July-September 2004

SPACE india

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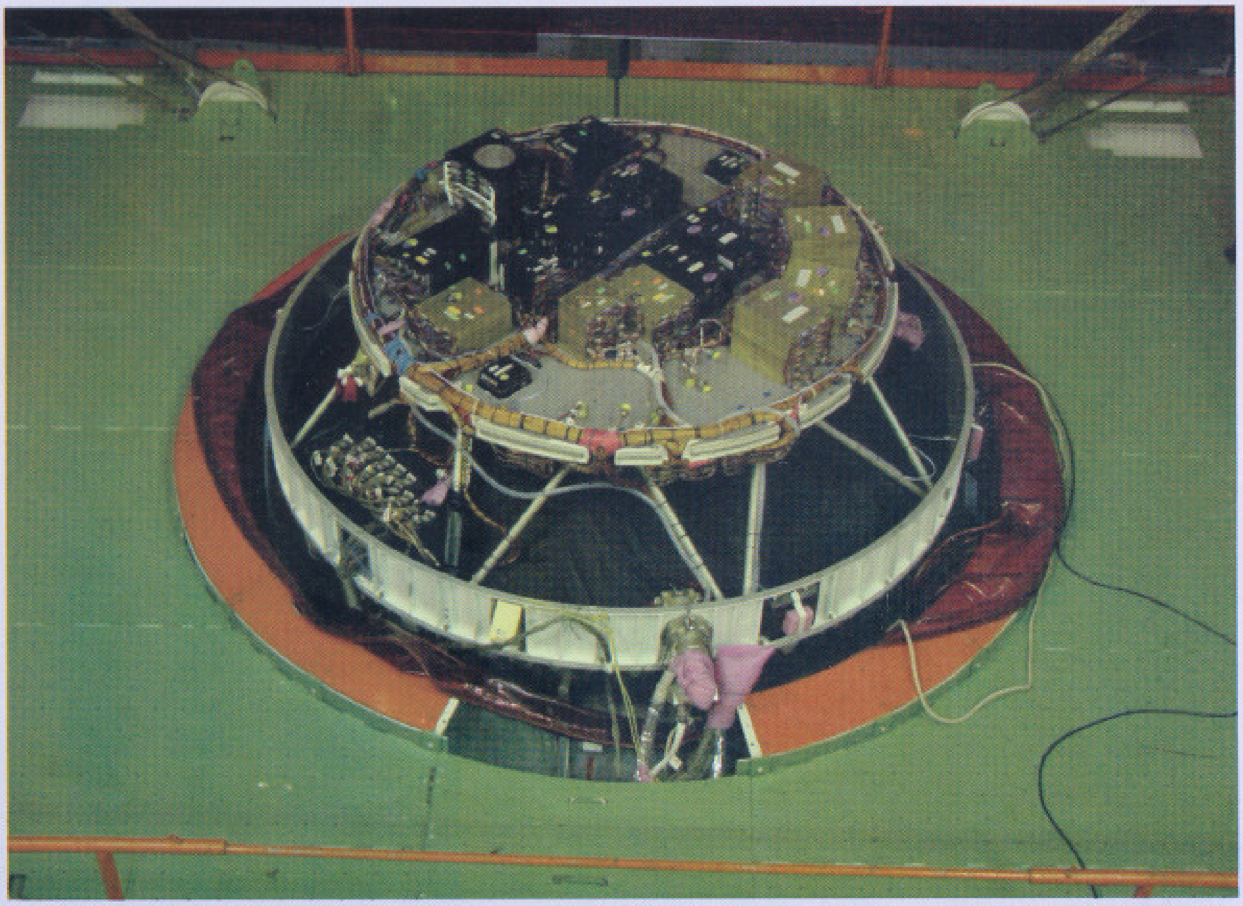

Equipment Bay – *The 'brain of GSLV-F01*

Cover Page:
GSLV-F01 – the final moments of lift-off

SPACE india

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C O N T E N T S

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GSLV-F01 Launch Successful – Places EDUSAT in Orbit

India's Geosynchronous Satellite Launch Vehicle, GSLV successfully launched EDUSAT, the country's first thematic satellite dedicated exclusively for educational services, into a Geosynchronous Transfer Orbit (GTO) on September 20, 2004, from Satish Dhawan Space Centre SHAR (SDSC SHAR), Sriharikota. This was the first operational flight of GSLV (GSLV-F01) and the third in the GSLV series.

After separating from the GSLV third stage, EDUSAT started orbiting the Earth in GTO with a perigee (nearest point to Earth) of 181.5 km and an apogee (farthest point to Earth) of 35,988 km with an orbital inclination of 19.29 deg with respect to the equator. The orbital period was 10.5 hours. The pre flight specifications of perigee, apogee and inclination were 180.5 km, 35,975 km and 19.3 deg respectively. Thus, GSLV-F01 very closely matched the pre flight specifications.

GSLV, carrying the EDUSAT, lifted off from Sriharikota at 4:01 pm. About seventeen minutes after lift off, EDUSAT was successfully placed in GTO. About 5 seconds before the countdown reached zero, the four liquid propellant strap-on motors were ignited. After confirming the normal performance of all the four strap-on motors, the mammoth 138 tonne solid propellant first stage core motor was ignited at count zero and GSLV blazed into the sky.

The major phases of the flight included the first stage burn-out at 104 seconds, the strap on burn-out at 150 seconds, ignition of the second stage at 150 seconds, payload fairing separation at an altitude of 115 km and 227 seconds into the flight, second stage burn-out at 288 seconds, ignition of the 12.5 tonne cryogenic stage at 304 seconds and its shut down at 999 seconds after attaining the required velocity of 10.2 km per second.

EDUSAT was separated at 1014 seconds about 5000 km away from Sriharikota. The separated cryogenic stage was subsequently reoriented and passivated.

The 49 metre tall 414 tonne GSLV is a three stage vehicle. The first stage, GS1, comprises a core motor with 138 tonne of solid propellant and four strap-on motors each with 40 tonne of hypergolic liquid propellants (UH25 and N204). The second

GSLV-F01 soars into the sky

stage has 39 tonne of the same hypergolic liquid propellants. The third stage (GS3) is a cryogenic stage and carries 12.5 tonne of Liquid Oxygen (LOX) and Liquid Hydrogen (LH2).

The Aluminum alloy GSLV payload fairing is 3.4 m in diameter and is 7.8 m long.

Jubilance – Mr Madhavan Nair, Chairman, ISRO addresses ISRO community

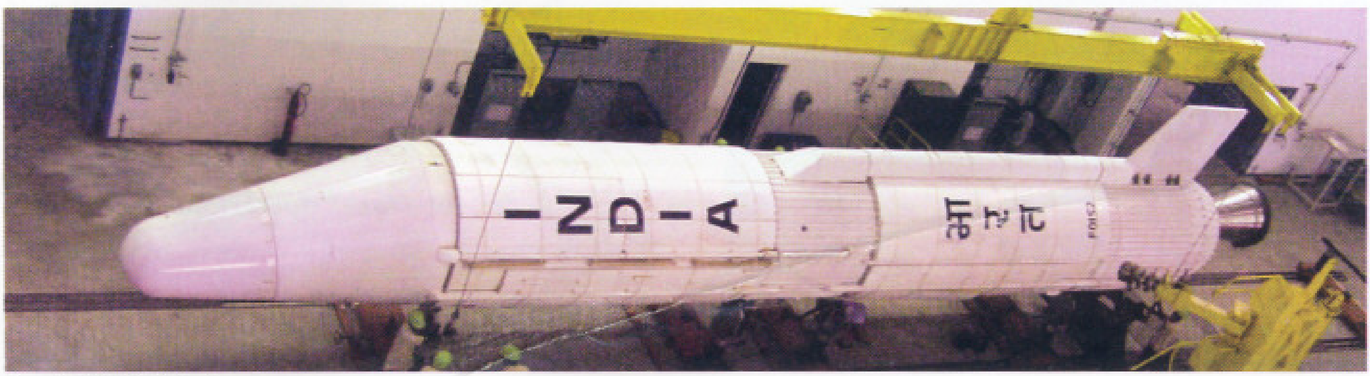
The three-axis attitude (orientation) stabilisation of GSLV is achieved by autonomous control systems provided in each stage. Single plane Engine Gimbal Control (EGC) of the four strap-ons of the first stage are used for pitch, yaw and roll control. The second stage has Engine Gimbal Control (EGC) for pitch and yaw and hot gas Reaction Control System (RCS) for roll control. Two swivellable vernier engines using LH2 and LOX provide pitch, yaw and roll control for the third stage during thrust phase and cold gas system during coast phase. The Inertial Guidance System (IGS) in the Equipment Bay (EB) housed above the third stage guides the vehicle till spacecraft injection. The closed loop guidance scheme resident in the on-board computer ensures the required accuracy in the injection conditions. GSLV employs

Integration of GSLV-F01 first stage segments

S-band telemetry and C-band transponders for the vehicle performance monitoring, tracking, range safety/flight safety and Preliminary Orbit Determination (POD).

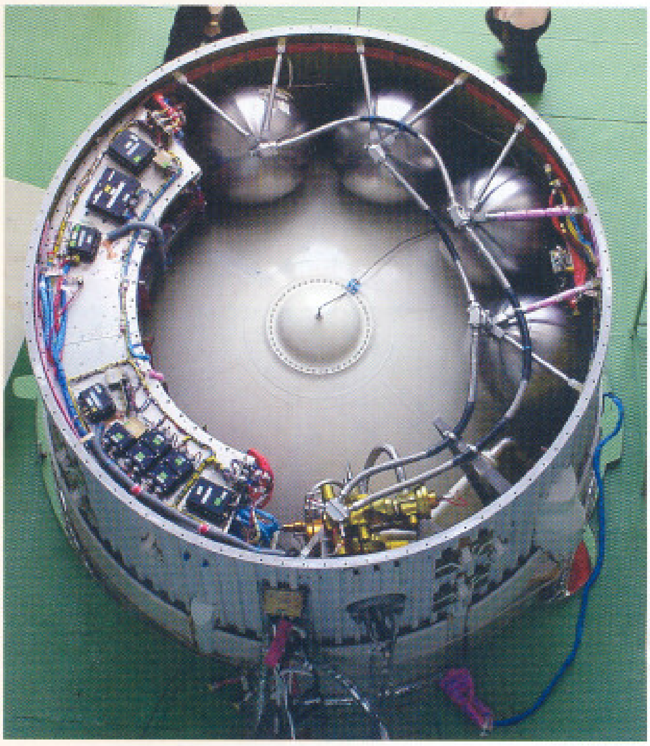
GSLV employs various separation systems such as Flexible Linear Shaped Charge (FLSC) for the first stage, pyro-actuated collet release mechanism for second stage and Merman band bolt cutter separation mechanism for the third stage. Spacecraft separation is by spring thrusters mounted at the separation interface.

GSLV, in its very first developmental test flight on April 18, 2001, succeeded in placing an experimental communication satellite, GSAT-1, into a Geosynchronous Transfer Orbit(GTO). It was declared operational after its second successful developmental test flight on May 8, 2003, when it placed GSAT-2 into its intended GTO. In its first operational flight, GSLV has launched a heavier satellite, the 1950 kg EDUSAT.



One of GSLV-F01 s giant strap-on motors

Hoisting of GSLV-F01 second stage



Top view of GSLV-F01 cryogenic stage

While in the present configuration (GSLV Mk I), GSLV is capable of placing 2000 kg class satellites into GTO, once its Russian supplied upper stage is replaced by the ISRO developed Cryogenic stage, it (GSLV-Mk II) will be able to place 2500 kg class satellites into GTO. Development of GSLV Mk III is now underway. GSLV Mk III will be capable of placing a 4 tonne satellite into GTO. It will have a 110 tonne core liquid propellant stage, two 200 tonne solid propellant strap-on motors and a 25 tonne cryogenic stage.

GSLV was designed and developed by Vikram Sarabhai Space Centre, Thiruvananthapuram. The inertial systems for the vehicle were developed by the ISRO Inertial Systems Unit (IISU) at Thiruvananthapuram. The Liquid Propulsion Systems Centre (LPSC) also at Thiruvananthapuram developed the Liquid propulsion stages for the Strap-ons and the second stage of GSLV as well as the reaction control systems. While the Russian supplied cryogenic stage is used for third stage propulsion, the guidance and control systems of the stage has been implemented by ISRO. The ISRO Telemetry, Tracking and Command Network (ISTRAC) provided Telemetry, Tracking and Command support.

Satish Dhawan Space Centre (SDSC) SHAR, located on the east coast of India is the launch station for all satellite launch vehicles of India. Sriharikota was selected as the launch site to take advantage of the earth's rotation and other factors affecting the flight of a launch vehicle. The state of the art Second Launch Pad (SLP) has been established at SDSC and it is awaiting its commissioning. SLP will help to increase the frequency of launches from SDSC and the new facility is designed to reduce the occupancy time for the launch vehicle integration and launch.

The successful first operational flight of GSLV, coming after the success of both the developmental test flights, has further demonstrated its reliability and its capability to place 2000 kg class of satellites into GTO with high precision.

Launches from India

Till now, 19 satellite launches have been conducted from the Indian soil of which 15 have been successful. The first successful launch from India took place on July 18, 1980 when the four stage Satellite Lanch Vehicle-3 (SLV-3) placed the 35 kg Rohini RS-1 satellite into a Low Earth Orbit (LEO). Later, SLV-3 successfully placed two more Rohini Satellites in 1981 and 1983.

The first successful launch of the second generation Augmented Satellite Launch Vehicle (ASLV) occurred on May 20, 1992 when that four stage rocket aided by two strap-on motors successfully placed the 106 kg SROSS-C satellite in a LEO. The subsequent flight of ASLV orbited the 113 kg SROSS-C2.

Between 1993-2003, eight launches of India's giant Polar Satellite Launch Vehicle (PSLV) have been conducted and except for the first developmental flight, the subsequent launches were consecutive successes. During these flights, the 295 tonne PSLV which is 44 metre tall has successfully put six Indian Remote Sensing (IRS) satellites into Polar Sun Synchronous Orbits (SSOs) and one weather satellite (KALPANA-1) into Geosynchronous Transfer Orbit(GTO). Besides, four satellites from abroad have been put into orbit by that work-horse launch vehicle of ISRO as piggyback payloads. The four stage PSLV uses Solid and liquid stages alternately and uses six solid strap-on motors.

GSLV, the latest launch vehicle of ISRO, has three stages which are solid, liquid and cryogenic respectively. It has four liquid strap-ons to augment its thrust during lift-off. The first three launches of GSLV conducted in 2001, 2003 and 2004 have been successful in putting their payloads to GTOs.

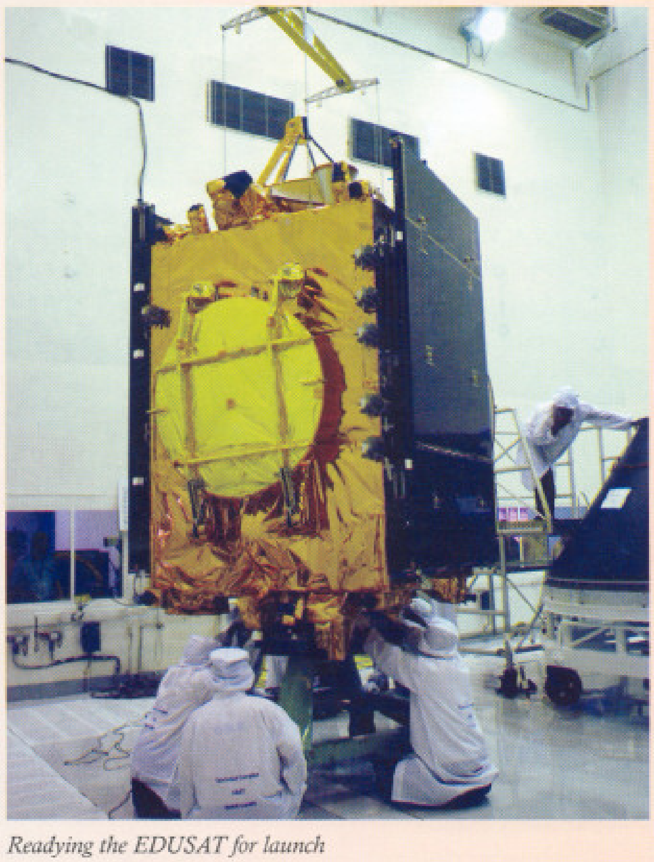
EDUSAT

EDUSAT is India's first exclusive satellite for serving the educational sector. It is specially configured for audio-visual medium, employing digital interactive classroom and multimedia multicentric system. The satellite has multiple regional beams covering different parts of India — five Ku-band transponders with spot beams covering northern, north-eastern, eastern, southern and western regions of the country, a Ku-band transponder with its footprint covering the Indian mainland region and six C-band transponders with their footprints covering the entire country.

EDUSAT was built around a standardised spacecraft bus called I-2K. It has certain new technological elements – a multiple spot beam antenna with 1.2 m reflector to direct precisely the Ku-band spot beams towards their intended region of India, a dual core bent heat pipe for thermal control, high efficiency multi-junction solar cells and an improved thruster configuration for optimised propellant use for orbit and orientation maintenance.

The satellite uses radiatively cooled Ku-band Travelling Wave Tube Amplifiers (TWTAs) and dielectrically loaded C-band DEMULTIPLEXER for its communication payloads. The solar arrays of EDUSAT generate about 2,000 Watt of electrical power.

EDUSAT was developed by ISRO Satellite Centre, Bangalore. The payloads were developed by Space Applications Centre, Ahmedabad. Master Control Facility (MCF) at Hassan in Karnataka is responsible for all post launch operations of the satellite. EDUSAT will join the INSAT system that already



Readying the EDUSAT for launch

has more than 130 transponders in C-band, Extended C-band and Ku-band providing a variety of telecommunication and television broadcasting services.

Soon after its injection into GTO, the two solar arrays of EDUSAT were automatically deployed. The deployment of the solar arrays as well as the general health of the satellite were monitored by the ground station in the Indonesian island of Biak which forms part of ISTRAC. Later, MCF took control of EDUSAT for all its post launch operations. Ground stations at Lake Cowichan (Canada), Fucino (Italy) and Beijing (China) supported MCF in monitoring the health of the satellite and its orbit raising operations.

EDUSAT was placed in near Geosynchronous Orbit (GSO) by firing its Liquid Apogee Motor (LAM) in steps. After the completion of these orbit raising operations on September 24, 2004, the satellite started drifting towards its orbital slot of 74 deg E. In all, LAM was fired for a total duration of 94 minutes and it added a total velocity of 1.66 km per second at the apogee point of the orbit to take EDUSAT from GTO to near GSO.

EDUSAT had 1,128 kg of propellants at the time of its injection into GTO by GSLV. After orbit raising operations, it now has 300 kg of propellants remaining which is sufficient to maintain the satellite in its orbit and control its orientation during its design life of 7 years.

Payloads of EDUSAT

Five lower Ku-band transponders for spot beam coverage with 55 dBW Edge of Coverage-Effective Isotropic Radiated Power (EOC-EIRP)

One lower Ku-band transponder for national coverage with 50 dBW EOC-EIRP

Six upper extended C-band transponders for national coverage with 37 dBW EOC-EIRP

One Ku-band beacon to help ground users for accurate antenna pointing and uplink power control

The East side antenna, intended for transmitting and receiving Ku-band signals with multiple Spot beam coverage, was deployed on September 24, 2004 and the three-axes stabilisation of the satellite and its West side antenna deployment were carried out the following day. West side antenna is intended for transmitting and receiving Extended C-band signals. Besides the two deployable antennas, the satellite has one body-mounted antenna meant for transmitting and receiving Ku-band signals with National coverage beam.

EDUSAT has since been positioned in its allocated orbital slot of 74 degree east longitude where it is co-located with KALPANA-1 and INSAT-3C. The communication transponders of EDUSAT are now being tested before commissioning the satellite for regular use.

प्रधान मंत्री

Prime Minister

MESSAGE

I was very pleased to be informed of the first operational flight of the GSLV which marks an important landmark in the history of our launch vehicle programme.

I am also happy to learn that the GSLV has successfully put into orbit our first satellite dedicated to education, EDUSAT, that would provide connectivity to educational institutions across the country. This is indeed a proud moment for our indigenous space programme.

I convey my congratulations and good wishes to all the Scientists and Engineers of the Department of Space and ISRO, who have worked tirelessly to ensure our country is among the select group of countries with advanced space capabilities.

Manmohan Singh

(Manmohan Singh)

Camp : London
September 20, 2004

Vikram Sarabhai Bust Unveiled at Antariksh Bhavan

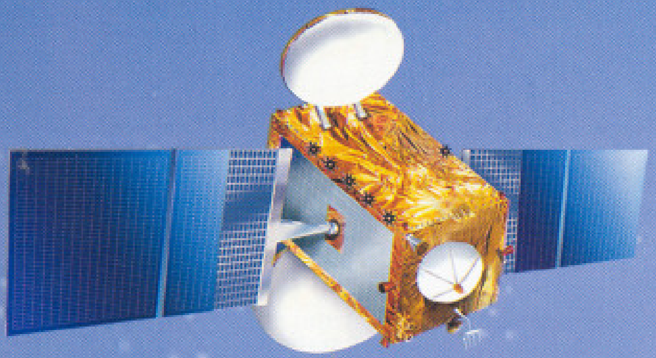
A Bust of Dr Vikram Sarabhai, the Father of Indian Space Programme, was unveiled in front of Antariksh Bhavan, the Headquarters of Indian Space Research Organisation and the Department of Space, at a brief function organised on August 12, 2004 on the occasion of the 85th birthday of Dr Vikram Sarabhai. Prof U R Rao, former Chairman of ISRO, who had carried out research in High Energy Astronomy under Dr Sarabhai, unveiled the Bust. Mr G Madhavan Nair, Chairman, ISRO and several dignitaries were present during the unveiling function.

Dr Vikram Sarabhai had said

"There are some who question the relevance of space activities in a developing nation. To us, there is no ambiguity of purpose... We are convinced that if we are to play a meaningful role nationally, and in the comity of nations, we must be second to none in the application of advanced technologies to the real problems of man and society".

Even today, the Indian space programme is driven by the vision of Dr Vikram Sarabhai. The unveiling of the Bust of Dr Sarabhai at Antariksh Bhavan, from where the Indian space programme is directed, is a tribute to this great visionary. The bust was carved in bronze by the famous sculptor Mr Kanayi Kunhiraman.

Paying respects to the visionary – Mr G Madhavan Nair and Prof U R Rao standing in front of the bust



EDUSAT

— *Bridging the Divide*

The pivotal role of education as an instrument of social change by altering the human perspective and transforming the traditional mindset of society is well recognised. The universalisation of education has become the top priority, especially for the developing countries. But the extension of quality education to remote and rural regions becomes a Herculean task for a large country like India with multi-lingual and multi-cultural population separated by vast geographical distances, and in many instances, inaccessible terrain. Since independence, India has seen substantial increase in the number of educational institutions at primary, secondary and higher levels as well as the student enrolment. But the lack of adequate rural educational infrastructure and non-availability of good teachers in sufficient numbers adversely affect the efforts made in education.

Satellites can establish the connectivity between urban educational institutions with adequate infrastructure imparting quality education and the large number of rural and semi-urban educational institutions that lack the necessary infrastructure. Besides supporting formal education, a satellite system can facilitate the dissemination of knowledge to the rural and remote population about important aspects like health, hygiene and personality development and allow professionals to update their knowledge base as well. Thus, in spite of limited trained and skilled teachers, the aspirations of the growing student population at all levels can be met through the concept of tele-education.

The concept of beaming educational programmes through satellites was effectively demonstrated for the first time in India in 1975-76 through the Satellite Instructional Television Experiment (SITE) conducted using the American Application Technology Satellite (ATS-6). During this unique experiment, which is hailed as the largest sociological experiment conducted anywhere in the world, programmes pertaining to health, hygiene and family planning were telecast directly to about 2400 Indian villages spread over six states. Later, with the commissioning of INSAT system in 1983, a variety of educational programmes are being telecast. In the 90s, Jhabua Developmental Communications Project (JDCP) and Training and Developmental Communication Channel (TDCC) further demonstrated the efficacy of tele-education.

With the success of INSAT based educational services, a need was felt to launch a satellite dedicated for educational service and ISRO conceived the EDUSAT Project in October 2002 and it was launched within two years by GSLV.

EDUSAT is primarily meant for providing connectivity to school, college and higher levels of education and also to support non-formal education including developmental communication. The scope of the EDUSAT programme is planned to be realised in three phases. In the first phase of pilot projects, a Ku-band transponder on board INSAT-3B, which is already in orbit, is being used. In Karnataka, Visveswaraiah Technological University (VTU) is the main beneficiary of this pilot project. Under this pilot project, all engineering colleges of VTU are networked with one hundred nodes. Besides Karnataka, the Y B Chavan State Open University, Nasik in Maharashtra and the Rajiv Gandhi Technical University in Madhya Pradesh are covered under the pilot project.

In the second phase, EDUSAT spacecraft once commissioned in orbit, will be used in a semi-operational mode with at least one uplink in each of the five spot beams. About 100-200 classrooms will be connected in each beam. In addition to Karnataka, Maharashtra and Madhya Pradesh included under the first phase, coverage will be extended to two more states and one national institution. In the third phase, EDUSAT network is expected to become fully operational. ISRO will provide technical and managerial support in the replication of EDUSAT ground systems to manufacturers and service providers. End users are expected to provide funds for this. In this phase, ground infrastructure to meet the country's educational needs will be built and during this period, EDUSAT will be able to support about 25 to 30 uplinks and about 5000 remote terminals per uplink.

While ISRO is providing the space segment for EDUSAT System and demonstrating the efficacy of the satellite system for interactive distance education, content generation is the responsibility of the user agencies. The quantity and quality of the content would ultimately decide the success of EDUSAT System. This involves an enormous effort by the user agencies. To help in this, ISRO, in cooperation with the user agencies, has already organised five conferences at the regional level and one at the national level to create awareness about EDUSAT and its capabilities.

EDUSAT Conference at Bangalore

A Conference on EDUSAT was organised at Bangalore on July 23, 2004 to increase the awareness on EDUSAT capabilities among the institutions of learning and elicit the views of experts in implementing the EDUSAT system.

The Conference was organised by ISRO, jointly with the Association of Indian Universities (AIU). It was inaugurated by His Excellency Dr A P J Abdul Kalam, President of India. Mr N Dharam Singh, Hon'ble Chief Minister of Karnataka and His Excellency Mr T N Chaturvedi, Governor of Karnataka were the Guests of Honour.

During the inaugural function, Dr Abdul Kalam interacted, via INSAT, with students at Nasik, Ahmedabad, Bangalore, Belgaum and Mangalore and also released a compendium "EDUSAT – Indian Satellite in Education".

The participants in the Bangalore conference included Chairman of University Grants Commission, Education Secretary, Directors of Indian Institutes of Technology, Agricultural Universities, Medical Universities and about 250 Vice Chancellors, besides important educationists and administrators.

His Excellency Dr A P J Abdul Kalam formally inaugurating the EDUSAT conference by lighting the lamp. Other dignitaries from l to r are – His Excellency Mr T N Chathurvedi, Governor of Karnataka, Dr K Mohan Das, President, AIU, Mr N Dharam Singh, Chief Minister of Karnataka and Mr G Madhavan Nair, Chairman, ISRO

Airdrop Test for Space-capsule Recovery Experiment Successfully Conducted

The airdrop test of the instrumented Space-capsule Recovery Experiment (SRE) was successfully conducted using a Helicopter on August 19, 2004 from Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota, about 80 km north of Chennai. This was the third and the last of the three airdrop tests. The earlier two tests had been conducted from SDSC in June last. These three tests were crucial for the qualification of SRE for its flight.

Space-capsule Recovery Experiment (SRE) is intended for demonstrating the capability to recover an orbiting space capsule. The experiment envisages the development of a 500 kg recoverable capsule and the associated technologies. SRE will be launched on board ISRO's Polar Satellite Launch Vehicle (PSLV) during the second half of 2005.

The SRE comprises the aero-thermo structure (ATS), spacecraft platform, deceleration and floatation system and micro-gravity payloads. It has a sphere-cone-flare configuration with a spherical nose of about 0.5 m radius, base diameter of 2 m and a height of 1.6 m. The capsule is made of mild steel. The parachute, pyro devices, avionics packages of triggering unit and sequencer, telemetry and tracking system and the sensors for the measurement of system performance parameters are located inside SRE capsule.

After its launch by PSLV, SRE will remain in orbit for a few days during which it will be used to perform experiments in micro-gravity environment. The capsule will then be de-orbited and it re-enters the earth's atmosphere. On re-entry, after initial aerodynamic braking, a parachute system will reduce the touch down velocity. The SRE will splashdown in the Bay of Bengal, about 140 km east of Sriharikota coast. A floatation system will keep the SRE afloat and enables its recovery. The SRE is intended to test a host of technologies including reusable thermal protection system, navigation, guidance and control, hypersonic aero-thermodynamics, management of communication blackout, deceleration and floatation system and recovery operations.

Prior to the actual mission and recovery operations, a series of qualification trials at land and sea are planned to qualify the deceleration systems of the module and validate the recovery operations. In the test conducted on August 19, 2004, during the drop phase, a series of parachutes — stabiliser chute, pilot chute, drougue chute and main chute — were deployed at pre-specified time intervals and altitudes. The capsule was successfully recovered by recovery operations team.

Helicopter carrying the capsule for airdrop test

The joyous recovery team with the capsule

Vikram Sarabhai Award for Prof Willmore

Prof Albert Peter Willmore is the recipient of the ISRO-COSPAR Vikram Sarabhai Award for the year 2004. The award was presented to Prof Willmore by Mr G Madhavan Nair, Chairman, ISRO on July 19, 2004 during the COSPAR Opening and Awards Ceremony at Paris. Prof Willmore received the award for his outstanding scientific contributions in the field of X-Ray Astronomy as well as his contribution for competence building related to space science research in developing countries.

Prof Willmore started his research career in solar and ionospheric physics in 1957 by joining the group working on the newly established Skylark Program under Sir Harrie Massey. One of his major contributions in the area of ionospheric research, working jointly with Robert Boyd, has been the design of a number of Langmuir Probe experiments for *in-situ* measurements using rockets and spacecraft. His involvement in the first US-UK collaborative mission, *Aerial-I*, led him to propose that photoelectrons from the ionosphere were an important heat source in the magnetosphere which led eventually to the modern understanding of ionosphere–magnetosphere coupling. During this period, he also contributed to the generation of the first near global maps of electron temperature in the ionosphere.

Around 1970, X-ray astronomy attracted Prof Willmore's interest when he started to explore a range of instruments, which give imaging capabilities without requiring reflection or refraction. His efforts culminated in realising Rotation Modulation Collimator instrument on *Ariel V* in 1975 and Coded

Mr G Madhavan Nair, Chairman, ISRO, honouring Prof Willmore

Mask X-ray Telescope for *Spacelab-2* in 1985. These instruments produced new results on X-ray structure and presence of ultra-hard sources in the Galactic Centre region.

Since 1999, Prof Willmore has been devoting his time and effort in developing the COSPAR Capacity-Building Programme by organising practical workshops using via Internet space archives in developed countries and creating funding streams to supplement the resources of COSPAR allocations. The four workshops organised under his overall direction and supervision were held in Brazil (2001), India (2003), China (2004), and South Africa (2004).

The Vikram Sarabhai Award, instituted in 1990, is conferred jointly by COSPAR and ISRO in honour and memory of Dr Vikram Sarabhai, who pioneered the space research activities in India. The biennial award, consisting of a medal and a citation, is given to recognize outstanding contributions made by individual scientists to space research in developing countries. The earlier recipients of the award are: Academician Kotelnikov of Russia (1990), Prof C Y Tu of China (1992), Prof Jaques Blamont of France (1994), Prof U R Rao of India (1996), Dr James Baker of USA (1998), Dr Zhen Xing Liu of China (2000) and Prof Rong-Lan Xu of China (2002).

Prof U R Rao Among Top Ten International Space Personalities – *Space News*

Space News, the popular space weekly published from the US, in its August 23, 2004 issue, ranked Prof U R Rao among the top ten international personalities who have made a difference in civil, commercial and military space in the world since 1989. Prof Rao, former Chairman of ISRO and presently Chairman of the Council of Physical Research Laboratory, Ahmedabad, is widely regarded as the man who guided India to the status of a major space power, the weekly said. During his tenure, India developed its own communication satellites, weather satellites, high resolution imaging satellites and the Polar Satellite Launch Vehicle.

SPACENEWS

100

Who Made a Difference

15th Anniversary Special Edition

As *Space News* prepares to celebrate its 15th anniversary, we are publishing this special edition to take a look at some of the people who have made a difference in civil, commercial and military space since 1989. Space is an industry filled with thousands of highly accomplished people and this list, compiled by the *Space News* editorial staff with contributions from Space.com and readers, is merely a sampling of individuals who made a significant contribution, not a hall of fame list. Strong arguments can be made for any number of people left off the list. We hope you have as much fun debating it as we did.

The Top 10, *page 11*

Joan Johnson Freese, an analyst of Asian space programmes and chair of the department of national security decision making at the Naval War College in Newport, USA said in the weekly that one of the testaments to Prof Rao's skill was that he built such a robust space programme in a democratic country, which is much more difficult than in countries with autocratic rulers. Throughout his career, Prof Rao emphasised the importance of keeping the space programme focused on technologies that would aid the country's development such as imaging and communication satellites.

Today, with a maturing space industry, India is planning a science satellite and even discussing the possibility of human space flight in a few decades, the Space News said.

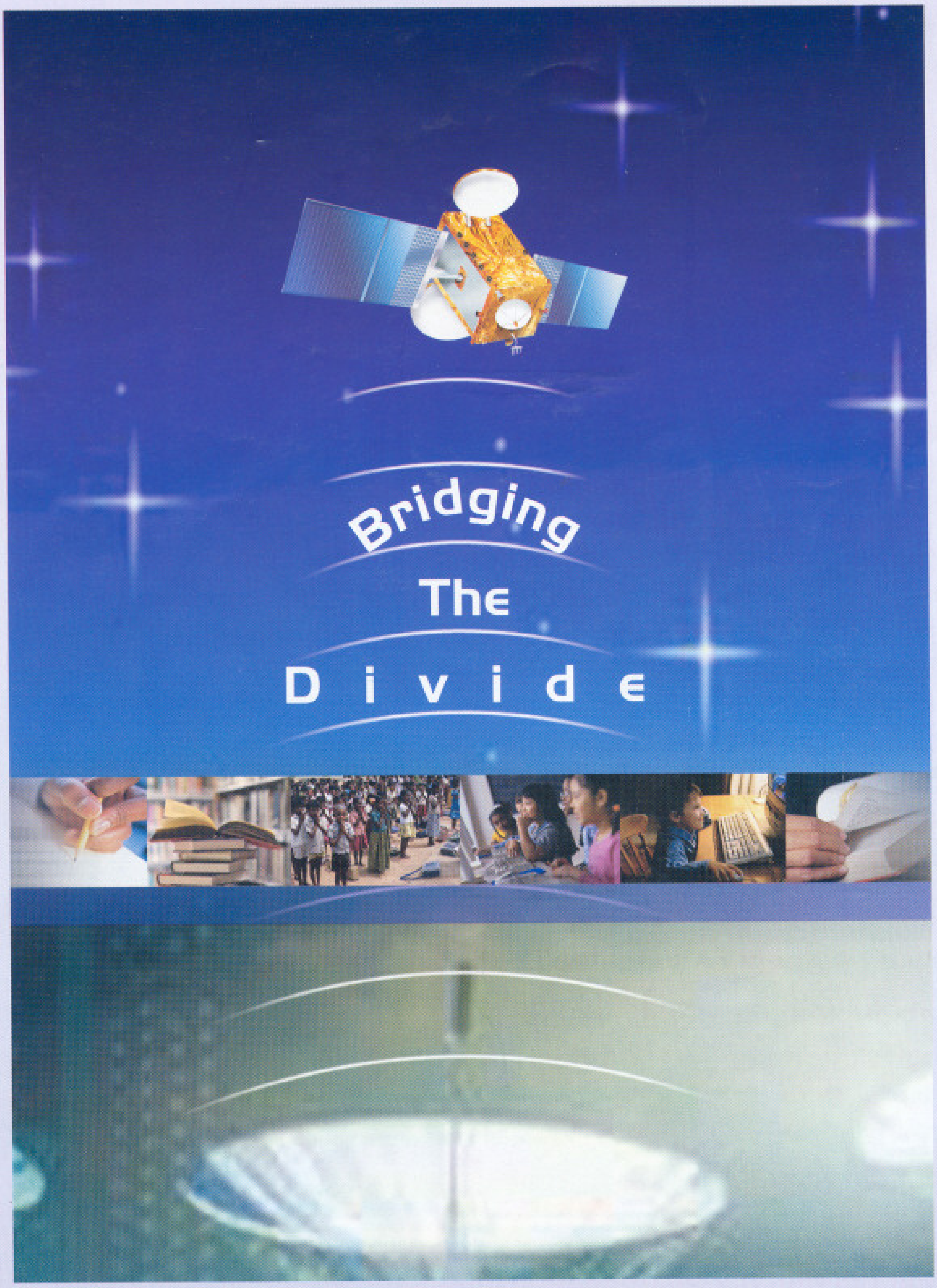
On his being named as one of the world space leaders, Prof Rao said that the credit indeed goes to the larger space community in India who have toiled hard to make the Indian space programme an outstanding success.

His Excellencey Dr A P J Abdul Kalam, President of India, presented the Awards instituted by the Astronautical Society of India (ASI) at a function organised at the ISRO Satellite Centre (ISAC) on July 23, 2004. During the function, Mr G Madhavan Nair, Chairman, ISRO, presented him a replica of the rocket used by Tipu Sultan against the British forces in the Anglo-Mysore Wars of the late 18th Century.

Proudly displaying a relic of the past

Tippu Sultan ruled the kingdom of Mysore in southern India between 1782 and 1799. The rockets used by him in the third and fourth Anglo-Mysore wars were attached to long bamboo sticks or steel blades. They were built using plate Iron and weighed about 2 kg of which the charge alone weighed 1 kg. The rockets attached to sword blades were about 25 cm long with a diameter of 6 cm. The sword blade was of 100 cm length.

The President also inaugurated the portal on the National Natural Resources Management System (NNRMS) at ISAC. This portal provides details on NNRMS and its framework, major projects and publications. The main attraction of the portal is that it provides access to NNRMS metadata for locating maps and image data sets.



Bridging
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