in Space Sector
- meet the needs of this Sector

François Becker, International Space University, UN/IAF Workshop, Melbourne, 24 Sept..1998 T. 2

INTRODUCTION (2)

In this presentation, Professionals comprise :
- Providers of space technologies , i.e., providing access to space
- Users of
+ Space systems (telecommunication, GPS, Earth Observation,..)
+Data acquired by those systems
- Facilitators (Agencies, Administrations, ...)
- Educators

Presentation based on
- ISU experience
- Survey of Space Training and Education, with a Workshop held in Dec.1996 at ISU (Strasbourg)
- Series of Focus Groups meetings

François Becker, International Space University, UN/IAF Workshop, Melbourne, 24 Sept..1998 T. 3

INTRODUCTION (3)

<u>Survey of Space Training and Education</u>

158 organizations (Industrial, Governmental) of 17 countries contacted : 16% responded : 26 replies :
- 52% industrial, 48% governmental
- 32% Europe, 64% North America, 4% Far East

<u>Focus groups meetings</u>

11 meetings in US, Canada and most European Countries

François Becker, International Space University, UN/IAF Workshop, Melbourne, 24 Sept..1998 T. 4

Presentation in two parts :

- **Changing Space Sector**
  - political reasons
  - Scientific and technical development
  - Rationale for Space Activities

- **Impacts on Education in order to meet**
  - the new challenges of such a changing world : *content, pedagogy, tools*
  - the emerging needs of the space sector

François Becker, International Space University, UN/IAF Workshop, Melbourne, 24 Sept..1998 T. 5

Changing Space Sector (1)

- **change in motivation for Space**

-End of cold war : → less political competition
less governmental money

- From age of enthusiasm to era of business

- From government to commercial :
→ New government/commercial partnership

This leads to an increase in partnership, but also of the competition

François Becker, International Space University, UN/IAF Workshop, Melbourne, 24 Sept..1998 T. 6

Changing Space Sector (2)

- **role and place of Space :**

- Space has a lower priority :
+competition with other activities
+ Rationale for Space Activities should be reassessed
- Humankind must benefit from Space
→ Earth oriented Applications will become a priority :
+ Increased awareness of Earth as a limited planet with limited resources leads to an increase of needs for Earth Observation
+ Increased needs of Telecommunication (data & voice),
+ Navigation
- Space a major element of Information Society : Space allows an Integrated Global Observing Strategy and Global Data Distribution
→ + important link in Information chain
+ important provider of information

François Becker, International Space University, UN/IAF Workshop, Melbourne, 24 Sept..1998 T. 7

Changing Space Sector (3)

• Government spending ,

- will decrease, except for new space countries
- will focus on +Exploration
  + Science
  + Technological development
  + Development of new applications

(Improvement of Remote Sensing, Space Solar Energy, Space Tourism, Space resources(?),.)

• Private sector (users and providers) spending:

- will increase (demand pull)
- focus on Applications (user pull instead of provider push) :

+Telecommunication and Navigation /GPS

+ Remote Sensing /GIS (emerging new companies : Value added companies, and providers of satellites and data)

François Becker, International Space University, UN/IAF Workshop, Melbourne, 24 Sept..1998

T. 8

Changing Space Sector (4)

• Government/Commercial partnership

- long term vision new applications, finance future programs

• Smaller Countries : Niche Players

Focus on
- Telecommunication
- Earth Observation

• Space systems :

- "faster, smaller " → micro and mini satellites
- Development of LEO beyond telecommunications and remote sensing
- ISS : development of applications

François Becker, International Space University, UN/IAF Workshop, Melbourne, 24 Sept..1998

T. 9

Changing Space Sector (5)

• Globalization : main thrust
- Many nation will be major players
- Interdependence
- cost sharing and distribution of risks

• Military / Civilian
- Increased interdependence (collaboration and reciprocal influence)

• Management
- integrated project teams and internationalization
- corporate risk taking
- Spin-in and Spin-off; "on the shelf approach"

François Becker, International Space University, UN/IAF Workshop, Melbourne, 24 Sept..1998 T. 10

Impacts on Education : meet the new needs and new challenges

(Result of Focus groups and surveys)

• Fast evolution of techniques and utilization of space
imply updating curriculum (skills, know-how), pedagogy and tools :
- continuing education
- reorganization of initial education

• Specific needs of users and providers :
- technical, political and managerial skills

• New pedagogical tools and services
- Self-education, multimedia and computer-aided education
- Tele-Education (interactive and non-interactive)

• Public awareness, particularly the youth

François Becker, International Space University, UN/IAF Workshop, Melbourne, 24 Sept..1998 T. 11

Education : Quality to Develop (1)

- **Young professionals :** Both users and developers

- Innovative : → Critical thinking → Problem solving
- Creative : → Creative thinking
- Open to all aspects of Space → Global thinking
- No fear of changes → open minded
- Communication skills (with the public)
- International skills
- Intercultural skills (open-minded to other cultures)
- Team-working ; ability to discuss with and understand specialists from other disciplines

François Becker, International Space University, UN/IAF Workshop, Melbourne, 24 Sept..1998 T. 12

Education : Quality to Develop (2)

- **Leadership :** Both users and developers

- Building and Maintaining International Teams

- Facilitators to bridge gaps between government, academic and private/commercial sectors

- User oriented :
+ awareness of the needs of users and of their own way of doing things
+ good information on applications of space

- Awareness of Changing environment

François Becker, International Space University, UN/IAF Workshop, Melbourne, 24 Sept..1998 T. 13

Education : Objectives to Achieve

	Providers	Users
	• Personal interdisciplinary knowledge, ability to discuss with specialists • International & intercultural opening	
Engineers Scientists	• New skills to achieve faster, better, cheaper • Understand users needs ("on tap", not "on top") GH	• New skills to - evaluate potentials of space - use and sell space "products" • Understand technical constraints
Business Managt	• Respond to user needs •Technology management	• Become "intelligent" customer
	• Able to develop business and marketing within complex political, cultural, administrative and commercial structures	
Policy & Decision	• Appreciation of global perspectives and of the challenges • Understand other cultures, other national ways & practices contracts, policy, risks/liability/control,	

Education : Professional Knowledge to acquire

users and **Providers**

Space as a system, Basic disciplines to understand the components
Space Technology and Space Environment : access to space
Mission Analysis, Architecture, Design and Operation
Applications of Space : Engineering and Utilization of Space
Project management
Business Development & Marketing, Norms
Commercialization of Space activities, risks/liability/quality control
Finance and budgeting
Planning, control of schedules and costs
Facilitation &Negotiation, Contracts
Proposal Preparation & Procurement
International policies and law, World Space Policy

Continuing Education :General Needs

During the survey made by ISU, Executive Directors, Managers, Technical Staff, Marketing and Sales Staff, Lawyers, Accounting staff and Actuaries, as well as Administrators indicated which domains of space related activities they need to be trained on.

They ranked from 1 (low) to 5 (very high) their needs.
For each job, the resulting average of this ranking for each type of training is indicated in the next table.

All values above the average of 2.5 have been underlined.
Communication skill is a high priority for all jobs

François Becker, International Space University, UN/IAF Workshop, Melbourne, 24 Sept..1998 T. 16

Continuing Education :General Needs

Training / Job	Communicat	Proj. Mangt	Quality Risk-Managt	Finance	Techn.	Policy Law	Market-ing	Basics
Executive Directors	<u>4</u>	<u>3.2</u>	<u>3.3</u>	<u>3</u>	2.1	2.5	2.1	2.1
Manager	<u>4.2</u>	<u>4.2</u>	<u>3.7</u>	<u>2.9</u>	2.2	2.5	2.1	2.4
Technic. Staff	<u>3.9</u>	<u>3.4</u>	<u>3.5</u>	2.3	<u>5</u>	2	<u>3.2</u>	2.2
Market & sales staff	<u>3.9</u>	2.4	2.1	2.3	2.1	<u>3.7</u>	<u>3.1</u>	2.1
Lawyers Account. Actuaries	<u>3.7</u>	2.3	2.4	2.5	<u>2.7</u>	<u>2.7</u>	2.1	<u>2.6</u>
Adminis-trators	<u>3.9</u>	1.7	1.6	2.4	1.6	1.5	1.4	<u>3.6</u>
Total	<u>**23.6**</u>	**18.2**	**16.6**	**15.4**	**15.7**	**14.9**	**14**	**15**

François Becker, International Space University, UN/IAF Workshop, Melbourne, 24 Sept..1998 T. 17

The Development of Chinese Small Satellite Program*

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*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

ABSTRACT

At the beginning of 1990s, China started to develop small satellite program. Now China has finished engineering phase of Practice-5 (SJ—5) satellite, a satellite used for scientific and technical experiment. Oceansat-1 (HY—1) has entered into engineering phase. Environment and Disaster Monitoring Satellite Constellation now is under conception design phase. On the basis of single satellite application, China plans to expand the application of small satellite through the establishment of satellite constellation. We wish to broaden the application area of small satellite with foreign countries, especially the developing countries. The SMMS project is a paradigm for this kind of cooperation.

INTRODUCTION

Small satellite represents a promising trend of today's space science and technology. It is the outcome of development of space technology and applications. The small satellite is a highly integrated new satellite which is based on the advanced micro-mechanism, micro-electronics and light weight material techniques. The growing interest for small satellites (from about 300 to 500 Kg) has been notable since the beginning of the 1990's in the fields of Earth observation, telecommunications and science. Compared with large satellite, small satellite has such features as smaller volume, lighter weight, shorter developing period, lower cost for development and launching etc. These advantages have a strong appeal to the users and it is necessary and in right time to develop small satellites and ground application system to fulfill the needs for Earth observation, telecommunication service, technical demonstration, scientific and technical experiments.

CAST's experience of 30 years in satellites development, its installations for short cycle production and testing for commercial satellites, and its motivation for meeting challenges, made it possible for CAST to propose an industrial approach to the small satellites development. The SJ-5 and HY-1 small satellite projects are under the development and production. A family of multi-mission platforms called CAST-968 is also developed coincidentally for different missions with tailored configuration. It has first been used for the SJ-5 mission in which it was called CAST-968A, then the HY-1 mission in which it was called CAST-968B. In follow-on mission, CAST 968C, the most powerful platform of CAST968 series up-to-now, may be used for the establishment of Environment and Disaster Monitoring Constellation. CAST968 is designed to obtain a very attractive recurrent production price, while taking multi-mission requirements into account. It can accommodate orbital altitudes from 500 to 1,500 km (SSO), Earth or Sun pointing attitudes, and pointing accuracies from 0.05°to 5°. The platform is designed to be compatible with the Long March family launch vehicles for small satellites, and can carry up to 320 Kg of payload. This reconfigurable platform can be used for observation, telecommunications, and science applications.

THE PROJECTS UNDER ENGINEERING DEVELOPMENT

There are two projects in CAST which are in the engineering development phase. The first is SJ-5, which is used for scientific and technical experiment. The second one is HY-1, which is applied mainly for ocean color observation. The general information of those two projects are described below.

Practice-5 (SJ - 5) Project

The mission of Practice-5 (SJ—5) is to carry out the experiment of SEU and SEL measurement and correction, space fluid research and demonstration of platform technology. CAST 968A platform will be adopted as SJ-1 platform. It's planned to be piggy-back launched by CZ4B next year. The system parameters of SJ-5 satellite is as follows:

Table 1:

• Orbit: SSO	
• H= 870km	
• e= 0	
• i= 98.80	
• Local time at descending node:	08:30~9:00 hrs
• Mass:	300 Kg
• Dimension:	1100x1200x1040 mm
• Area of Solar Panel:	1000x620x6 mm
• Power (BOL):	340 W
• Capacity of Battery (Cd-Ni):	17 Ah
• Attitude Control System:	
• Measurement Accuracy:	<±4°
• Control Mode:	
• Three Axes Stabilization:	
• Point Accuracy:	±5°
• Angular Rate:	<0.05°/s
• Sun Oriented Stabilization:	
• Spin Rate:	10-15 rpm
• TT&C:	S Band Unified System
• Mission Life:	3 Months

Oceansat-1 (HY—1) Project

Oceansat-1(HY—1) is mainly used for observation of productive forces distribution, sea fish, breed resources, the mud and sand distribution law of river mouths and ports. HY-1 is the first satellite developed for ocean research. HY-1 carries one ocean color scanner(10 bands with 1100m resolution and 1600km swath), one CCD camera(4 bands with 250m resolution and 500km swath). CAST968B platform will be adopted as HY-1 platform. It's planned to be piggy-back launched by CZ4B around 2000.The system parameters of HY-1 satellite is as follows (see next page):

Table 2:

• Orbit:	SSO
• Height:	798km
• Local time at descending node:	8:30-1:00hrs
• Mass:	350kg
• Dimension:	1.2x1.1 x1.08m3
• Ocean Color Scanner:	
• Resolution:	1100m
• Swath:	1600km
• Bands:	$0.412 \pm 0.01\mu m$, $0.433 \pm 0.01\mu m$ $0.490 \pm 0.01\mu m$, $0.520 \pm 0.01\mu m$ $0.560 \pm 0.01\mu m$, $0.670 \pm 0.01\mu m$ $0.765 \pm 0.02\mu m$, $0.865 \pm 0.02\mu m$ 10.3-10.4μm, 11.4-12.5μm
• CCD Camera:	
• Resolution:	250m
• Swath:	500 km
• Bands:	Four bands in 0.42μm-0.86μm
• Data Transmission:	
• Store Capability:	80Mbytes
• Data Rate:	2.6616Mbps
• Attitude Control:	
• Point Accuracy:	<0.5°
• Attitude Stability:	<0.01°/s
• Measurement Accuracy:	<0.3°
• Orbit Control:	13kg Propellant (Hydrazine)
• TT&C:	S band Unified System plus GPS
• Power Supply:	
• Area of Solar Panel:	5.54m
• Solar Panel Output (BOL):	550W
• Capacity of Battery:	23Ah
• Mission Life:	2 years

THE PROJECTS UNDER CONCEPT STUDIES

Besides project in engineering development, CAST has carried out concept studies for the foresee missions. For these missions, there are two projects which may step into engineering phase this year. Some introductions of these two missions are briefed in the follows.

The Asian-Pacific Small Multi-Mission Satellite (SMMS)

In recent years, space technology and its application in remote sensing and telecommunication is becoming more and more important for developing countries in the Asia-Pacific region. Based on results of negotiation and discussions among related countries, a 3-axis stabilized small multi-mission satellite (SMMS) would be satisfied to different users and take great economic and social benefits. The payloads are mainly remote sensing instruments: a multi-spectral CCD camera, other payloads would be the Wide Field Imager, data transmission device, Ka-band communication experiment equipment, data collection system, space environment probe equipment etc..

The development of SMMS will be developed in multi-lateral cooperation among Asia-Pacific countries and will take the technical advantages and experiences of Asia-Pacific countries. The CAST968B platform will be adopted as the reference platform for SMMS mission. The key parameters of SMMS are as follows:

Table 3:

• Orbit	Sun-synchronized orbit
• Orbit height	796Km
• Local time at descending node	10:30~11:00 AM
• Injecting mass	380kg
• Bus	241kg
• Payloads	99kg
• Hydrazine	10kg
• Margin	30kg
• Size (main body)	1.2(X)x1.1(Y)x1.08(Z)m3
• Main payloads	
• CCD Camera	4 bands, 20m resolution, 120km swath
• WFI	3 bands, 250m resolution, 1500km swath
• Power supply	solar arrays and Ni/Cd battery
• Output power (BOL)	550W
• Capacity of battery	23AH
• Attitude and orbit control	3-axis attitude stability
• Pointing accuracy	
• Pitch and roll	<0,4°
• Yaw	<0,3°
• Measurement accuracy	
• Pitch and roll	<0,4°
• Yaw	<0,5°

3-axis attitude stability	<0,01°
• Telemetry, tracking, command and data handling	
• Telemetry	>300 channels
• Telecommand	>148 channels ON/OFF commands
• Lifetime	3~5 years

The Constellation for Environment and Disaster Monitoring

According to the nation's requirement on environment and disaster monitoring, we plan to develop a small satellite constellation, which consists of six LEO small satellites. The reasons to utilize the small satellite constellation for Environment and disaster monitoring are to achieve both short time resolution and reasonable spatial resolution, while keep a favorable cost limit.

Among the constellation, four optical satellite will be located in the 700-900km near noon SSO with 40m resolution for visible band and 300m resolution for infrared band. The width of swath is 700km, two SAR satellites will be located in 500km dawn-dusk SSO with different resolution/swath mode of 4m/25km, 12m/40km and 25m/125km, and the selectable observation range is 450Km. CAST968B and 968C platform will be adopted as the optical satellite and SAR satellite platform separately The system is scheduled to be established around 2003.

Table 4:

• Main characters of the constellation is as follows:	
• Optical satellite(4 satellites):	
• Sun-synchronous orbit:	~600km
• Local time at descending node:	10:30AM
• Weight:	~ 350kg
• Coverage time: visible sensor:	24hrs; IR:12hrs
• Solar array power output:	~340W
• Payload weight:	~100kg
• Dimension:	1 m x 1m x1.2m
• Platform:	CAST 968B
• Payload: Multiband CCD (2 for each satellite):	
• Band:	0.45~0.52μm, 0.52~0.60μm 0.63~0.69μm, 0.76~0.90μm
• Resolution:	~40m
• Width:	2 x 350km

• IR:	
• Band:	0.75~1.1μm, 1.55~1.75μm 3.5~3.9μm, 10.5~12.5μm
• Resolution:	300m
• Width:	700km
• DATA transmission:	X-band,~8GHz,~20~50Mbps (CCD), ~<10Mbps (IR)
• SAR satellite(2 satellites):	
• Sun-synchronous orbit:	~600km
• Local time at descending node:	6:00AM
• Payload weight:	~ 250kg
• Dimension:	1m x 1m x 1.2m
• Platform:	CAST 968C
• Payload: X band SAR:	
• Resolution/swath:	4m/25km; 12m/40km; 25m/125km
• Steered visible range:	450km
• Peak/average power:	3.2KW/300W

LAUNCHING STRATEGIES FOR SMALL SATELLITES

In order to save cost, the small satellites could be launched by piggyback or cluster-launch. The Chinese launcher has the capability of launching satellite cluster or single satellite.

China has 25 years' experiences for developing its own launcher of LEO, GTO and GEO orbit. The Long-March series has provided 51 launchings for the satellites of other countries. There are mainly four types of launcher developed for launching the satellite. Among these launches, LM4B and LM-2D and LM2C/FP are suitable for SSO mission. The CZ-2C/FP and CZ-2D launch vehicles are two-stage rockets. The CZ4B is three-stage rocket. The specifications of these launch vehicles are as followings:

- CZ-2C/FP: It has successfully launched the Iridium satellites. Its capacity is 1200kg for launching satellite to 800km sun-synchronous orbit. If to launch two satellites in a single mission, it could provide about 1000kg for the payloads (satellites), excluding 150kg

- Additional mass: If to launch three satellites in a single mission, it could provide about 900kg for the payloads (satellites), excluding 250kg additional mass.

- CZ-2D: It has successfully launched 3 recoverable satellites. Its capacity is 1000kg for launching satellite to 700km sun-synchronous orbit. It could provide about 700kg for the payloads (satellites), excluding 300kg additional mass.

- CZ4B: It is mainly used for launching the satellite to 500-900km sun-synchronous orbit or polar orbit. It has enough margins for launching the small satellite. If to launch small satellite by CZ4B, it is possible to launch three small satellites in a single mission, its capacity will be 1 650kg for launching small satellites into 900km sun-synchronous orbit.

CONCLUSION

The small satellite technology and application has a prosperous prospect in developing country. CAST has paid a special attention and great effort to the development of small satellite and its application to the national sustainable development. The preliminary ability of small satellite development and application have been established through the engineering development of SJ-5 and HY-1. With the installation of environment and disaster constellation, our abilities will be much more enhanced in both technical development and data application.

With the "OPEN Policy" of Chinese government, China space now is welcome to the cooperation in space technology, with an special emphasis on small satellite development. SMMS represents a new tendency of satellite cooperation. With mature and advanced techniques and research results, a low cost and reliable SMMS will be developed in no long time. The multi-lateral cooperation in space field will enhance the mutual understanding among nations, and be helpful to the stabilization and peace of this region. The SMMS (Small Multi-mission Satellite) project in which China is a key partner is a paradigm of space cooperation between/among developing countries. We are much willing to establish and enhance bilateral /multilateral cooperation relations with foreign countries in order to broad the function of small satellite in sustainable development.

Regional Development of Small Satellite Multi-Mission Platforms*

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*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

PRELUDE

Asia-Pacific Region is a huge region stretching from Korea to New Zealand on the one side and Fiji to Azerbaijan on the other, comprises 58 countries having about 56% of the total world population. This vast region covers oceans, mountainous territories, rivers, snow covered high mountainous, coastal zones, deserts, agriculture lands, forests, mineral rich areas and almost all kinds of terrain. Although rich in natural and human resources, the Asia-Pacific region consists mainly of the developing countries or least developed countries with the lowest GNPs in the world. Except very few countries, the majority of the Asia-Pacific region lacks the basic infrastructure including transport, communications, etc. Power generation and its efficient distribution is also a major issue in the countries of the region. Most of the regional countries are thus relying on traditional industries whereas high-tech and heavy industry is almost non-existent. Basic research on materials, semi-conductors and use of high-tech for monitoring and management of the resources in a scientific way is also lacking. Moreover, there is great diversity in economy, culture, political set up and stability in the region. Most of the Asia-Pacific countries are in tropical/monsoon region and are therefore prone to floods, cyclones, forest fires, deforestation, desertification, drought and other natural disasters. All these factors affect greatly, directly or indirectly, the life of the people leaving in the region.

For the socio-economic uplift of the region, there is a need to look critically into the existing state of infrastructure, industrial level, literacy rate and resources management structure. This demands enhancement of, and encouragement for, bilateral B multilateral cooperation among the Asia-Pacific region countries in the project of mutual interest by ways of sharing the financial resources, acquiring advanced technologies and transfer of technologies at a reasonable cost, learning from each other's experiences as well as creating better understanding among the people of the region and devising innovative methodologies for effective project management.

Recent developments in technologies (computers, semi-conductors, telecommunication, miniaturization of electro-mechanics and memories etc.) is witnessing a change in the traditional trends of development and use of space technologies especially in the area of telecommunication, earth observation and science. In today's world, space technologies are playing a great role in planning, monitoring and management of new and existing resources in addition to providing valuable services to mankind in the areas of communication, education and health. Following is the list of market / demand in these key areas:

Table: List of market and demand

Area / Services	Market / Demand
Earth Observations	Agriculture, Environment Control and Management, Meteorology, Deforestation, Mineral resources, Fishery, Disaster prevention and control

Area / Services	Market / Demand
Telecommunication Fixed	Health service support, Transportation system support, International telephony, Fax / data / paging services, VSAT communication networking, Government
Mobile	Agriculture, Aeronautical / maritime traffic control, Localization services, Mobile and wireless communications, Satellite-aided search and rescue
Broadcasting	DBS, TV and Radio Networking, Tele-education, Tele-medicine, Tele-conferencing, Assistance to farmers/agriculturists, etc.
Science	Local geophysical phenomena, Use of privileged position for astronomical observations
Engineering Evaluation	Evaluation of different modules / subsystems and appropriateness of technologies / techniques to problems of various regional issue

The use of space technologies can thus play an important role in providing valuable service by way of real-time monitoring of different phenomena and exploration of resources for an effective long-term planning of the individual country in its resources management.

Although the recent development in space technologies have provided the opportunities of developing small satellites for specific applications at a considerably lower cost compare to the traditional large satellites program, still the space activities requiring large investments and high risks cannot be afforded by individual countries especially the developing countries.

Realizing the above mentioned facts and the benefits which can be achieved by the use of space technologies, the interested countries in the Asia-Pacific region initiated a program, from the forum of Asia-Pacific Multilateral Cooperation in Space Technology and Applications (AP-MCSTA), of developing a Small Multi-Mission Satellite (SMMS) with the following objectives:

- Development of a small multi-mission satellite and ground application system for technology and engineering evaluation, scientific experiments, earth environment and resources survey, disaster monitoring and mitigation and information exchange.

- Availability of the opportunity for the Asia-Pacific region countries in joining hands and pooling their financial, technical and human resources under mutually beneficial collaborative program.

- Implementation of collaborative projects among Asia-Pacific countries in the high-tech fields of Space Technology for socio-economic development of the people in the region.

BACKGROUND OF AP-MCSTA FRAMEWORK AND SMMS PROJECT

AP-MCSTA Conference and Their Recommendations

Ushered into 1990′ s, the socio-economic development in the Asia-Pacific region created good conditions for the regional cooperation in space field. To meet the needs and through the friendly consultations, the Asia-Pacific Workshop on Multinational Cooperation in Space Technology and Applications held in Beijing, China in 1992, jointly organized by Ministry of Aero-Space of China, Pakistan Space and Upper Atmosphere Research Commission and the Ministry of Transport and Communications of Thailand, and later became the AP-MCSTA Initiative. The Workshop and its Recommendations defined the principle of AP-MCSTA B voluntary participation, equality, mutual benefits and common development B which laid solid foundation for the development of fruitful cooperation in space activities in the Asia-Pacific region.

Following the Beijing Workshop, the First, Second, Third and the Fourth Asia-Pacific Conference on Multilateral Cooperation in Space Technology and Applications were held, successively, in Bangkok, Thailand (Jan. 1994), Islamabad, Pakistan (Apr. 1995), Seoul, R. O. Korea (May, 1996) and Manama, Bahrain (Dec. 1997). The Liaison Committee for AP-MCSTA, LCAP-MCSTA was set up in May, 1993 comprising representatives from 14 members countries, and the Preparatory Committee for Asia-Pacific Space Cooperation Mechanism (the PREP-COM for APSCOM) was established in August 1994 composed of high level representatives from the governments of 10 countries. These two Committees work on identification and formation of cooperative project and institutionalization of AP-MCSTA.

The SMMS Project as a „common interested project“

The SMMS Project started as soon as the AP-MCSTA Initiated and its concept development accelerated as more and more countries and governments are focusing on some of the substantial projects and their applications. It is due to the regional characteristic that the SMMS project displayed its charm in the Asia-Pacific region and to AP-MCSTA Initiative.

Taking into account the diversity in economy, culture and political conditions of the countries in Asia-Pacific Region, especially the reality that most members of it are developing countries AP-MCSTA chose the Small Multi-Mission Satellite (SMMS) as its first joint project.

Small Satellites development is a new tendency of satellite development and applications. In comparison with large satellites, small satellites have small volume and weight, which are convenient for piggyback launching or multi-satellite launching by one launcher. Small satellite does not pursue completeness, synthesis and perfection in design but the modern ripe techniques and modularized and standardized software and hardware design. Through this project, a modulated platform could be jointly developed so that each and every of the participating country could obtain full understanding of the platform. This will not only provide a system for payload development, but also provide options for future projects similar to the SMMS for joint development of new technology and applications.

It is reasonable to believe that SMMS is a good form to pool the limited resources and to be of great benefit to the development and applications of space technology of all the participants of AP-MCSTA. The multilateral cooperation in space needs the support of the governments and related mechanism of all the participating countries. It is also necessary to build on regional organization to coordinate the course and relations. Interchange of technology and personnel is also one of the great benefits deriving from this project.

Signing of Memorandum of Understanding (MOU) for Implementation of the SMMS project

In April, 1995 the Second AP-MCSTA Conference held in Islamabad, Pakistan appreciated the joint proposal offered by the Small Satellite Technology Working Group set up by the Liaison Committee for AP-MCSTA to develop the Small Multi-Mission Satellite (SMMS). At the next conference held in Seoul, Korea in 1996 reviewed the proposal and recommended signing an inter-governmental MOU to push the SMMS project into sustainable stage.

Through joint efforts of member countries, the first substantial cooperative project under the AP-MCSTA Initiative - the Small Multi-Mission Satellite (SMMS) project - has been formed. An inter-governmental Memorandum of Understanding for Cooperation in Small Multi-Mission Satellite and the Related Activities (MOU) was signed April 22, 1998 in Bangkok by the authorized signatories from 6 countries, namely, China, I.R. Iran, R.O. Korea, Mongolia, Pakistan and Thailand.

The MOU expresses the signatory governments' continuous interest and willingness in supporting the implementation of the SMMS Project, so as to promote multilateral cooperation in space technology development and applications among Asia-Pacific countries. The signing of MOU is a milestone for AP-MCSTA Initiative and will strengthen further the space cooperation between developing countries in this region.

TECHNICAL PRESENTATION ON SMMS PROJECT

Mission Objectives

- Development of 3-Axis stabilized bus to support the following payloads:

  - Multi-spectral CCD camera
  - Wide Field Imager (WFI)
  - Store and forward date transmission device
  - Ka-band communication experiment equipment
  - Space environment probe equipment
  - Any other experiment devices under the capacity limit of the bus

- Provision of the following services to the Asia-Pacific countries:

  - Remote sensing of natural resources
  - Environmental monitoring
  - Store and forward data communication
  - Experimentation in space environment, etc.

Design Drivers and Requirements

- Standard bus to support multi-payloads and sun-synchronous orbit
- Modular design, flexible / adaptable for future mission
- Smaller weight / volume compatible with different launch vehicles for low-cost piggy-back launch/multi-sat single launch
- Simple and reliable design with low-coat, shorter development period
- Standard, modular design of sub-systems / payloads

System Configuration

- Bus

  - Structure
  - Electrical Power Supply Subsystem
  - Attitude and Orbital Control Subsystem
  - Telemetry, Tracking, Command and Data Handling Subsystem (TTC&DH)
  - Thermal Control Subsystem

- Payloads

  - Multi-spectral CCD Camera
  - Wide Field Imager (WFI)
  - Remote Sensing Data Transmission Equipment
  - Ka-band Communication Experiment Equipment
  - Data Collection System (DCS)
  - Store and Forward (e-mail) Data Transmission
  - New Technology Experiment

Payload Details

- Primary Payload

♦ Multi-spectral CCD Camera
- Coastal zone mapping, environmental monitoring, soil/vegetation differentiation, deciduous/coniferous differentiation.
- Monitoring plant diseases and pest infestation, estimation of crop production, differentiation between soil / rocks.
- Distinction between plants varieties and the soil/geological borders, etc.

- Secondary Payloads

♦ Wide Field Imager (WFI)
- Coastal mapping, environment research
- Measurement of reflectance of plant
- Monitoring of plant diseases and insect pests
- Estimation of the crop production
- Distinguish the soil/rocks
- Distinguish the soil/geological border

♦ Remote Sensing Data transmission Equipment
- Conversion / modulation and amplification of remote sensing data for transmission to ground receiving station

♦ Ka-Band Communication Experiments
- Future telecommunications

♦ Data Collection System
- Collection of information for environment monitoring, disaster forecasting and mitigation

◆ Store and Forward Communication
- Provision of very low-cost solution to exchange messages for radio amateurs in the region

◆ Space Environment Probe
- Monitoring of the earth electromagnetic field, solar ultra violet radiation, experimentation on radiation resistance electronic components (CPU, Memories etc) and exploration of the cosmos etc.

Spacecraft Specifications

• Orbit	Sun Synchronized
-Orbital height	~800 km
-Local time at descending	10:00 to 11:30 am
-Node	
-Life time	3 to 5 years

• Injection Mass	
-Bus	300-400kg
-Payloads	100-150kg
-Size	1.2(X) x 1.1(Y) x 1.0(Z)M3
-Total SMMS mass	300-400kg

• Power supply	Solar array and NiCd battery
-Output power	450-550W
-Power (stand-by)	~130W
-Power (operation)	~210W

• Attitude Control System	
-ACS Stabilization	3-asix stabilization
-Pointing Accuracy	
-Pitch and Roll	<0.4 deg
-Yaw	<0.5 deg

-Measurement accuracy
-Pitch and Roll <0.2 deg
-Yaw <0.3 deg
-3 axis stability <0.01 deg/s (3 row)

- TT&C Data handling

-Telemetry 256 channels
-Telecommand 128 channels on/off

TABLE: SMMS MASS AND POWER BUDGET

Item	Mass(KG)-Power	Power Stand by	Power Operational
Structure	60	0	0
Thermal Control	10	3	0
Power Supply	50	2	0
Attidude & Orbit	50	35	10
Control TT&C & DH	30	35	8
System Circuitry	25	0	0
Total of Bus	255 (dry)	75	18
CCD Camera	15	0	15
Multispectral Infrared Imager	30	15	30
Remote Sensing	20	1	40
Data Transmission DCS	5	1	10
Store and Forward	5	1	10
Data Transmission KA Communication	25	1	20
Spaceenvironment Prob	15	5	5
Total of Payload	115	24	130
Total of SMMS	340 (dry)	99	148

APPLICATION AND BENEFITS

Applications

- Remote Sensing/earth imaging through CCD camera (0.45-0.703)

  - Coastal mapping
  - Soil vegetation / deforestation
  - Measurement of the reflections of plants to monitor plat diseases
  - Estimation of crop production
  - Distribution among plant variations and the soil/rock border

- Provision of earth observation data through multispectral earth imager (0.75-12.53)

  - Determination of the border of water/land, sand and soil at river mouth
  - Snow cover observations
  - Measurement of the Humidity of soil
  - Detection of forest/crossland fires
  - Mining survey
  - City environment observation
  - Earthquake forecast research

- Ka-band communication experiment for
  - Mobile Communication/point-point communication test

- Data collection through remote data platforms

- Store-and Forward data transmission
  - Provision of real-time as well as delayed communication services

- New Technology Experiment

- Academic Training

- Education and training of scientists and engineering by providing a means of direct hands-on experience of all stages and aspects (both technical and managerial) of a real satellite mission - from design, production, test and launching to orbital operation at a reasonably low cost and shorter development time
- The advantage of low cost, shorter development time, low cost launch and in-orbit operation and manageable project are very attractive to countries wishing to develop and establish a national expertise in the fields of space technology

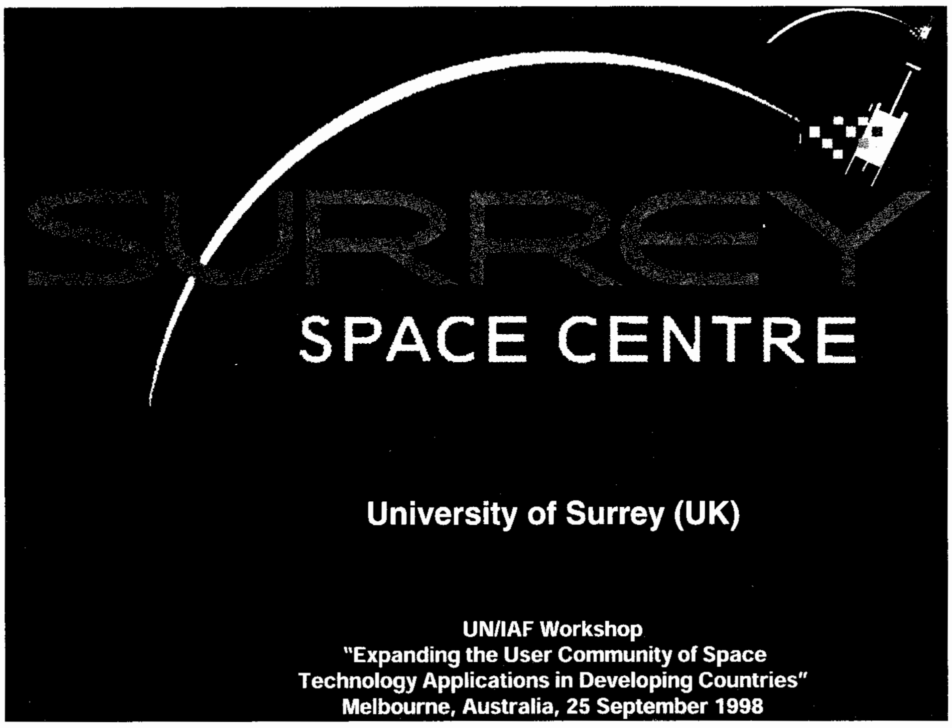
Benefits

- Establishment of a Common Platform for mutual cooperation in Space Technology and Applications
- Sharing of Know-how / Technology by the Collaborating Countries in the Space Fields
- Establishment of Infrastructure for the development Large Application Satellite in the Future
- Exploitation of the Technical Manpower of the Participating Countries for Hands-on Experience in Space Technology and Applications
- Use of the Existing Ground Receiving Facilities for Data Collection and Establishment of the New Ground Facilities
- Opening up of Avenues for Participation of Local Industry in Space Development Programs
- Training of the Technical Personnel in Space High-Tec Fields
- Opportunities for Collaboration in Economically Feasible Projects
- Enhanced Economic Activities of the Region as a whole through Rural Development

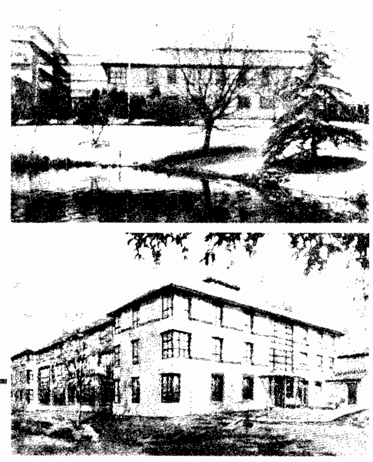
The Surrey Space Club*

Martin Sweeting,
Managing Director/Chief Executive Officer
Surrey Satellite Technology Ltd. SSTL, United Kingdom

*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of United Nations.



SURREY SPACE CLUB



SPACE RESEARCH

Microsatellites & Minisatellites - Platforms & Applications

Commercial Exploitation

Surrey has Pioneered Microsatellites

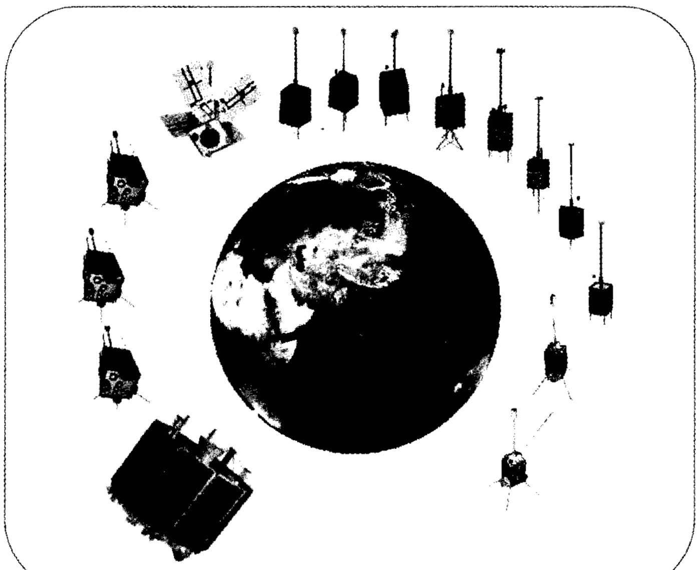
1979

⇩

1999

"Affordable Access to Space"

Surrey Microsatellites in Orbit



72 orbit-years experience in low Earth orbit

In-Orbit

UoSAT-1 (1981)
UoSAT-2 (1984)
UoSAT-3 (1990)
UoSAT-4 (1990)
UoSAT-5 (1991)
KITSAT-1 (1992)
S80/T (1992)
HealthSat-2 (1993)
PoSAT-1 (1993)
KITSAT-2 (1993)
CERISE (1995)
FASat-A (1995)
FaSat-B (1998)
Thai-Phutt (1998)
UoSAT-12 (1999)

Awaiting launch

TiungSat-1 (1999)

Clementine (1999)
PicoSat (1999)
SNAP-1 (1999)
Tsinghua-1 (1999)

Know-How Transfer Programme

'faster, cheaper & better'

* Train engineers as nucleus of a space agency & industry
* Establish national space facilities & capabilities
* Launch first national microsatellite & demonstrate its applications

Know-How Transfer

Academic & 'Hands-On' Training by Total Participation

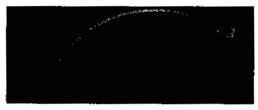
- ✶ Complete Know-How transfer
- ✶ Management techniques as well as technology
- ✶ Satellite designs for all systems & payloads
- ✶ Component level & software
- ✶ 15-month programme
- ✶ Ability to build microsat in their own country

Know-How Transfer

Most successful group - KITSat-2 and KITSat-3 built a strong team & national nucleus

Korea Advanced Institute of Science & Technology (KAIST)

Know-How Transfer

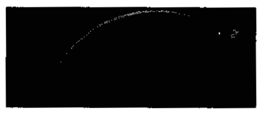


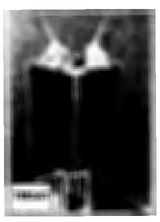
Surrey - Thailand

a basis for long-term collaboration

Mahanakorn University of Technology (Bangkok)

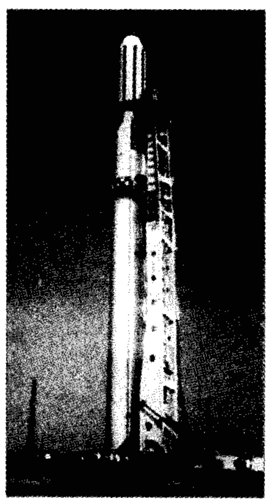
SSTL Launches in 1998





July 10: Thai-Phutt + FASat-B

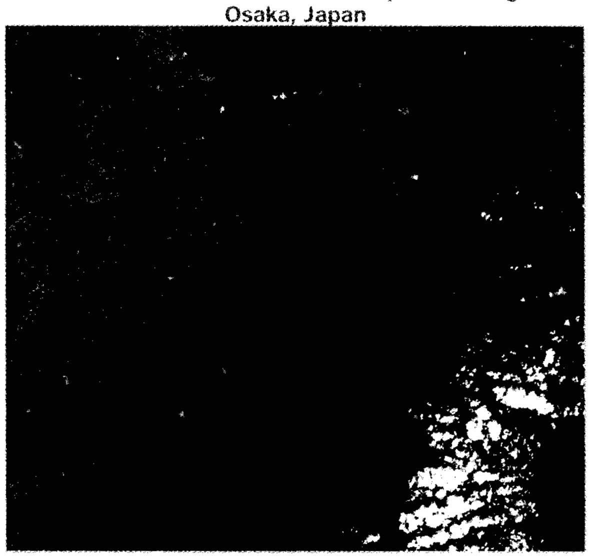
successfully launched

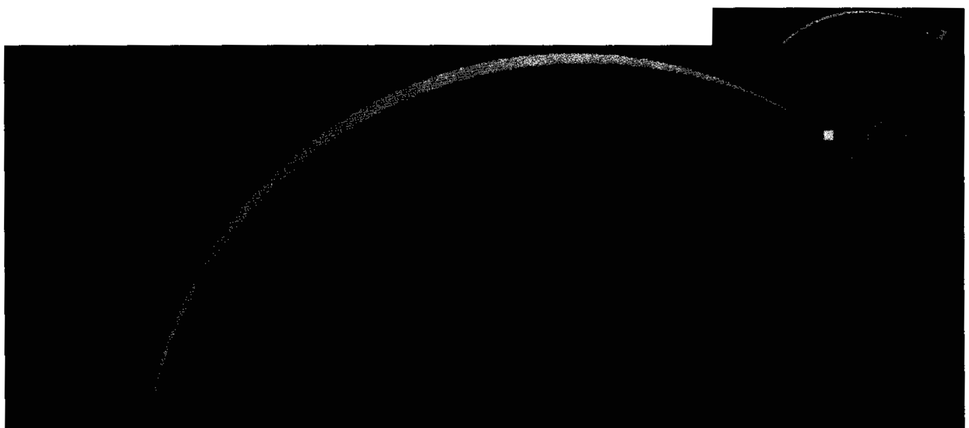


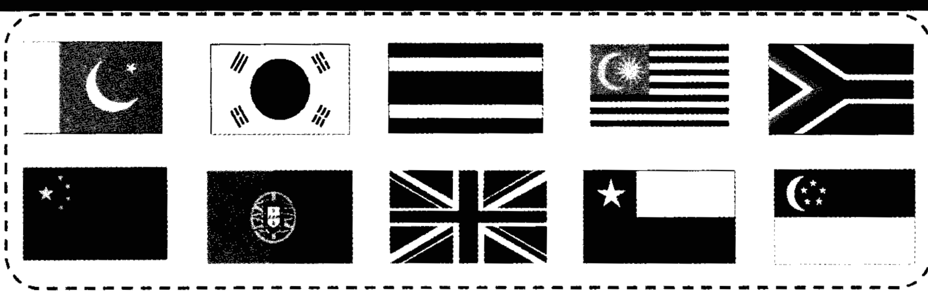
Microsatellite Earth Observation Break-through

50kg microsatellite
90 metre GSD
3 LANDSAT-MSS bands
0.81 - 0.89 nm
0.61 - 0.69 nm
0.50 - 0.59 nm

Thai-Phutt Microsatellite Multi-spectral Image
Osaka, Japan







Surrey Space Club

Pakistan - S.Africa - Portugal - Korea - Chile - Malaysia - Thailand - Singapore - China - UK

Concept

Meeting forum for international partners who share common small satellite experiences with Surrey through collaboration on Know-How Transfer Programmes

Objectives

- new ideas - stimulate collaborative research
- better the existing satellite resources
- constellations of small satellites together
- low cost launch opportunities
- each other with long term national planning

Activities

- - regular forum for discussion
- - with external participants
- - inform
- - inform, collaborate
- - publish results (e.g. IJSSE)
- - terms of reference

Background

- came from talking to our partners
- that we share experiences & ambitions
- proposed at UN meeting in Malaysia in May'98
- at IAF (Melbourne) in Oct'98
- to be held at Surrey in Dec'98

Great Interest

- NASA
- ESA
- Aerospace Corp.

Nigeria	Ireland	Sri Lanka	Philippines	Zimbabwe
Uzbekistan	Vietnam	Romania	Indonesia	Cambodia
Jordan	Taiwan	Sudan	Norway	Madagascar
Saudi	Angola	Peru	Mauritius	Bangladesh
Egypt	Ghana	Brunei	Senegal	Nepal
Turkey	Mongolia	Greece	Laos	Zambia
Nicaragua	Myanmar	Uganda	Tanzania	Ethiopia

First Forum at Surrey

HM Queen inaugurates Surrey Space Centre

Duke of Edinburgh inaugurates Surrey Space Club

SSC Forum

Objectives

Share New Ideas

- Meet annually - hosted by members in turn
- Presentations on members research activities
- Discuss co-operative research - development projects
- Propose joint small space projects
  - **nanosatellites - swarms**
  - **constellations**
  - **lunar mission**

National Space Programme Planning

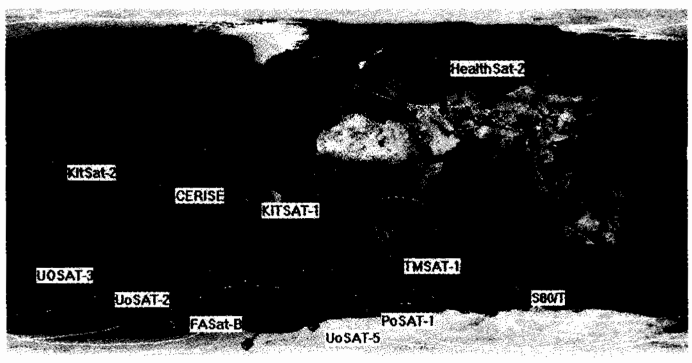
- help members maintain momentum of space activities
- share experience in space planning

Share Satellite Resources

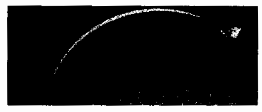
In-Orbit

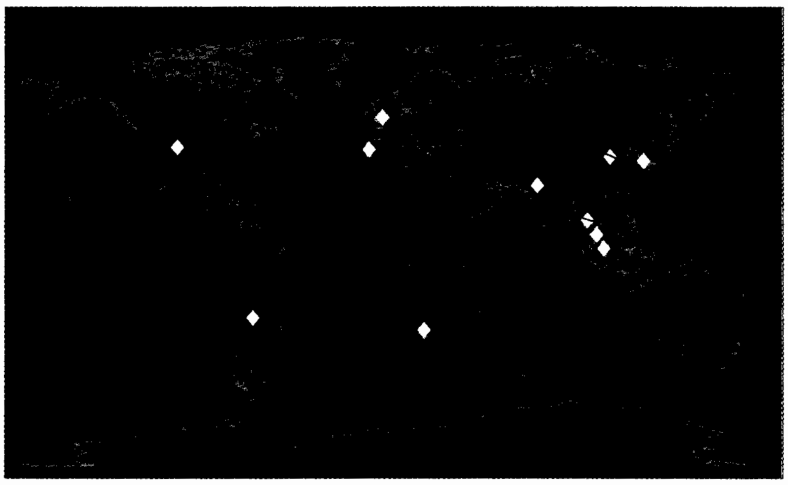
UoSAT-2 (1984)
UoSAT-3 (1990)
UoSAT-5 (1991)
KITSAT-1 (1992)
PoSAT-1 (1993)
KITSAT-2 (1993)
FaSat-B (1998)
TMSat (1998)

TiungSat-1 (1999)
Tsinghua-1 (1999)
UoSAT-12 (1999)

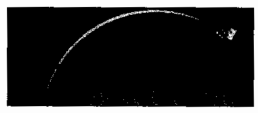


Increased Groundstation Coverage





Constellations of Microsatellites



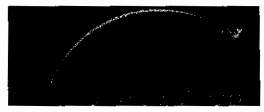
Trend for the next decade emphasised by NASA

Single microsatellite has many applications
- but constellations offer certain advantages:

- **increased communications coverage**
- **enhanced EO temporal resolution - shorter revisit**
- **improved space system redundancy**

Low cost microsatellites now make these constellations economically feasible

Constellations

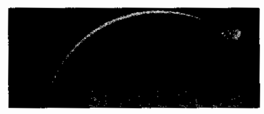


Focus for Microsatellite Constellations

- The cost of microsatellites is small but it is still difficult for one nation to afford the whole constellation
- Common microsatellite technology heritage
- All use SSTL software and communications protocols
- All use SSTL groundstation configurations

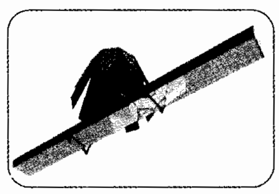
- Each member builds 1 or 2 microsatellites for the constellations - easier to get support
- Each member can access, use and benefit from the entire network

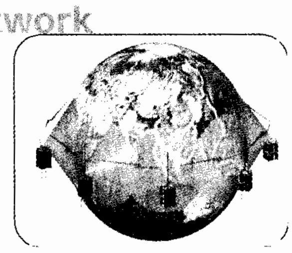
Constellations



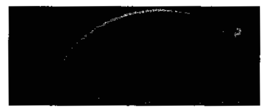
Proposed Small Satellite Constellations

- Disaster Monitoring Network
- LEqO Communications Network
- LEqO EO Enhanced Microsatellite Network
- Radar Altimeter (Sea-State) Network
- Light-SAR Network





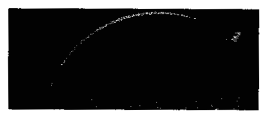
Disaster Monitoring from Space



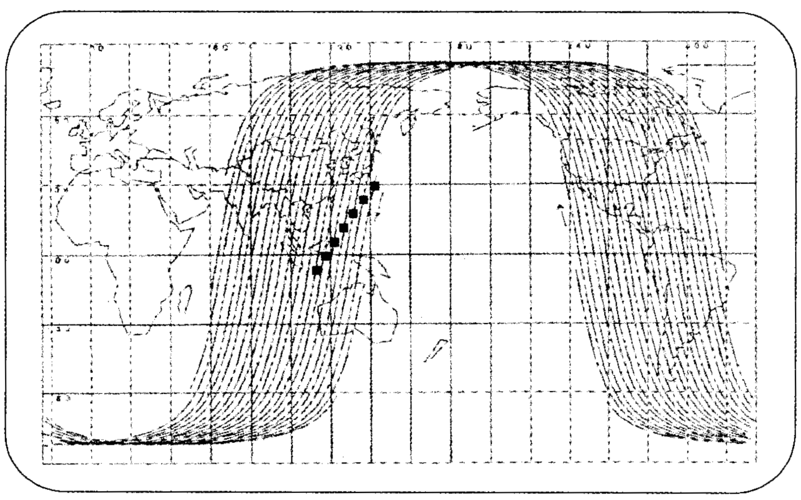
($1 billion p.a.)

to image anywhere on Earth's surface at least daily

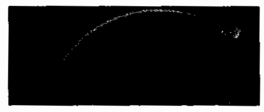
Disaster Monitoring Network



seven microsatellites in 772 km 98° sun-synchronous orbit

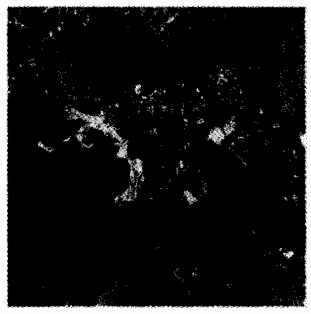


Network of EO Microsatellites



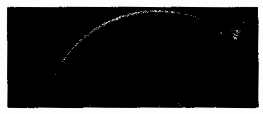
dedicated to disaster prediction & monitoring

Requirements



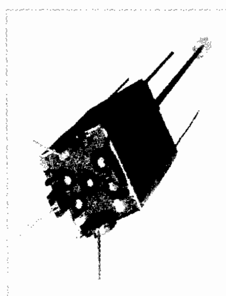
- 772km 98° sun-synchronous LEO
- 24hr revisit - anywhere *(12hr day/night)*
- 400km imaging swath width
- 40m resolution, 4-band multi-spectral
- low manufacture and launch cost
- rapid implementation

Network of EO Microsatellites



dedicated to disaster prediction & monitoring

Uses latest imaging sensors and on-board processing:



- 1024x1024 CCD array sensors *(snap-shot mode)*
- 4 cameras with spectral filters
- 35-metre resolution, 400 km swath width
- sophisticated on-board processing of data
- low power, low cost, high reliability

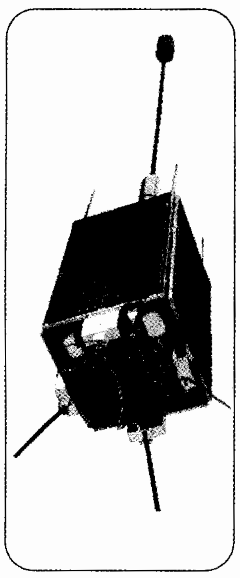
Network of EO Microsatellites

dedicated to disaster prediction & monitoring

Launch:

- **insufficient secondary payload opportunities available into same S-S LEO**
- **the small size & mass of microsatellites enables them to be launched together economically on a single small launcher**
- **cold gas system for orbit separation and station-keeping on-board microsatellite** (1.25kg = 10 years)

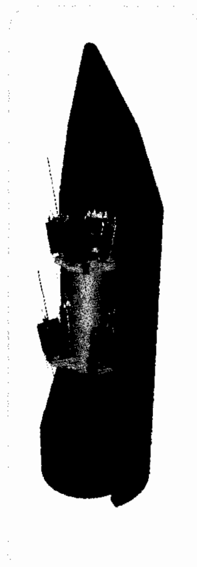
Disaster Monitoring Network



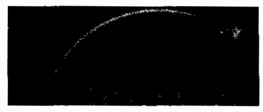
Proposal

network of 7 microsatellites launched together on one rocket

provides an affordable solution and real opportunity for international co-operation

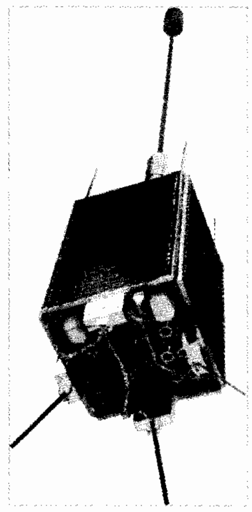


First Demonstration Mission

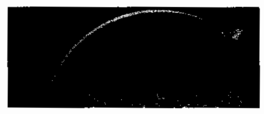


Tsinghua-1 microsatellite

- 40-metre 4-band multi-spectral
- 1km NIR meteorological
- off-nadir pointing
- commenced Oct'98
- Joint Surrey-China team
- launch at end 1999



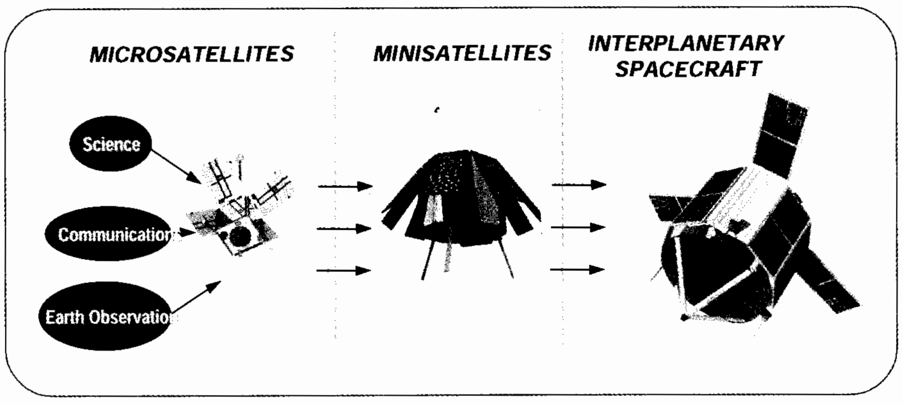
SUMMARY



An affordable disaster warning, monitoring & mitigation satellite network is both feasible and affordable using low cost microsatellites

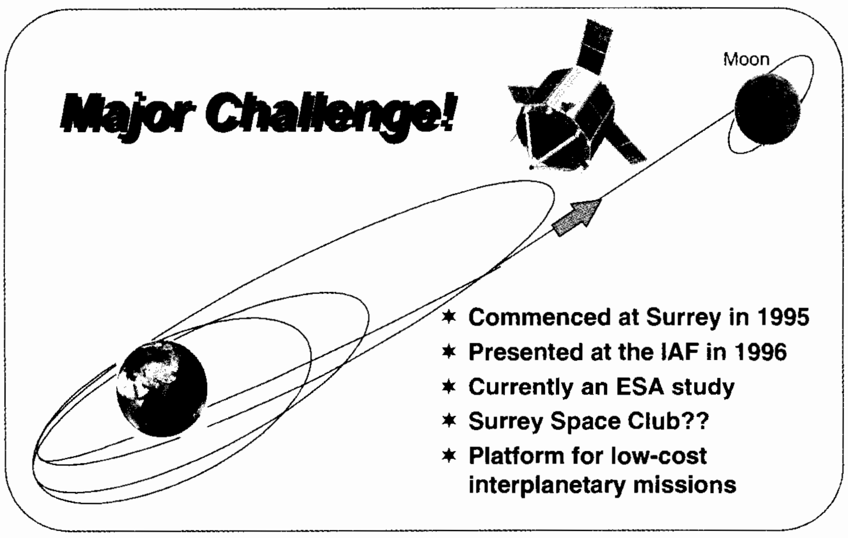
- provides 40m resolution, multi-spectral images of anywhere on Earth at least once each & every day
- uses 2-D CCD imaging cameras and advanced on-board processing to reduce mass, volume and cost
- uses flight proven microsatellite heritage
- ★ total 7-satellite network cost: US $28 million (incl. launch)
- ★ Surrey Space Club - work together to orbit in 2000

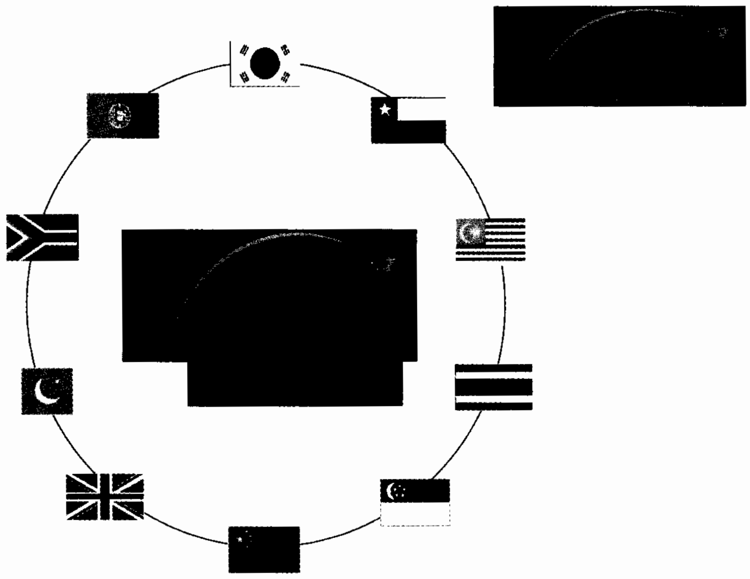
Real Collaboration in Space



Innovative & Affordable Access to Space

Lunarsat Mission 2001





Thank You!

Disaster Monitoring in Bangladesh*

A. M. Choudhury
Chief Scientific Officer,
Bangladesh Space Research And Remote Sensing
Organization (SPARRSO), Bangladesh

*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

ABSTRACT

Bangladesh currently ranks as one of the world's foremost disaster-prone country. The situation is aggravated, all the more by its being the most densely populated country in the world. Environmental disasters like tropical cyclones, storm surges, floods, norwesters, tornadoes and droughts ravage the country almost every year. During the last thirty-eight years, the country was devastated by thirty-eight severe cyclones of varying intensities. One of the severe ones in recent times was that of 29 April 1991, when material damage was to the tune of about 2.4 billion US dollars and human casualty of about 140000 lives. On a previous occasion of a similar catastrophe in 1970, about half a million lives were lost. The Bangladesh flood of 1988 caused economic loss to the extent of about one billion dollar. The loss due to the current 1998 flood of Bangladesh is being assessed and will exceed that due to any previous flood.

And flooding in Bangladesh is a perennial problem. Every year Bangladesh is also affected by norwesters and tornadoes causing loss of lives and immense damage to property. Though Bangladesh is affected by floods frequently it is not spared from drought which occurs in Bangladesh occasionally causing extensive damage to crops. Bangladesh also lies in the seismic zone and hence comes under the risk of earthquakes.

The physical cause of these disasters are embodied in laws of science and hence proper scientific research is necessary to deal with them. The Role of Remote Sensing in the monitoring of various natural disasters like tropical cyclones, floods, norwesters, tornadoes, earthquakes, greenhouse effect etc. has been described in this paper.

TROPICAL CYCLONES

The tropics can be regarded as the region of the earth lying between 30oN latitude and 30oS latitude. All the tropical seas of the earth with the exception of the south Atlantic and east south Pacific give birth to deadly atmospheric phenomena known as tropical cyclones. On the average, 80 tropical cyclones are formed every year all over the globe.

Bangladesh is a part of humid tropics, with the Himalayas in the north and the funnel shaped coast touching the Bay of Bengal in the south. This peculiar geography of Bangladesh causes not only the life giving monsoons but also catastrophic ravages of cyclones, norwesters, tornadoes and floods. The Bay of Bengal is an ideal breeding ground for tropical cyclones.

Though solar energy ultimately controls the terrestrial weather, the following environmental conditions have been found to be prerequisites for the development of cyclones.

- Absence of strong vertical wind shear of the horizontal wind near the cyclone centre and presence of strong vertical shear of opposite sign on either side of this system. The difference between the wind vectors between two vertical levels is known as the vertical wind shear.

- Presence of low pressure region with cyclonic vorticity.

- Warm ocean temperatures. A tropical storm does not form if the sea temperature is less than 270C. Such a high surface temperature is necessary to produce a steep lapse rate for maintaining the vertical circulation in a cyclone. This condition is met throughout the year in regions of the Bay of Bengal where cyclones are formed. A cyclone can extend up to a height of 15 kms. All the low pressure systems may not develop into cyclones. Some just die out whereas others intensify into cyclones. A list of the major cyclones affecting Bangladesh is given in Table 1.

Table 1: Cyclone affecting Bangladesh since 1960

Date	Max. wind speed in kms/hr	Storm surge ht. (in ft)	Deaths
09 Oct. 1960	162	10	3,000
30 Oct. 1960	210	15-20	5,149
09 May 1961	146	8-10	11,466
30 May 1961	146	20-29	-
28 May 1963	203	14-17	11,520
11 April 1964	-	-	196
11 May 1965	162	12	19,279
31 May 1965	-	20-25	-
14 Dec 1965	210	15-20	873
01 Oct 1966	146	15-30	850
11 Oct 1967	-	6-28	-
24 Oct 1967	-	5-25	-
10 May 1968	-	9-15	-
17 April 1969	-	-	75
10 Oct. 1969	-	8-24	-
07 May 1970	-	10-16	-
23 Oct. 1970	-	-	300
12 Nov. 1970	223	20-30	500,000
08 May 1971	-	8-14	-
30 Sep. 1971	-	8-14	-
06 Nov. 1971	-	8-18	-
18 Nov. 1973	-	8-13	-
09 Dec. 1973	122	5-15	183
15 Aug. 1974	97	5-22	-
28 Nov. 1974	162	7-16	a few
21 Oct. 1976	105	8-16	-
13 May 1977	122	-	-
10 Dec. 1981	97	6	2
15 Oct. 1983	97	-	-
09 Nov. 1983	122	-	-
03 June 1984	89	-	-
25 May 1985	154	10-15	11,069
29 Nov. 1988	162	5-10	2,000

Date	Max. wind speed in kms/hr	Storm surge ht. (in ft)	Deaths
29 April 1991	140	20-25	138,000
02 June 1991	100	6	-
02 May 1994	200	-	170
19 May 1997	225	15	126
26 Sept. 1997	150	10	70
20 May 1998	120	0,0	3

Determination of the Cyclone Track : The precise force responsible for the motion of tropical cyclones is not understood clearly and hence determination of the path of the cyclone in advance is one of the most difficult tasks in meteorology.

Recently various statistical and numerical dynamical methods have also been introduced for the forecast of cyclone paths:

- Steering Principle was first applied by H. Mohn in 1870. Until 1950 forecasts of tropical cyclones were made by subjective methods based on synoptic maps and climatological behavior. Following are some of the objective methods applied in modern times for cyclone forecasting.

- Statistical methods relate predicted movement to one or more parameters in an empirical way.

- Dynamical techniques, on the other hand make use of some forms of the equation of motion to predict numerically the motion of cyclone from an observed initial state of the atmosphere.

- Hybrid model in which output parameters from a dynamical model are used in a statistical model. SPARRSO has installed a model named TYAN for predicting the track of a cyclone based on climatology of Bay of Bengal Cyclones for the last one hundred years. The model has shown promising results for the forecast of cyclone movement twenty four hour ahead of landfall. In Bangladesh, Meteorology Directorate is, responsible for the issue of cyclone warning.

Protection Against Cyclones: What can be done to protect ourselves from the cyclones ? A cyclone is a natural phenomenon like an earthquake or a volcanic eruption. We have to learn to live with it. We have to strengthen the cyclone warning system and adopt protective and relief measures to minimize their onslaught. SPARRSO monitors the tropical cyclones on an hourly basis with the help of the remote sensing equipment installed and passes the information to all concerned agencies including Bangladesh Meteorological Dept., Bangladesh Air Force, Honorable Prime Minister's Office, Ministry of Disaster and Relief and so on. With the help of the facilities at SPARRSO, we can determine the location, the intensity and the future course of motions of the cyclone. As a matter of fact no cyclone in the Bay of Bengal can escape the notice of the remote sensing equipment of SPARRSO. An integrated computerized method of Cyclone warning system needs to be developed.

Strongly built houses have to be constructed high above the sea level to serve as shelter places. People from the low lying areas in the coastal region can be evacuated into these shelters in the event of a cyclonic hit.

Coastal embankments have to be made to protect life and property from the onslaught of storm surges. Plantation of trees along the coastal area can also diminish the fury of the storm surges.

FLOODS

The primary cause of flood in Bangladesh is rainfall in the catchment areas of the rivers of Bangladesh. Situated in the monsoon belt with the Himalayas in the north, Bangladesh falls in the region of very heavy rainfall. About 80 percent of the rainfall occurs during the 5 month period from May to September. The annual rainfall varies from about 60 inches in the western part of the country to about 200 inches in the north eastern part. At Cherapunjee in Assam very near our Sylhet Border the average annual rainfall is about 500 inches which is the highest in the world.

But the average rainfall in Bangladesh generates annually only 100 million acre feet of water whereas 1100 million acre feet of water comes from outside Bangladesh. Thus about 90 percent of the water carried by our river system, the Brahmaputra, the Ganges, the Meghna and other smaller rivers is brought from outside the country. These rivers carry water from an area of about 600,000 sq. miles of which only 7.5 percent lies in Bangladesh.

Water enters in Bangladesh through three major channels but the discharge takes place through one major channel. The river system has evolved to carry the normal flow of water generated in the catchment area. Whenever the inflow of water is greater than the carrying capacity of the rivers (and this happens very often) flood results. The magnitude of the flood depends on the magnitude of excess water that is generated. A list of area flooded in different years is shown in Table 2.

Table 2: Area affected by flood in Bangladesh

Year	Thousand Sq. Km.	Year	Thousand Sq. Km.
1954	36.4	1968	36.3
1955	49.9	1969	41.0
1956	35.1	1970	42.0
1960	28.2	1971	35.8
1961	28.4	1972	20.5
1962	36.9	1973	29.4
1963	42.5	1974	52.0
1964	30.7	1975	16.4
1965	28.2	1976	27.9
1966	33.0	1977	12.3
1967	25.3	1978	10.8

Year	Thousand Sq. Km.	Year	Thousand Sq. Km.
1980	32.5	1989	6.1
1982	3.1	1990	3.5
1983	11.0	1991	28.6
1984	27.9	1992	2.0
1985	11.3	1993	28.7
1986	3.1	1994	0.42
1987	56.6	1998	85.0
1988	81.8		

Besides the primary cause, namely rainfall in the catchment area, there are other factors which may aggravate the floods. They are:

- Snow melting in the Himalayas.
- Hydrographic changes in the Brahmaputra basin.
- 2.4 billion tons of sediments carried by the river system of Bangladesh every year reduces the water carrying capacity of the rivers, which worsens the flood.
- Deforestation in the catchment area tends to aggravate the flood.
- Construction of unplanned roads, railways, barrages, embankments etc. also create obstacles to the flow of water and aggravate the flood.

Flood Forecasting and Warning: Bangladesh Govt. has taken up both the structural and non-structural measures of flood mitigation. In this respect regional and international cooperation has been sought. A Flood Action Plan with 26 components with the assistance of World Bank has been undertaken.

Structural measures of flood control like storage reservoirs, embankments or levees, channel improvements and bypasses or floodways are costly and time consuming. For immediate benefit to public, non structural measures are accomplished at a much smaller cost and time. For flood forecasting a network of hydrological stations connected with telemetering gauges or by telecommunication or teleprinter links with the forecasting centre has been established by the Water Development Board. Available hydrological data consist of discharge, water level and rainfall records.

Historical records of data have been analysed to prepare forecasting procedure. For major rivers, correlation of water levels or discharges between upstream and downstream stations are utilized in preparing forecasting procedure. For rivers with smaller catchments rainfall-runoff relation, flood routing, co-axial graphical correlation methods are used. Extensive modelling of flood in our river system is necessary for effective forecasting. The Flood Forecasting Cell of Bangladesh Water Development Board has considerably improved its facility for the issuance of flood forecasting. It uses the remote sensing data along with ground data.

The methods need further automation. Remote Sensing data have been used to delineate the flood affected areas.

It has been found that Southern Oscillation Index (SOI) can be used to gain advance forecast of floods and droughts.

NORWESTERS AND TORNADOES

Though cyclones are the most devastating storm affecting Bangladesh, there are other kinds of storms which affect Bangladesh. Of these, mention may be made of Norwesters and Tornadoes which cause lot of destruction of lives and property.

Norwesters come mainly from the north westerly direction (and hence the name) and are land based. They are a very common phenomenon in Bangladesh during late Chaitra and Baishak months and are known in Bengali as Kalbaishaki.

Another kind of storm very similar to a tropical cyclone but is of much smaller dimensions and very destructive is known as a Tornado.

A tornado is also a low pressure region where strong winds blow around a centre in an anticlockwise direction in the northern hemisphere and clockwise direction in the southern hemisphere. But unlike a cyclone a tornado develops on land.

A cyclone lasts for days whereas a tornado lasts for a very short duration.

A tornado is formed because of the interaction of two air masses, one moist and warm air and the other dry and cold air resulting in extreme form of instability. Tornadoes often form a series and travel in almost parallel paths. The whole tornado moves at a speed of 25-30 miles an hour, whereas the maximum wind in a tornado could be 300 miles/hr.

Since the horizontal diameter of a tornado is so small and it forms so suddenly that it is difficult to recognize a tornado either in the surface weather map or in the satellite picture and hence forecasting of a tornado well ahead of occurrence becomes very difficult. We have observed that certain cloud features as obtained from satellite pictures and some other meteorological parameters like the Showalter or Total. Total Stability Index may indicate the occurrence of a tornado but again it is very difficult to pinpoint the place, time and severity of a tornado occurrence.

Surface meteorological observations are taken usually at certain specified towns whereas a tornado can occur anywhere. A network of radars and frequent satellite observations may be very helpful in the early detection of tornadoes. Extensive research is needed on tornadoes to make any forecast possible.

DROUGHT

Though Bangladesh is a land of abundant rainfall, drought is very familiar to us. It is difficult to define the term drought precisely and hence any definition is rather subjective. It simply means lack of water and may be defined as lack of sufficient water to meet requirements. Thus drought can be of various kinds according to various requirements.

Drought History: The scourge of drought may be regarded as an integral part of the world climate. Wherever there is rainfall, there is drought also. Just like there is excess of rain causing floods, there is inadequate rain causing drought. Drought is by no means an isolated phenomenon or a purely local phenomenon. Sometimes drought occurs in large part of the globe and sometimes in many parts of the earth simultaneously. Excess rainfall may occur in some parts of the earth and drought may occur in another part.

This may be due to the atmospheric teleconnections. Drought is again a recurrent phenomenon. There are records of severe droughts in history. In Bangladesh, drought of 1979 is the severest in living memory.

In the seventeenth century, repeated drought and consequent crop failures occurred in Scotland which in the opinion of some forced the union of Scotland with England. In the 19th century repeated drought occurred in many parts of USA and Canada . In the sixties, drought occurred in various parts of India and in the late sixties and early seventies, there was drought in the Sahel region of Africa.

Bangladesh Climate : Bangladesh is situated in the active monsoon regions of the world with an average rainfall of about 90" per year.

But the rainfall distribution is not uniform throughout the year. Most of the rainfall i.e. about 80% occurs during the monsoon period i.e. June to October. About 5% rainfall occurs during November to February and about 15% rainfall occurs during March to May. This shows that the months November to February are very dry and may be regarded as permanent drought months. But this does not mean that Bangladesh has an arid climate because aridity in these four months is amply compensated by abundant rainfall during the rest of the year. However, the amount of rainfall varies considerably from year to year and from region to region. In some areas in the northwestern part of the country, the amount of annual average rainfall may be as low as 50" whereas in the north-eastern part, average annual rainfall may be as high as 200". There is a lot of variation of rainfall at different places from year to year. Specially during the premonsoon period, decrease of rainfall may seriously affect various crops. For example in 1979 rainfall during January to May was about one third of the normal though for the whole year, rainfall was only about 10% short of the normal. As people have adapted their crop to average climatic conditions, substantial decrease of rainfall may seriously affect the crops and other activities. Though a severe drought like the one that occurred in 1979 is not very frequent a study has shown that milder droughts occur in Bangladesh after an interval of 5-10 years.

The years 1950, 1951, 1957, 1958, 1966, 1967, 1972 and 1979 were years of less rainfall in Bangladesh. We have witnessed severe drought in 1989 also.

Some drought occurred during the post-monsoon season in 1997. Drought condition prevails in some part of the country almost every year for some of the time. Some of the droughts in Bangladesh seem to be related to El-Niño phenomenon.

THE GREENHOUSE EFFECT

Man through his activities has started acting as an agent of climatic change. He is releasing enormous quantities of CO_2 (carbon dioxide) by burning both fossil fuels and non-fossil fuels (including burning wood).

Part of the CO_2 is absorbed in the ocean and part is released in the air. It is estimated that since 1860, the CO_2 content in the atmosphere has risen by about 20% and will continue to rise further in future and may double by the middle of the next century. CO_2 and other greenhouse gases can increase the temperature of the lower atmosphere by re-emitting back part of the radiation emitted by the earth. Thus this can definitely change the earth's climate. Large scale increase of the earth's temperature and the consequent rise of sea level has been predicted because of the increased amount of CO_2 and other gases in the atmosphere in future. Even there could be damaging change in the regional climate because of the global warming. for example, Bangladesh could face increasing floods because of this effect.

Thus the disaster situation in Bangladesh will multiply manifold because of the greenhouse effect. If the prediction of the greenhouse effect comes true then low lying deltaic countries like Bangladesh will be faced with the worst kinds of disaster in human history.

Here again various space platforms under Mission to Planet Earth are being launched by US and other countries. These space platforms will help in understanding the greenhouse effect and adopting remedial measures.

EARTHQUAKES

There is ample evidence from various geological studies that the earth's crust is in motion both horizontally and vertically. The modern theory of this aspect of the earth's surface is called plate tectonics.

Earthquakes occur in regions of the earth's crust which are undergoing deformation. As the region is deformed, energy is stored in the rock in the form of elastic strain. This continues until at some point the accumulated strain exceeds the strength of the rock. Then fracture or faulting occurs.

Of the theories of earthquakes, perhaps the elastic rebound theory is the most successful one. This states that opposite sides of the fault rebound to a position of equilibrium and the energy is released in the form of heat, in the crushing of rock and in the vibration of elastic waves. The waves or vibrations which are generated at the moment of fracture produce the shaking which is experienced in earthquake.

The major earthquakes that have affected Bangladesh since the middle of the last century are the Cachar Earthquake of January 10, 1869, the Bengal Earthquake of July 14, 1885, the Great Earthquake of July 12, 1897, the Srimangal Earthquake of 8th July, 1918, the Dhubri Earthquake of July 3,1930, the Bihar-Nepal Earthquake of January 15, 1934 and the Assam Earthquake of August 15, 1950. Of these, only the Bengal Earthquake of 1885 and the Srimangal Earthquake of 1918 had their epicentres in Bangladesh.

The damages caused by these shallow focus earthquakes however were restricted to narrow zones surrounding the epicentres. The greatest damage was caused by the 1897 earthquake. The tremors were felt all over the country and severe damages were caused in the northern parts of Sylhet and Mymensingh districts and in the eastern part of Rangpur district. The 1950 earthquake was also felt all over the country though no damage was reported.

Thus we see that Bangladesh is not entirely free from the menace of earthquakes. Specially the northern belt of greater Sylhet, Mymensingh and the eastern part of Rangpur Districts could be vulnerable.

Bangladesh should develop adequate facilities for detection and study of earthquakes.

Satellite Remote Sensing can easily identify earth's fault zones where the earthquake mainly occurs. Very high resolution satellites are being used for the detection of tectonic movement of the earth.

Skybridge*

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General Manager,
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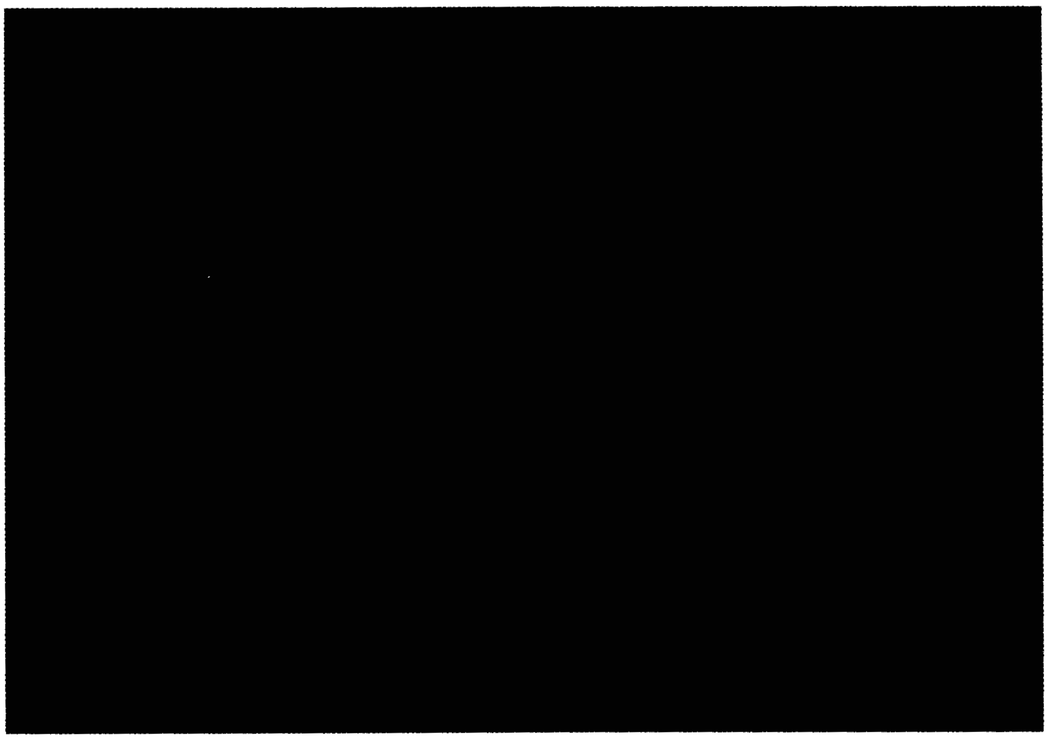
*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.



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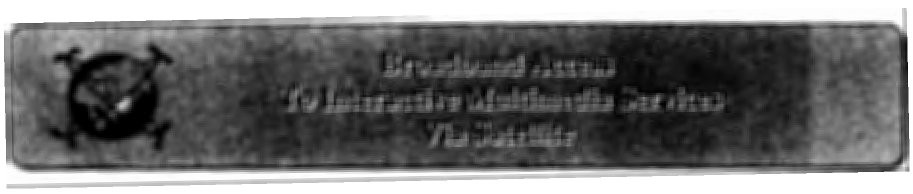

Bruce Jones
General Manager,
Mobile, Radio and Space
Alcatel Australia.

SkyBridge
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Market Drivers

High demand for broadband

- Growth of Internet
- e-business opportunity
- Development of rich content interactive multimedia services
- Market convergence of IT, Telecoms, Broadcast into one market delivering and manipulating digital information

PPT-V174973

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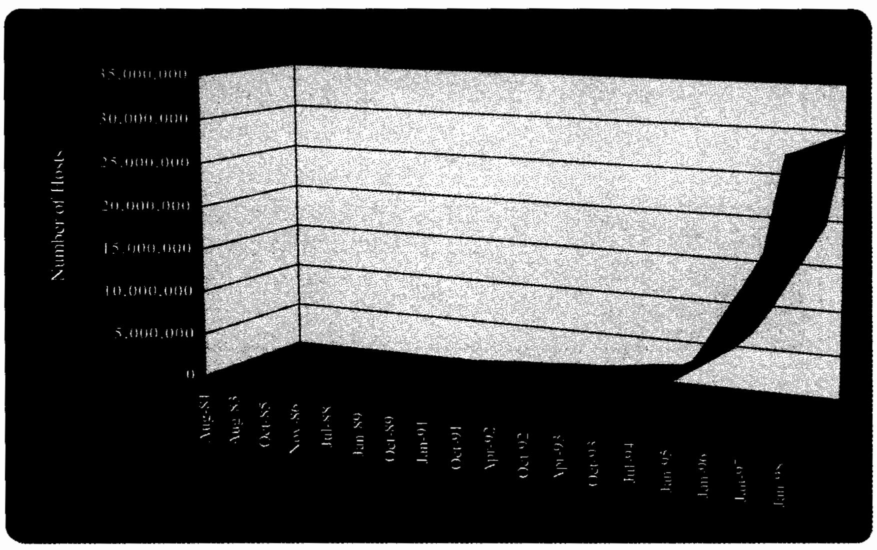
Market Drivers
Internet Host Growth



Source : Network Wizards (www.nw.com)

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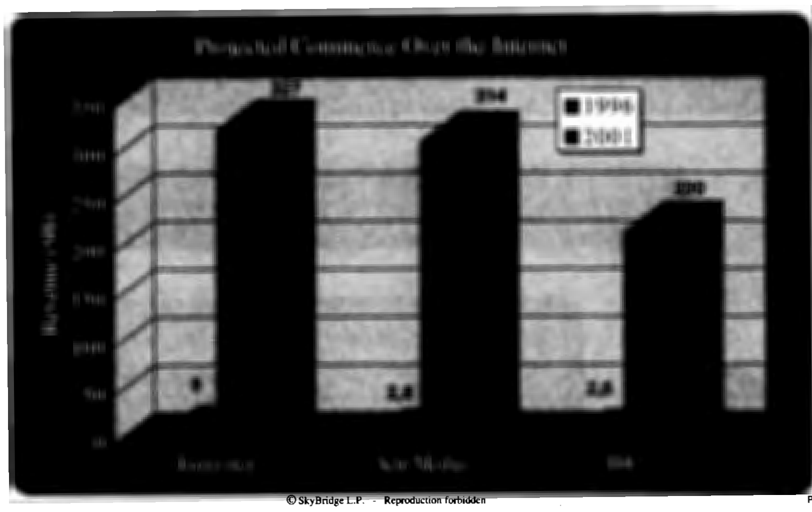
Market Drivers
e-Business Opportunity

A Demand Driver Too Powerful to Ignore !



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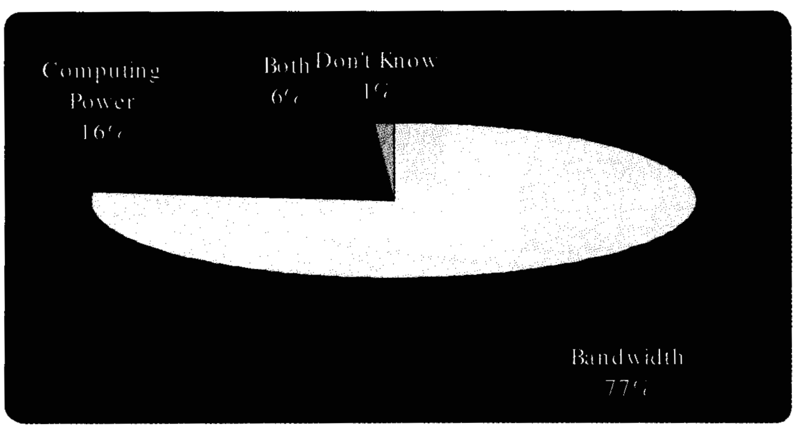
Market Drivers

What Would Deliver the Most Noticeable Results for End Users: Computing Power or Bandwidth ?



Source : Network World 500, IDC 1997

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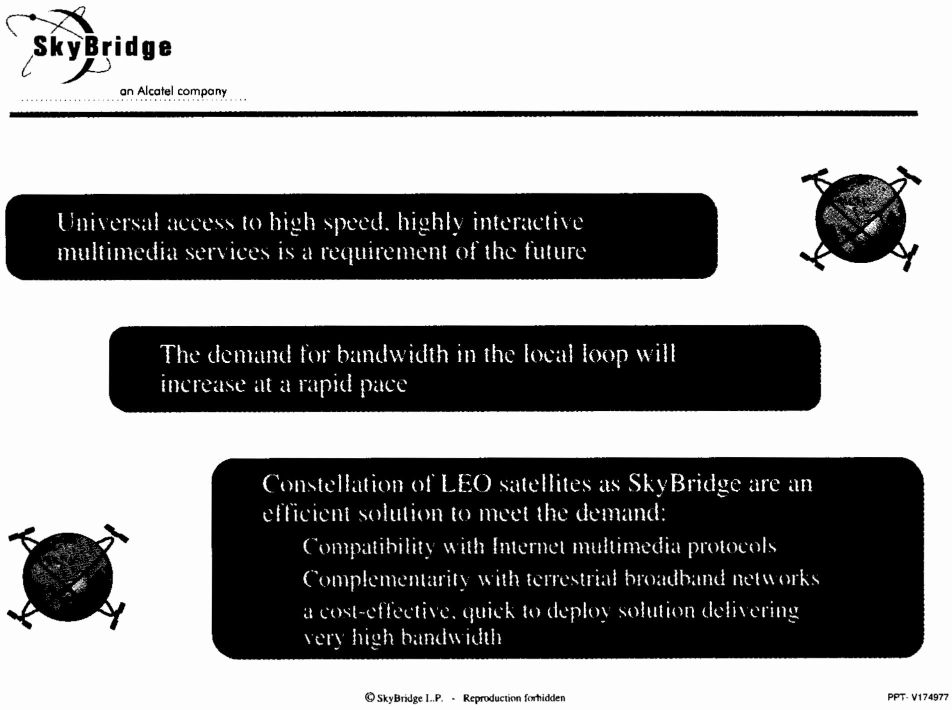
SkyBridge
an Alcatel company
Universal access to high speed, highly interactive multimedia services is a requirement of the future
The demand for bandwidth in the local loop will increase at a rapid pace
Constellation of LEO satellites as SkyBridge are an efficient solution to meet the demand:
Compatibility with Internet multimedia protocols
Complementarity with terrestrial broadband networks
a cost-effective, quick to deploy solution delivering very high bandwidth
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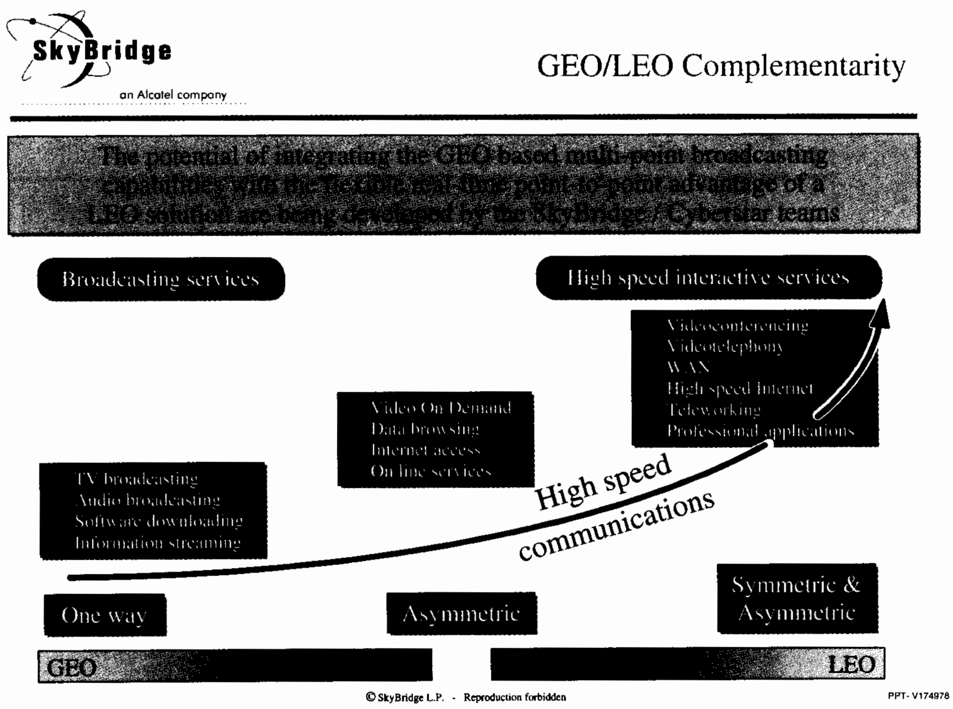
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GEO/LEO Complementarity
The potential of integrating the GEO based multi-point broadcasting capabilities with the flexible real-time point-to-point advantage of a LEO solution are being developed by the SkyBridge / Cyberstar teams
Broadcasting services
High speed interactive services
TV broadcasting
Audio broadcasting
Software downloading
Information streaming
Video On Demand
Data browsing
Internet access
On line services
Videoconferencing
Videotelephony
WAN
High speed Internet
Teleworking
Professional applications
High speed communications
One way
Asymmetric
Symmetric & Asymmetric
GEO
LEO
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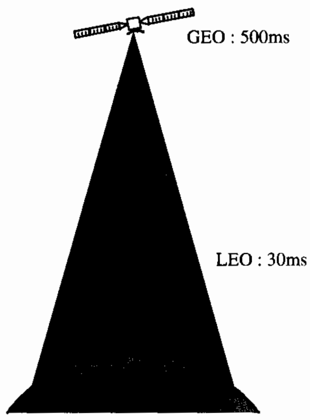
LEO Main Advantages



Round-trip
propagation time

Interactive services require very short response times

LEO short propagation time guarantee similar performances to terrestrial solutions

- Possible reuse of communication protocols and applications developed for terrestrial networks

Global coverage

 PPT- V174979

SkyBridge an Alcatel company

SkyBridge Capacity

The entire constellation has an average capacity exceeding 200 Gbps

North America
75 Gbps

Western Europe
37 Gbps

Eastern Europe / CIS
20 Gbps

Africa / Middle East
19 Gbps

Asia / Pacific
50 Gbps

Latin America
14 Gbps

Total average capacity : 215 Gbps

 PPT- V1749710

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A Broadband Access System

SkyBridge is a global broadband access system fully compatible with terrestrial infrastructure

One single focus : solve the local loop limitation

Broadband bandwidth on demand

Service introduction : 2001

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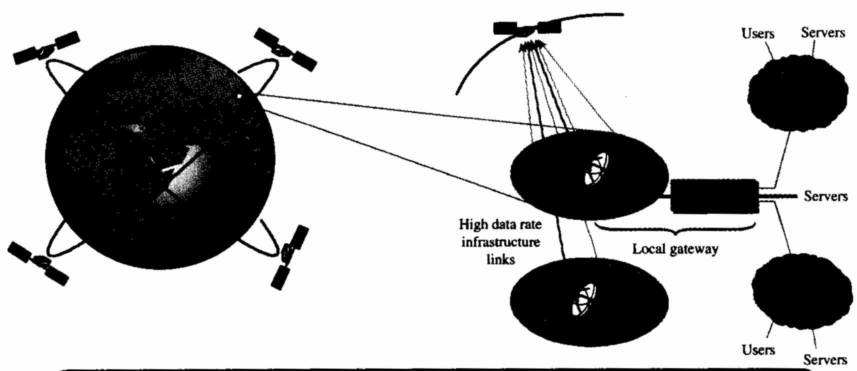
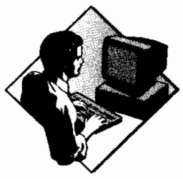
SkyBridge System



- ATM based access network
- Seamless interconnection with terrestrial infrastructure
- Use of the Ku band (10-18 GHz)
- Global coverage, local operation
- 15 to 20 million users worldwide

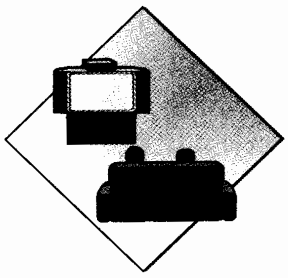
PPT- V1749712

Market and Services



Main Target : Interactive Broadband Services

- High speed access to Internet and on-line services
- Remote access to entreprises (teleworking, LAN interconnection, WAN)
- Teleteaching, teletraining
- Telemedecine
- Entertainment services (video games, video on demand)



Additional Services

- Narrow-band services (voice, videoconference, data services)
- Infrastructure links (connection of base stations for wireless local loops)

Available bit rates

- 16kbps to n x 20Mbps to the user
- 16kbps to n x 2Mbps return link

PPT- V1749713

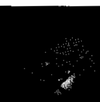
SkyBridge System

Ground Segment

200 gateways (700 km diameter coverage) : modular design

User terminals

Outdoor Unit : 2 types are under design



Indoor Unit : Standard interface with user terminal (PC, TV set, InternetScreenPhone, Network Computer, PBX, . . .)

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Positioning

Strategic choices

- Maximize flexibility
  - Capacity usage
  - Service evolution
- Time to market
- Low risk - Low cost

→

- Ku-band
- Transparent satellites
- No intersatellite link
- Switching on the ground
- Standard ATM protocole

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SkyBridge Unique Advantages

- LEO altitude : adapted to real time services/latency issue (TCP)
- Integration into the terrestrial networks
- Ku band selection (mastered - propagation characteristics)
- CPE price
- Flexibility vs evolutions of market and service
  - Distributed architecture
  - Processing done at gateway level
- Lower technology risks through simple system architecture
- Early time to market

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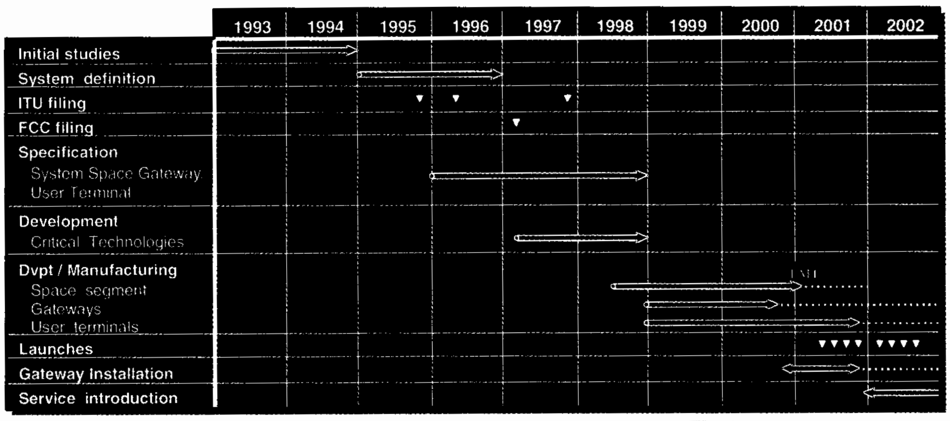
Timeline



Satellite and system design finalized

 PPT- V1749717

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Business Model

SkyBridge is complementary to the Telco Business Model

SkyBridge and Operators : a Strategic Partnership
- Investment in Space Segment - "GLOBAL"
- Development of New Markets - "LOCAL"

 PPT- V1749718

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The SkyBridge critical Success Factors

1. Demand is here : multimedia is booming
   - Data traffic is growing dramatically
   - Huge potential for broadband multimedia
2. SkyBridge has a single focus : hi-speed local access
3. SkyBridge : a low-risk, low-cost, carrier-friendly solution
4. First to market

PPT- V1749720

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PPT- V1749721

VSATs Capabilities and Applications*

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*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

INTRODUCTION

Satellite based communication systems have contributed significantly to national communication infrastructures over the last 15 years and continue to do so with enhancing proportions. Use of satellite systems for TV broadcasting, telecommunication, meteorology and search and rescue applications was established after a decade of development and experimental activities in the field of satellite communication. Developments in RF hardware, software, modulation and multiple access techniques have enabled rapid proliferation of VSAT, now a well established acronym for Very Small Aperture Terminal, networks to provide a variety of services suitable for business communication. VSAT was originally a trademark for a small earth station and are one of the trends of the general trend in earth station downsizing that has been observed in satellite communications technology.

VSATs are basically connected by radio frequency links via a satellite. An up-link from the terminal to the satellite and a down-link from the satellite to the terminal provides the basic signal exchange hop. A radio frequency link is a modulated carrier conveying information. Basically the satellite receives the radio frequency signals from stations within the field of view of its receiving antenna, amplified those carriers, translates their frequency to a lower band in order to avoid possible output/input interference and transmits the amplified signal carriers to the terminals located within the field of view of the satellite. Presently, VSAT networks use geo-stationary satellites and as the satellite appears fixed, it can be used for all round the clock.

A VSAT consists of an Outdoor Unit (ODU) which performs radio frequency transmission and reception functions and Indoor Unit (IDU) which performs digital baseband signal processing function. VSAT network. Like any satellite communication system, consists of ground segment and space segment. Ground segment will consist of population of VSATs and Hub earth station. VSATs are installed at remote sites of geographically dispersed organisation and are used to provide communications via satellite to a Hub earth station that is generally at central site of the organisation.

This generally meets the communication needs of the organisations wherein the remote sites need to transmit small sporadic bursts of data to a central location and central location constantly has to address different remote locations. This facilitates remote sites to be small, simple and of low power capability and also follows sharing of a common communication channel by a number of VSATs. The central hub station is large in size and has high power capability. It also does complex switching and networking management functions.

VSAT TECHNOLOGIES

Traditionally Fixed Satellite Service (FSS) were provided using large expensive earth stations. These were mostly for point to point communications. VSATs evolved when there was need for large networks covering continental areas with busty thin traffic between them. Typical early applications were data communication between central office computer and point of sales computers in a super market chain. Economical small VSATs of sizes 1.2m to 1.8m could be deployed for such low bit rate applications. Subsequently, the large voice requirements in third world countries have led to the development of large (3.8m) VSATs that share the communication channels in a Demand Assigned Multi Access (DAMA) mode.

VSAT Network Architectures

Basically there are two major architectures of VSAT configuration that provide differences in services:

- Interactive Star Network: Time Division Multiple Access (TDMA) a form of shared access technique, has been the core of corporate communication VSAT network since its inception. It is referred as TDM/TDMA technique as the Hub transmits in Time Division Multiplexing (TDM) signal and VSATs share a common carrier (to the Hub) in TDMA mode. These networks allow dynamic allocation to support on-line connectivity necessary for supporting LAN, Interconnect, credit verification, stock exchange applications etc. FIGURE -1 shows the configuration of a TDMA.

  In TDM/FTDMA technology, instead of a single channel being shared by VSATs on time division mode, a pool of frequency and time-differentiated channels are available to population of VSATs. VSATs thus have the freedom to access the network both in frequency and time domain. This technology is more suitable for response time critical data applications such as stock exchange, financial transactions. FIGURE - 2 shows the configuration of TDM/FTDMA network.

  These star networks require a large central hub with a sophisticated network management system and remote sites using VSATs usually of 1.8 m size. These networks run at data rate up to 64 Kbps.

- Mesh network: Demand Assigned Multiple Access (DAMA) systems can either use dedicated links between remote sites (PAMA) or get allocated channels on demand basis from a central shared pool. Scarce resources such as Satellite Communication Channels are used on a as-and-when-required basis. This system is useful constant use data applications and real time applications like voice, video conferencing. Present regulation allows only VSATs of 3.8 m size to be used in this system. FIGURE - 3 shows the DAMA network.

  - Star DAMA: It is a subset of Mesh DAMA. Here multiple hubs are used as gateways. Small terminals of 1.8 m size supporting one or two dial up public voice/fax services are linked to these hub gateways. These systems hold great potential for competitive rural communication network in India

  - TDMA Mesh: Unlike TDM/TDMA Star Network, there is no central hub in this system. All terminals share a common channel to transmit and receive in TDMA form. This system is attractive for small number of high end data nodes. This enjoys mesh connectivity of DAMA and dynamic allocation capability of TDMA. FIGURE - 4 shows the framework of TDMA Mesh.

- SCPC Systems: This is leased line equivalent in satellite system. Data rates from 9.6 Kbps to 2 Mbps are normally supported by dedicated satellite links between two remote terminals or between a remote and hub. SCPC links is relatively expensive because they are available whether used or not. High quality, high bandwidth applications are easily supported. FIGURE - 5 shows a SCPS System.

- Hybrid VSAT: Remote terminal capable of communicating with Star TDMA and DAMA terminal is also a possibility. These terminals have come into existence to suit the communication hierarchy of corporate systems. When part of the business network use TDMA Star terminals for data services and part need to support data and real time voice, video applications, certain central/regional terminals should have the capabilities to link to these two types of terminals. FIGURE - 6 shows the Hybrid VSAT.

While multiple technologies are used to provide data, voice and fax services, new application areas are emerging where VSATs with new technological advances can exhibit viable solutions.

Technologies Vs Application

Theoretically any technology available today can meet any requirement, but at a cost. FIGURE - 7 shows the relation between bandwidth and application. The figure depicts the positioning of technology over a bandwidth Vs sites for a network. For a Network with very high bandwidth requirements per node but with very few sites (2-4), SCPC PAMA is the best suited for this implies that the application over the network generate high traffic all the 24 hrs of network operation. TDM/TDMA based technologies would best suite an environment where the nodes in the network are high (50 - few thousands) with each node generating light busty traffic. SCPC DAMA suits a network with medium (10500) number of nodes all requiring high bandwidths but not at the same time.

The above generalisation might not hold true for all the cases as each network is a different Network. Consider a network that has some sites with very low traffic requirement and at the same time has some nodes with very high bandwidth requirements. So how to arrive at the optimum design? The answer to this question lies on a hybrid platform which seamlessly and transparently integrates the best fit technologies (w.r.t. application) across the network.

VSAT NETWORK SYSTEM REQUIREMENTS

The first step in any VSAT network planning is the understanding of the total system requirements. These include both qualitative and quantitative requirements. Important parameters for defining network requirements are the following:

- Network size - total number of nodes

- Type of applications - voice, fax, interactive data, messaging, data broadcast

- Quality of service - voice quality, blockage, response times

- Security requirements
- Reliability, redundancy requirements
- Interface requirements- PBX, PSTN, X.25, X.28
- Priority and call pre-emption requirements
- Geographic location of sites (for link analysis)

It is also essential to know the resource constraints in terms of total project cost, operational cost and satellite transponder availability. Frequency planning is another important exercise.

Network Capacity

System requirement analysis will lead to the total network capacity requirements. Once the voice and fax requirements are available in erlangs, it is possible to estimate the number of circuits required if the blockage factor is know. The channel rate will be decided by the voice coding acceptable to users. It is fairly more complex to estimate the data rate requirements for data communication. Some complex simulations have been done to find out the throughput-delay properties of data networks with different multi access schemes. If the total peak traffic is known it is possible to decide the data rates required for reasonable response times. Hence, the total network capacity in terms of data bandwidth and number of circuits can be estimated.

Transponder Capacity

While planning a VSAT network it is necessary to work out the satellite transponder requirements in terms of EIRP required and total bandwidth requirement. These calculations will depend upon the VSAT technology chosen. Selection of small VSATs (1.8m) in start topology with TDM/TDMA access scheme will lead to power limited transponder capacity. This is due to the fact that large eirps per TDM carrier will be needed to transmit high data rates from Hub to small VSATs. On the other hand the transponder capacity will be limited by bandwidth if one chooses SCPC/DAMA approach which requires typically about 10 kHz for each 9.6 Kbps channel. One could optimize the transponder capacity by going for a hybrid solution involving both these schemes.

Network Interfaces

This is an important set of specifications for any VSAT network. There are a number of interface options for voice and fax. These are at physical level, signalling level and functional level. The choices could be between 2-wire and 4-wire E&M. Similarly connections could be FXO or FXS compatible. Normally all VSATs provide RJ-11 interfaces for handsets.

Data ports also have physical and protocol interface specifications. Physical interfaces could be RS232, RS422 or V.35 standards. Usually al data VSATs support S.3, S.25 and X.28 protocols. Some VSATs come with standard TCP/IP LAN interface protocols.

VSAT TRAFFIC

Depending upon the service the traffic flow between the hub and the VSATs varies (Table 1), as follows:

- Data transfer or broadcasting, which belongs to the category of one-way services, typically displays file transfers of 1-100 MB of data. This is not delay sensitive but requires a high integrity of the data that can be transferred. Examples of such traffic are computer downloads and distribution of data to remote sites.

- Interactive data is a 2-way service corresponding to several transactions per minute and per terminal of single packets of 50-250 bytes long on both in-bound and outbound links. The required response time is a few seconds. Examples of traffic is transaction applications and fund transfer applications.

- Enquiry/Response is a 2-way service corresponding to several transactions per minute and terminal. Inbound packets (30-1-00 bytes) are shorter than outbound packets (500-2000 bytes). The required response time is typically a few seconds. Database searches and enquiries are traffic examples.

- Supervisory Control and Data Acquisition (SCADA) is a 2-way service corresponding to one transaction per second or minute per terminal. Inbound packets (100 bytes) are longer than outbound packets (10 bytes) with response time of few seconds to minutes. Data security is very important.

VSAT STATION

A VSAT is made of 2 elements:

- Outdoor Unit, consisting of the antenna and the electronic package containing the transmitting amplifier, the low noise receiver, up- and downconverters and the frequency synthesiser. Issues that are important are the transmit/receive frequency (C, Ku or Ka); frequency sizing (adjustment for transmit or receive) ; Equivalent Isotropic Radiated Power (El RP) for conditioning the performance of the radio frequency up-link and the antenna side-lobe gain for conditioning the interference.

- Indoor Unit, which is at the user end and connects to the user terminals - telephone, fax, TV receiver, computer etc. Major issues related here are the port types (mechanical, electrical) and the port speed (rate at which data is exchanged).

A VSAT Hub Station is a master controller with a Network management ,System (NMS). Some characteristics of VSATs are in Table 2.

VSAT APPLICATIONS

VSAT have a large number of civilian applications. Some of the services supported by VSAT Networks are given below:

Services supported by VSAT

One-Way VSAT Networks	Two-Way VSAT Networks
Stock market and News Broadcasting	Interactive Computer Transactions
Distance Education	Database enquiries
Training	Video Conferencing
Distributing financial analyses	Bank and ATM Transactions
Product Introduction	Reservation Systems
Pricing databases	Remote Control and Telemetry
TV Broadcasting	Voice Communications
Audio Broadcasting	Emergency Services
Relay Advertising	E-mail
	Satellite News gathering

Some of the major VSAT based applications are described in the ensuing sections. In India, VSAT network was established as early as in mid 80's for linking district headquarters and State capitals with New Delhi for administration. This first network, NICNET, was the pre-cursor of a large proliferation of VSAT Network services for private agencies. Today, the largest VSAT network in India is being used by National Stock Exchange (NSE) to provide on-line trading of stocks. Many VSAT service providers have set up central Hub earth Stations and provide data, voice, fax services to corporate houses having geographically dispersed business units. Varieties of VSAT technologies are being used for this purpose.

INSAT - A Veritable Information Infrastructure

Established in 1983 in India, INSAT provides a multitude of information services making it the most versatile and valuable information infrastructure of the country. The information services range from the commercial applications such as stock exchange information at one end to the rural development requirements at the other end. INSAT system, as an information infrastructure, has been able to meet the specific information requirements of different sections of the country leading to operational networks that utilise the space segment resources and the other infrastructure available in the country.

Presently there are four operational satellites in the INSAT series providing telecommunications, broadcasting and meteorological services.. These satellites are INSAT-1D located at 83°. E longitude in the geostationary orbit, INSAT-2A located at 74° E location, INSAT-2B and INSAT-2C satellites collocated at 93.5° E locations. Together these satellites are providing a total of 62 transponders in C-band, S-band and in Ku-band. All the transponders are allocated to various user agencies such as DOT, Docrdarshan, AIR etc and are being used for their services. Recently, a Mobile Satellite Service payload has been introduced on INSAT-2C. The meteorological services from the INSAT are provided through a Very High Resolution radiometer (VHRR) instrument and a data relay transponder onboard INSAT. The present capacity is getting augmented INSAT-2E scheduled for launch this year. Together they will` add additional transponder capacity to the INSAT system. The transponders on INSAT-2E are high power transponders having land mass coverage from Australia to Europe.

Broadcasting Services

The most visible impact of the INSAT system has been in the area of Television distribution and broadcasting. Today INSAT provides national, metro and 14 regional language services. The ground network consists of more than 18 TV up-link stations, vehicle mounted satellite news gathering terminals, single box portable satellite news gathering terminals; 780 terrestrial transmitters covering more than 85 % of population and 65 % of land; 200,000 dish antennas reaching 12 million homes, and vibrant programme production and TV manufacturing industries. The entire 28 channel radio networking system of the country interconnecting more than 180 AIR stations is solely dependent on the INSAT with about 13,000 hours of monthly cumulative utilisation.

Rural Telecommunications

INSAT has enabled distant and remote areas to be connected to the national telecom and broadcast networks. The social and commercial life patterns of the denizens of these far-flung areas have undergone radical changes. They are no longer communities that are isolated - geographically, commercially, politically, socially and culturally. The hilly terrains of the north-east, the far-flung islands, the desert regions of the west are connected to the national mainstream via INSAT through 200 small earth stations and Very Small Aperture Terminals (VSATs). More than two hundred additional VSATs are planned for commissioning in the rural areas in the coming years.

Corporate and Administrative Communications

The advent of VSATs have enabled business houses to interconnect their branches, retail outlets, computers, etc. through a reliable communication system and transact business in a more focused, coherent and efficient way. The last mile problem has been solved through rooftop terminals. Developments of different communication and access protocols have enabled sharing of satellite resources for real-time transactions. Airlines, Banks, Distributors, Stock Exchanges, Utilities Sector are some of the major users of VSATs. Demand Assigned techniques allow a pool of low bit rate voice channels to be shared between a number of terminals to provide cost effective and reliable communication system.

The corporate and the administrative sectors are having improved connectivity via INSAT. The National Informatics Centre Network (NICNET) connects the government offices in all districts with 700 low bit rate data VSATs. The Remote Area Business and

Message Network (RABMN), with over 500 VSATs, enables work sites in remote areas to be connected to the corporate headquarters to provide timely inputs on project implementation and directions. The private service operator provided VSAT services have become very popular over the last three years with more than 2000 VSATs already commissioned. The national stock exchange network connecting over 1000 VSATs has provided a new dimension to the country's commercial transactions. The Automatic Teller Machines are connected via VSATs providing instant verification and authorisations. Many business houses have found the VSATs as a vital communications and information system to transact their activities in a more effective way. The Banking sector is looking at VSAT system for interconnecting all the banks and their branches as a necessity for its effective operations. The power sector will be one of the major users of satcom technology to improve the information flow between the generating, distribution and load dispatch stations.

Educational, Training and Development Communications

Educational TV programmes for school children and for university students has been broadcast via INSAT for quite sometime. These limited duration broadcasts are received all over the country and are popular even to the general public. The major emphasis has been on the use of "One-way-video and two-way-audio system". This system is particularly useful for simultaneously training large number of people at large number of dispersed locations. It has been used to train adult education functionaries, rural development functionaries, Panchayati Raj women elected members, students of engineering and management, industrial workers, banking staff, etc.

The response to the demonstrations of the inter-active system had been so overwhelming that an operational system was established in 1995. A Training and Development Communication Channel (TDCC) on INSAT has been earmarked for this purpose. To allow the users to avail of the channel, up-link and studio facilities have been set up in two locations-one in New Delhi and the other in Ahmedabad. The utilisation of the channel has gone much beyond expectations. From an average of ten days in a month in 1995, the present utilisation has shot up to about 22 days in a month. This is being extensively used by the State Governments for training Primary Teachers, Panchayati Raj (Local Bodies) elected representatives, Anganwadi workers associated with Women and Child Development, Watershed Development Functionaries, Health and Family Welfare Functionaries, Animal Husbandry and Cooperative Members. The number of personnel getting trained is very large, making this system the most appropriate one. e.g., the number of Panchayati Raj elected representatives in one State (i.e., Karnataka) alone is 80,000. The number of Anganwadi Workers and Primary Teachers runs into hundreds of thousands. The utilisation of the system by individual organisations has gone up to such an extent there is a demand for dedicated up-links and studios in their premises.

Jhabua Developmental Communications Project

To demonstrate the efficacy of a satellite based development communication and training network for rural development a Pilot Project viz., Jhabua Development Communications Project (JDCP) is being carried out in India in the Jhabua District of

Madhya Pradesh, which is a major tribal area, for a period of two years. The regular transmissions have started on 1st November, 1996.

In this project 150 receive terminals at the village level and one talkback terminal in each of the twelve block headquarters are installed. The studio facilities and the earth station in Ahmedabad of ISRO are being used as the teaching-end. This network is being utilised to conduct training programmes for the field staff and for communicating specific development oriented messages to the audiences at the receive terminals. The priority areas of development where communications support is required include Watershed Management, Health, Education and Panchayati Raj. Watershed Development includes Agriculture, Animal Husbandry, Forestry, Fisheries. The contents of the programmes to be transmitted are being defined jointly with the subject experts, State/District/field officials keeping the needs of the people of Jhabua in view. It is also planned that the talkback terminal classrooms at the block headquarters would become rural information centres of the future providing a variety of general and specific information services including telemedicine applications.

VSAT Based Money Order System

The Indian Department of Posts (DOP) is responsible for collecting the distributing the Money Orders (MO) through their Post Offices located all over India. In the traditional MO system the major source of delay in money transfer process is the physical transportation of the MO form. This is also the major cause of delay in receipt of the acknowledgement by sender. The new system is based on transmitting the details of MO over a satellite communication medium for long distance and over the PSTN for short distances. Given the face that a large number of the POs are located in relatively remote areas with little or no telecom infrastructure, satellite communications is the obvious choice. This is not only location insensitive but has the added advantage of quick implementation. In particular, VSATs provide an even more cost-effective solution by taking advantage of the star topology with a single relatively expensive hub station but a large number of inexpensive VSATs.

With the solution, the major source of delay associated with the traditional system (physical transportation of MO forms) is completely eliminated. All the jobs associated with physical transportation of the MO, such as, sorting, routing etc. get eliminated. Also, as the outstanding MO list is automatically generated and fad to HAC, tallying of transactions gets simplified.

VSATs IN A NATIONAL INFORMATION INFRASTRUCTURE (NII)

Information infrastructures have become an essential element of the development of any country. In the global sense, the concept of a Global Information Infrastructure (GII) is being talked of based upon the vision of open connectivity and information access. The thrust of the GII is an open access, universal service, flexible regulatory environment, competition and private investment. The basic issue in the operation of the NII is the backbone on which information travels from one point to another. Today, India has a good telecommunication network and a space based satellite communication network in the country. The backbone carrier will have to be a high speed carrier capable of providing bandwidth on demand to intermediate levels of the network and to users of the network.

With rapid advances in technology, network configurations are transgressing to provide high band-width connectivity using fibre optics, fast Ethernet, Fast Distributed Data Interface (FDDI), Asynchronous Transfer Mode (ATM), etc with capacities of up to 100 Mbps datarate, communication networking of up to 2 Mbps datarate with VSATs and high-speed satellite broadcast/delivery. Therefore, the network backbone will have to be a mix of satellite and terrestrial communications. The advantage of satellite communication is its regional reach and also its ability to serve miniature hubless VSATs and Direct-To-Home delivery of information services. Thus, the network encompasses computers and databases, TV and radio, multimedia broadcast etc. - all in one single "mother of networks".

VSAT APPLICATIONS IN THE COMING DAYS

While the existing levels of services from VSATs - will continue and expand to impact almost the total population, a new set of services will emerge which will derive benefits from the technological trends of networking, communications, imaging and databases. Some of the applications of the future will be:

- Home Banking: As the mega-media Highway reaches every living room, Smart Cards will give us a full-function Automated Teller Machine (ATM) at home, except for cash deposits and withdrawal. Customers can get account balances, can transfer funds and pay bills.

- Video-On-Demand: Watching any movie, any time, "Video-On Demand" (VOD) is supposed to be another killer application that propels dozens of new mega-media services into homes by the end of the century using VSATs.

- Tele-shopping: Even the more conservative companies in mega-media have put TV shopping near the top of their list. In other words, the TV will deliver the same kinds of still images and text as are now in the printed catalogues.

- Online Services: An online computer service, is exploring ways to bring multimedia services.

- Into homes on cable networks: High capacity VSAT/cable delivery will allow PCs to receive video and images as well as text and data.

- Digital Agents: Electronic commerce will get interesting, especially if specific software can be embedded in mega-media networks to give computer users what it calls an "agent". This, acting like a little digital assistant, could find and buy anything over the network.

- Digital Map Information shops - which will be the major source of all map data and will be the repositories of natural resources and developmental data. Information on different parameters - soils, water resources, agriculture, urban development, socio-economic development etc would be available as part of these "shops".

- Developmental databases that will be the core of major databases for use by decision makers - both within and outside the government. Private sector involvement in the databases of images and resources information, societal and developmental information will open up new vistas of commerce in information.

- Financial and Stock-market database which will be a commercial entity on the NII - serving the needs of trading, financial transactions etc.

CONCLUSION

The Information age has set in and VSATs will become a common man's requirement. Old paradigms are giving way to new ones and is earmarking possibly the most significant era of change in human civilisation. It has refined the concept of information and the communication methods and thus applies to everyday aspects of life. The concept of a Global Village is a reality and VSATs have a major role to play in this.

Today large satellites with high power are providing direct to home (DTH) compressed digital TV channels to dish antennas as small as 45 centimeters.

Each satellite can provide 100 to 150 TV channels. Availability of such large number of channels opens up new opportunities not only to the entertainment industry, but also for distance education. Education on demand, information on demand would not be too far. Wide bandwidth Internet services via satellites are becoming increasingly popular.

On the Ka-band front, studies are being made for satellite configurations for wideband multi-media applications with small antennas. The architecture calls for multiple spot beams with onboard processing payloads providing switching, demodulation, routing and multiplexing functions. The idea is to provide direct connectivity up to 2 Mbps between 75 centimeter VSATs. It will be like a switch in the sky. Such capabilities are required in the none too distant future to meet the exploding information infrastructure requirements.

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Table 1: Types of Traffic

Type of traffic	Packet length Inbound	Outbound	Required response time	Usage mode	Examples
Data Transfer or broadcasting	Not relevant	1-100 Mbytes	Not delay sensitive	-,-	Computer down load, distribution of data to remote sites
Interactive data	50-250 bytes	500-250 bytes	A few seconds	Several trans-actions per minute per terminal	Bank transactions, electronic funds, transfer at point of sale
Enquiry/ response	30-100 bytes	50-200 bytes	A few seconds	Several trans-actions per minute per terminal	Airline reservations, database enquires
Supervisory control pipelines and data (SCADA)	100 bytes	10 bytes	A few seconds	One transaction per second/ minute per terminal	Control/monitoring of and off-shore platforms acquisition electric utilities and water resources

Table 2: Typical Hub Station Parameters

	Compact hub	Medium hub	Large hub
Antenna diameter	2 to 5m	5 to 8m	8 to 10m
Transmitter power: Ku-band C-band	3-15W SSPA* 5-20W SSPA	3-15W SSPA* 5-20W SSPA	50-100W TWT + 100-200W TWT
Receiver noise temperature: Ku-band C-band	80-120K 35-55K	80-120K 35-55K	80-120K 35-55K
Cost	About $ 100000	About $ 500000	About $ 1 million

GIS for Resources Location and Sustainable Exploitation*

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*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

CONTEXT

♦ Increasing constraints on resources exploitation (Optimization)

♦ Complexity of natural phenomena

➢ Global change
➢ Interaction climate/ocean
➢ Desertification
➢ etc...

♦ Need of long-term trends identification in the evolution of natural resources and phenomena

♦ Interaction at different scales (global, regional, local)

♦ The complexity of decision-making process.

→ necessary to establish adequate and durable tools and economic development, strategies for resources management and environment protection

REQUIREMENTS FOR RESOURCES EXPLOITATION

♦ Needs of measurements of descriptive and significant parameters (with location and spatial variation).

♦ Up-to-date changes data to monitor rapid changes

♦ Multi-criter analysis/parameters correlation

♦ Modeling
→Need of a system for:
- data acquisition / collection
- information analysis and interpretation
- facilitating decision-making

USES OF A GIS

Natural resource-based GIS may be used:

♦ As an inventory tool

♦ To better manage the resources

♦ To protect the resources from improper development

♦ To mode the complex interactions between phenomena

♦ To predict eventual situations

♦ Etc...

GIS FOR SUSTAINABLE DEVELOPMENT

How a GIS contributes to sustainable development programmes ?

It enables

♦ integration of all components involved in resources management:

- global approach
- optimization of resources
- avoid redundancy

♦ to develop humain resources and strengthen long-term institution capabilities

♦ to ensure continuity and fellow-up of planed actions (control and evaluation)

WHY IS GIS IMPORTANT ?

♦ A catalyst to dissolve the dichotomies that have long plagued geography and other disciplines which use spatial information

♦ GIS integrates spatial data and other kinds of information within the same system

→Consistant framework for analyzing geographical data

♦ By putting maps and spatial information into digital form

→Flexibility and facility manipulation

♦ GIS makes connections between several activities

GEOGRAPHIC INFORMATION SYSTEM

♦ The objective of a GIS
→ translate Data to Information for decision-makers

♦ What affects the performance of a GIS

→ the quality of the (accuracy, frequency, date,...)

→ competences involved in data analysis and interpretation affect directly the type and quality of the decision

→ technical caracteristics :

- capacity of handling data from different origins, contents, ...
- great flexibility in manipulating data,
- → management of operators and users

ELABORATION OF A GIS

♦ Guided by end-users requirements:

- ➢ should be clearly defined
- ➢ experts and specialists should work closely with end-users

♦ Assess data needed:
→ availability, access, format, accuracy, quality, cost, continuity, ...

♦ Relay on the existing experiences /expertises

♦ Long-term approach: continuity of data and services

♦ Standardization of procedures(inputs, analysis, outputs)

♦ Optimal co-ordination of actors and inter-face to decision-makers

MAIN PROBLEMS

♦ Availability of data

- ➢ at the right moment
- ➢ with the right frequency

E.0 systems are one of the most important sources of data. But in many cases these data do not fulfil these requirements (low revisiting rate, delay in delivery, ...)

♦ When considering "global" problems:

- ➢ data exchange procedure
- ➢ calibration of measurement methods
- ➢ data transmission etc..

♦ Copy right problems (intellectual property)

- ➢ lack of a legal framework to increase the protection of intellectual property rights of data bases

- avoid to restrict data exchange, access and use (specially in education, research, public interest, disaster cases, ...)

- Lack of expertise (in developing countries) for services, values added products, ..

MAIN PROBLEMS (Cond')

Causes related to data

- Poor "useful" of spatial data and information
- Scarcity and obsolescence of information
- Lack of information circulation
- Lack of harmonization between information sources

Causes related to technology :

- High investment costs
- The required training duration to master tools and to develop application

GIS IMPLEMENTATION

Implementation of a successful GIS project requires :

- A strong determination by national policy makers
- Mechanisms for effective interaction between these various agencies/departments
- An appropriate industrial and institutional infrastructure

GIS implementation involves:

- Formulating well defined objectives
- Establishment of a suitable organization
- Allocation of commensurate financial resources
- Developed of a competent technical human base

FORMS OF INTERNATIONAL ASSITANCE REQUIRED BY THE D. C. s. INCLUD

- Strengthening of technical training programmes to help planners, decision makers, scientists to master GIS technology
- Helping D. C. s. to evolve and implement suitable GIS development strategies
- Providing data from satellites at affordable prices and filling the existing gaps in coverage (receiving station)
- Stimulating the growth of indigenous nuclei to establish self-sustaining GIS programmes
- Strengthening international organization UN, FAO, UNPD, ..., to enable them to effectively channel the required assistance

EDUCATION AND TRAINING FOR GIS

There are needs of training and education at different levels

- Decision-markers to increase there awareness
- Technical specialists: system handling, data processing, analysis, ...
- University for methodology development, research, models, ...
- Project managers coordination , integration, up-date, ...

THE CRTS EXPERIENCE

Actions have been addressing three levels:

- Training and Education
- Projects conception and execution
- Co-ordination

Training and education

- Annual program : general initiation to GIS and specific training modules (urbanism, agriculture, fisherise, ...)

- Beneficiaries government departments, private sector, university, countries of the region, international institution (FAO, OSS, ..), etc..

- Method: case studies, pilot projects, practical works, ...

- Co-operation: experts in GIS development, Software, thematic aspects, etc...

Projects conception and execution
The approach is based on :

- End-users' needs and requirements

- Participation of users both in conception and execution

- Training to facilitate know-how transfer

- Assistance to department to develop their own capacities

- Coordination through the National Committee for RS and GiS

- Multidisciplinary projects

- Standardization

- Data exchange: procedures, format, national data-base, ...

- International and regional cooperation

NASDA Earth Observation Application Program on Asia-Pacific Region*

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*This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries", from 24-27 September 1998, in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

NASDA ACTIVITIES ON ASIA-PACIFIC REGION

1. Education / Training / Seminar

2. Pilot Project

3. Satellite Data Reception

4. Data Utilization

5. Experiment

6. Data Network

CONCEPT OF NASDA REMOTE SENSING PILOT PROJECT FOR INDONESIA

NASDA have been promoting pilot project with government of Indonesia, expect to use operationally Japanese satellite imagery into their governmental activities and also conduct to future earth observation satellite mission of NASDA.

Objectives

1. Rice Field Classification and acreage assessment

2. Monitoring of rice crop growth development based on the spectral characteristics model of JERS-1

3. Rice yield estimation

4. Pest disease detection and identification

NASDA ACTIVITIES ON ASIA-PACIFIC REGION

Program	Content	Counter-part	Duration
1. Education Training Seminar	Remote sensing and GIS on-site training	AIT (Thailand, Indonesia, Philippines, Nepal)	1995~
	Tropical Eco Seminar	AIT (Vietnam, Thailand, Malaysia, Indonesia, Philippines, Fiji)	1992~
2. Pilot Project	Satellite map generation Urban Development City Planning Land Development Agriculture Planning Consultation Marine/Coastal Environment preservation	NRCT AIT DTCP LDD OAE DOF	1997~
	Land use change DEM Rice Paddy classification	LAPAN AIT	1998~
3. Satellite Data Reception	MOS-1 JERS-1 (ALOS)	Thailand (NRCT) Thailand (NRCT) Indonesia (LAPAN) China (NRSC) Korea (KAIST) Australia (AUSLIG) New Zealand (NIPR)	1990~1995 1994~ 1994~ 1993~
4. Data Utilization	ADEOS PI ESCAP/RESAP GRNS GRFM	20 PI from 20 countries ESCAP Thailand, Indonesia, China, Australia Thailand	1996~ 1994~ 1998 1997 ~
5. Experiment	TRMM Validation Ozone measurement Airborne measurement	China (Tibet) Indonesia Indonesia	1997~ 1996~ 1998~
6. Data Network	GOIN (Global Observation Information Network) APAN (Asia Pacific Advanced Network)	US-Japan (Indonesia)	1993~

RELATIONAL STRUCTURE AMONG THE ORGANIZATIONS IN PILOT PROJECT

Role of NASDA

- Satellite Operation
- Provision of Equipment
- Provision of Data
- Training

Role of the project members in Thailand

- Data Distribution
- Data Analysis and Recognition
- Generation of Report and Map

Role of NRCT

- Data Reception
- Processing and Distribution
- Project Coordination in Thailand

Role of the Asian Institute of Technology

- Cooperator
- Training
- GCP Data Collection

Spatial Information Systems, Sustainable Development And Technology Transfer*

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* This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

INTRODUCTION

Only in the last few decades have we recognised the extent to which humans can modify and alter the energy and mass exchanges that occur between atmosphere, oceans and biota and to understand that the changes being wrought may be beyond the resilience of natural systems to absorb. While we marvel at the diversity of the earth's environments, we have little knowledge of the functioning and interaction of these environments at a global scale nor do we have precise information on the location, extent and impact of the human modification taking place.

There is general agreement among scientists that unravelling the processes involved in the functioning of the earth system together with identifying the forces acting to promote global change, as well as determining the rate of that change, requires the availability of sets of compatible, homogeneous global data for a variety of key terrestrial variables.

Over the last two decades there has been a revolution in the way information about the environment is acquired, processed and stored. This centres around the use of computer technology in all stages of data collection and manipulation, and its ability to spatially integrate, interrogate and analyse the nature of the relationships that exist in co-located information. In the geographical sciences this revolution started with embracing statistical methods in analysing aggregated data sets and the use of computers for automated map production in the 1960's. More recently, remote sensing, geographic information systems (GIS) and global positioning systems (GPS) have had a tremendous impact on the way local, regional and global information about the environment is acquired and analysed.

Together the spatial information technologies of remote sensing, GPS and GIS can facilitate the manipulation of environmental data to provide better or more appropriate information for decision making and resource management than has been previously available.

SUSTAINABLE DEVELOPMENT

Sustainable development refers to the adoption of practices in relation to environmental use and management which provide a satisfactory standard of living for today's population and which do not impair the capacity of the environment to provide for and support the needs of future generations.

The concept of sustainability in respect to the use of environment resources includes the notion that the outputs derived, whether they be from land, water or air can be produced continuously over time and that a balance can be achieved between the rate of economic growth, their use and environmental quality that minimises the risk of long term degradation. It is argued that through careful management and the use of appropriate practices the long term viability of the environment can be maintained. The exploitation of non-renewable resources should be addressed through a societal based transition to the use of renewable resources.

A sustainable development practice is one, which is sensitive to ecological constraints and seeks to minimise the undesirable effects of exploitation and use, which might impact negatively on the longer-term viability of a resource. It is also one in which the full economic and environmental replacement costs associated with the use of a resource should be met.

Sustainable development cannot be divorced from issues of equity, welfare, lifestyle and the expectation of improved standards of living in most countries. Nor can the implementation of sustainable development practices be separated from the economic and political structures that exist within and between countries.

The implementation of sustainable development practices on a large scale is unlikely to occur or be successful without accompanying economic, social and political change. Governments have to institute policies that encourage the implementation of production methods that operate within ecological limits and which lead to different patterns of resource consumption developing than currently exist. Policies should favour innovation and technological changes, which offer resource efficient solutions and what *Clayton et.al.,* (1996) call progressive adjustments with emphasis on system level sustainability at the national level and project sustainability at the local level. They also advocate using the "precautionary principle" which assumes that all natural systems are vulnerable thereby demanding that adequate risk evaluation be part of any development process.

Governments should remove measures that are resource depletion incentives such as concessions for mineral extraction, offering underpriced logging permits and providing subsidies for cultivating marginal land, all of which operate against sustainability, and implement policies that regulate, control or prohibit excessive resource exploitation and that encourage conservation and efficiency (*Clayton op.cit.*).

Also, the concept of environmental resources as natural capital together with a well developed theory of economic valuation of the environment need to be enunciated and embraced more openly in planning and management to ensure that the true costs of environmental use are factored into production.

Obviously changes have to take place at the local level. But change must also be addressed within national boundaries and through international cooperation and collaboration. Sustainable development can only result through a participatory process of assessment and commitment which involves international, national, community and individual stake-holders in the decision making process. Spatial considerations in this process extend from individual parcels of land to regions of continental and oceanic proportions.

SPATIAL INFORMATION TECHNOLOGIES

Space and airborne remote sensing systems can be used to acquire data on the type and condition of the earth's surface in a systematic and regular fashion.

Global Positioning Systems (GPS) involving a network of twenty-four communication satellites enables the precise position of objects and locations on the earth's surface to be calculated with an accuracy of metres and for these co-ordinates to be stored within any desired mapping projection. Precise geodetic control has not only improved the overall accuracy of the mapping process but has more easily facilitated the incorporation of field data into spatial analysis.

Dedicated processing systems exist to store and analyse spatial information and integrate and link it with other geographic and tabular data, GIS efficiently store, retrieve, and allow the manipulation and analysis of data acquired from a variety of sources.

There is not doubting that the advent of remote sensing technology and its continued development over the past three decades has been crucial in respect to providing the information needed to describe, analysis, monitor and understand the environmental changes that are taking place at the end of the 20^{th} Century. Meteorological and earth observing satellites, together with improved telecommunications and navigation systems, and GIS provide the technological infrastructure from which the scientific analysis necessary to address environmental concerns at both the local and global scale can take place. It is also fortuitous that these systems permit information to be analyzed on earth system changes a both the local and global scale.

Chrisman (1997) notes that the technical aspects of remote sensing, GPS and GIS are somewhat overwhelming and present the temptation to learn commands, operate software and produce automated analysis and information. While spatially related technologies are powerful tools, they should not determine the nature of the information sought nor drive the information gathering process. Rather the technical advances made in these spatial information technologies should be used to optimise and improve the quality of the geographic information available for decision making in respect to how environmental resources are located, measured and their use monitored.

The major characteristic of "geographic information" is that the feature or object in question can be accurately located, its dimensionality captured, is capable of being measured and can be adequately described. Given that such characteristics are attributed of data obtained through remote sensing and GPS it is important that the processed or interpreted information is stored systematically, can be interrogated, transformed from one measurement framework to another, and is capable of being linked with tabular and other attribute data to map and model real world scenarios. GIS's provide such an environment. Such connectivity in important because an understanding of sustainability requires not only an interdisciplinary approach, but the integration of information derived from a variety of sciences which span the physical and human disciplines.

TECHNOLOGY TRANSFER

Technology transfer is the process of transferring ideas, personal expertise and operational procedures to individuals, groups and organisations outside the initiators and developers of the technology, together with the necessary infrastructure to support and ensure the efficient adoption and continued incorporation of the technology into routine information gathering procedures.

The aim of any technology transfer program is to extend the knowledge, skills, and benefits of that technology to a broader sector of a potential user community. Effective technology transfer requires a systematic program in which *liaison, demonstration, training* and *assistance* become essential activities between the innovators and the adopters of the technology. In the following discussion emphasis is given to transferring remote sensing technology to potential user groups

Liaison

An initial step is to identify those groups who are the potential users of spatial information technologies; establish contact and seek to inform them of the benefits of such technology to their enterprise. Usually we identify potential user agencies as being found within either the government sector or private industry and traditionally, professional and technical officers from government agencies have been regarded as the more receptive in terms of endorsing and adopting remote sensing technology. Private industry groups, concerned with short term capital expenditure and cost benefit recovery ratios, tend to be more demanding in terms of identifying the deliverable products obtainable from the technology before taking the decision to implement remote sensing technologies in the work place.

For too long remote sensing innovators have assumed that potential user groups will unquestioningly embrace remote sensing as a viable and necessary information technology. Clearly this is not the case. Resistance to implementing remote sensing in the work place brought about by attitude, reluctance to change traditional methods, lack of expertise, financial considerations and the like is not easily overcome.

Often the real players in technology change are overlooked. Senior management in both government and private industry make decisions about future direction, infrastructure and staffing needs. While the remote sensing community has been relatively successful in capturing the imagination of technical and middle management personnel, it has not been as successful in conveying to top management the potential benefits of the technology. At this level arranged appointments, one on one interviews, luncheons, and short demonstrations matched to the specific needs of the client organisation may be better avenues for communication than short courses, workshops and lectures, which are appropriate strategies for capturing the commitment of those who will undertake the actual implementation of the technology, namely, the professional, para-professional and technician groups. This means strategies have to be developed that will target particular user and management groups and provide them with specific information relevant to their needs.

Demonstration

Few users adopt remote sensing without serious evaluation of the technology. Hence the initial contact and continued liaison between the innovator and potential adopter of the technology is very important, particularly in the early stages of the transfer process.

The ability to clearly explain the utility of remote sensing in an operational environment and to provide examples of turn-key applications with the generation of useable products along with advice on possible system configurations and staffing needs, are essential components of any package designed to demonstrate the worth of the technology.

For remote sensing to be accepted, as routine in resource analysis and management requires the existence of operational procedures producing credible results. Potential users within the public or private sectors are not interested in risk taking or in using experimental or untried routines. A major factor responsible for user adoption is the availability of clear examples of successful applications and in particular, ones which contain repeatable methodologies.

Training

The knowledge that trained personnel are available and that the necessary opportunities exist to instruct existing staff will obviously influence the decision whether or not to adopt remote sensing technologies.

On the whole, remote sensing education and training is poorly organised, fragmentary and geographically restricted. As a proportion of the total annual budget contributed to the space sector worldwide, very little is actually spent on remote sensing education and training.

Training programs in high-tech societies tend to centre around institutions offering courses ranging from a few days, to weeks and months. Specialised training facilities such as the ITC, the Asian Institute of Technology, University of New South Wales, EROS Data Centre are too few in number to meet current demands for specialised short course type training. In technologically developing regions such as Africa and Asia there is at present heavy reliance on aid sponsored courses and out-of-homeland training programs. Clearly the lack of trained personnel could prove to be a major contributing factor to the under-utilisation of this technology now and in the future.

Few University institutions have been able to finance the establishment of adequate image processing facilities in order to cater for staff research and student needs. There are few well designed programs in remote sensing that provide comprehensive training at both the undergraduate and postgraduate level. Attempts by individual faculties or schools are often less than successful because neither the time nor the resources are available for meaningful training in remote sensing to occur.

The success of short course programs in the past twenty years is a clear indication of the need for a more formalised approach to training in remote sensing. It is also necessary because the innovators of a new technology are not always the best teachers or perpetrators of that technology.

A total training program in remote sensing technologies should be structured so as to match the existing experience and employment levels of those seeking training. Training for *professional* and *para-professional* personnel should be aimed at providing experience in the design and implementation of projects and investigations using remotely sensed data and where necessary, in the procedures associated with remote sensing analysis. Not all participants at this level however, need to be proficient in skills related to image processing and ground data collection. *Technician* level training may require instruction in the methods of collecting relevant ground data, conducting field measurement and undertaking basic image analysis. Clearly theoretical considerations, research frontiers or instruction in the principles of remote sensing may be inappropriate at this level.

The high demand for short courses in the past stems from the fact that many professionals currently occupying leadership roles in user agencies were trained before the advent of applied remote sensing. Already in Australia, however, the demand has fallen for basic and introductory courses and increased for more specialist and applied instruction. This results from the fact that many potential users have already adopted the technology and have developed a basic level of expertise. Also, as new graduates entering the work force have skills in the use of remote sensing and related information technologies, the need for introductory type courses has declined.

While there will always be a market for the specialist short course and in particular those dealing with new advanced procedures, long term benefits are most likely to accrue from programs aimed at training *student* personnel about to enter the work force in remote sensing and GIS. This requires setting up an appropriate infrastructure at the university and technical college level of instruction.

A fourth and often overlooked group needing training are *teachers* at both the tertiary and elementary school levels of education. It is difficult to conceive how remote sensing can be taught effectively within undergraduate programs or pursued at the postgraduate or research level without adequately trained and experienced lecturing staff. Training is needed within the university sector in order to up date lecturing staff in remote sensing science; to assist them in the design of adequate programs and courses of instruction and to help initiate theoretical and applied research in remote sensing.

Many university staff already have appropriate qualifications such as Ph.D's and are reluctant to consider undertaking additional periods of long-term training. They may be able to obtain the necessary skills through sabbaticals, occupational leave programs, short courses and the like. Academic staff with bachelor and master's qualifications, however, are usually keener to explore the possibility of extended training and research in remote sensing and should be enabled to do so by there employer institutions.

The need for interdisciplinary involvement in remote sensing education within universities and colleges is both fundamental and necessary. Remote sensing draws on the knowledge and skills of a range of theoretical and applied sciences, such as physics, computing, engineering, surveying, geography, geology, agriculture and forestry. Any specialist tertiary program in remote sensing must be able to incorporate and integrate components from these and other discipline areas in the curricula. While the initiative for remote sensing might come from a single faculty, school or department within a university or college, and while the bulk of the equipment might reside with that faculty, school or department, the contribution of academic staff from other areas will be required if a viable remote sensing training program is to be established.

On the practical side, interdisciplinary involvement ensures that remote sensing is not seen to be the sole prerogative of one discipline or school. The involvement of staff from a number of discipline areas will increase the range and scope of courses offered, ensure the maximum use of facilities and attract larger student numbers.

Training strategies used to communicate and instruct both primary and secondary school teachers in the usefulness of remote sensing are fundamentally different from those employed with other groups involved in the technology transfer process. For most school teachers space science and remote sensing are topic areas which compete with many other topic areas for recognition and a place in the day-to-day school program. While many teachers find remote sensing intrinsically interesting, the demands on time and curricula usually preclude them from developing more than a cursory understanding of the basic technology and its usefulness in the mapping, monitoring and managing of earth resources. The best that might be hoped for is a course of in-service education for practising teachers that will help them develop a basic literacy in remote sensing interpretation and analysis and an appreciation of how and where they can implement remote sensing into their syllabus and teaching programs. This will nearly always involve the instructing agency in providing teachers with already prepared teaching materials and demonstrations of how they can be used in the classroom.

Ideally the most effective transfer occurs in pre-service teacher preparation courses where more time and structure can be given to the instruction. This means remote sensing innovators need to become involved with teacher educators and be willing to provide them with information and even lecturing assistance in order that those about to begin teaching in primary and secondary schools can feel relatively familiar with the products and application of remotely sensed information.

Innovators also need to interact with the educational authorities responsible for establishing school curricula; with teacher organisations concerned with the on-going education of their members and with the publishers of textbooks and audio-visual materials in order to create a greater awareness of the need for the inclusion of remote sensing into school education. One of the more useful activities that innovators could be involved in is to undertake an in-depth analysis of existing school curricula in order to identify where space science examples could be incorporated and then to produce classroom materials that would assist the classroom teacher in incorporating remote sensing into their existing teaching programs.

Assistance

In the context of remote sensing education and training at least two forms of assistance are necessary in order to sustain a viable remote sensing industry, namely, financial assistance and technical assistance to help adopters continue to obtain useful and reliable information.

Financial commitment to the successful implementation of remote sensing, however, has been limited in the past lacking any overall strategy at either the government, industry or institution level. Few governments be they national or regional have committed sufficient funds to allow remote sensing and GIS technologies to become fully operational, let alone provide sufficient money for the necessary training of personnel.

Priorities often lie with space related research which is not akin to the remote sensing of earth resources or else is supportive of those research initiatives that are likely to result in the development of commercial products from space science. As most agencies associated with the management of renewable resources like agriculture, forestry and hydrology are government funded, these organisation also have found it difficult to commit sufficient resources to remote sensing infrastructures and training.

Private industry groups, such as those in the geological and mining sector have committed substantial amounts to implementing remote sensing technology and to the training of their personnel. Much of this training, however, has been in-house or else "within" the industry and has not necessarily benefited the general remote sensing user community.

Until such time as sufficient potential users become actual adopters of the technology and thereby create a demand for trained and capable personnel, the developers of that technology and agencies committed to technology transfer may be required to support and fund the establishment and maintenance of training programs in remote sensing.

Technical assistance is not considered here, suffice to state that it is promoted by the establishment of a well developed communication network within that user community for the sharing information. Also, the availability of specialist consultants from private industry, universities and research groups does much to provide the basis for such support.

CONCLUSION

Government Policy, financial support and implementation strategies are needed that will extend the existing use of spatial information technologies in environmental resource assessment and monitoring and thereby enhance the process of sustainable development.

Key components of such an initiative should include:

- Formulation of a national policy with guidelines for the use of the technology in clearly defined priority areas.
- Continued development of supportive infrastructures that link government, research and private sector.
- Development of strategies that identify and then educate potential users in the benefits of the technology.
- Establishment of mechanisms that ensure the translation of experimental procedures into commercial applications.
- Expansion of investment in both the pure and the applied areas of spatial applications research.
- Extension and co-ordination of training opportunities to meet the needs of all staff involved in using remote sensing and related spatial technologies.

The success of any technology transfer program depends on the provision of trained personnel. Failure to give due attention to the education and training needs that accompany the adoption of this technology could well be the major limiting factor to the successful adoption and increased use of spatial information technologies in support of sustainable development in the future.

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RAPIDS – A PC-Based Local Ground Station*

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ABSTRACT

The lack of direct access to satellite data is a major global restriction on resource management needs in developing countries. The removal of this obstacle lies in direct readout satellite transmissions and low cost, reception systems for local area data acquisition and processing. This paper outlines RAPIDS (Real-time Acquisition and Processing – Integrated Data System): a local low cost PC-based ground station for the acquisition and processing of high resolution SAR data and optical data from the ERS satellites, the SPOT satellites and the J-ERS satellite.

In addition to the description of RAPIDS, two major projects will be outlined which will demonstrate the use of RAPIDS for resource management in an operational environment.

INTRODUCTION

There is a clear environmental and commercial need to stimulate high resolution data markets and product uptake in both developed and developing world. An EU funded study [1] on the constraints and opportunities of Earth Observation in developing countries identified the lack of more direct access to satellite data as a major global restriction on resource management needs in these countries.

Reduced ground station operational costs, lower data (capital and running) costs, together with an improved, timely service to customers, especially in developing countries, will remove this obstacle and will be highly advantageous for applications development and market growth. So much so, that access to remote sensing data will become increasingly open to many potential users that would otherwise not be aware of, or inclined to utilise earth observation products and information.

Remote sensing satellite operators and data providers currently rely on a system of large, regional ground stations for operational data acquisition and dissemination. However, this presents significant obstacles to meeting the needs for inexpensive and timely data of a very large number of potential EO users. Most of the investment in Earth Observation (EO) goes into the space segment rather than the ground segment. What the user sees of EO is the data distribution (ground segment) side. Growth in demand, the variety of satellite data available and increases in the number of applications mean that greater flexibility in data access is therefore necessary to improve the supply side. This requires increased consideration of direct broadcast and a lower level of control on data distribution [2].

PROBLEMS IN THE ACCESS TO DATA

In many previous studies problems have been observed in the access to data, especially but not limited to developing countries [1, 3, 4].

Access to data, especially when data are crossing borders, is hindered by technical factors, by economic factors and by political factors.

- Technical factors relate to:
  - Cloud problems [Optical satellites cannot see through the clouds]
  - Interpretation of SAR data is perceived as being difficult

- Training and education are lacking

- Economic factors relate to:
  - Prices of data are too high
  - Ground station access fees are too high
  - Copyright

- Political/Institutional factors relate to:
  - Security issues
  - National prestige
  - Autonomy

The political and institutional factors can cause the most problems, particularly in developing countries. Especially with regard to regional operating ground stations, it is virtually impossible to obtain data from these stations unless you are a user in the same country. The CRISP ground station in Singapore is a notable exception and perhaps the only positive example in this respect.

THE EXAMPLE OF RAPIDS

Research developments funded by the UK Government Department For International Development (DFID) and British National Space Centre (BNSC) have produced RAPIDS - a PC based receiver system for ERS, SPOT and J-ERS data. In parallel, The Netherlands Remote Sensing Board (BCRS), the Netherlands Agency for Aerospace Programmes (NIVR) and NLR are funding the development of the data processing system and are funding a number of field trials in Europe and overseas [5].

RAPIDS DESIGN REQUIREMENTS

The Real-time Acquisition and Processing - Integrated Data System (RAPIDS) is a PC-based X-band receiver designed to provide local users with rapid access to earth observation data at least cost.

The design philosophy of the RAPIDS PC-based transportable ground station is to meet national and/or local needs for timely environmental data. In most countries, a large number of resource managers, planners and decision makers would benefit from timely information on their environment, if it were available promptly (on demand), reliably and as inexpensively as possible [6]. For these local areas/users the demands are less than for horizon-to-horizon systems. Thus the resulting ground segment can be inexpensive, easy to transport, install and maintain.

The principal design requirement is for a system to handle capture for local areas when the satellite is within $\pm$ 45° of the overhead position. The system has to maximise control during these passes where the rate of change in satellite position is highest. The $\pm$ 45° cone of acquisition enables capture of small unit volumes of data of local interest. The system also has to be robust enough to minimise the effect of wind forces during tracking, and to be simple to maintain and operate. Standard PCs were selected as the platforms for management, tracking, capturing and processing of data. This is because of their increasing performance/cost advantage and their widespread availability and use (compared to UNIX workstations) in developing countries. This makes for easier local maintenance and cost-effective integration with existing capacity BURS designed and now manufacture the system. NRI and NLR provide processing software, applications development, project implementation and technical support.

RAPIDS SATELLITE TRACKING AND DATA RECEPTION

Many high resolution satellites include a beacon (e.g. ERS) or data signal operating on a 2.2 GHz signal, the satellite pointed tracking is done using this frequency. All the current high resolution satellites transmit data on the 8 GHz band and these data streams are collected separately so as not to mix the tracking function with data collection issues.

The current set-up for receiving consists of a dish antenna of 2.7 metres that can be tilted over a range of +60° to -30° in two perpendicular directions. This range is enough to capture data within a circular area of approximately 1000 km diameter, depending on the site. A set of four patch aerials each with its own low noise amplifier for the 2.2 GHz tracking system is mounted at the dish centre. The 8 GHz data reception LNA is positioned in the same focal plane as the patch aerials at the centre of the dish.

The antenna dish is moved by a hydraulic configuration. A hydraulic power unit with oil reservoir pumps, motors, and valves controlling the drive rams is used to move the aerial. Position monitors are linked to the power supply for safety cut out, "safe park" mode and alarms. The receiver system is thus capable of tracking on S-band beacon signals and capturing X-band data signals from satellites over 90 arc-degrees using a 2.7 metre antenna. Capability currently includes ERS, SPOT and JERS. Potentially, other satellites (e.g. IRS, Landsat, EOS et al) could be added to the capability.

Data rates that can be captured vary from 6 Mbits sec^{-1} to 150 Mbits sec^{-1}. For example, the data rate of ERS is 105 Mbits sec^{-1}. These data rates limit the use of standard computers. Nonetheless, due to improvements in computer technology it is possible to capture these data using fast hard disks and by addressing large volumes of electronic RAM in the capture PC. At present, the size of each volume of data capture has been determined at 512 Mbytes (approximately 38 seconds of ERS data transmission).

RAPIDS SYSTEM

RAPIDS consists of four major subsystems:

- Tracking of SPOT, ERS and JERS satellites
- Data capture for SPOT, ERS SAR, JERS Optical and JERS SAR
- Frame and data synchronisation
- QSAR processor and QOPT processor

The subsystems are currently configured in such a way that separate PCs are utilised for specific functions.

RAPIDS DATA ACQUISITION

The orbit planning for ERS, SPOT and JERS takes place on one PC. This is used to send timing information to both the tracking and data receiver control/monitor computers. These computers in turn control and monitor the whole tracking and reception process and return signals via RS232 links for logging of the system operation. The computers also link to various power supplies for control and monitoring and various warning and safety devices.

Input to the orbit planning is based on standard TLE (Two Line Element) data, which are available via the Internet.

A second, Pentium based PC is used to set up the tracking receiver, to process the patch aerial signals and to generate signals to drive the aerial. The tracking receiver is a dedicated processor system to lock onto beacon signals and provide patch signal information.

A third Pentium based PC is used to set up, control and monitor the data receiver and data demodulator. The data receiver is a general purpose programmable X-band receiver, operating in the range 8 to 8.4 GHz. There is set of data demodulators for each channel of each satellite. Data capture for specified parts of an orbit takes place on this third PC. Currently the capture capacity of a standard system is selective capture of 0.5 Gbytes of data per orbit per computer. In this way it is possible to run a fourth PC (in parallel) to increase data volumes captured to 1 Gbyte.

Frame and data synchronisation, SAR and optical data processing (QSAR for SAR data processing and QOPT for SPOT/OPS data processing) and the generation of output products takes place on a further Pentium PC. The PC's are connected to each other by fast Ethernet or RS232 links.

RAPIDS DATA PROCESSING

A RAPIDS User Interface has been developed to enable the user to process the data in an easy manner. Three steps can be distinguished:

1. Processing of SPOT/OPS data using QOPT
2. Frame- and line synchronisation and conversion of raw ERS data into the CEOS-SAR format
3. Processing of the converted SAR data using QSAR

QSAR

QSAR is a simple SAR processor to process raw SAR data into quick-look images of the captured data. The design philosophy is based on the assumption that users want a simple, easy-to-handle, easy-to-understand software tool enabling them to transform raw radar data into an image to assess the information content. As standard Pentium PC platform was selected, operating under Windows'95 or Windows NT. Because of the need for local PC serviceability, local acceptance and of local integration, software running on PC's is a prerequisite for running an operational service, particularly in developing countries.

The number of QSAR output products is selectable (see figure 4). The default parameters only process data in a 64m pixel spacing Windows bitmap (see figure5; options 16m and 23m), for which it is not necessary to have (expensive) image processing software (MS-Paint can read it!). Alternative options are to process the data into 32 bits intensity and/or phase data. These options are normally used in a more scientific environment.

On the basis of the intensity and phase information, contained in the data, it is possible to develop dedicated SAR processors. These dedicated processors take into account the basic ERS data but are constructed in such a way that they process the data into information, taking away the burden for the user. Currently, dedicated QSAR processors exist for determining the extent of flooded areas in rice areas (FLOODSAR: a collaboration between Synoptics, NLR and EGIS) and for determining the bathymetric information in ERS data (BASSAR: a collaboration between ARGOSS and NLR).

QOPT

In developing QOPT, the same philosophy was followed as with QSAR. QOPT has been developed in collaboration with Paradise Green Technical Services from the UK. Basic SPOT output products are level 0 data (i.e. raw data; no corrections) and level 1A data (i.e. radiometric corrected data). The latter is performed using the calibration coefficients as provided by SPOTImage.

QOPT basically performs a frame- and line synchronisation and the subsequent processing into level 0 or level 1A products. Output is presented in Windows bitmap (.bmp) format, which makes it possible to display the output in MS-Paint (included in every Windows-version).

RAPIDS DETAILS

RAPIDS is now being put on the market by NRI (Contactperson: Ian Downey). A typical price is 500.000 US$. That price includes:

- Trailer, including 2.7m dish antenna and hydraulics
- Receiver system
- Power supply
- Two capture PC's
- One tracking PC
- One orbit planning PC
- One processing PC
- Two CD writers
- Orbit planning software
- Acquisition diagnostics software
- Tracking software
- Dish handling software
- Capture software
- RAPIDS processing software, including QSAR and QOPT
- Support for one year
- Installation, including shipment

Licence fees for ERS, SPOT and J-ERS are not included. These fees are estimated at:

- ERS: Total fee amounts 400 US$/scene, composed of an access fee of 220 US$/scene and a royalties fee of 180 US$/scene.
- SPOT: The fee depends on whether the user is interested in data per area or data per seconds (minimum 7 seconds). The price per 7 seconds has been estimated at 250 US$.
- JERS: The negotiations with NASDA are on-going.

ADVANTAGES OF RAPIDS

RAPIDS is essential in providing a direct link between the data and the use of that data. The advantages are:

- Investment costs are less compared to large ground receiving stations.
- Running costs are less compared to large ground receiving stations.

- Local area reception reduces the long lead times before data actually gets in the hands of the users.
- Data needs can be tuned to the actual needs of the user of which it is assumed that the user will be the operator of the ground receiving station.
- Data access is controlled by the user, the user remains autonomous
- There is no exchange of foreign currency across borders, required when ordering data at a regional, large ground receiving station. Royalties need to exchange.

EXPERIENCE IN THE NETHERLANDS

Since November 1997, a RAPIDS system has been installed at NLR Noordoostpolder. During that period the system has been demonstrated to a wide audience of interested organisations. At the same time the system has been used routinely in support of specific operations. The operational experience of the NLR operators indicates that a minimum of operator intervention is required. It takes in general one to two hours to plan, acquire, process and archive optical data and between two and three hours to plan, acquire, process and archive SAR data. Of this time approximately 85% is processing time.

Transportation of the system to a different location has been demonstrated. In May 1998 the system was successfully transported and installed at ITC in Enschede during the annual EARSeL symposium [7].

In close collaboration with the Netherlands SPOT data distributor, Geoserve bv, several SPOT data were successfully captured, processed and put on the Geoserve website.

From October/November this year the RAPIDS ground station will be used to monitor early crop estimates based on the ERS radar data and will be used to monitor crop estimates throughout the 1999 growing season using SPOT and ERS data. The crop estimates will be estimated by Synoptics BV in support of the Netherlands agri-business.

EXPERIENCE IN BANGLADESH

In the framework of the ESA Data User Programme, a project proposal was submitted by Synoptics BV, NLR and EGIS to set up a RAPIDS system in Bangladesh to set up a RAPIDS system in Bangladesh under the Water Resources Planning Organisation (WARPO) under the Ministry of Water Resources. The project is part of a long-term programme to deliver timely information on floods in Bangladesh. NRI and BURS are supporting the project through technical and applications support for operations in Bangladesh.

During the monsoon season of 1999, a RAPIDS system will be stationed in Dhaka, Bangladesh at the Environment and Geographic Information Systems Support for Water Sector Planning (EGIS), to perform flood monitoring and mapping. This will be performed under ESA contract, as part of the Data User Programme.

NLR, NRI and BURS will install the RAPIDS system in Bangladesh. NLR will train EGIS operators in the use of RAPIDS and use of the dedicated SAR and optical processing software and, together with NRI and BURS, will support operation throughout the monsoon season.

Synoptics BV, a Dutch value-adding company will install dedicated software, running under ERDAS, to analyse the data for flood monitoring and flood mapping.

EGIS is responsible for offering an operational service in running the RAPIDS system and in providing flood mapping and monitoring products to various users in Bangladesh, allowing instant views of flooding and other environmental characteristics with applications in flood modelling and forecasting, coastal and river morphology, crop monitoring, etc.

RAPIDS will make it more possible to develop a near-real-time flood mapping and monitoring capacity on Bangladesh. In addition there is potential for a number of other applications which could involve co-operating agencies in Bangladesh, such as WARPO, Flood Forecasting and Warning Centre of the BWDB, SWMC, SPARRSO, Meghna Estuary Study, etc.

Currently the methodology for retrieving the flood information is being developed. Based on historical data, available from Bangladesh (see figure 8) and data acquired during the 1998 monsoon season, the dedicated FLOODSAR processor will be developed. This processor will then be tested during the monsoon season of 1999 in an operational environment.

EXPERIENCE IN INDONESIA

A field trial is also planned in Indonesia. During October/November this year, a RAPIDS station will be installed, demonstrated and operated near Jakarta, Indonesia. The objective of the demonstrations is to improve the appreciation of the usefulness of near real time data delivery in support of real management decisions. In particular the data will be used to:

- Assess forest areas in Southern Sumatra (with respect to forest fire damage and deforestation) in support of the EU Forest Sector Support Programme and the Netherlands Tropenbos/ Ministry of Forestry research project.
- Determine the bathymetry in Banka Strait in support of the joint Indonesian/Netherlands SIMBA project.
- Assess the coastal zone in Banten bay in support of the Royal Netherlands Academy of Sciences Global Change project and in support of the Aerospace Programme on Education, Research and Training Programme (APERT).
- Assess the usefulness of the RAPIDS data for rapid estimates of rice extent and production estimates in support of the SARI (Satellite Application for Rice in Indonesia).

During a 6 weeks period, RAPIDS will be used to fulfil the data needs of the above projects. RAPIDS will be installed at two different locations near Jakarta.

DISCUSSION

Great many applications using high resolution optical and SAR data have already been developed to support environmental monitoring and decision making around the world. Easier access to less expensive high resolution data would lead to an explosive growth in its utilisation by developing countries.

However, institutional issues need very careful consideration. Significant previous experience with direct reception of (low resolution meteorological) satellite data and its implementation in-country has been obtained. This experience shows that remote sensing applications, which improve already on-going activities, are more likely to start well, and be sustained, than applications in totally new domains. Once potential customers get used to seeing such products on a regular basis, ideas and interests develop to diversify the use of the data for other purposes. It is anticipated that this will be the case in Bangladesh and Indonesia.

This process has to start with the real decision making needs of the many potential users and customers. Focussing remote sensing onto operational activities and needs helps to avoid institutional inertia that may arise with (for example) a self-serving, highly centralised remote sensing centre. It is also important to prepare the Institution for the associated, and necessary, changes in working practice and attitude towards information use and provision. Once started, sustained operation of a satellite receiver and associated data processing routines requires a commitment to (minimal) running costs as an essential prerequisite [6].

Operational remote sensing in developing countries can thus be sustainable if applications, benefits and costs are carefully matched by the means of appropriate technology.

CONCLUSIONS

RAPIDS is now available on the market. It is a good example of how appropriate technology can be used to make meaningful contributions in a developing country. From the experience gained so far in the Netherlands and judging from the positive reactions that have been received, RAPIDS clearly shows promising features to stimulate the uptake of remote sensing applications. One aspect that has become evident is that users realise through RAPIDS that it is possible to get vast amounts of data in a regular and cost-effective manner. The conditions that govern access, distribution and pricing of EO data are vital to the exploitation of this important environmental information resource [2].

The lack of more direct access to satellite data is clearly a major global restriction on resource management needs in developing countries. The removal of this obstacle lies increasingly in direct readout satellite transmissions and the capabilities of low-cost, reception systems for local area data acquisition and processing.

Results to date demonstrate that the capabilities of low cost, PC based date reception and processing can be realised. The innovative RAPIDS system is optimally suited to regular reception of moderate amounts of data, to meet the real-time needs of customers and users within a radius of the order of 1000 km.

Together, BURS, NRI and NLR are working closely to actively promote and develop RAPIDS. This is to enable a growing number of institutes and organisations in developing countries (and elsewhere) to access and utilise this technology for improved understanding and management of their natural resources.

The potential benefits offer significant advantages for the reception, analysis and distribution of information from the predicted expansion in satellite and sensor availability.

Such developments have profound implications for future EO system design, operation, market development and data policy.

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2. http://www.neonet.nl/nlr/ - information about NLR
3. http://www.nri.org/capstats/esdcap.htm - information about NRI
4. http://www.burs.demon.co.uk/ - information about BURS
5. http://www.synoptics.nl/ - information about Synoptics
6. http://bppt.go.id/ - information about BPPT
7. http://styx.esrin.esa.it:8099/ - information about ESA's Data User Programme

Matching Developing Country Needs And Commercial Space Applications[*]

Joao Vaz
BRAZSAT, Brazil

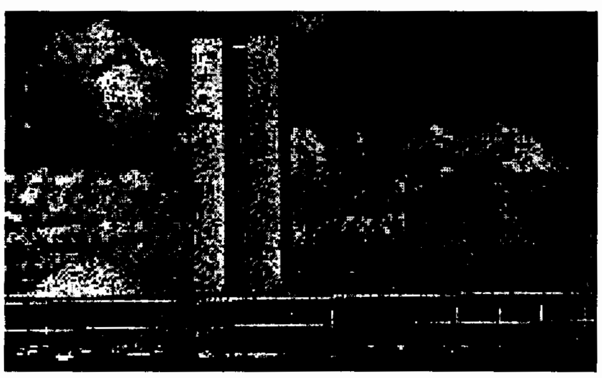
[*]This paper was presented at the UN/IAF Workshop on "Expanding the User Community of Space Technology Applications in Developing Countries" from 24-27 September 1998 in Melbourne, Australia, and does not necessarily reflect the views of the United Nations.

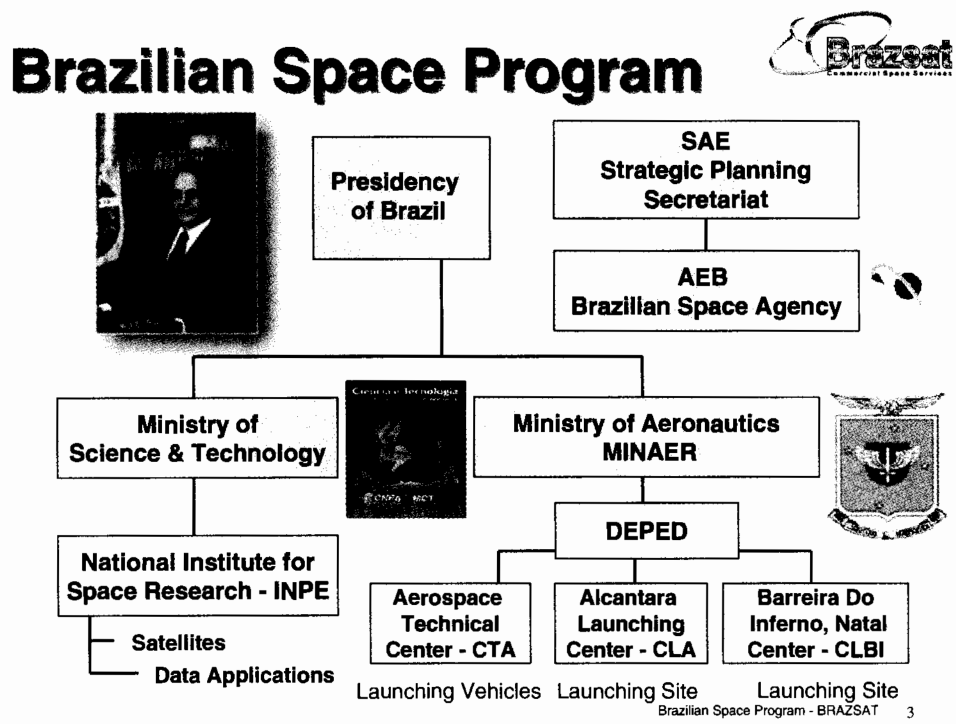
Brazilian Space Program Overview

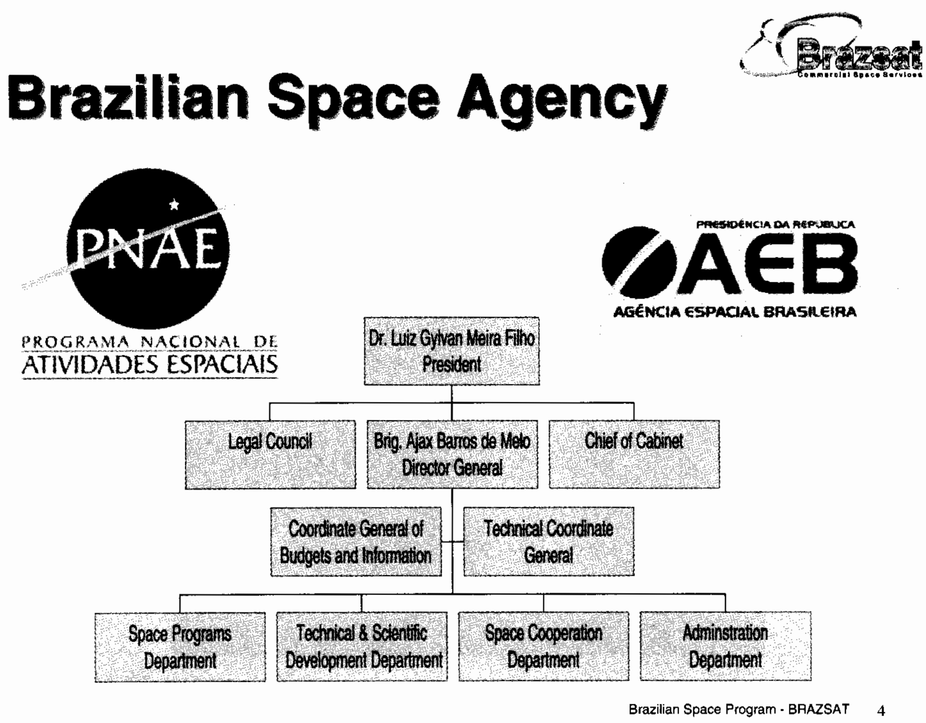
•Prepared By: João Gilberto Vaz- President
Brazsat- Commercial Space Services

Brazilian Space Program

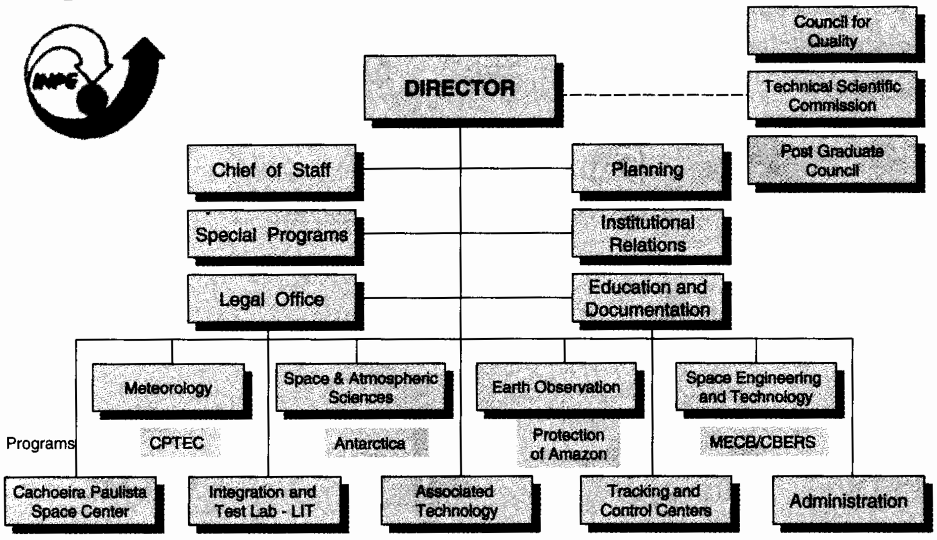
- Decision Making Process
  - Key Agencies




Brazilian Space Program
Brazsat
Commercial Space Services
Presidency of Brazil
SAE Strategic Planning Secretariat
AEB Brazilian Space Agency
Ministry of Science & Technology
Ministry of Aeronautics MINAER
DEPED
National Institute for Space Research - INPE
Satellites
Data Applications
Aerospace Technical Center - CTA
Alcantara Launching Center - CLA
Barreira Do Inferno, Natal Center - CLBI
Launching Vehicles
Launching Site
Launching Site
Brazilian Space Program - BRAZSAT 3


Brazilian Space Agency
Brazsat
PNAE
PROGRAMA NACIONAL DE ATIVIDADES ESPACIAIS
PRESIDÊNCIA DA REPÚBLICA
AEB
AGÊNCIA ESPACIAL BRASILEIRA
Dr. Luiz Gylvan Meira Filho President
Legal Council
Brig. Ajax Barros de Melo Director General
Chief of Cabinet
Coordinate General of Budgets and Information
Technical Coordinate General
Space Programs Department
Technical & Scientific Development Department
Space Cooperation Department
Adminstration Department
Brazilian Space Program - BRAZSAT 4

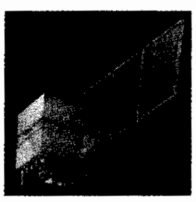
National Institute for Space Research - INPE

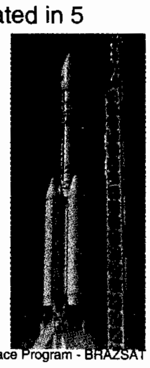


Brazilian Space Program - BRAZSAT 5

Brazilian Aerospace Industries Association - AIAB

- The Brazilian Aerospace Industries Association (AIAB) was established in 1993 in São José dos Campos, São Paulo State.The city of São José is also known as the birth place of Brazilian defense and aerospace activities.
- AIAB joins together Brazil-based aerospace corporations for the purpose of promoting their common goals and capabilities. Members are located in 5 states within Brazil
- The Brazilian aerospace sector employs 8,000 people directly.
- 1997's Turnover was more than U.S$ 1.2 billion





Brazilian Space Program - BRAZSAT 6

AIAB MEMBERS

Brazsat Commercial Space Services

AIAB — Associação das Indústrias Aeroespaciais do Brasil

GRUPO AEROMOT, Brazsat, digicon, ETR, LEG Tecnologia, NEURON Eletrônica

AKROS, CENIC, elebra, GE Celma, Mectron, Motores Rolls Royce

AVIBRAS, COMAF, EMBRAER, GESPI, helibras

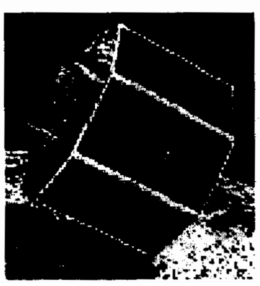
atech, COMPSIS, equatorial sistemas ltda., IMAGEM, TECSAT, VASP

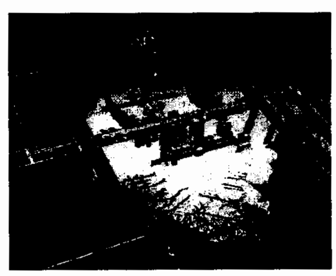
Brazilian Space Program

Brazsat Commercial Space Services

- Main activities and plans
- Budgetary overview

PNAE — PROGRAMA NACIONAL DE ATIVIDADES ESPACIAIS





Brazilian Space Program

- Brazil's space policy is totally orientated towards civilian applications for the sustainable exploration, protection of natural resources, satellite based telecommunications, distance learning, microgravity research and several other areas as described in the National Space Policy Plan (PNAE).

- The Complete Brazilian Space Mission (MECB), initiated in 1980, calls for the construction of satellites, the development of a launching vehicle (VLS) and the implementation of operations of a launching site in Alcântara (CLA). Over U.S$ 2 (two) billion has been invested over the last 15 years. (estimated '99 figures)

- Since joining the Missile Technology Control Regime (MTCR) and NPT (Non Proliferation Treaty), Brazil has slowly gained more access to foreign technology required to develop its space program. Restrictions were mainly in the development of the VLS (Satellite Launcher).

Brazilian Space Program
International Cooperation Aspects

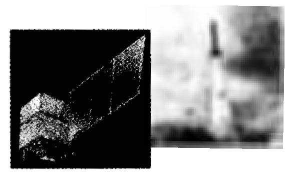
- The global space market is becoming increasingly commercialized and even privatized, especially in the areas of telecommunications, earth observation and launching services. Brazilian industry is following the world trend, teaming up with international firms to promote commercial space.
- AEB/INPE have several international space agreements in place and others are under discussions, consequently private sector ventures are being formed between Brazilian and foreign aerospace companies.
- Brazilian government authorities have demonstrated to be very supportive of commercial space activities and also to strategic industrial and academic alliances with foreign partners with proven experience in the space industry.
- Basically, Brazil's Space Program is becoming commercially orientated and aware of international market competition. Thus, opening new areas of investments.

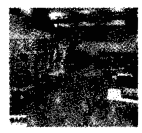
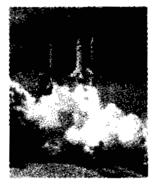
cnes

NASDA

Current Space Activities

- Launching Vehicles VLS, VLM
- Sounding Rockets VS40-30, Sonda III-IV
- Communication Satellites
  - LEO Constellation Satellites
  - Large GEO Satellites
  - The SCD Program -- SCD-2, SCD-3 (Data Collection)
  - Earth Observation -- SSR1, SSR2, SSR3. CBERS Satellites are being developed in cooperation with China and small scientific satellites with France & Argentina.
- Microgravity - Since April, 1997 Brazsat has organized 5 experiments flown aboard the Space Shuttle, in partnership with INPE, University of São Paulo (USP), Fiocruz and the University of Alabama. Experiments flew on STS-83/94/84/91and 95.



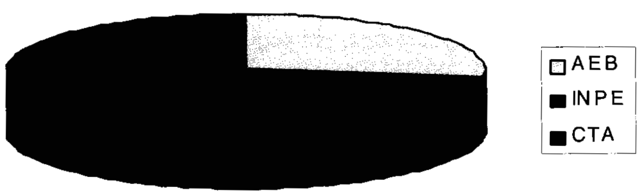




Brazilian Space Program - BRAZSAT 11

Budget for Space Activities in Brazil

- Brazil's total annual spending on space research and development is currently estimated at US$ 150 million per year. (PNAE)

FEDERAL BUDGET FOR 1998



Brazilian Space Program - BRAZSAT 12

Brazil - Government

BNDES

- Current financial information
- Government priorities & investments
- Privatization program

Brazilian Space Program - BRAZSAT 13

Why Brazil ?

- Brazil is still the 8th largest economy in the world.
- Brazilian economy has undergone significant changes and improvements over the last three years; the country has had the lowest inflation rates ever - due to the "Real Plan", thus facilitating the management of budgets for space activities .
- The market is now fully open to foreign investments more than at any time in its history. In general, US industries have invested more than $45 billion dollars in Brazil from 1994-1998.
- From a regulatory stand point, market reforms have made doing space business in Brazil much easier than in the past, as foreign owned Brazilian corporations have the same rights under the new regulations.
- Brazil contributed with a third of Latin America's privatization in the last ten years. The next phase of privatization will generate over $100 billion dollars
- Political and economic stability, are good elements for a successful space business ! The Democratic Government in Brazil has been in place for the last 15 years.
- The Brazilian space program is one of the 10th largest in the world

Brazilian Space Program - BRAZSAT 14

Brazil - Financial Overview *

- The Brazilian Congress voted positively on recent tax and social security reforms. A strong coalition is in place.
- Unknown gold reserves -- estimates could double with improved mining techniques and discovering new deposits.
- 3rd successful year of the Real Plan (June's 1998 inflation rate was at .3% = lowest monthly rate in four decades)
- Privatization program moving ahead with recent sales of state owned mining, utilities and telecommunication companies.
- Recent financial crisis was damaging to the Brazilian economy but Brazil was not hit as hard as other nations and prompt financial support from IMF and others were in place to support Brazil's economic reforms.
- Budgetary cuts for 1999 are estimated at US$ 4 billion -- funding for space activities should not be affected (as recently stated by authorities)
- **** As of February 1999***

Privatization Program Benefits to the Brazilian Space Activities

- The Official Privatization program from 1999-2005 is estimated to generate $100 billion in sales and over $20 billion in direct investments in the sectors to be privatized.
- Airports, utilities, roads, oil and mining are some of the industries to yet be privatized. Petrobras (the State Oil Company) will also be privatized.
- Newly elected Brazilian Government will follow the *"Social Action Plan"* -- increasing the budget for priority areas. Thus increasing funding directly and indirectly for science & technology and space related projects.
- Science and Technology (S&T) is one of the top priorities for the Government. Space Activities will receive increases in funding from 1999 to 2004. (See PNAE - National Program for Space Activities).
- If Brazil continues with the current plan to invest 2% of the GDP in S&T, the Brazilian Space Program will surely be one of the funding priorities because it would bring high tech jobs and new technologies to the country. As well as fulfilling basic needs from monitoring the Amazon to developing new drugs.

Brazilian Economic Figures (1995 - 1998)

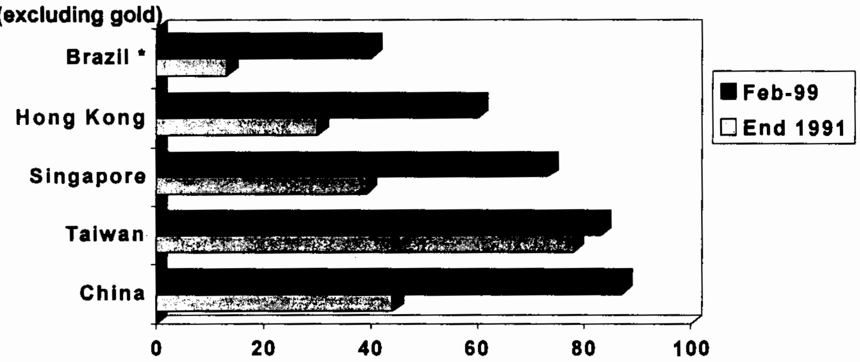
	1995	1996	1997	1998	1998 Third Trimester
GDP	728	749	782	800 billion*	
Inflation	23,2%	10,0%	4,5%	3-4%	1.7%
Annual GPD growth	4,3%	3,0%	3,5%	1-2%	- 0.14%
Investment rate (% of GPD)	16,6%	16,9%	17,0%	17,0%	
Exports (US$ Mrd)	46,5	47,7	53,0	60,0	
Import (US$ Mrd)	50,0	53,3	62,0	65,0	
Trade balance (US$ Mrd)	-3,5	-5,6	-9,0	-5,0	
Aerospace Related Exports	230 million	340 million	760 million	1.3 billion	2.6 billion

Source: *CNI "The Brazilian Economy: Performance and Prospects - 1997/1998".*
AIAB- Brazilian Aerospace Industries Association
All figures are in US Dollars

** Estimated*

World's Emerging Economies Official Reserves

(excluding gold)



*** Brazil 1991 = US$ 10 billion**

Sept 1998 = US$ 55 billion

Source: The Economist

***** Asiatic late 97 crisis had little effects in the Brazilian economy, but most recent crisis in Russia, Europe and Latin America did affect the Brazilian economy, but effects will not result in dramatic budgetary cuts to the ongoing space activities.***
The Brazilian currency devaluation of January '99 dropped the national reserves to $40billion dollars

World Facts
People and Prosperity

1997	Population (Millions)	GNP per person, $
China	1,220	530
India	936	310
United States	264	25,860
Indonesia	198	880
Brazil	**162**	**3,370**

Sources: United Nations; World Bank; World Reference Atlas (Dorling KinderSley)

Brazil has one of the highest GNP per person among developing nations with substantial demand for technologies including new space related products and services.

Government priorities & areas of investments

Government top priorities and areas of investments ➤ New business for space activities

Government Priorities

(Plano de Ação Social - Fernando Henrique Cardoso Government)

Telecommunications Network	Building 14 New Satellites – improving existing group network
Using Microgravity Research & Telemedicine	Using Microgravity Research & Telemedicine as tools to improve health
Education Programs	New market for Internet & Distance Learning Hardware and Space related Technology
Agriculture	Precision Farming Activities & use of Remote Sensing
Science & Technology	New Space Projects, Grants, Training Programs
Land Reform Projects	Use of Remote Sensing Data to identify productive land and zone farming
Creation of Jobs	Space Generates New High Tech Jobs and brings innovative cooperation
Exports	Export of Aerospace products are excellent for trade Balance

Emerging Space Business in Brazil

- **Launch Activities** - Commercial use of sounding rockets and launchers for Low Earth Orbit payloads with VS-40, VS-43 , VLM, VLS 1 and VLS-2.(New Market)
- **Life Sciences/Microgravity Projects** - Biotech research, materials and other life science projects using microgravity. Brazilian industry and researchers in partnerships will also build space hardware for the ISS.(New Market)
- **Telecommunications** - Design, integration and hardware. (New Market), Launch of a LEO Constellation to improve Brazil's telecommunication needs, thus creating a new market for ground segment hardware and software.
- **Tele-Education** - Implement programs and ground links in the Amazon region + emerging education programs being created by the government and private sectors. This is a new priority for the Brazilian Government, and private Universities.

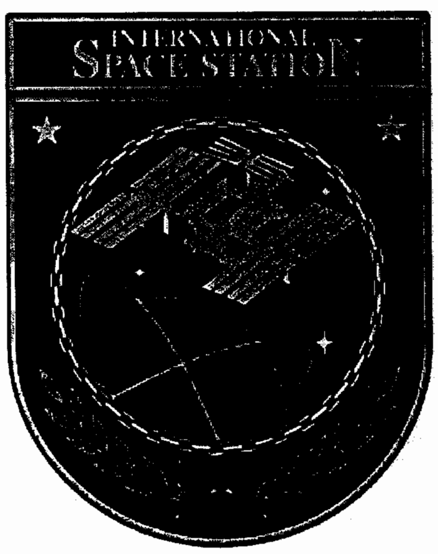
Emerging Space Business in Brazil

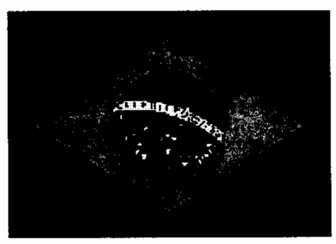
- **Telemedicine** - Projects to be implemented in the Amazon region, UN Peacekeeping missions and large Private Hospitals and Medical Centers. Hardware and perhaps space related technologies will generate additional business. (New Market)

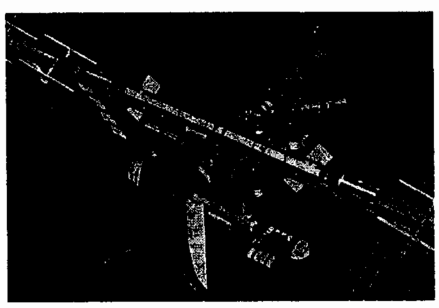
- **Remote Sensing** - Brazil has the interest in becoming a world leader in Remote Sensing (SSR-1 and 2, CBERS, FAME) with total of 5 to 7 satellites. Precision farming, remote sensing training, and data gathering are opportunities in an emerging market with realistic space technology needs. There is also an emerging market for 1meter resolution data.

- **Robotics** - Industrial cooperation between Canada and Holland is Space Robotics are moving forward in Brazil. It will result in several spin off businesses in Brazil and high technology transfers to the industries and universities. Automotive, oil and the nuclear industry are excellent markets for these Robotics Technology spin offs. (New Market)

Brazil and the ISS Project







Key points on the Brazilian participation on the ISS

- Space activities gives Brazil a strategic position in the world, and the prestige of being a member of ISS (New image of Brazil).
- Creates business with commercial & political interests - biotech research - drug development and creation high tech jobs.
- ISS project will foster space projects with direct or any indirect results to the Brazilian society (spin offs) that could be integrated in the Brazilian scientific community research areas of expertise and interest
- Space activities in Latin America could trigger multilateral discussions amongst countries for the creation in the future of a South American Space Agency
- Brazilian scientific community still has a budget of US$ 1.8 billion a year for research, surely new users of microgravity research will arise with Brazil's ISS role. AEB recently initiated a Microgravity Program.
- Will generate new contracts for Brazilian aerospace firms (AIAB members)
- Having a Brazilian astronaut will improve education and interest for science.

Hardware to be provided by Brazil for ISS Program

- AEB has appointed INPE to oversee Brazil's participation in the ISS Program and *first contracts for the program have been signed with Boeing Space and INPE early September 1998*. (Embraer Contract scheduled for April 1999.)
- **List of hardware elements to be provided according to NASA-AEB-INPE Agreement (Deliveries 2000-2005)**
  - 1) Unpressurized Logistics Carrier (ULC)
  - 2) Z1 Logistics Site
  - 3) Cargo Handling Interface Assembly (CHIA)
  - 4) Technology Experiment Facility (TEF)
  - 5) EXPRESS Pallet
  - 6) Window Observational Research Facility (WORF)

- **Total Cost : Estimated to be $180 million dollars**

* ***Possible involvement of Brazil on the X-Ray Crystallography Facility is still under discussion. This hardware is of high interest to the Brazilian scientific community, industry and government agencies.***

Conclusion

- Brazil has an ambitious space program with steady market for aerospace industries and open to creative commercial activities.
- Brazilian Space program has strong political support in the Congress and other high level government agencies in Brazil, including the President.
- User community has real needs for space products and services !
- Brazil is the only developing nation in the ISS project. It has a capable space infrastructure and recently with a solid commitment in biotechnology research using microgravity. Also a key player in the Mercosur Region.
- Space applications in Brazil are being developed in accordance to a well defined space plan (PNAE) which was approved by 16 Ministries Council.
- BRAZSAT is proud to be the space company, leading the way to commercial space activities in Brazil with direct benefits to the country and also to the Brazilian Society.
- 1999 Funding for space activities will remain at the level of investments and the current financial situation will not affect funding for 2000.

The Brazilian Space Program - We Believe

Annex I: Workshop Programme

UN/IAF WORKSHOP ON
"EXPANDING THE USER COMMUNITY OF SPACE TECHNOLOGY APPLICATIONS IN DEVELOPING COUNTRIES"

Co-sponsored by the Government of Australia and CNES

Melbourne, Australia, 24-27 September 1998
Victoria Vista Hotel, 215 Little Collins Street

Previous UN/IAF Workshops have demonstrated the utility of space technology applications for accelerating the social and environmental development and economic growth of developing countries. Examples are satellites for meteorological applications, satellite telecommunications and Earth observation applications, and navigation and localization systems. However, the use of space technology applications is in some cases still restricted to a relatively small user community. Due to a number of reasons, some of which have been identified in previous Workshops, potential users and decision makers are sometimes unaware of the capabilities and benefits of space technology applications. The Workshop will focus on how the user community of certain applications can be increased. This will be accomplished by identifying the obstacles, by suggesting possible solutions and by presenting new, innovative applications of space technology.

The Workshop will provide a unique forum for discussion with space experts, policy- and decision makers and representatives from private industry. Participants will be encouraged to share their experiences and to examine opportunities for better cooperation. In the past, contacts established between participants have resulted in a number of initiatives and activities strengthening the role of space technology applications for improving the quality of life in developing countries.

The Workshop is composed of a series of technical presentations, followed by open discussions. Panel discussions at the end of each day will focus on specific topics of interest and will provide additional opportunities for participants to share their opinions.

Co-Chairpersons of the Programme Committee: N. Jasentuliyana (UN), U.R. Rao (IAF/CLIODN), B. Embleton (CRCSS)

Programme Committee: A. Abiodun (UN), S. Camacho (UN), M.G. Chandrasekhar (IAF/ISRO), J. Hess (IAF), J. Ortner (IAF/ASA), C. Graham (CRCSS), K. Bergquist (ESA), M. Laffaiteur (CNES), Cheng Yongzeng (CNSA)

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Thursday, 24. September 1998

08:30 - 09:00	Registration	
09:00 - 09:45	Opening and Welcoming Statements	UN, Australia, IAF

Keynote Addresses

Chairperson: N. Jasentuliyana, United Nations

09:45 - 10:15	Expanding the Use of Space Technology Applications: Opportunities and Constraints in Making it Happen	K. Kasturirangan (India) ISRO

10:15 - 10:45	Expanding the User Community of Space Technology Applications: New Applications and New Users	R. Franzen (Australia) AUSPACE
10:45 - 11:00	Coffee / Tea Break	

Session 1: Establishing and Enhancing the Use of Space Applications in Developing Countries

Chairperson:	J. Ortner, International Space University	
11:00 - 11:30	Review of Recommendations of Previous UN/IAF Workshops	J. Hess (USA) The Aerospace Corporation
11:30 - 12:00	Introducing Space Technology in Developing Countries: How to Increase the Awareness of Policy and Decision Makers	Ajax Barros de Melo (Brazil) AEB
12:00 - 12:30	Drafting Space Policy Plans for Developing Countries A Necessity to Effectively Coordinate and Enhance the Use of Space Technology Applications	S. Karunaratne (Sri Lanka) Arthur C. Clarke Institute of Modern Technologies
12:30 - 14:00	Lunch Break	

Session 2: Training Users of Space Applications

Chairperson:	Samarajeewa Karunaratne, Director, Arthur C. Clarke Institute of Modern Technologies (Sri Lanka)	
14:00 - 14:30	The UN Regional Centres for Space Science and Technology Education	K.R. Sridharamurthy (India) ISRO
14:30 - 15:00	The WorldSpace Digital Sound Broadcasting System for Distance Education and Applications in Rural Areas	M.G. Chandrasekhar WorldSpace
15:00 - 15:30	Commercial Radar Applications and Training	Stanley Stigdon (USA) Northrop Grumman Corporation
15:30 - 15:45	Coffee / Tea Break	
15:45 - 16:15	Educating Future Space Managers and Space Professionals	François Becker (France) ISU
16:15 - 17:00	Discussion and Brief Presentations by Developing Country Participants	
17:00 - 18:00	**First Panel Discussion (followed by General Discussion):** Expanding the User Community of Space Technology Applications: Opportunities and Constraints	

18:15 - Reception hosted by Dr Brian J J Embleton,
Cooperative Research Centre for Satellite Systems, on behalf of CSIRO

Friday, 25. September 1998

Session 3: Small and Micro Satellite Systems for Promoting Space Capabilities and Applications in Developing Nations

Chairperson:	H. Wiryosumarto, Chairman LAPAN, Indonesian Space Society (Indonesia)	
09:00 - 09:30	The Development of the Chinese Small Satellite Program	Zhu Yilin (China) CAST
09:30 - 10:00	Regional Development of Small Satellite Multi-mission Platforms	Abdul Majid (Pakistan)

		SUPARCO Cheng Yongzeng (China) CNSA
10:00 - 10:30	The Surrey Space Club	M. Sweeting (UK) SSTL
10:30 - 10:45	Coffee / Tea Break	
10:45 - 11:15	The Proteus Multi-mission Platform: Opportunities for Participation	G. Huttin (France) Alcatel
11:15 - 12:30	Discussion and Brief Presentations by Developing Country Participants	
12:30 - 14:00	Lunch Break	

Session 4: Space Technology for Disaster Management

Chairperson:	Joe Hess, The Aerospace Corporation	
14:00 - 14:30	Space Technology for Disaster Monitoring	Guy Duchossois ESA
14:30 - 15:00	Telecommunication Systems for Disaster Management	Vicki Barns Inmarsat
15:00 - 15:30	Disaster Monitoring in Bangladesh	A.M. Choudhury (Bangladesh) SPARRSO
15:30 - 15:45	Coffee / Tea Break	
15:45 - 16:30	Discussion and Brief Presentations by Developing Country Participants	
16:30 - 18:00	**Second Panel Discussion (followed by General Discussion):** International and Regional Cooperation: Small Satellites and Disaster Warning Projects	

Saturday, 26. September 1998

Session 5: Satellite Communications and Applications: Mobile Systems and VSATS

Chairperson:	Robert Boroffice, Federal Ministry of Science and Technology (Nigeria)	
09:00 - 09:30	Iridium - Global Personal Mobile Satellite Communications and Applications	Tuomo Rutanen (USA) Iridium
09:30 - 10:00	Skybridge	Bruce Jones (Australia) Alcatel Australia
10:00 - 10:30	VSATs Capabilities and Applications	Mukund Rao (India) ISRO
10:30 - 10:45	Coffee / Tea Break	
10:45 - 12:30	Discussion and Brief Presentations by Developing Country Participants	
12:30 - 14:00	Lunch	Break

Session 6: Earth Observation Applications

Chairperson:	Abdul Majid, SUPARCO (Pakistan)	
14:00 - 14:30	GIS for Resources Location and Sustainable Exploitation	Driss El Hadani (Morocco), CRTS
14:30 - 15:00	NASDA Earth Observation Programme on the Asia-Pacific Region	Takashi Moriyama (Japan) NASDA
15:00 - 15:30	Spatial Information Systems, Technology Transfer and Sustainable Development	Tony Milne (Australia) University of New South Wales
15:30 - 15:45	Coffee / Tea Break	
15:45 - 16:15	RAPIDS - A PC-based Local Groundstation	Wim Looyen (Netherlands) NLR
16:15 - 16:45	SpaceImaging EOSAT	M. Judd (Australia) Geomatic Technologies
16:45 - 18:00	**Third Panel Discussion (followed by General Discussion):** Matching Developing Country Needs and Commercial Space Applications	

Sunday, 27. September 1998

Session 7: The Way Forward

Chairperson: U.R. Rao, Chairman UN-COPUOS

09:00 - 09:30	SpaceHab	B.A. Harris (USA) SpaceHab
09:30 - 10:00	Matching Developing Country Needs and Commercial Space Applications	João Vaz (Brazil) BRAZSAT
10:00 - 10:30	NASA Earth Science in the Asia Pacific Region including Recent and Planned Airborne SAR Deployments	M. Baltuck (USA) NASA
10:30 - 10:45	Coffee / Tea Break	
10:45 - 11:15	UNISPACE III	Werner Balogh (Austria) United Nations

Wrap-Up Session

11:15 - 12:30	Presentations by the Chairpersons and Summary of the Workshop	Chairpersons and Rapporteur of the Workshop
12:30	Final Discussion	

Annex II: List of Participants

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