अक्तूबर 2005 - मार्च 2006

October 2005 - March 2006

अन्तरिक्ष भारत

SPACE india

भारतीय अन्तरिक्ष अनुसंधान संगठन

इसरो isro INDIAN SPACE RESEARCH ORGANISATION

Children eagerly watching a TV programme beamed from NASA ATS-6 satellite during ISRO's pioneering Satellite Instructional Television Experiment (SITE) conducted during 1975-76. Three decades later, interactive education at university level has become a reality in India, with the launch of EDUSAT, a satellite dedicated exclusively to the educational field *(see article on page no. 15)*

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Cover page: Artist's impression of INSAT-4A in orbit

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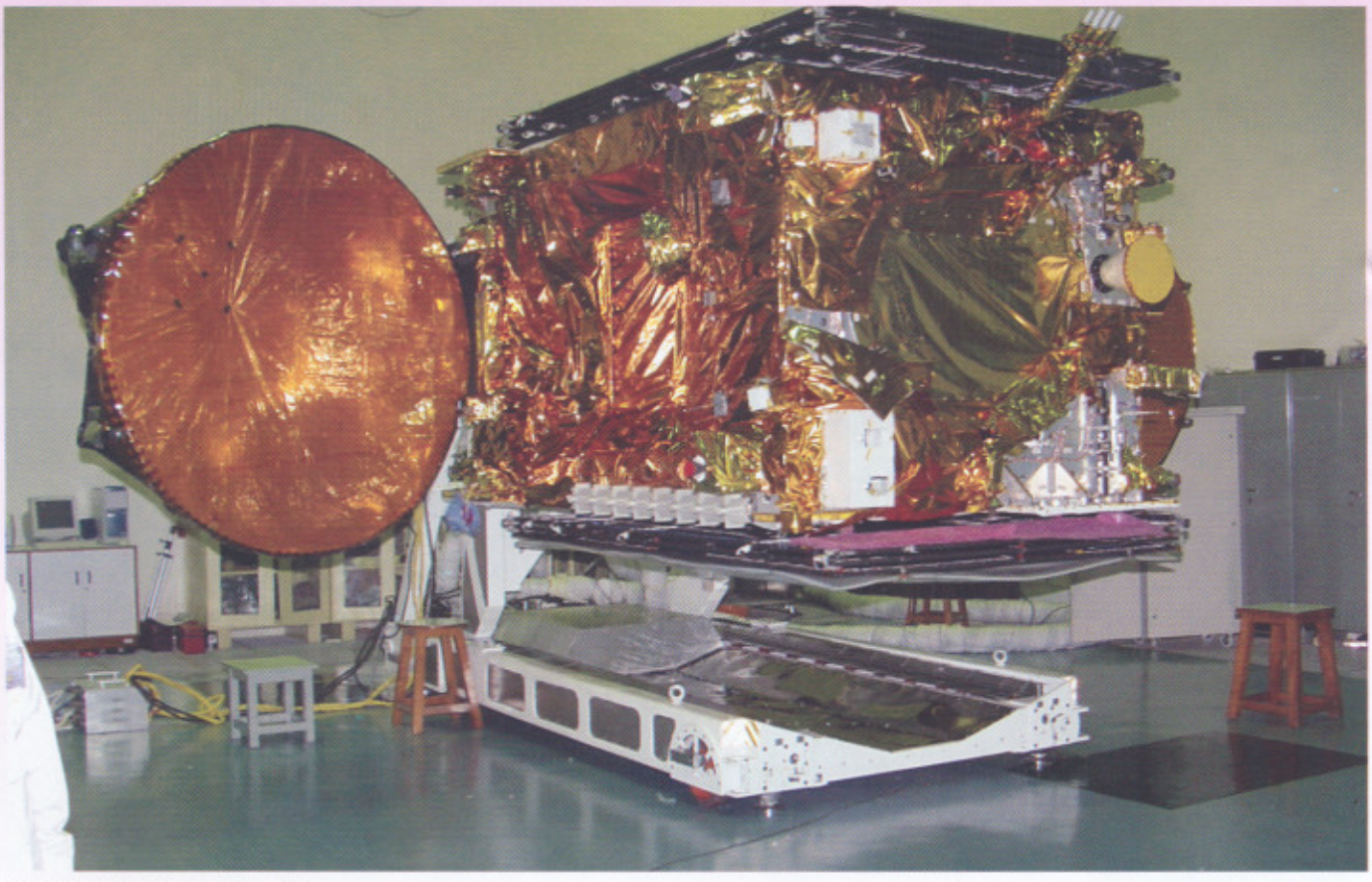
INSAT-4A Launched

India's latest satellite, INSAT-4A, was successfully launched from Kourou in French Guyana on December 22, 2005 by the European Ariane-5 launch vehicle. INSAT-4A has given further boost to the INSAT system capacity, especially for Direct-To-Home (DTH) Television broadcast. INSAT-4A is the first of the seven satellites planned in the INSAT-4 series.

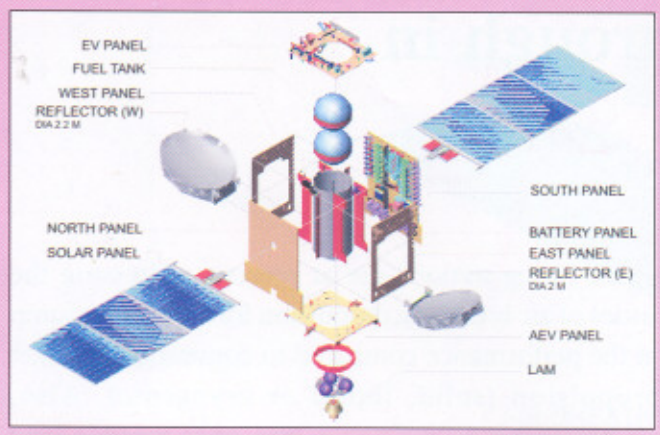
INSAT-4A carries 12 high power Ku-band transponders and 12 C-band transponders for television services. The Ku-band transponders provide ground coverage that includes the Indian mainland while the C-band transponders provide ground coverage encompassing not only the Indian geographical boundary but also regions beyond India in the southeast and northwest regions as well as parts of Asia-Pacific and Gulf countries.

INSAT was established in 1983 and it has now become one of the largest domestic communication satellite systems in the Asia Pacific region with nine satellites in operation — INSAT-2E, INSAT-3A, INSAT-3B, INSAT-3C, INSAT-3E, KALPANA-1, GSAT-2 and EDUSAT besides INSAT-4A – providing 174 transponders in various frequency bands like S-band, C-band, extended C-band and Ku-band for television, telecommunications, VSATs, tele-education and telemedicine as well as instruments for meteorological services.

Soon after the launch of 3086 kg INSAT-4A by the Ariane launch vehicle into a Geosynchronous Transfer Orbit, Master Control Facility at Hassan in Karnataka acquired the first signals from the satellite. In the following days, through three critical orbit raising manoeuvres by firing the 440 Newton Liquid Apogee Motor on board, INSAT-4A was successfully placed in Geostationary Orbit. Subsequently, deployments of the two solar panels and two antennas were also completed without any hitch.



INSAT – 4A during prelaunch tests



Disassembled view

After detailed in-orbit testing of the communication transponders, INSAT-4A has been positioned at 83 deg E longitude. It shares this geostationary orbital home with the earlier launched INSAT-2E and INSAT-3B. The satellite is designed for a life of 12 years.

INSAT-4A Salient Features

Orbit	:	Geostationary (83 deg E longitude) co-located with INSAT-2E and INSAT-3B
Lift-Off Mass	:	3086 kg
Dry Mass	:	1387 kg
Physical	:	2.0 x 1.77 x 2.8 m cuboid, 15.16m with solar panels deployed
Propulsion and Control	:	440 Newton Liquid Apogee Motor with Mono Methyl Hydrazine as fuel and Mixed Oxides of Nitrogen as oxidiser for orbit raising
		3-axis body stabilised using Earth Sensors, Momentum and Reaction Wheels, Magnetic Torquers and eight 10 Newton and eight 22 Newton bipropellant thrusters
Power	:	Solar array providing 5,500 W and three 70 Ampere-Hour Nickel-Hydrogen Batteries
Antennas	:	2.2 meter diameter transmit/ receive, polarization sensitive dual grid, shaped beam deployable reflector with offset-fed feed illumination for Ku-band
		2.0 meter diameter transmit/ receive, polarization sensitive dual grid, shaped beam deployable reflector designed for offset–fed feed illumination for C-band
Design Life	:	12 years

Communication Payloads

- 12 Ku-band 36 MHz bandwidth transponders employing 140 W TWTAs to provide an EIRP of 52 dBW at the edge of coverage polygon with footprint covering Indian mainland
- 12 C-band 36 MHz bandwidth transponders employing 63 W TWTA to provide an EIRP of 39 dBW at the edge of coverage with expanded radiation patterns encompassing Indian geographical boundary and area beyond India in southeast and in northwest regions

Launch of INSAT – 4A

ISRO Achieves Breakthrough in Supersonic Combustion

As a part of the advanced technology initiative in the area of air-breathing propulsion, the Vikram Sarabhai Space Centre of ISRO at Thiruvananthapuram has successfully carried out the design, development, characterisation and realisation of the Supersonic Combustion RAMJET (SCRAMJET). Through a series of ground tests, a stable supersonic combustion has been demonstrated for nearly seven seconds with an inlet Mach number of six (which means six times the speed of sound).

Air Breathing Propulsion

Advanced reusable launch vehicles with air-breathing propulsion are expected to reduce substantially the cost of access to space which is presently about $12,000 per kg for launch into near earth orbit. The cost can be brought down by reducing the vehicle size and by recovering and reusing the hardware. More importantly, reducing propellant is imperative for low cost access to space as propellant forms about four fifth of launch vehicle mass at take-off (Space Shuttle: 78 percent and GSLV: 86 percent).

In the present day launch vehicles, the propellant constitutes more oxidiser than fuel burnt and oxidiser to fuel ratio varies from two to six (depending on whether it uses solid, liquid or cryogenic rocket propulsion). In air breathing propulsion, the need for carrying oxidiser is minimised (if not eliminated) by using oxygen from the air. But since dense air is available only up to about 50 km altitude, question arises regarding the extent of benefit of using air. However, three fourth of the propellant is consumed by the vehicle within this portion of the flight.

For example, taking off vertically, GSLV, which is used for launching satellites into 200 X 36,000 km Geosynchronous Tranfer Orbit, consumes 75 percent of propellant before it reaches an altitude of 44 km. An air breathing launch vehicle can opt for off-verticle trajectory and benefit more by using oxygen from the air.

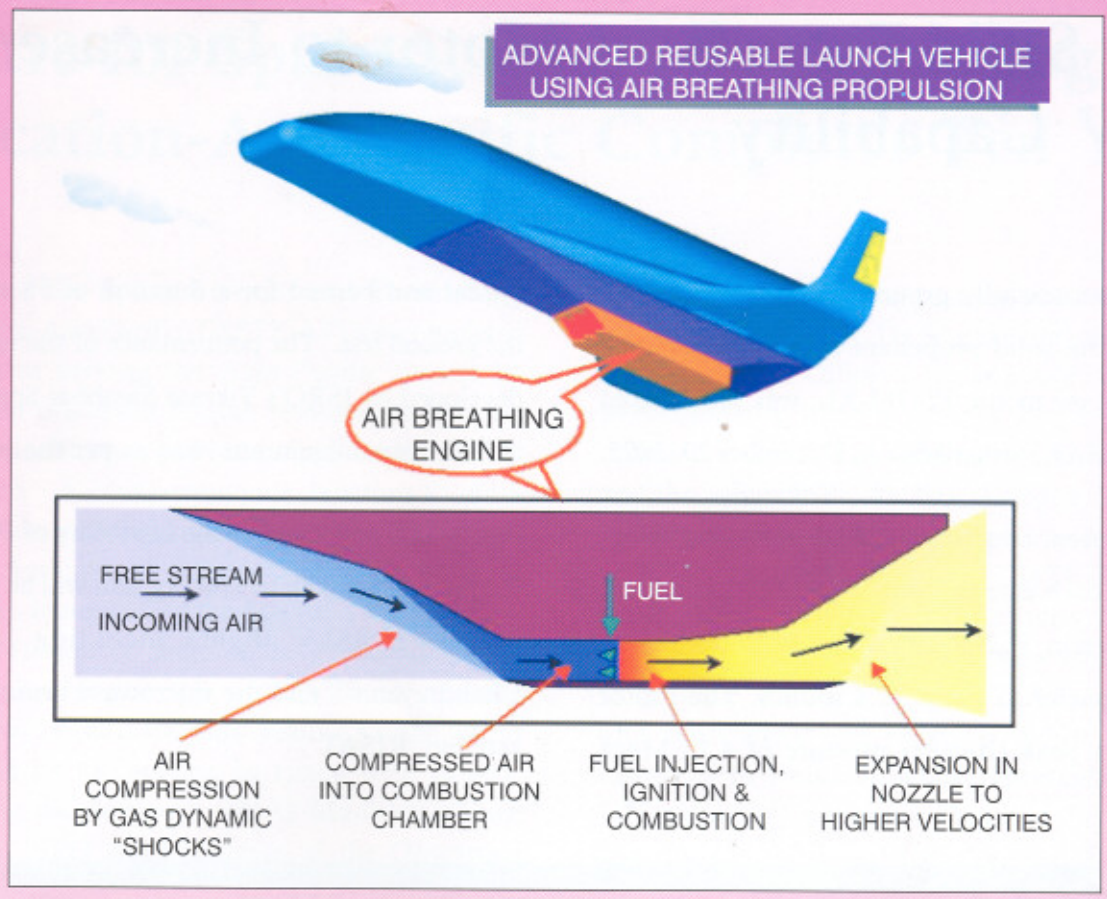
But there are challenges in the collection and use of air as the vehicle accelerates through the atmosphere.

Space-faring nations are at present addressing the issues of air-breathing propulsion for a quantum jump in the performance compared to conventional rocket propulsion (solid, liquid or cryogenic). Also, air-breathing propulsion is the only feasible way for a powered return (cruise) flight necessary for reusable launch vehicle which should 'fly back to base'.

Modern aircraft use turbojet air breathing engine (or its variant turbo-fan) for their propulsion. They carry only fuel, and air pressurised by turbo-compressor to the required level, supplies the oxidiser. Fuel is injected and burned within the combustion chamber and expanding high pressure high temperature gases within the nozzle produce high velocity jet, generating thrust. Turbines are used to drive the compressor. The compressor-turbine combination is the most complex and expensive element of the engine and also puts limits on its operability — turbojet engines do not operate at flight Mach numbers higher than three.

But at higher flight speeds, the 'ram effect' of air speed is capable of compressing air to required levels. This concept is used in a RAMJET engine. The compressor-turbine combination is discarded and the remaining 'simple' engine consists of only the air-intake, combustion chamber and nozzle. In RAMJET, combustion chamber speeds are higher than that in turbojet but are still subsonic. As the flight speed increases, decelerating air from supersonic flight speeds to subsonic speeds becomes more and more inefficient, both in terms of pressure recovery and combustion processes. For flight Mach numbers of about six and above, there is a need to restrain the level of air deceleration and to retain its lower supersonic speed as it enters the combustion chamber. This necessitates Supersonic Combustion RAMJET or SCRAMJET.

In general, Specific Impulse, the performance parameter of a propulsion system which indicates how much thrust is generated for unit mass flow



consumption of propellant, reduces with flight Mach number for air breathing propulsion. This, along with the problem of increasing air stagnation temperatures, generally limits the upper operability of SCRAMJET to flight Mach number of about ten. Beyond this, rocket engines will be called upon to propel the vehicle, though thrust levels and propellant requirement would be quite small — GSLV which uses only 15 percent of the total propellant for flight beyond Mach ten.

Air breathing propulsion for launch vehicles envisages a combination of propulsion cycles: turbojet engine (widely used in aircraft), RAMJET engine (currently being used in missiles), SCRAMJET engine (being developed around the globe) and rocket engine (the workhorse of today's launch vehicles). They could either function as separate propulsion systems co-located or as a "combined" propulsion cycle engine by synergistically integrating them. A variant, rocket based combined cycle engine, which avoids the complex (rotating) turbojet component where the rocket engine in its air augmented mode is used for the low speed flight, is also gaining popularity. A less complex option is to combine the RAMJET and the SCRAMJET (to have Dual Mode RAMJET for Mach 3 to 10) and have rocket engine separately.

Of the different propulsion cycles, SCRAMJET, with its supersonic combustion is the most critical. Fuel injection, mixing, ignition and flame holding as air travels at speeds greater than one kilometer per second within combustion chamber is often equated to lighting a candle in hurricane.

ISRO had earlier flown a rocket for testing a combined cycle system, for a low speed regime of up to Mach number 2.3. Thus, the present success of ISRO in demonstrating stable supersonic combustion through a series of ground tests for an equivalent flight Mach number of seven, assumes significance. Theoretical studies and extensive use of Computational Fluid Dynamics tools have helped in this achievement.

ISRO is planning to flight test an integrated SCRAMJET propulsion system (comprising air intake, combustor and nozzle) using a two-stage sounding rocket. Development of such a high technology system will be a major step towards the future space transportation systems.

(This article is contributed by Mr J D A Subramanyam, Project Director, Air Breathing Propulsion Project, Vikram Sarabhai Space Centre, Thiruvananthpuram)

New Solid Propellant Motor to Increase PSLV Capability

ISRO has successfully ground tested an improved version of the solid propellant strap-on motor for PSLV. The new motor, PSOM-XL, was static tested at SDSC SHAR, Sriharikota on December 29, 2005.

PSLV at present employs six solid propellant strap-on motors, each carrying nine tonnes of propellant. The new version, PSOM-XL, with a length of 13.5 m, has the capacity to carry 12.4 tonnes. The motor developed a peak chamber pressure of 4.16 Mega Pascal and burned for a duration of 58 seconds in the ground test. The performance of the new motor, developed by ISRO's Vikram Sarabhai Space Centre at Thiruvananthapuram, was as per the prediction.

PSOM-XL will improve the capability of PSLV from the present 1450 kg to 1600 kg and will be employed in future PSLV flights including launching Chandrayaan-1 and the microwave remote sensing satellite, RISAT.

PSOM-XL in its static test stand

Centre for Space Science and Technology Education-Asia Pacific Completes Ten Years

The Centre for Space Science and Technology Education in Asia Pacific (CSSTE-AP) has completed ten years in serving the Asia-Pacific region by creating the important human resources to develop and use space science and technology for the benefit of mankind. A commemoration function to mark the occasion was held on November 8, 2005 at National Agricultural Science Centre Complex at New Delhi. Inaugurating the function, Mr Prithviraj Chavan, Minister of State in the Prime Minister's Office applauded the role of CSSTE-AP and the commitment of India towards creating a better world by sharing its knowledge in space with others. Welcoming the delegates, Mr G Madhavan Nair, Chairman, ISRO and Chairman of the Governing Body of CSSTE-AP highlighted the progress made by the Centre during the past ten years and touched on the future strategy. Dr Sergio Camacho, Director, United Nations Office of Outer Space (UN-OOSA) presented the history of UN initiatives in the creation of CSSTEs in different regions of the world and the role CSSTE-AP has played in the capacity building in the use of space science and technology. Dr V K Dadhwal, Director, CSSTE-AP made a presentation on the CSSTE-AP activities and the achievements. Governing Board and Advisory Committee members of CSSTE-AP, ambassadors and representatives of Asia-Pacific and other countries in Delhi, officials/representatives from UN agencies, previous Directors and Deputy Director of CSSTE-AP, Directors and Heads of host institutes of CSSTE-AP, officials of Andhra

Mr G Madhavan Nair, Chairman, ISRO (third from right), Mr Prithviraj Chavan, Minister of State in Prime Minister's Office (to Mr Nair's right) and Dr Sergio Camacho, Director UN-OOSA (third from left) and other dignitaries during the inguaration.

University, Visakhapatnam, were among those who participated in the function.

It was on November 1, 1995, that CSSTE-AP was established in India. UN-OOSA facilitated the establishment of the Centre, acting on recommendations by UNISPACE-II (1982) Conference and the UN Committee on the Peaceful Uses of Outer Space (COPUOS), endorsed by the UN General Assembly.

CSSTE-AP headquarters is located in Dehradun and its programmes are executed by the Department of Space (DOS) at campuses in Dehradun and Ahmedabad. DOS institutions involved include the Indian Institute of Remote Sensing (IIRS) in Dehradun, the Space Applications Centre (SAC) and the Physical Research Laboratory (PRL), both at Ahmedabad. Core funding, facilities, equipment and staffing are provided by DOS through its institutions, namely, IIRS, SAC and PRL.

Similar UN-affiliated Regional Centres for Space Science and Technology Education have been, or are in the process of being established in other regions of the world: in Morocco for Francophone Africa, in Nigeria for Anglophone Africa, in Brazil/Mexico for Latin America and the Caribbean, and in Jordan for the West Asia Region (Arab countries). In addition, a network of collaborating institutions and countries is being established in Eastern Europe. The mission of the Regional Centres is to establish national capabilities in developing countries to design and implement education, research and application programmes in space science and technology, in particular in the areas of (1) Remote Sensing and Geographic Information Systems, (2) Satellite Communications and Global Positioning Systems, (3) satellite meteorology and global climate, and (4) space and atmospheric sciences.

A teaching session in progress

Educational Programmes

The Centre offers post-graduate (PG) level courses in the fields of:

(a) Remote Sensing and Geographic Information Systems (RS & GIS),

(b) Satellite Communication and Global Positioning Systems (SATCOM & GPS),

(c) Satellite Meteorology and Global Climate (SATMET & GC) and

(d) Space and Atmospheric Sciences

Successful completion of the nine month PG-phase of the programme leads to the award of a post-graduate diploma by the Centre. For those students who successfully finish their PG course and who are interested in continuing for a Master of Technology (MTech) degree, the Centre offers the opportunity to do so, in collaboration with Andhra University in Visakhapatnam, India. Short term courses/ workshops are also conducted in the above disciplines. All the centres implement the PG courses based on model curricula approved by UN-OOSA.

The Centre has so far conducted twenty one nine-months PG courses: nine in RS & GIS, four in SATCOM & GPS, four in SATMET & GC and four in Space Science. The Centre has further conducted 17 short courses and workshops in the past 10 years. These programmes have benefited about 612 participants from a total of 30 countries in the Asia-Pacific Region. In addition to this, about 26 participants from 16 countries outside Asia Pacific region have also been benefited from the educational programmes.

Management of the Centre

The administrative body of CSSTE-AP consists of Advisory committee (AC) and Governing Board (GB). Members of AC are composed of prominent individuals in the Government, private industry and the academic and scientific community in the field of space science and technology applications. AC provides technical guidance to the centre's programmes. GB is the principle policy making organ. At present, 15 countries in the region are represented in the GB with two observers.

CSSTE-AP conducts all of its educational programmes in close collaboration with DOS institutions and thus has direct access to its physical facilities and intellectual capabilities. In addition to providing facilities, infrastructure and skilled manpower, the Government of India, through the Department of Space, also provides funding for the Centre. Funding for travel grants, tuition fees and scholarships of students of CSSTE-AP is mainly provided by UN-OOSA, UN Economic and Social Commission for Asia and Pacific in Bangkok, Thailand, and the Ministries of Finance and External Affairs of India and UNESCO, besides Department of Space.

CSSTE-AP building at Indian Institute of Remote Sensing Campus, Dehra Dun.

Bopal campus of Space Applications Centre at Ahmedabad

Five Years of International Charter on Space and Major Disasters

The International Charter on Space and Major Disasters has completed five years of successful operation worldwide. To mark the occasion, a special session of the charter was organised by ISRO during October 4-5, 2005 at Bangalore. It was followed by the Executive Secretariat and Board meetings on October 6 and 7, 2005.

The Charter is a cooperation initiative created between the European Space Agency (ESA), the National Centre for Space Studies of France (CNES) and the Canadian Space Agency (CSA). Later, many other space agencies including ISRO joined the charter and committed their space resources to respond to natural and technological disasters in terms of Earth Observation enabled products to civil defence agencies. The Charter aims to provide easy access to value added earth observation satellite data from all parties to countries affected by a natural or technological disaster.

Since November 2000, the Charter has been activated for more than 80 times to assist on emergencies such as floods, fires, landslides, typhoons, volcanic eruptions, oil spills, tsunamis, hurricanes, earthquakes and civil accidents which occurred all over the globe. With a low response time of 38 to 48 hours and by facilitating high quality data, the Charter has time and again reconfirmed the effectiveness of space information for emergency management.

Mr G Madhavan Nair, Chairman, ISRO (sixth from left) and other dignitaries on the dais.

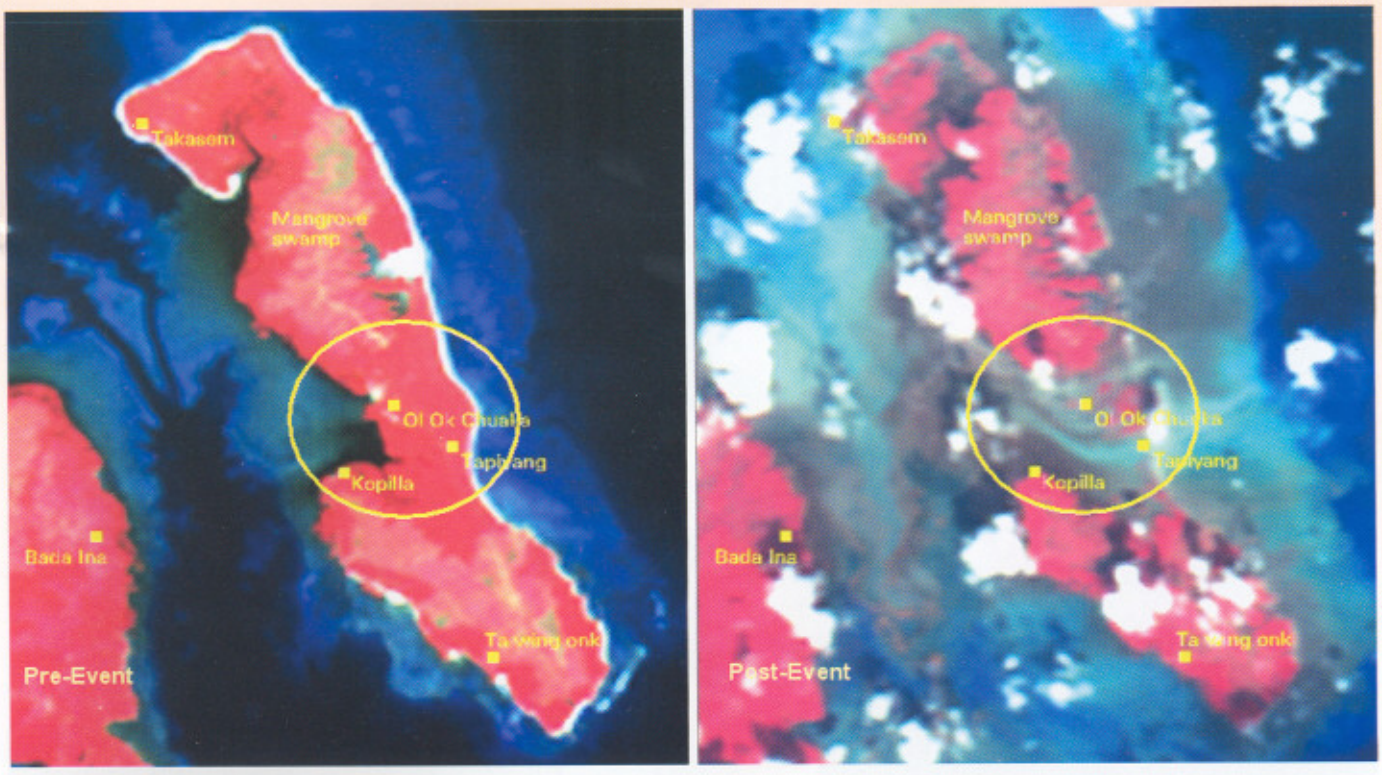
The Charter on Space and Major Disasters was outlined by its founding members on the occasion of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space held in Vienna, in 1999. Recently, the United States Geological Survey (USGS) and the British National Space Centre (BNSC), incorporated their valuable and diverse capabilities and technical resources.

In 2004, through its Office for Outer Space Affairs, the United Nations became a cooperating body enhancing the promotion of the Charter as a gateway for United Nations agencies responding to natural disasters and emergencies.

As an example of its impact, during December 2004 Indian Ocean tsunami disaster in India, Sri Lanka, Indonesia and Thailand, no less than 200 passive (electro-optical) and active (Synthetic Aperture Radar) sensor images acquired from satellites owned or operated by the Charter members were processed. Subsequently, an equally large number of image products were delivered in the field.

The Charter also provided space based information on the onslaught of Hurricane Katrina, when levees were breached and floodwaters submerged the city of New Orleans in August 2005.

The special session, organised by ISRO to mark the fifth anniversary, was presided over by Mr G Madhavan Nair, Chairman, ISRO. Mr Jean-Luc Bessis of CNES delivered the keynote address on Disaster Management. Charter functionaries from CNES, CONAE (Argentina), CSA, ESA, ISRO, JAXA (Japan), NOAA and USGS (of USA) participated in the proceedings. Representatives from UN were also present. During the event, functionaries assessed the impact of the Charter and its performance, reviewed the real capabilities of Remote Sensing for Disaster Management with feedback from real disasters during this period including the response of the Charter to recent Asian Tsunami and Hurricane Katrina disasters. Besides, operational aspects such as lessons learnt, effectiveness and improvements were also reviewed thus aiming to establish future directions for the Charter.



Imagery from RESOURCESAT-1 showing damage to Trinkat island (of Nicobar chain of islands) caused by December 2004 Indian Ocean Tsunami

Monitoring and Evaluation of Watershed Development

ISRO, jointly with Antrix Corporation and Watershed Development Department, Government of Karnataka, organised a one-day workshop on Watershed Development on November 9, 2005 at Antariksh Bhavan, Bangalore, the headquarters of ISRO. The workshop was inaugurated by Shri G Madhavan Nair, Chairman, ISRO. Dr Dunu Roy, World Bank Expert was the chief guest and Shri A Ramaswamy, Principal Secretary, Department of Agriculture and Horticulture, Government of Karnataka, presided.

Karnataka initiated the watershed development project, SUJALA, in 2001 with the assistance of World Bank. The project covers 77 sub-watersheds and 747 micro-watersheds in 38 talukas located in five districts of Karnataka and extends to 5.11 lakh hectares. It is expected to benefit more than 4 lakh households. So far, activities in 80 micro-watersheds have already been completed and work is in progress in 184 micro-watersheds. Another 473 micro-watersheds' development has been initiated.

Under the contract from World Bank, Antrix has been assigned the responsibility of monitoring the progress of SUJALA project. Data from Indian remote sensing satellites and conventional ground data have been successfully used to monitor and evaluate the SUJALA watershed development project for which the methodology has been developed by ISRO/Antrix.

Inauguration of workshop by Mr G Madhavan Nair, Chairman, ISRO in the traditional way

Indian Gamma-ray Telescope to Fly on Russian Satellite

A Roentgen Telescope, RT-2, consisting of a low energy Gamma-ray telescope, jointly developed by ISRO and Tata Insitute of Fundamental Research, will be included as one of the instruments on board a Russian scientific satellite under the CORONAS (Complex Orbital Observations of Near-earth Activity of the Sun) programme. An agreement to this effect is already in place and technical interfaces have already been finalised with the Astrophysical Institute MEPhl, Moscow, which is developing the satellite.

CORONAS programme aims at the launch of three solar observation satellites into near earth orbit. CORONAS-PHOTON, on which RT-2 will be flown, is the third satellite in this series. The main objective of CORONAS-PHOTON mission is to study the solar hard electro-magnetic radiation in a wide energy range from extreme Ultraviolet to high energy gamma radiation which roughly corresponds to about 2000 Million electorn-Volt (MeV).

RT-2 aims to register variation in the profile of solar and galactic X-ray radiation with time. It is sensitive to such variations in the energy range of 10-150 Kilo electron-Volt (KeV). The experiment also aims at X-ray radiation spectrometry in the energy range of 0.10-2 MeV.

The 55 kg RT-2 contains three co-aligned Phoswich scintillation detectors that point towards the sun. They will have three different fields of view, thus enabling the experiment to make spectral measurements on the cosmic diffuse X-ray background.

The technology model of RT-2 is expected to be realised soon.

Dr Suresh Elected Chairman of UN Committee

Dr B N Suresh, Director of ISRO's Vikram Sarabhai Space Centre (VSSC) at Thiruvananthapuram, has been elected as the Chairman of Science and Technology (S&T) Sub-committee of the United Nations Committee On Peaceful Uses of Outer Space (UN-COPUOS) for the current year. He was the nominee of Asian Group of countries for the coveted post. Dr Suresh was elected to the post at the beginning of the 43rd Session of S&T Sub-committee at the Vienna International Centre, Austria, on February 20, 2006.

S&T Sub-committee of UN-COPUOS, which is attended by 69 member states and other international professional organisations, focuses on the international co-operation in the field of space, with specific reference to space science and technology and their applications.

Dr B N Suresh, who is the Director of ISRO's largest Centre, VSSC, has been leading the Indian delegation to S&T Sub-committee of UN-COPUOS for the past three years. He has made significant contributions to the development of launch vehicle technology and played a key role in formulating a number of bi-lateral co-operation agreements between ISRO and other space agencies.

Antrix-EADS Astrium to Build Satellite for Eutelsat

Antrix Corporation, the commercial arm of ISRO and EADS Astrium, Paris, signed a contract on February 20, 2006 to jointly offer communications satellites in the market segment of around 4 kW of payload power with a launch mass of 2 to 3 tonnes. This cooperation, combining Indian satellite platforms along with European payloads, is designed to offer optimal, flexible and cost effective solutions to telecommunications operators.

ISRO has established operational space systems such as INSAT for telecommunication, television broadcasting and meteorological services and the Indian Remote Sensing Satellites for resources monitoring and management. Satellite launch vehicles such as the Polar Satellite Launch Vehicle for launching remote sensing satellites into polar orbits and the Geosynchronous Satellite Launch Vehicle for launching communication and meteorological satellites into geosynchronous transfer orbit have also been operationalised. Antrix globally markets the products and services developed/offered by ISRO.

EADS Astrium is Europe's leading specialist in satellite systems. Its activities cover complete civil and military telecommunications and earth observation systems, science and navigation programmes, and all spacecraft avionics and equipment. EADS Astrium is a wholly owned subsidiary of EADS SPACE, which is dedicated to providing civil and defence space systems. EADS is a global leader in aerospace, defence and related services.

The first success of Antrix-EADS Astrium alliance has already been demonstrated by the award of W2M satellite contract by Eutelsat Communications. Under W2M contract, EADS Astrium is the prime contractor in charge of overall programme management and will build the communications payload. Antrix/ISRO will build the satellite bus, integrate and test the spacecraft. ISRO will also be in charge of early in-orbit operations. W2M will be delivered to Eutelsat in 26 months for launch in the second quarter of 2008. W2M will operate typically 26 transponders in Ku-band and up to 32 depending on operational modes, for a design operational lifetime of 15 years. It will have fixed beam coverage for Europe, North Africa and Middle East and a steerable beam, which can be re-oriented in orbit according to market requirements, notably towards Africa and central Asia.

Eutelsat Communications is the holding company of Eutelsat S.A. The Group is a leading satellite operator with capacity commercialised on 22 satellites providing coverage over the entire European continent, as well as the Middle East, Africa, India and significant parts of Asia and the Americas. The Group is one of the world's three leading satellite operators in terms of revenue. Its satellites are used for broadcasting over 1,700 TV and 860 radio stations to nearly 120 million cable and satellite homes. The Group also provides TV contribution services, corporate networks, mobile positioning and communications, Internet backbone connectivity and broadband access for terrestrial, maritime and inflight applications.

VTU's EDUSAT backed 1000th Lecture Session Completed

Visvesvaraya Technological University (VTU), Belgaum, Karnataka, the first university to implement EDUSAT-based e-classes for technical education, has successfully completed 1000 sessions of lectures via EDUSAT. To mark the 1000th session, a special panel discussion was organised at the Department of State Educational Research and Training Campus, Bangalore on March 23, 2006.

VTU had initiated pilot projects even before the launch of EDUSAT by using other INSAT system satellites. Since the commissioning of EDUSAT, classes are being conducted for about eight hours daily using EDUSAT network that connects all the 120 engineering colleges of VTU. The students spread across Karnataka have benefited immensely by listening and interacting with some of the best subject experts. Seven to eight subjects are taught every semester. So far, three programmes covering 669 sessions and 331 sessions under the on-going fourth programme, have been completed. The subjects covering various disciplines like civil, mechanical, electronics, electrical, computer science and information science are being transmitted live everyday from VTU studio situated at Bangalore.

VTU has also used EDUSAT network for interaction between talented youth and the chief executives of various corporate entities, which has been well received and well attended. This has enabled industries to spot talented students from the universities. VTU's experience on the effectiveness of satellite based technical education in terms of equipment, classroom infrastructure and programme content will be useful for EDUSAT projects that are being implemented in other parts of the country.

In his message on the occasion of the 1000th live session using EDUSAT, Mr G Madhavan Nair, Chairman, ISRO congratulated VTU for being the first to implement EDUSAT programme and said that VTU can become a role-model for other institutions of higher education to implement EDUSAT based classrooms across the country. He added that EDUSAT network could be used for administrative purposes and even for conducting on-line examinations and evaluations. Mr Madhavan Nair said that possibility exists to upgrade technology to enable interconnectivity between national and regional beams of EDUSAT for conducting classes across the country. "While ISRO has been striving to use space technology for efficient societal benefits, it should be the user community, which has to come forward and use advanced technologies to improve the efficiency and capacity of the conventional systems" he said.

Participating in the panel discussion, Mr D H Shankara Murthy, Minister of Higher Education, Karnataka, expressed happiness about the functioning of VTU EDUSAT network and said that the Karnataka Government will provide all necessary support for extending this facility. He also added that the Government is proposing to set up a separate directorate for technology enabled education to adopt the latest technology at all levels of education. Mrs Sobha Nambisan, Principal Secretary, Higher Education, Government of

Karnataka, said that in the present context of severe paucity of well trained teachers, VTU EDUSAT is a boon to share the knowledge of expert teachers by a large student community. Mr A Bhaskaranarayana, Director, Satellite Communications Progarmme, ISRO said that VTU Project has successfully demonstrated the efficacy of satellite-based technology for technical education. He also said that with the fast pace of technological evolution, it is very difficult for teachers to keep themselves updated on the latest and EDUSAT can help in bringing the best of lecturers to teach students of all colleges of VTU simultaneously. Dr K Balaveera Reddy, Vice Chancellor, VTU thanked ISRO for providing necessary satellite bandwidth and other facilities for VTU EDUSAT project and said that VTU will go ahead to implement various other projects like technology enabled education, e-learning, e-campus, etc.

EDUSAT, launched on September 20, 2004, is configured for audio-visual medium employing digital interactive classroom lessons and multimedia content. Its ground coverage is specially configured to cater to the educational requirements of the country. EDUSAT programme is primarily intended for school, college and higher levels of education and to support non-formal education. In the present semi-operational phase of EDUSAT programme, Karnataka Primary Education Project under 'Sarva Shiksha Abhiyan' covering 885 primary schools has been made operational using the southern regional beam of EDUSAT. Networks for IGNOU, CEC/ University Grants Commission, CIT/National Council of Educational Research and Training, All India Council for Technical Education and Department of Science and Technology have been set up using the national beam. Interactive networks for Kerala and Tamil Nadu are operational and extensively used for teachers' training and other training programmes using regional beam.

The teaching end

The learning end

School networks in Chamarajanagar and Gulbarga in Karnataka, Madhya Pradesh, Uttar Pradesh, Bihar, Mallapuram in Kerala and Lakshadweep are under various stages of implementation. As of now, about 2,700 schools are benefited by this programme. About 900 interactive networks for application of higher and technical education and teachers' training are operational at present. Many networks in J&K and North Eastern states will soon be operational. A total of 33 interactive/Receive Only Terminal networks are proposed in the national beam as well as the regional beams of which 12 are operational. This includes a unique network for Blind People's Association operating in Ku-band western regional beam established in 10 blind schools of Gujarat. At present, more than 2300 classrooms have been connected through EDUSAT in various educational networks.

IRS-1C Completes Ten Years of Operation

The Indian Remote Sensing satellite, IRS-1C, which was launched on December 28, 1995, has completed ten years of operation. IRS-1C carries a unique combination of three state-of-the-art cameras – a Panchromatic Camera with a spatial resolution of 5.8 metre, a Linear Imaging Self Scanner-3 with a resolution of 23 metre and a Wide Field Sensor with a resolution of 188 metre. When it was launched, IRS-1C was the most advanced civilian remote sensing satellite. This satellite was launched into a polar sun synchronous orbit of 817 km height by the Russian *Molniya* launch vehicle.

Though designed for three years life, the meticulous in-orbit operations of the satellite by ISRO Telemetry, Tracking and Command Network coupled with the highly efficient use of the on-board propellant for its orbit and orientation control as well as the high reliability built into its subsystems have enabled IRS-1C to far outlive its design life. The success of IRS-1C paved the way for India to enter into the global remote sensing market and to capture a substantial share of remote sensing data market. More than US $ 10 million in revenue by data sale from IRS-1C has accrued so far.

IRS-1C data provided a great fillip to remote sensing applications in India like crop acreage and yield estimation, forest resources survey, urban mapping, flood mapping, wasteland mapping and drought monitoring and assessment. IRS-1C was followed by an identical satellite IRS-1D, which was launched by India's own Polar Satellite Launch Vehicle on September 29, 1997. This, in turn, paved the way for the launch of more theme-oriented remote sensing satellites like OCEANSAT-1, RESOURCESAT-1 and CARTOSAT-1.

In the past one decade, IRS-1C has orbited earth nearly sixty thousand times and beamed lakhs of imageries back home .

Artist's concept of IRS-1C

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Tableau of 'Central Industrial Security Force (CISF) at Department of Space' during CISF Raising Day celebrations at New Delhi on March 10, 2006