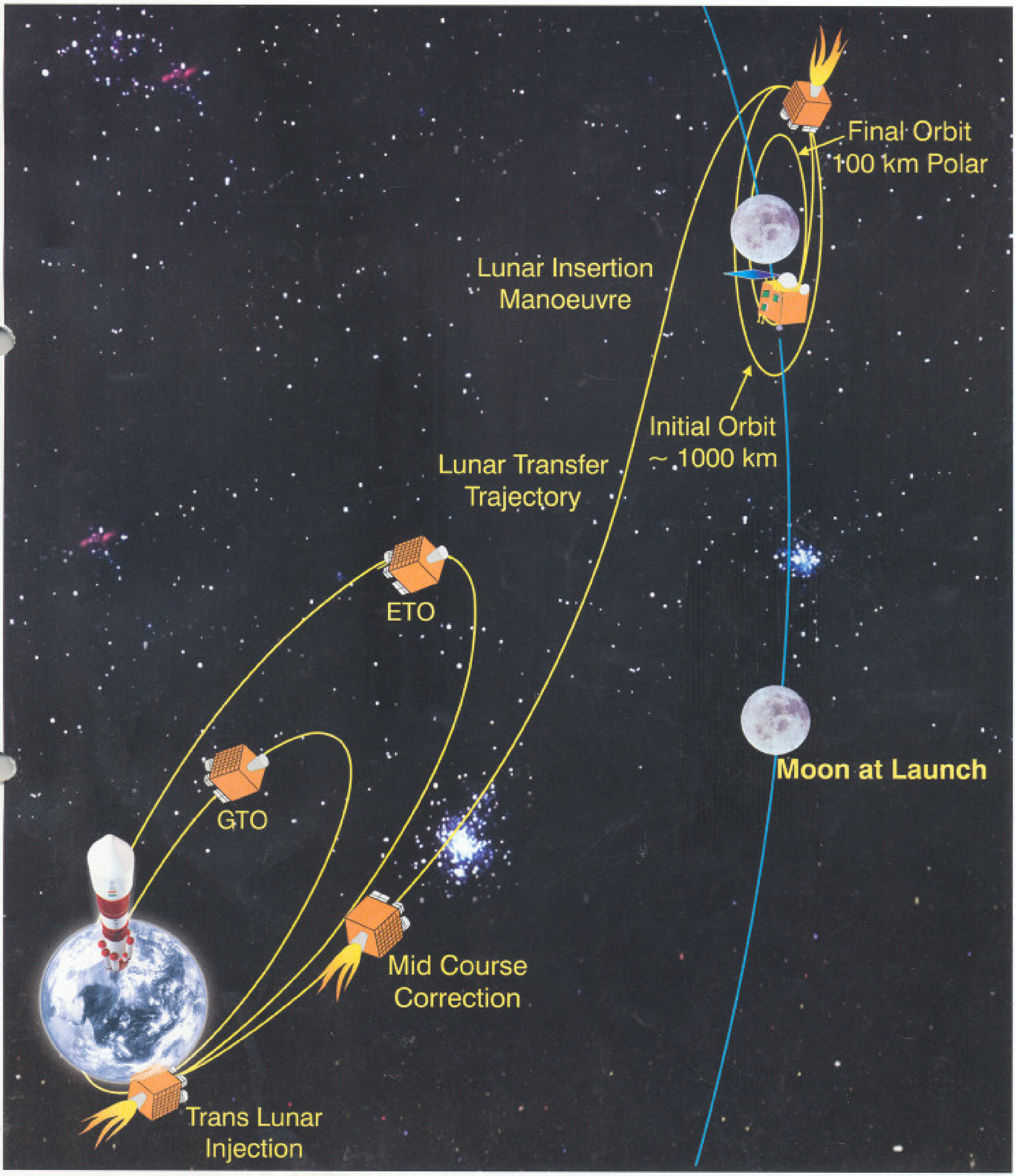
July-September 2003

SPACE india



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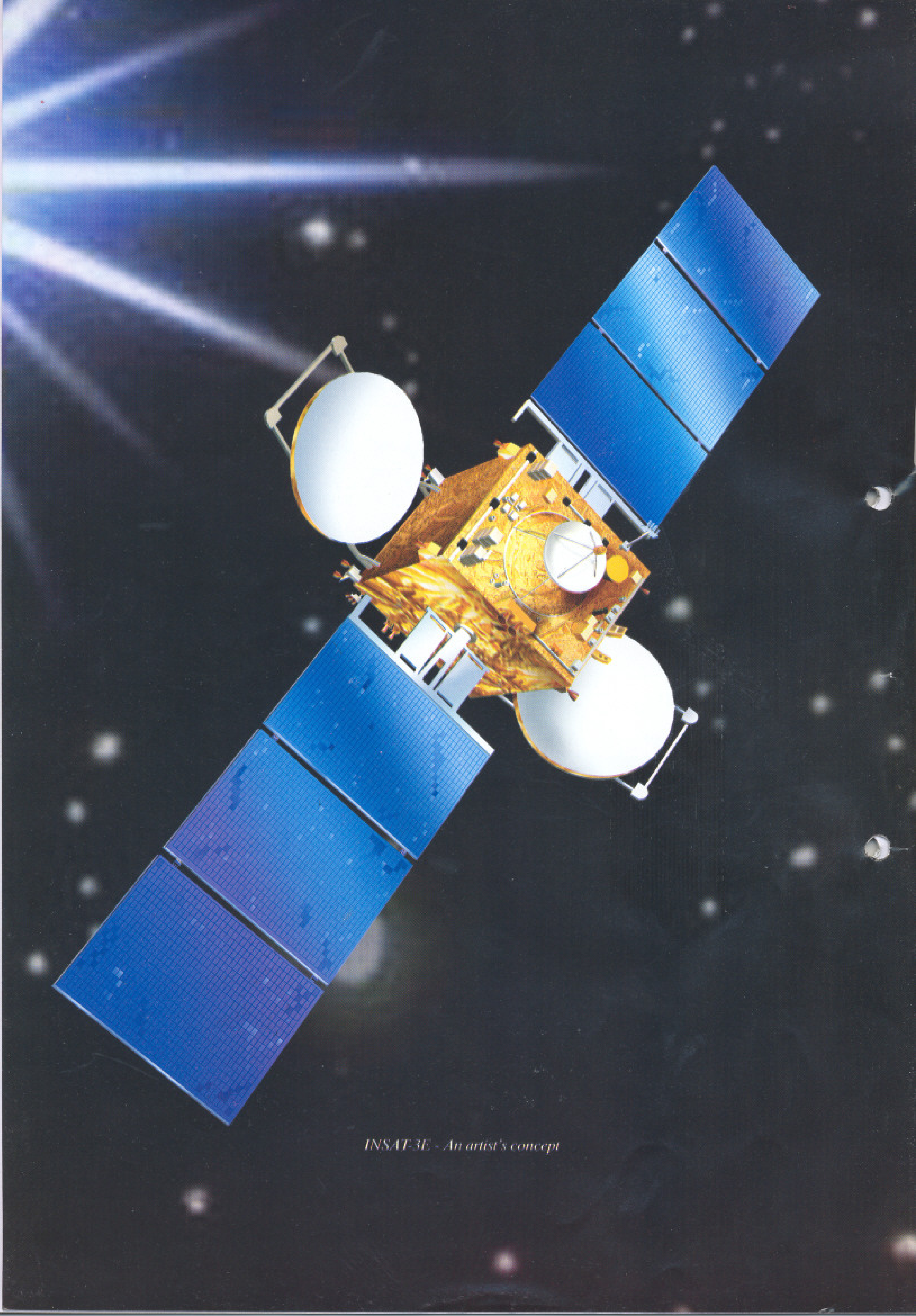

INSAT-3E - An artist's concept

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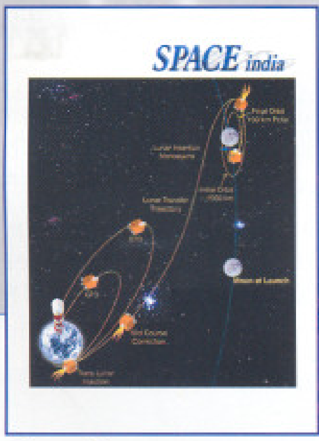

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Prime Minister Announces India's Mission to Moon

The Prime Minister, Mr Atal Bihari Vajpayee, announced in his Independence day address on August 15, 2003, that India will undertake an unmanned mission to Moon, "Chandrayaan-1". The mission is aimed at expanding the scientific knowledge about the moon, upgrading India's technological capability and providing challenging opportunities in planetary research for the younger generation.

The spacecraft will carry the following scientific instruments:

- Terrain Mapping Camera (TMC) with stereo imaging capability operating in panchromatic band, with 5 m spatial resolution and 40 km swath
- A Hyper-Spectral Imager (HySI) operating in 400-900 nanometer(nm) band with a spectral resolution of 15 nm, a spatial resolution of 80 m and a swath of 40 km

Scientists discussing details of Chandrayaan-1

The scientific objective of Chandrayaan-1 will be the high resolution remote sensing of the Moon in the visible, near Infrared, low energy X-ray and high-energy X-ray regions for preparing a 3-dimensional atlas of regions of scientific interest with a high spatial and altitude resolution of 5-10 m; Chemical mapping of the entire lunar surface for elements such as Magnesium, Aluminium, Silicon, Calcium, Iron and Titanium with a spatial resolution of 10 km and elements of high atomic numbers (Z), such as ^{222}Radon, Uranium, Thorium and Gadolinium with a spatial resolution of 20 km.

- A Lunar Laser Ranging instrument (LLRI) with a height resolution of 10 m
- A Low Energy (1-10 keV) X-ray spectrometer (LEX) for measuring fluorescent X-rays emanating from lunar surface with a footprint of 10 km
- A High Energy X-ray (10-200 keV) mapping camera (HEX) with a footprint of 20 km to identify degassing faults or zones on the moon by mapping ^{222}Radon, and its radioactive daughter ^{210}Lead

The spacecraft will also allow scientific instruments of other space agencies weighing up to about 10 kg that could supplement and complement the scientific data from the Indian instruments.

The spacecraft for Chandrayaan-1 will be a 1.5 m cuboid with a dry mass of 525 kg in its final lunar orbit. It will be 3-axis stabilized using reaction wheels and attitude control thrusters. Star Sensors, Inertial Reference Unit and accelerometers will help in attitude determination. The spacecraft will be powered by a single-sided canted solar array generating 750 W of electrical power. It will have a Lithium-Ion battery back-up for operation during eclipse.

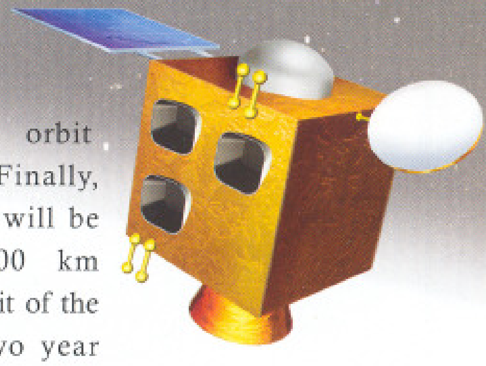
The spacecraft will use a bi-propellant propulsion system for transferring it from Geosynchronous Transfer Orbit (GTO) to lunar orbit and for orbit and attitude maintenance.

The telemetry, tracking and command system will operate in S-band and the scientific data will be transmitted in X-band.

India's Polar Satellite Launch Vehicle (PSLV) will be used to launch the spacecraft. With seven successful launches so far, the PSLV has become a workhorse vehicle, placing Indian Remote Sensing Satellites as main payloads and four satellites of other space agencies as piggy-backs. With a lift-off weight of 295 tonne, the 44.4 m tall PSLV has also launched a meteorological satellite, KALPANA-1, to GTO. This is the orbit in which the spacecraft for Chandrayaan-1 will also be placed by PSLV.

In the Chandrayaan-1 mission, the spacecraft will be initially launched into a GTO with a perigee of about 240 km and an apogee of 36,000 km. Two consecutive in-plane perigee maneuvers, using the Liquid Apogee Motor(LAM) on board the spacecraft, will raise the apogee to 3,86,000 km, which is very close to the Moon (Lunar Transfer Trajectory - LTT). It will take 5½ days for the spacecraft to approach the moon. When the spacecraft is at peri-selene (nearest point around the moon), another maneuver by LAM firing will place the spacecraft in a near circular 1,000 km orbit of moon. In this orbit, the solar panel of the spacecraft will be deployed.

Subsequently, the orbit height will be reduced to 200 km and orbital plane corrections carried out to place the spacecraft in polar orbit. The spacecraft will be maintained in this orbit for 1-2 weeks that will help in studying the orbit perturbations. Finally, orbital altitude will be reduced to 100 km circular polar orbit of the moon for its two year scientific mission.



While ISRO has already established its capability to design the spacecraft and has already commissioned PSLV, which will be used for launching the lunarcraft, a few new technologies will have to be developed that would enhance ISRO's capability further. The important technologies to be developed include Lithium-ion batteries, gimbaled antenna system, miniaturized communication system, miniaturized star sensor and spacecraft bus management.

A Deep Space Network Station will be established at Bangalore, which will have a 180-deg longitudinal shift with respect to Goldstone, California, USA. The station could support spacecraft at a slant range of upto 4,00,000 km for TTC and payload data reception. The station will have a 34 m diameter antenna with an uplink power transmission at 2 kW. The station will be able to receive data in X-band with a spacecraft transmitter power of 2 W.

A National Science Data Centre to process raw data into user-friendly format will be set up at a suitable location.

The total estimated cost of Chandrayaan-1 mission is Rs 386 Crore including Rs 100 Crore for the establishment of Deep Space Network.

The Chandrayaan-1, planned for 2007-2008, will provide a unique opportunity for frontier scientific research and it is expected to be the forerunner of more ambitious planetary missions in the years to come including landing robots on the moon and visits by Indian spacecraft to other planets of the solar system.

Some of the Contemporary Unmanned Lunar Missions

SMART-1 of European Space Agency (ESA), weighing 366 kg, was launched on September 28, 2003 (as one of the co-passengers of India's INSAT-3E) with the objective of detailed mapping of the geological and mineralogical composition of the moon and searching for ice at the bottom of permanently shadowed craters around the lunar south pole. SMART-1 carries a multi-spectal camera with 40 meter resolution, an infra-red spectrometer and an X-ray spectrometer.

Japan's **Lunar-A**, which is a 520 kg Lunar Orbiter, is proposed for launch in August 2004 to study the moon's internal structure by sensing moonquakes and monitoring heat flow from the lunar interior. It will carry a high resolution camera and two instrumented torpedo probes capable of penetrating 2 metres into the lunar surface.

SELENE, (Selenological and Engineering Explorer), also of Japan is to study the moon's origin and evolution by collecting the most detailed information on moon's topography, the elemental and mineral content of its surface, magnetism and gravity. It is expected to help scientists in the determination of moon's wobble in its orbit and will collect data on the lunar interior by the comparison of the radio signals coming from the two small satellites (carried piggy-back) stationed in the lunar orbit. Besides, it will study the plasmasphere surrounding the earth and using a small probe, it will test controlled landing technologies for use on more distant bodies. Planned for launch in 2005, the 1600 kg spacecraft will carry an array of spectrometers, imagers, laser altimeters, radar sounders and magnetometers.

Chang'e 1 of China for obtaining a three-dimensional map of the lunar surface and analysis of soil composition and material distribution is planned for launch by 2006-2008.

Madhavan Nair is New Chairman of ISRO

Passing on the baton – Dr Kasturirangan (left) handing over the reins of ISRO to Mr Madhavan Nair

Mr G Madhavan Nair took over as Chairman, ISRO, Chairman, Space Commission and Secretary, Department of Space, on September 01, 2003. He assumed the new position after Dr K Kasturirangan relinquished the office consequent to the President of India nominating him as Member of Rajya Sabha (Upper House of Parliament).

Mr Madhavan Nair is a leading technologist in the field of rocket systems. He has made significant contributions to the development of multistage satellite launch vehicles for the Indian space programme. After graduating in Engineering from the Kerala University in 1966, Mr Madhavan Nair underwent training at Bhabha Atomic Research Centre (BARC), Mumbai. He joined Thumba Equatorial Rocket Launching Station (TERLS) in 1967. Since then, he has held various positions in ISRO. Impressed with his contributions to the first Indian Satellite Launch Vehicle, SLV-3, he was designated as the Project Director of India's first operational launch vehicle, the Polar Satellite Launch Vehicle (PSLV). With seven successful flights so far, PSLV has convincingly demonstrated its reliability and versatility for not only launching multiple satellites but also its capability to place satellites in Geosynchronous Transfer Orbit (GTO). Mr Madhavan Nair also contributed to the indigenous development of cryogenic technology and as Director, Liquid Propulsion Systems Centre during 1995-99, he gave concrete shape to its vital infrastructure for the development of technology.

As the Director of the largest centre of ISRO, the Vikram Sarabhai Space Centre (VSSC), from 1999 till he took over the present position of Chairman, ISRO, Mr Madhavan Nair led the successful flight of Geosynchronous Satellite Launch Vehicle (GSLV) in the very first attempt followed by another successful flight in May 2003. GSLV has since been commissioned into operational service for launching 2,000 kg class satellites into GTO.

The outgoing Chairman of ISRO, Dr Kasturirangan, led the space programme for nearly a decade when India crossed several major milestones including the commissioning of India's prestigious launch vehicle, the PSLV, and, more recently, of the GSLV. Further, the world's best civilian remote sensing satellites, IRS-1C and 1D, experimental remote sensing satellites, IRS-P2 and IRS-P3, besides an exclusive ocean observation satellite IRS-P4 were launched. A 1-m spatial resolution experimental satellite, TES was also launched during his tenure. He saw the development of the second generation INSAT satellites which vastly enhanced the capacity of INSAT system for telecommunication, television broadcasting and meteorology. Three satellites under the third generation series, INSAT-3A, INSAT-3B and INSAT-3C, were also launched besides an exclusive meteorological satellite, KALPANA-1.

Under the leadership of Dr K Kasturirangan, ISRO posted impressive progress in the fields of International co-operation and space commerce among many others.

The new Chairman of ISRO, Mr Madhavan Nair, thus inherits a rich legacy left behind by Dr Kasturirangan.

Earlier Chairmen of ISRO

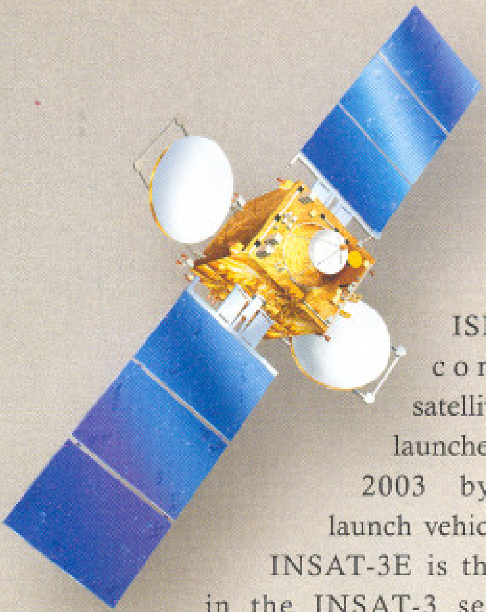
Dr Vikram A Sarabhai
November 1969 to December 1971

Prof M G K Menon
January 1972 to September 1972

Prof Satish Dhawan
September 1972 to September 1984

Prof U R Rao
September 1984 to March 1994

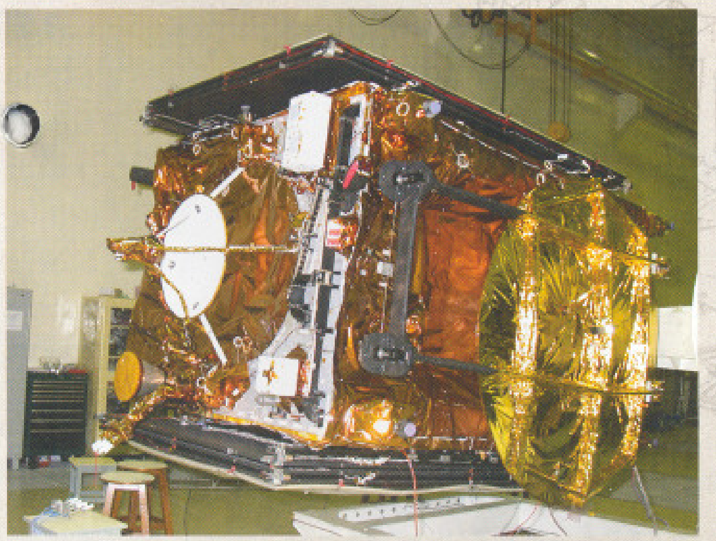
Dr K Kasturirangan
March 1994 to August 2003



INSAT-3E Launched

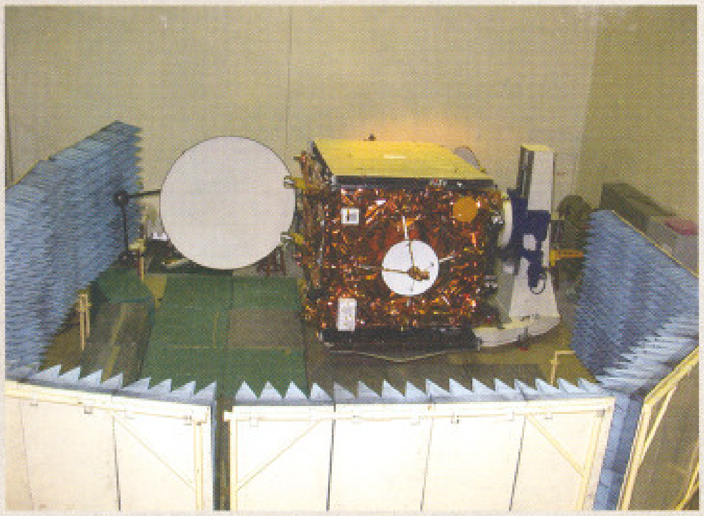
ISRO's latest communication satellite, INSAT-3E, was launched on September 28, 2003 by the Ariane-5 launch vehicle of Arianespace. INSAT-3E is the fourth satellite in the INSAT-3 series; INSAT-3A, INSAT-3B and INSAT-3C were launched on April 10, 2003, March 22, 2000 and January 24, 2002 respectively.

The 162nd flight of Ariane, with ISRO's 2750 kg INSAT-3E, e-BIRD of EUTELSAT and SMART-1 of European Space Agency, lifted off at 4.44 am IST from Kourou, French Guyana. Thirty minutes later, INSAT-3E was injected in 3-axis stabilized mode into a Geosynchronous Transfer Orbit (GTO) with a perigee of 649 km and an apogee of 35,923 km. The inclination of the orbit was 7 deg with respect to the equator and the orbital period was about 10 hours 50 minutes.



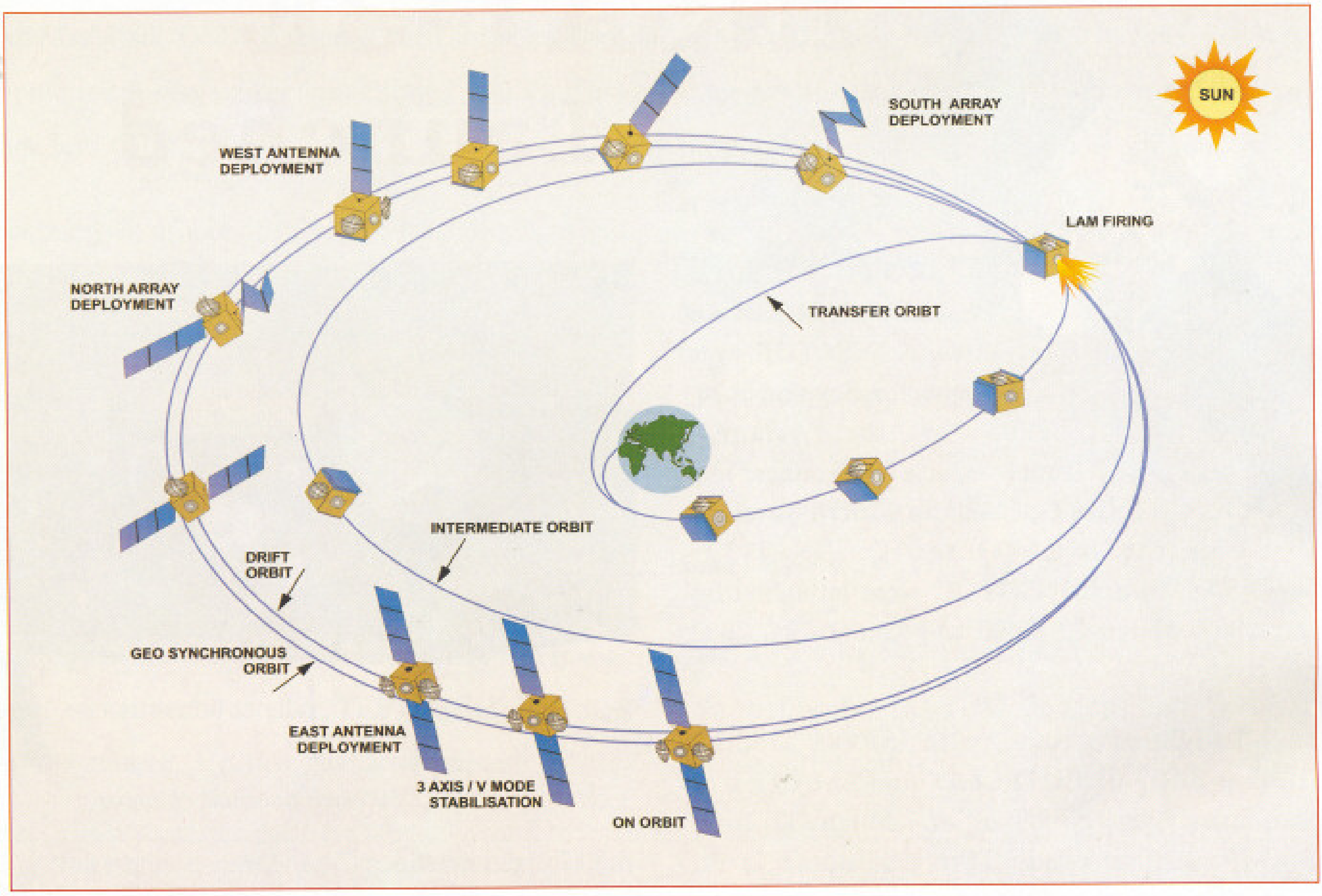
INSAT-3E on assembly Jig

INSAT-3E carries 24 C-band transponders, having India beam coverage providing an Edge of Coverage-Effective Isotropic Radiated Power (EOC-EIRP) of 38.5 dBW and 12 upper extended C-band transponders having India beam coverage providing an (EOC-EIRP) of 38 dBW. The spacecraft has its main body in the shape of a cuboid of dimensions 2.0 m X 1.77 m X 2.8 m with solar arrays on north and south sides. When its solar panels are fully deployed in orbit, it measures 15.44 m (North-South). The satellite is 3-axis body stabilized using sensors, momentum and reaction wheels, magnetic torquers and eight 10 Newton and eight 22 Newton Reaction Control thrusters. The satellite has two solar arrays together generating 2,400 Watt of electrical power backed up by two 70 Ah Nickel Hydrogen Batteries that support full payload operation during eclipse period. The satellite has two deployable antennas and one fixed antenna for various transmit and receive functions.



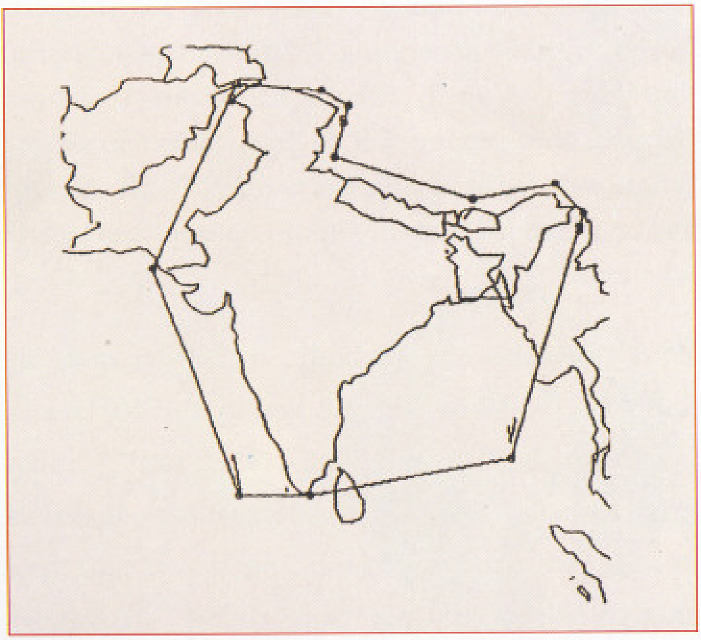
INSAT-3E inside anechoic chamber

Through a series of complicated maneuvers spanning four days, the Master Control Facility (MCF), Hassan in Karnataka steered INSAT-3E into a near geostationary drift-orbit, successfully deployed its solar panels and antennas and put it in its final three axis stabilised configuration. INSAT-3E carries adequate fuel to complete its design life of 12 years.



INSAT-3E Mission Profile

INSAT-3E will be positioned at 55 deg East longitude in the geostationary orbit. Other INSAT satellite locations are: INSAT-3A at 93.5 deg East longitude, INSAT-2E and INSAT-3B at 83 deg East longitude, INSAT-3C and KALPANA-1 at 74 deg East longitude and GSAT-2 at 48 deg East longitude.



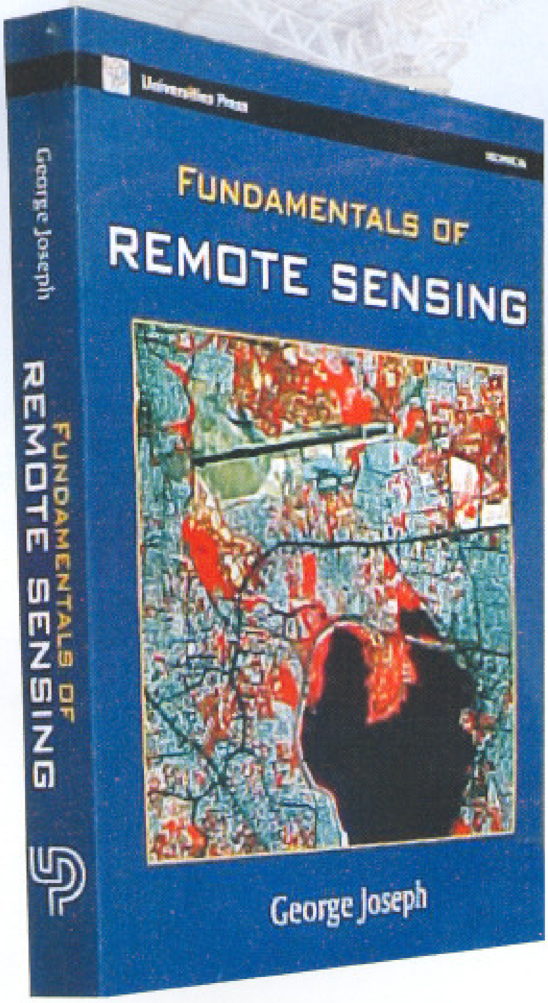
INSAT-3E Coverage Area

Commissioned in 1983, INSAT is the largest domestic communication satellite system in the Asia-Pacific region, providing telecommunications, TV broadcasting, meteorological imaging, disaster warning and satellite aided search and rescue services. INSAT system provides more than 130 transponders in S-band, C- band, extended C-band and Ku-band besides Very High Resolution Radiometers (VHRR) and Charge Coupled Device (CCD) cameras for meteorological imaging. An experimental satellite, GSAT-2, carrying 4 C-band, two Ku-band and a Mobile Satellite Service transponder along with scientific experimental payloads was launched in May 2003. INSAT-3D, an advanced meteorological satellite and the last in the INSAT-3 series, will be launched in 2004-05. Development of the first two satellites in the INSAT-4 series, INSAT-4A and INSAT-4B, has also commenced. An exclusive satellite for educational purposes, EDUSAT, is also planned for launch by India's Geosynchronous Satellite Launch Vehicle, GSLV, in 2004.

Book on *Remote Sensing* Released

At a brief function organized at Antariksh Bhavan, the Headquarters of ISRO in Bangalore, Mr G Madhavan Nair, Chairman, ISRO, released a book "Fundamentals of Remote Sensing". Dr K Kasturirangan, Member of Rajya Sabha (Upper House of Parliament) and former Chairman of ISRO, was the Chief Guest.

Mr G Madhavan Nair (Right) presents a copy of the Book to Dr George Joseph. Dr K Kasturirangan is in the centre



"Fundamentals of Remote Sensing" is authored by Dr George Joseph, Satish Dhawan Distinguished Professor of ISRO, who is one of the senior most and experienced remote sensing experts in India. This book covers the basics of remote sensing technologies and their applications in various fields with specific references to remote sensing technology and applications in India. Smooth flow and lucid explanation of technological terms has made the book easy to understand and simple to read. Well designed illustrations along with comprehensive bibliography and references have endeared it to the remote sensing enthusiasts and professionals alike.

Releasing the book, Mr Madhavan Nair said that the space based remote sensing for resources monitoring and management is one of the primary objectives of the Indian Space Programme and ISRO has been promoting this technology for various applications — agriculture, forestry, water resources, urban planning, waste land mapping, among many others. He recalled that the very second satellite of India, Bhaskara-I, was devoted to conducting experimental remote sensing and India was one of the earliest to set up a Data Reception Station at Hyderabad to receive data from US Landsat in 1978. "India has come a long way since then" he said and added that Indian Remote Sensing Satellite system was commissioned with the launch of IRS-IA in 1988.

In the 90s, ISRO launched world's best civilian remote sensing satellites, IRS-1C and IRS-1D, an exclusive ocean remote sensing satellite, IRS-P4, and recently a Technology Experiment Satellite, TES, that can provide a spatial resolution of 1 metre. He further added that the follow-on satellite, RESOURCESAT-1, was getting ready for launch by PSLV in October (since launched successfully) and the development of CARTOSAT-I for mapping application has reached an advanced stage. He also announced that the government had recently approved the development of a Radar Imaging Satellite, RISAT, enabling India to acquire capability for imaging during night as well as under cloudy conditions. India has made inroads in marketing data from its remote sensing satellites worldwide through a dozen ground stations.

Mr Madhavan Nair said that while India was taking the lead in remote sensing, the application of this technology has to spread to hitherto unexplored areas and this needed efforts to generate interest among the public and, more specifically, among the student community. "It is in this context that the book by Dr. George Joseph will help us" he pronounced with satisfaction.

Dr K Kasturirangan, who was the Chief Guest at the function and who, as Chairman of ISRO earlier, had encouraged Dr George Joseph to bring out this book, said that simple books on space technologies are to be encouraged so as to make the younger generation aware of these techniques for applications in areas they pursue. He appreciated Dr George Joseph for his intense efforts to bring out the book.

The author of "Fundamentals of Remote Sensing", Dr George Joseph was at the Space Applications Centre (SAC), Ahmedabad since 1973, where he was the guiding force for the development of earth observation remote sensors, data products, image processing and applications. During 1994-98, as Director, SAC, Dr Joseph guided activities related to satellite communications and various national level programmes towards the utilization of space technology for national development.

As Satish Dhawan Distinguished Professor, Dr Joseph is now engaged in studies related to various aspects of remote sensing technology and its applications and is actively associated in shaping and guiding the remote sensing programmes of ISRO.

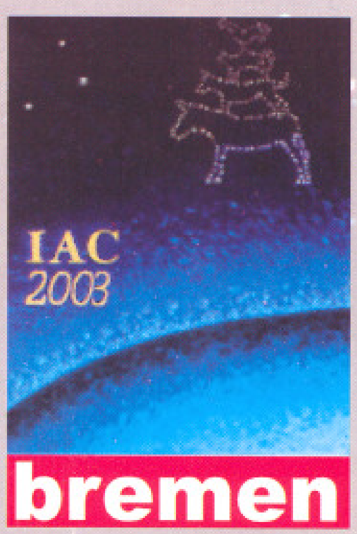
Introducing his book, Dr George Joseph said that the motive behind authoring the book "Fundamentals of Remote Sensing" was to develop a one-source textbook for students pursuing graduate and postgraduate courses in remote sensing and as an end-to-end source material for the professionals. The book could also serve as a teaching manual for those engaged in education and training in this new and promising field of remote sensing. For the international audience, the book is informative about India's foray in remote sensing.

"Fundamentals of Remote Sensing" is published by the Universities Press and distributed by Orient Longman.

International Astronautical Congress 2003

The 54th International Astronautical Congress organised jointly by the International Astronautical Federation (IAF), the International Academy of Astronautics (IAA) and the International Institute of Space Law (IISL) was held at Bremen, Germany from September 29 to October 3, 2003. The congress, organized in a well-equipped convention centre, was attended by about 1,500 delegates (the scintillating inaugural function was attended by about 2,500 delegates). Most space agencies of the world and 132 of the 158 IAF members participated. ISRO was represented by a 11 member delegation.

Indian space activities received a high level of recognition at the Congress. Dr K Kasturirangan, Member of the upper house of Parliament (Rajya Sabha) and former Chairman, ISRO was selected for the prestigious international award of the International Astronautical Federation (IAF) – the Allan D Emil Memorial Award for 2004. This award, which is given to a distinguished personality for significant and life-time contribution for the development of space and astronautics, will be presented in the 55th IAF in Vancouver during October 4-8, 2004. Also, Dr Kasturirangan was elected as the Vice President of the International Academy of Astronautics (IAA) and in this capacity, he will steer the scientific activities of the academy in the coming years. The IAA is an international academy, which aims to foster the development of astronautics and space for peaceful purposes. It is a non-governmental organisation recognized by the United Nations and has members from 65 countries. An IAA Regional Workshop is proposed to be held in India on a selected topic in 2005 which will be led by Dr Kasturirangan.



Prof U R Rao, Chairman of the Programme Council of Physical Research Laboratory and former Chairman of ISRO was re-elected as the Chairman of the IAF committee on Liaison for Developing Countries.

Prof Ranjan Roy Daniel, former Professor of Physics at the Tata Institute of Fundamental Research, Mumbai and former Chairman of ISRO's Advisory Committee on Space Science, has been presented the Basic Sciences Award of the IAA. He recently edited a book "Concepts in Space Science" which has articles written by reputed scientists from all over the world. This book, which was supported by ISRO, has received international appreciation.

Another recognition for India came in the form of the IAA Award for Excellence in Social Sciences to Mr K R Sridhara Murthi, Executive Director of Antrix Corporation and Director, Technology Transfer, ISRO. He has also been inducted into the Board of International Institute of Space Law (IISL).

Yet another significant event for India was on October 3, when the General Assembly of the IAF accepted India's proposal to host the 58th International Astronautical Congress (IAC) at New Delhi in 2007, 17 years after the country first hosted it in Bangalore in 1988. The venues for the 55th, 56th and 57th IAC are Canada, Japan and Spain. The acceptance of India's proposal was based on a detailed presentation made by ISRO and Astronautical Society of India, both members of IAF, which highlighted the infrastructure available in India for organizing international meets; the commitment of the Indian government and other related agencies; the tourist attractions in India; and, above all, India's successful applications-oriented space programme that stands as an example for several other countries.

"India in Space" pavilion at the 54th IAF, organised by ISRO and Antrix Corporation effectively showcased India's achievements in space. Besides ISRO and Antrix, National Remote Sensing Agency, Bharat Electronics, Hindustan Aeronautics, SPECK Systems, INFINIUM, TELEVITAL, Electronic Corporation of India, GOAL, Ananth Technologies, Andhra Sugars and Karnataka State Remote Sensing Applications Centre, who are contributing to the Indian space programme, had put up their displays at the "India in Space" pavilion. Space Imaging, USA, which receives and markets Indian Remote Sensing Satellite data worldwide, also took part in the pavilion. The Indian pavilion attracted the attention of a large number of delegates to IAC and other visitors.

ISRO made a significant contribution to the IAA Study Group on "Space to Promote Peace" under the Co-Chairmanship of Dr Kasturirangan, and at the UN/IAF Workshop on "Education and Capacity building in space technology for the benefit of developing countries" held prior to the IAF. Prof U R Rao delivered the keynote address in the UN/IAF Workshop.

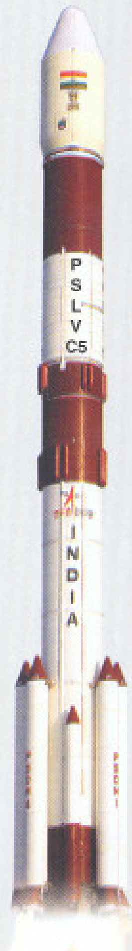
PSLV Launches RESOURCESAT-1 (IRS-P6)

STOP PRESS

In its eighth flight conducted from Satish Dhawan Space Centre, (SDSC), SHAR, Sriharikota, on October 17, 2003, ISRO's Polar Satellite Launch Vehicle, PSLV-C5, successfully launched the Indian remote sensing satellite, RESOURCESAT-1 (IRS-P6) into an 821 km high polar Sun Synchronous Orbit (SSO). The 1,360-kg RESOURCESAT-1 is the most advanced and the heaviest remote sensing satellite built and launched by ISRO so far. This marks the seventh successive success of PSLV.

RESOURCESAT-1 carries three cameras:

- A high resolution Linear Imaging Self Scanner (LISS-4) operating in three spectral bands in the Visible and Near Infrared Region (VNIR) with 5.8 metre spatial resolution and steerable up to 26 deg across track to obtain stereoscopic imagery and achieve a five day revisit capability
- A medium resolution LISS-3 operating in three spectral bands in VNIR and one in Short Wave Infrared (SWIR) band with 23.5 metre spatial resolution
- An Advanced Wide Field Sensor (AWiFS) operating in three spectral bands in VNIR and one band in SWIR with 56 metre spatial resolution



RESOURCESAT-1 also carries a Solid State Recorder with a capacity of 120 Giga Bits to store the images taken by its cameras which can be read out later to the ground stations.

Once commissioned, RESOURCESAT-1, which is the tenth in the Indian Remote Sensing (IRS) satellite series, will not only continue the services of IRS-1C and IRS-1D, but also enhance the remote sensing services by providing imagery with improved spatial resolution and additional spectral bands.

"India in Space" Pavilion at the International Astronautical Congress-2003 in Bremen, Germany