April-June '97

SPACE india

INDIAN SPACE RESEARCH ORGANISATION

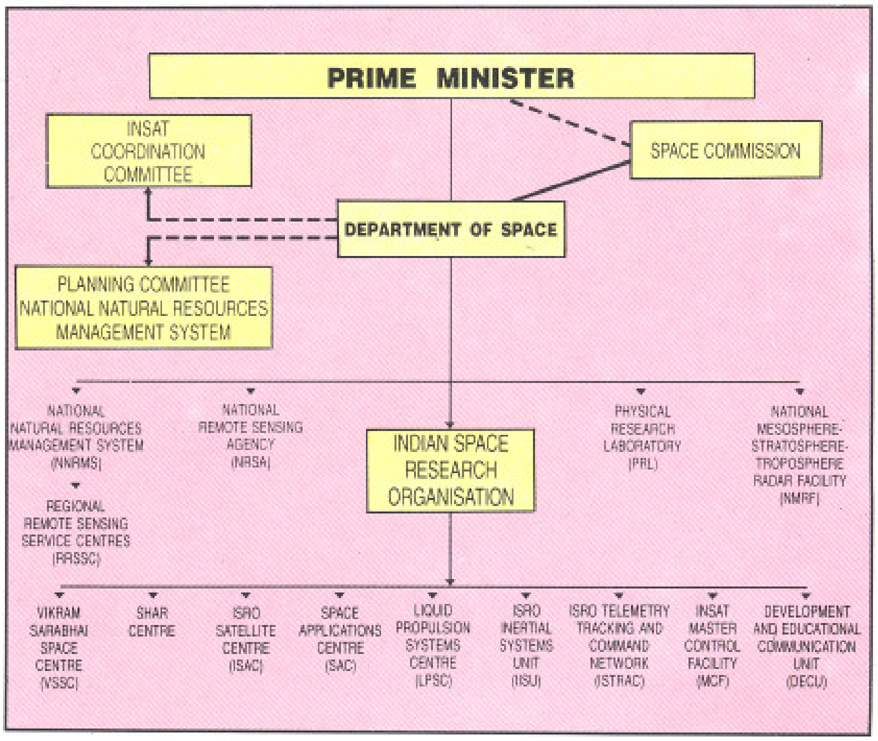
The Indian Space Programme

The setting up of the Thumba Equatorial Rocket Launching Station (TERLS) in 1963 marked the beginning of the Indian Space Programme. The Space Commission and the Department of Space (DOS) were established by the Government of India in 1972 to promote unified development and application of space science and technology for identified national objectives.

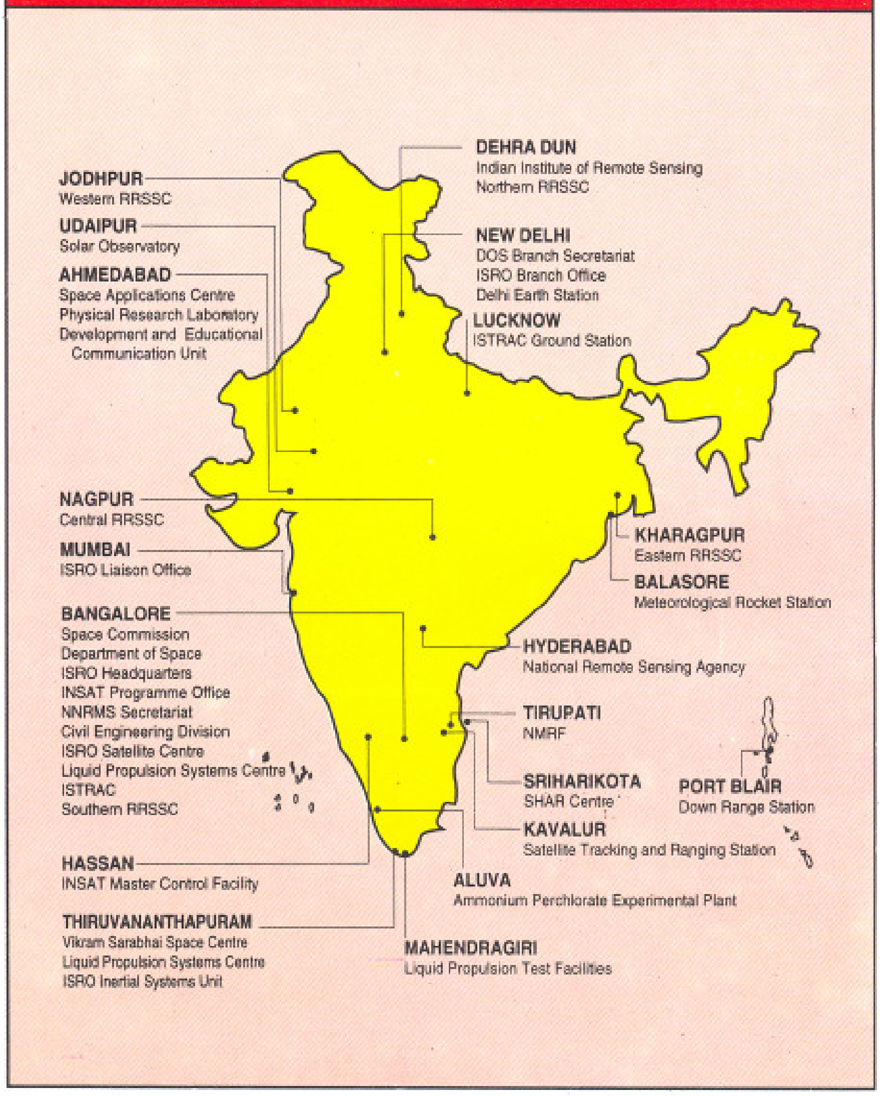
The Indian Space Programme is directed towards the goal of self-reliant use of space technology for national development, its main thrusts being: (a) satellite communications for various applications, (b) satellite remote sensing for resources survey and management, environmental monitoring and meteorological services and (c) development and operationalisation of indigenous satellite and launch vehicles for providing these space services.

The Indian Space Research Organisation (ISRO) is the research and development wing of DOS and is responsible for the execution of the national space programme. ISRO also provides support to universities and other academic institutions in the country for research and development projects relevant to the country's space programme.

Both the DOS and ISRO Headquarters are located at Bangalore. The development activities are carried out at the Centres and Units spread over the country.



Space Centres and Units in India



FRONT COVER:
An artist makes a collage of the achievements of Dept. of Space

EDITOR
S. Krishnamurthy

PRODUCTION ASSISTANCE

B.C. Suryaprakash

April-June '97

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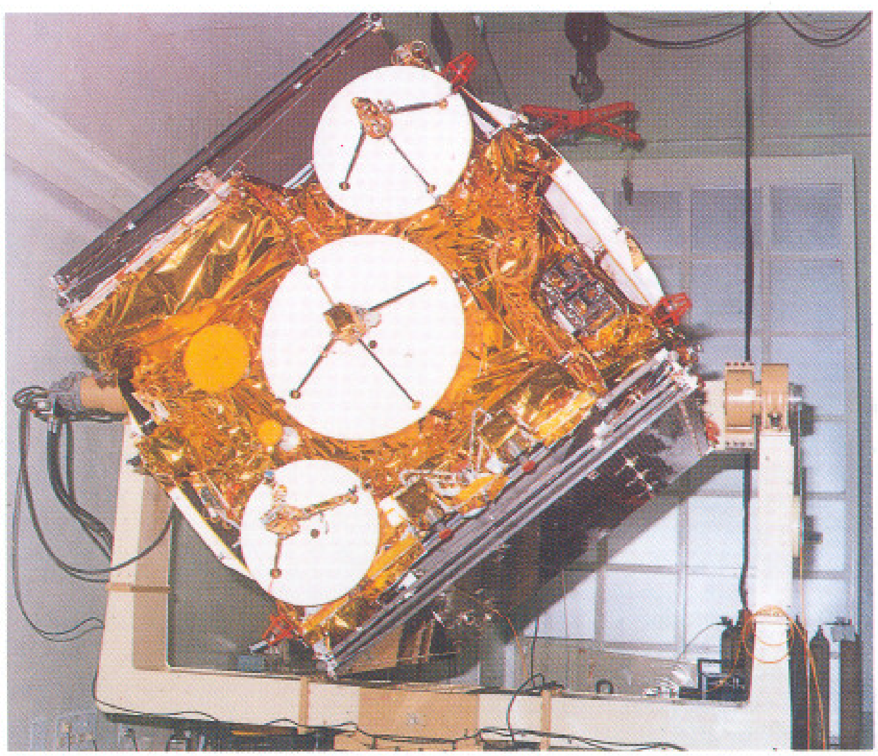
INSAT-2D Launched

Ariane Launcher lifting-off with INSAT-2D on board

INSAT-2D, the fourth in the ISRO-built INSAT-2 series of satellites, was successfully launched on June 4, 1997 by the Ariane vehicle of Arianespace. The 97th flight of Ariane, carrying INSAT-2D and INMARSAT-3 F4 satellites, lifted-off at 04:51 am (Indian Standard Time) from Kourou, French Guyana in South America. The INMARSAT-3 F4 was first injected into orbit 22 minutes after the lift-off, and 5 minutes later, INSAT-2D was injected into a Geosynchronous Transfer Orbit (GTO), with a perigee of 200 km and an apogee of 35,900 km with an orbital period of about 10.5 hour. The satellite was injected in a 3-axis stabilised mode.

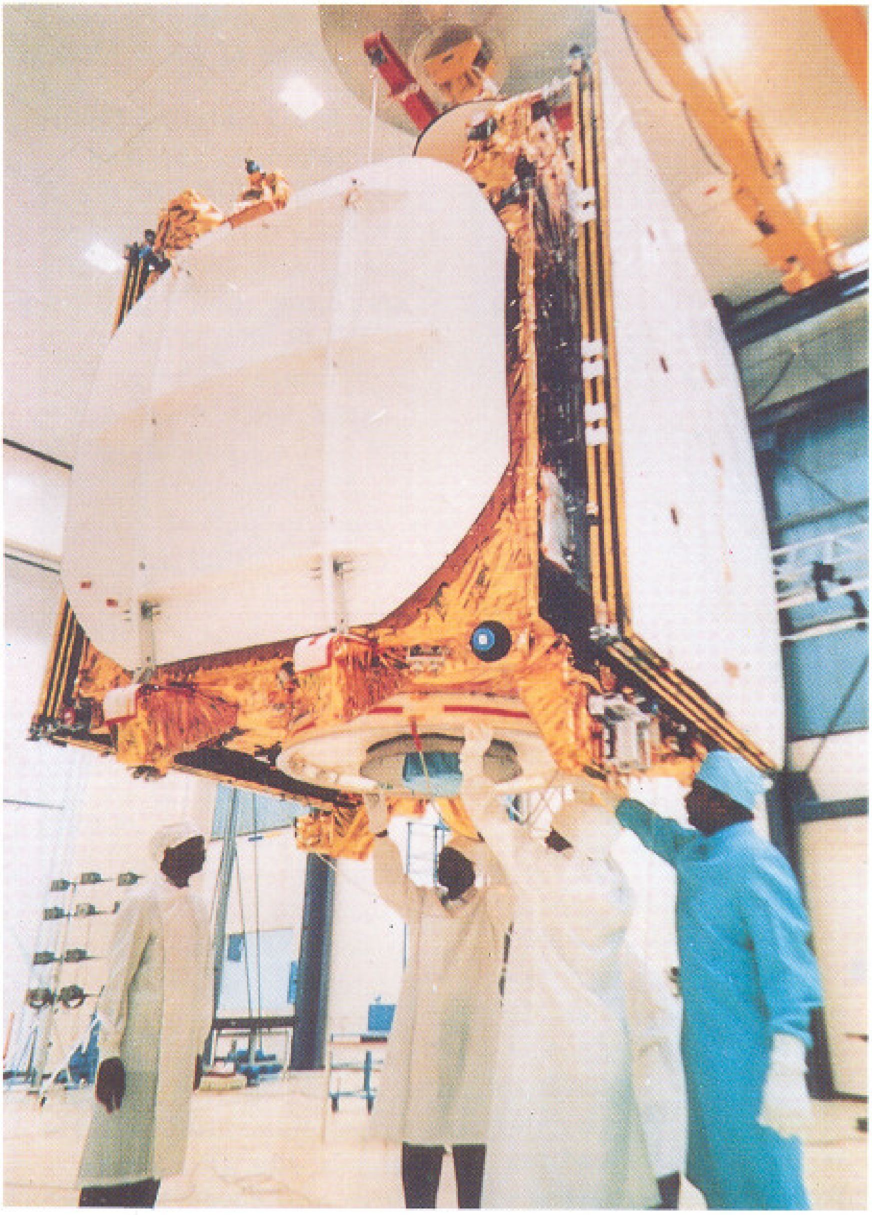


INSAT-2D on assembly jig

The INSAT Master Control Facility (MCF) at Hassan in Karnataka acquired the telemetry signal from INSAT-2D about 2 minutes after its injection into orbit. Immediately thereafter, satellite health checks were carried out and a series of commands issued from MCF so as to orient earth-viewing face of the satellite towards earth. The outermost panel of the stowed solar array on the south side of the satellite was also oriented towards the sun to start generating the electrical power required by the satellite during its transfer orbit phase. During the initial phases of the mission, INSAT-2D was tracked, apart from MCF, Hassan, by INTELSAT Organisation's ground stations at Perth (Australia), Fucino (Italy) and Clarksburg (USA).

Orbit Raising Manoeuvres

The 440 Newton thrust Liquid Apogee Motor (LAM) on board



INSAT-2D under final preparations at Kourou

INSAT-2D was fired for a duration of 67 minute on June 5, 1997 at 7:00 am IST by commanding from MCF, which placed the satellite in its first Intermediate Orbit. This firing raised the perigee of the satellite from 200 km to about 15,100 km. The apogee was 35,800 km and the orbital period increased to about 15.7 hour. The inclination of the orbit was also reduced from 7 degree at the time of injection to 1.5 degree by this firing. The second orbit raising operation was carried out on June 6, 1997 at 2.30 pm IST by firing the LAM for a duration of 26 minutes 42 seconds. This operation put INSAT-2D in its second Intermediate Orbit with an apogee of 35,823 km and perigee of about 35,442 km with an orbital period of about 23.00 hour. The orbital inclination was further reduced to about 0.1°. From then on INSAT-2D remained within the Radio visibility of MCF.

Precise orbit determination was carried out over the next two days before the third orbit raising manoeuvre was performed on June 8, 1997 at 11:27 am (IST) by firing the LAM for 146 seconds which placed the spacecraft in a circular geosynchronous orbit.

Solar Arrays and Antennas Deployment

In a series of operations carried out on June 9, 1997, deployment of two solar arrays and two antennas on board INSAT-2D was completed. The solar array on the south side of the satellite was first carried out at 9:45 am IST followed by deployment of the antenna reflector on the west side at 1:13 pm. The solar panel on the north side was deployed at 3:39 pm and the east side antenna at 4:45 pm.

Colocation and Testing

INSAT-2D, which was at 59.4° east longitude when the deployment operations were carried out, was slowly moving towards its final orbital location of 74° east longitude. It was colocated with INSAT-2A on July 1, 1997. Detailed characterisation of all the transponders on board the satellite was also carried out and the satellite made ready for commissioning into service. This is the second INSAT satellite to be colocated with another to optimally utilise the available orbital slots. INSAT-2B and INSAT-2C are colocated at 93.5° east longitude; INSAT-1D, the last of the first generation satellite is located at 83° east longitude.

INSAT-2D had arrived in

Special container of INSAT-2D being loaded into Air-France Boeing 747 aircraft at Bangalore for its transport to Kourou.

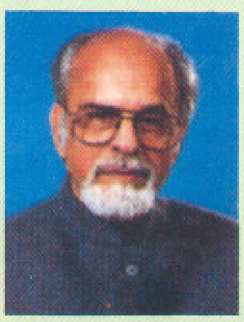
Kourou on April 10, 1997 and had subsequently underwent integrated tests, solar array and antenna deployment and pyro checks, alignment checks and final thermal preparations. After propellant loading, it was mated with the Ariane vehicle adopter and the co-passenger, INMARSAT-3 F4, on May 27, 1997.

INSAT-2D is identical to INSAT-2C except for some improvements in the payload capability. The Fixed Satellite Service payload of INSAT-2D comprises twelve C-band transponders — two 50 W transponders and ten 10 W transponders. The Broadcast Satellite Service payload employs a 70 W S-band TWTA. The satellite has two solar arrays, one on the south and the other on north side, each with an area of 11.5 sq m to generate a total power of about 1,650 W.

The ISRO Satellite Centre, Bangalore, as the lead centre for the INSAT-2 project, was in charge of the design, development and integration and testing of INSAT-2D. The communication transponders were developed by the Space Applications Centre, Ahmedabad. The Liquid Propulsion Systems Centre of ISRO developed the Liquid Apogee Motor and the reaction control systems.

The Vikram Sarabhai Space Centre supplied the various composite element subsystems such as CFRP antenna, solar panel substrates and the pyro system. The ISRO Inertial Systems Unit, Thiruvananthapuram, was responsible for the design and development of the gyros, momentum/reaction wheels, the solar array drive and power transfer mechanisms. Several industries and institutions, both in public and private sector, also contributed for the realisation of the satellite.

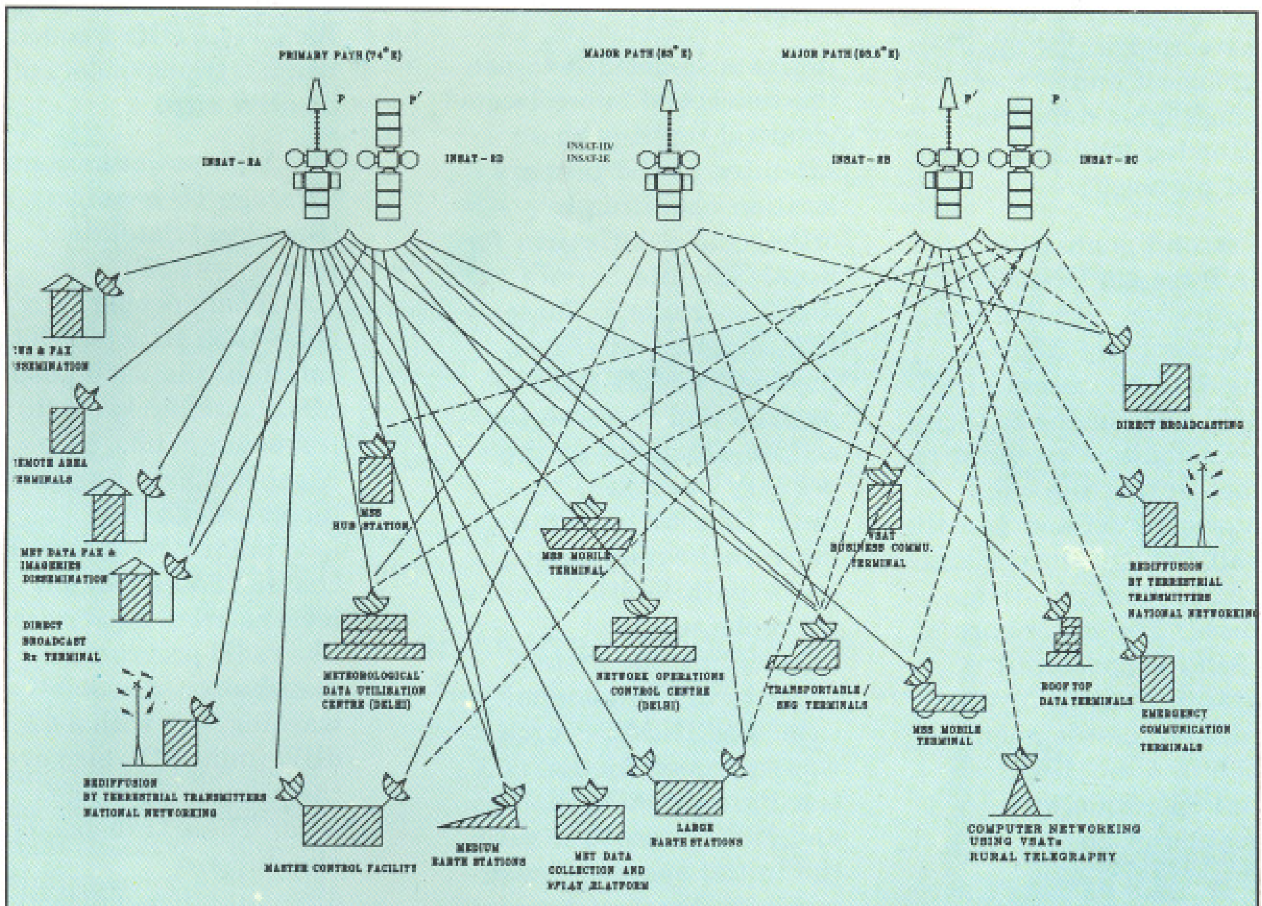
Messages



Prime Minister Mr I K Gujral, in a message to Dr K Kasturirangan, Secretary, DOS/Chairman, ISRO, said that India crossed another milestone with the launch of INSAT-2D. The ISRO-built INSAT-2D will open more doors in communication for the common man. This will provide vital links in TV broadcasting, mobile communication and telecommunication. He further said that it is the dedication and team work of all the persons involved that has enabled us to reach this significant milestone. "I join the nation in congratulating you and your excellent team" the Prime Minister said.

In his message, Prof Y K Alagh, Minister of State (S&T & PP&I) congratulated Department of Space on the successful launch of INSAT-2D.

Indian National Satellite System



INSAT SYSTEM CONCEPT

The Indian National Satellite System (INSAT) is one of the largest domestic satellite systems in Asia today. A joint venture of the Department of Space (DOS), the Department of Telecommunications (DOT), the India Meteorological Department (IMD), All India Radio (AIR) and Doordarshan (DD), INSAT provides long distance telecommunications, meteorological earth observation and data relay, nationwide direct satellite TV broadcasting to augmented TV receivers, nationwide radio networking, TV programme distribution and rebroadcasting to terrestrial transmitters, etc.
Conceived in 1975, INSAT was commissioned with INSAT-1B in 1983. Presently, there are five satellites in the INSAT system. INSAT-1D, the last of the first generation which is still in service, is located at 83°. INSAT-2A and and INSAT-2D are colocated at 74° E longitude while INSAT-2B and INSAT-2C are colocated at 93.5° E longitude.

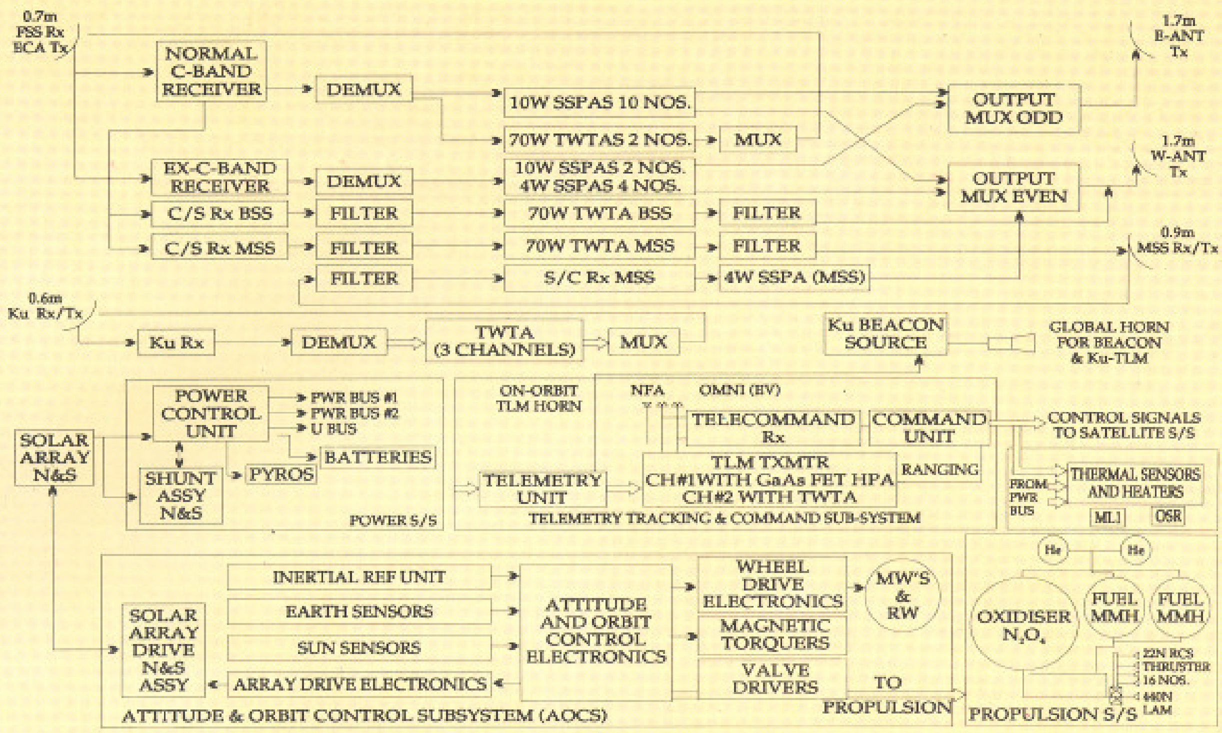
The first INSAT-1 satellite, INSAT-1A, was launched by a Delta 3910 launch vehicle in April 1982. But the satellite was deactivated in September, same year, due to propellant depletion. The second satellite, INSAT-1B, was launched by the US Space Shuttle in August 1983 and it provided uninterrupted service during its designed life of 7 years. The third satellite, INSAT-1C, was launched on July 22, 1988 on an Ariane rocket but, following a power anomaly, the spacecraft had to be abandoned in November 1989. INSAT-1D, launched by a US Delta 4925 vehicle in June 1990, is still in service. The INSAT-1 series of satellites carried 12 C-band telecommunications transponders, two high-power S-band TV broadcast transponders, a Very High Resolution Radiometer (VHRR) for meteorological earth imaging and a data relay transponder for relay of meteorological, hydrological and oceanographic data from unattended land and ocean based platforms.

The second generation INSAT system (INSAT-2) configuration studies had started as early as 1979. Along with the users of the INSAT system, the capacity and capabilities required to be met during the mid 1990s, were defined and the overall system concept and spacecraft configurations finalised. The experience of the APPLE spacecraft programme which involved the design, development, launch in June 1981, orbital operation and utilisation of an experimental 3-axis stabilised communications satellite, and other satellites such as the Indian Remote Sensing Satellite (IRS), the first of which was successfully launched in March 1988, gave ISRO the required confidence to design, develop and fabricate the INSAT-2 series of satellites. The INSAT system for the mid 1990s, had to cater to much larger user demands. The total telecommunications capacity was estimated to be about three times that during the INSAT-1 time-frame. Meteorology services required sensors with better resolution. Broadcast services also showed large growth. The INSAT-2 satellites were, therefore, designed to be about 50 percent heavier. But it was decided that the multi-purpose satellite concept, similar to INSAT-1, be continued.

It was also decided to use the concept of two colocated identical multi-purpose satellites at the primary location operating in orthogonal polarisation for Fixed Satellite Service (FSS) operations. These, two colocated satellites, together, double the FSS payload and increase the eclipse capability at the primary location. They could then be backed by individual satellites at the major path locations, either for replacement or augmenting the system capacity in the nominal case. The INSAT-2 project was approved by the Government in April 1985 and ISRO proceeded with the initial space-segment involving the first two satellites as test satellites.

INSAT-2 system concept envisages five satellites, INSAT-2A through INSAT-2E, of which four satellites have been already launched. INSAT-2A and INSAT-2B, launched on board Ariane in July 1992 and July 1993 respectively have the following payloads:

* Twelve national coverage telecommunications (Fixed Satellite Service—FSS) transponders of 36 MHz bandwidth each operating in 5930-6425 MHz (earth to satellite) and 3705-4200 MHz (satellite to earth) frequency bands, with 32 dBW (min) End of Life (EOL) effective isotropic radiated power (eirp) over the primary coverage area.
* Six extended C-band transponders operating in the 4.5-4.8 GHz frequency band (2 transponders of 34 dBW eirp).
* Two high-power national coverage TV broadcast (Broadcast Satellite Service — BSS) transponders operating in 5850-5930 MHz (earth to satellite) and 2550-2630 MHz (satellite to earth) frequency bands, each capable of handling one direct broadcast (community reception) TV channel and seven low level carriers for services like radio programme distribution, disaster warning, etc, with a 42 dBW (min) EOL eirp over the primary coverage area. These transponders also support dissemination of disaster warning and standard time and frequency signals.
* A Very High Resolution Radiometer (VHRR) for meteorological earth imaging in visible (0.55-0.75 micrometre) and infrared (10.5-12.5 micrometre) bands, with resolutions of 2 km and 8 km respectively, having half hourly full earth coverage and sector scan capability.
* A data relay transponder having global receive coverage with a 402.75 MHz earth to satellite link for relay of meteorological, hydrological and oceanographic data from



INSAT-2D BLOCK DIAGRAM

unattended land and ocean-based automatic data collection-cum-transmission platforms.

* A 406 MHz/C-band search and rescue distress alert transponder.

INSAT-2C was launched by Ariane launch vehicle on December 7, 1995 from French Guyana. It is colocated with INSAT-2B at 93.5 degree east longitude. INSAT-2D, similar to INSAT-2C, was launched on June 4, 1997 and it is colocated with INSAT-2A at 74^0 east longitude. The payloads on INSAT-2C and INSAT-2D are as follows:

Fixed Satellite Service (FSS) Transponders:

* Twelve Normal C-band (5.9-6.4 GHz in the uplink and 3.7-4.2 GHz in the downlink) transponders, six extended C-band (6.75-7.00 GHz in the uplink and 4.50-4.75 GHz in the downlink) transponders, three Ku-band transponders, one Mobile Satellite Service (MSS) Transponder and one Broadcast Satellite Service transponder.

* Two normal C-band transponders — No. 9 & 10 in INSAT-2D and 11 & 12 in INSAT-2C — have an expanded coverage, from West Asia to South-East Asia. In INSAT-2C, seven C-band transponders have 36 dBW and three transponders have 32 dBW EOC eirp whereas INSAT-2D has ten C-band trans-ponders with 36 dBW EOC eirp and 3:2 redundancy.

* Two extended C-band channels namely 13 and 14 use 10 W SSPAs to provide an Edge of Coverage (EOC) eirp of 35 dBW.

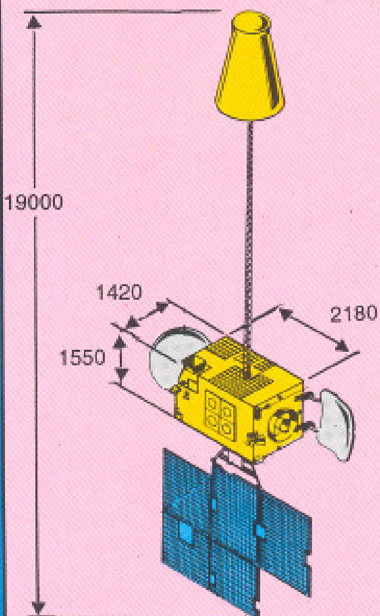
* Four channels namely 15, 16, 17 and 18 use 4 W SSPAs providing an EOC eirp of 32 dBW.

Ku-band Fixed Satellite Service Transponders:

* Three Ku-band (14.25-14.50 GHz in the uplink and 11.45-11.70 GHz in the downlink) trans-ponders using 20W TWTAs providing an EOC eirp of 41 dBW. The coverage beam essentially encompasses the four major cities of India, Delhi, Mumbai, Calcutta and Chennai. INSAT-2C Ku-band payload has a linear horizontal polarisation and 2D linear vertical. This payload also has a beacon transmitter at Ku-band to assist tracking of large size ground terminals.

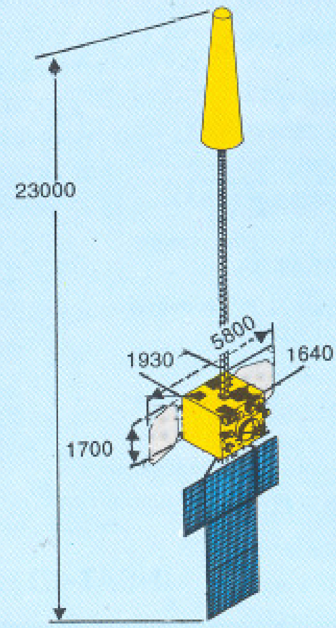
The INSAT satellites – a comparison

INSAT-1D



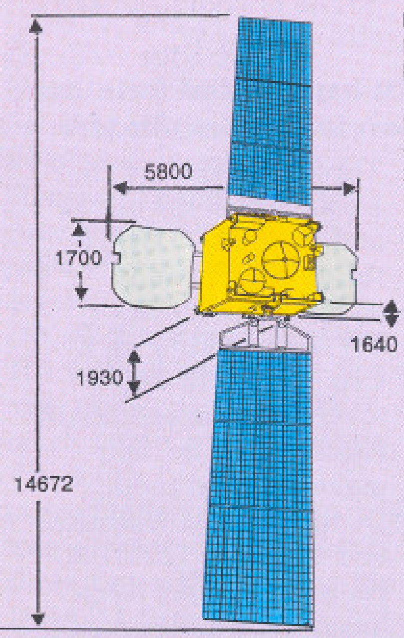
Length	: 19m
Dry mass	: 550 kg
Life	: 7 yrs
Power	: 930 W
Battery	: 2x12 (AH)
Structure	: 1930x1640 x1700mm
Payloads	
C-band	: 12 (4W)
Ext-C	: -
S-band	: 2 (50W)
S-mobile	: -
C-mobile	: -
Ku-band	: -
VHRR (Visible/IR /WV)	: 2.75/11 km
CCD camera	: -
DRT	: - Yes
SASR	: -

INSAT-2A/2B



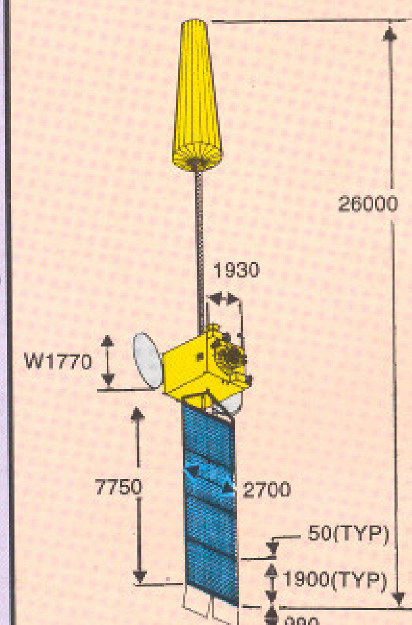
Length	: 23m
Dry mass	: 905 kg
Life	: 7 yrs
Power	: 1024 W
Battery	: 2x18 (AH)
Structure	: 1930x1640 x1700mm
Payloads	
C-band	: 12 (4W)
Ext-C	: 6 (4/8W)
S-band	: 2 (50W)
S-mobile	: -
C-mobile	: -
Ku-band	: -
VHRR (Visible/IR /WV)	: 2/8 km
CCD camera	: -
DRT	: Yes
SASR	: Yes

INSAT-2C/2D



Length	: 14.6 m
Dry mass	: 980 kg
Life	: 7 yrs
Power	: 1620 W
Battery	: 2x24 (AH)
Structure	: 1930x1640 x1700mm (North & South Panels extended by 500 & 350mm)
Payloads	
C-band	: 12 (50/10/4W)
Ext-C	: 6(4/8W)
S-band	: 1 (50W)
S-mobile	: 1 (50W)
C-mobile	: 1 (4W)
Ku-band	: 3(20W)
VHRR (Visible/IR/WV)	: -
CCD camera	: -
DRT	: -
SASR	: -

INSAT-2E



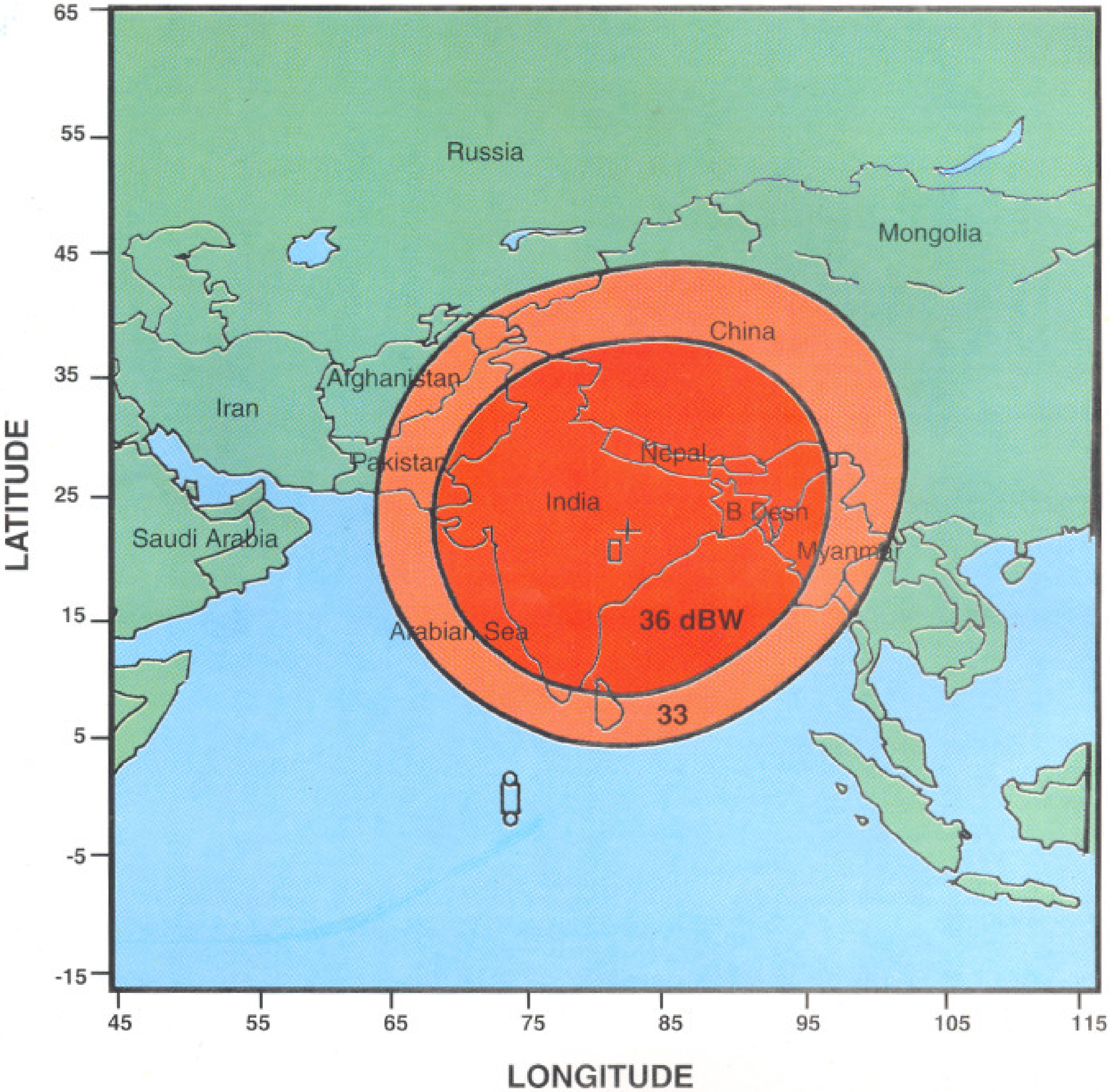
Length	: 26 m
Dry mass	: 1100 kg
Life	: 12 yrs
Power	: 2300 W
Battery	: 2x50 (AH)
Structure	: 1930x1700 x2300 mm
Payloads	
C-band	: 12 (65/35W)
Ext-C	: 5 (35W)
S-band	: -
S-mobile	: -
C-mobile	: -
Ku-band	: -
VHRR (Visible/IR/WV)	: 2/8/8 km
CCD camera	: 1 km
DRT	: -
SASR	: -

इन्सैट INSAT

INDIAN NATIONAL SATELLITE SYSTEM

INSAT I

INSAT-2D C-band Transmit Coverage



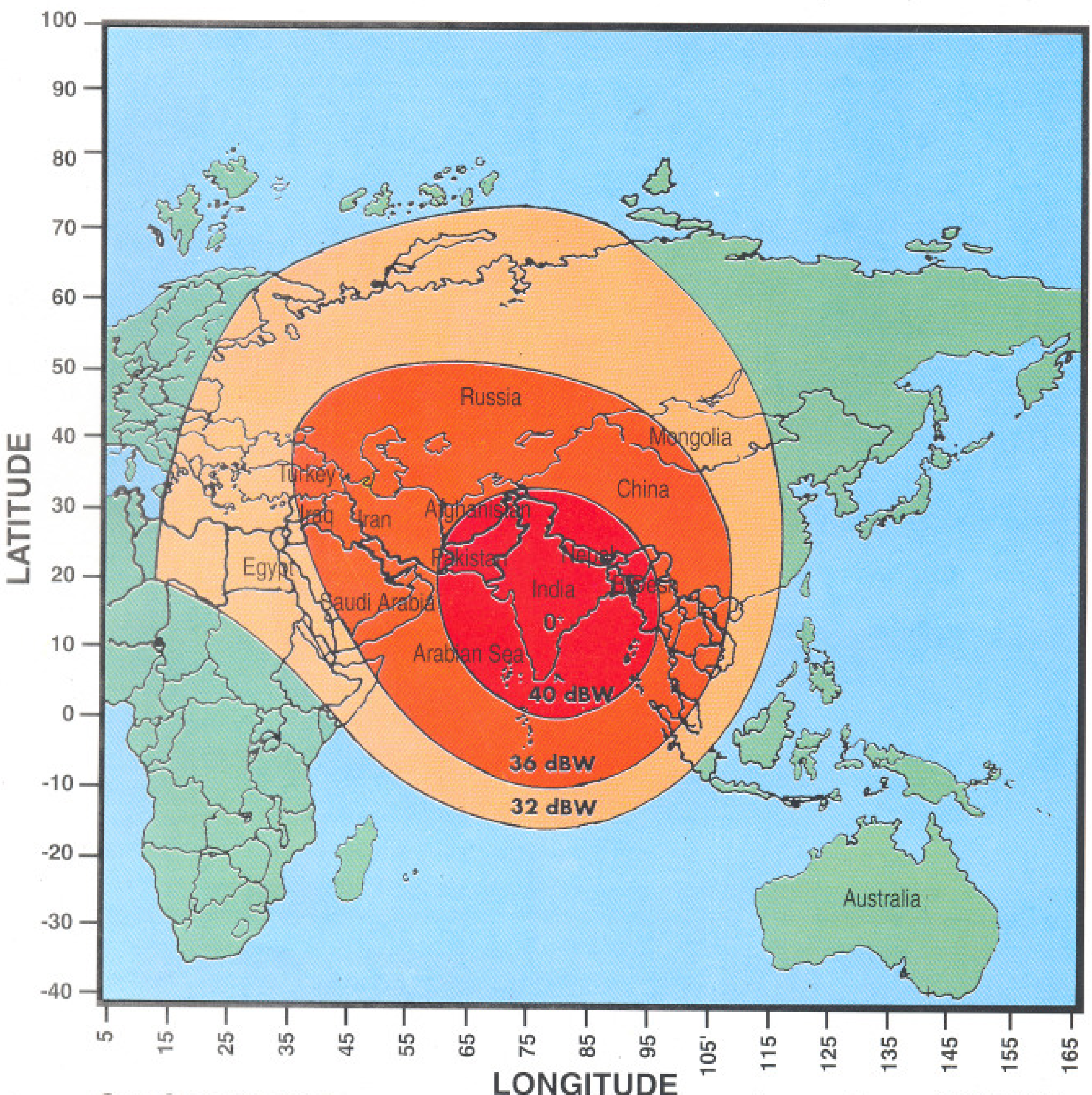
Geo Slot : 74° E

Freq : 3.745 GHz

Ch. No : 1

FOOT PRINTS

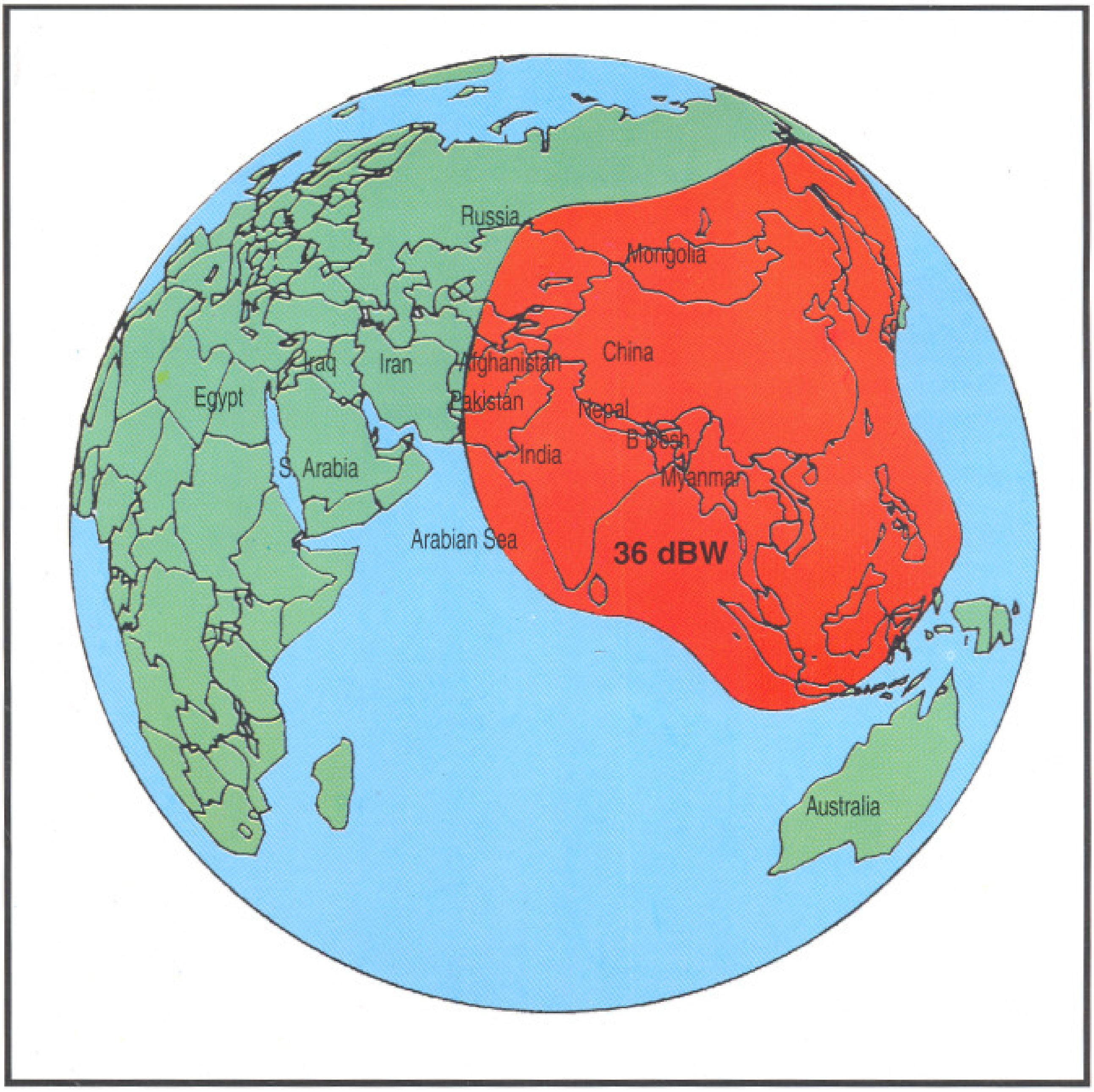
INSAT-2C C-band Expanded Coverage



Geo Slot : 93.5° E

Freq : 4165.0MHz

INSAT-2E Zonal-Beam Coverage



Freq : 4 GHz **Sat. Location : 83° E**

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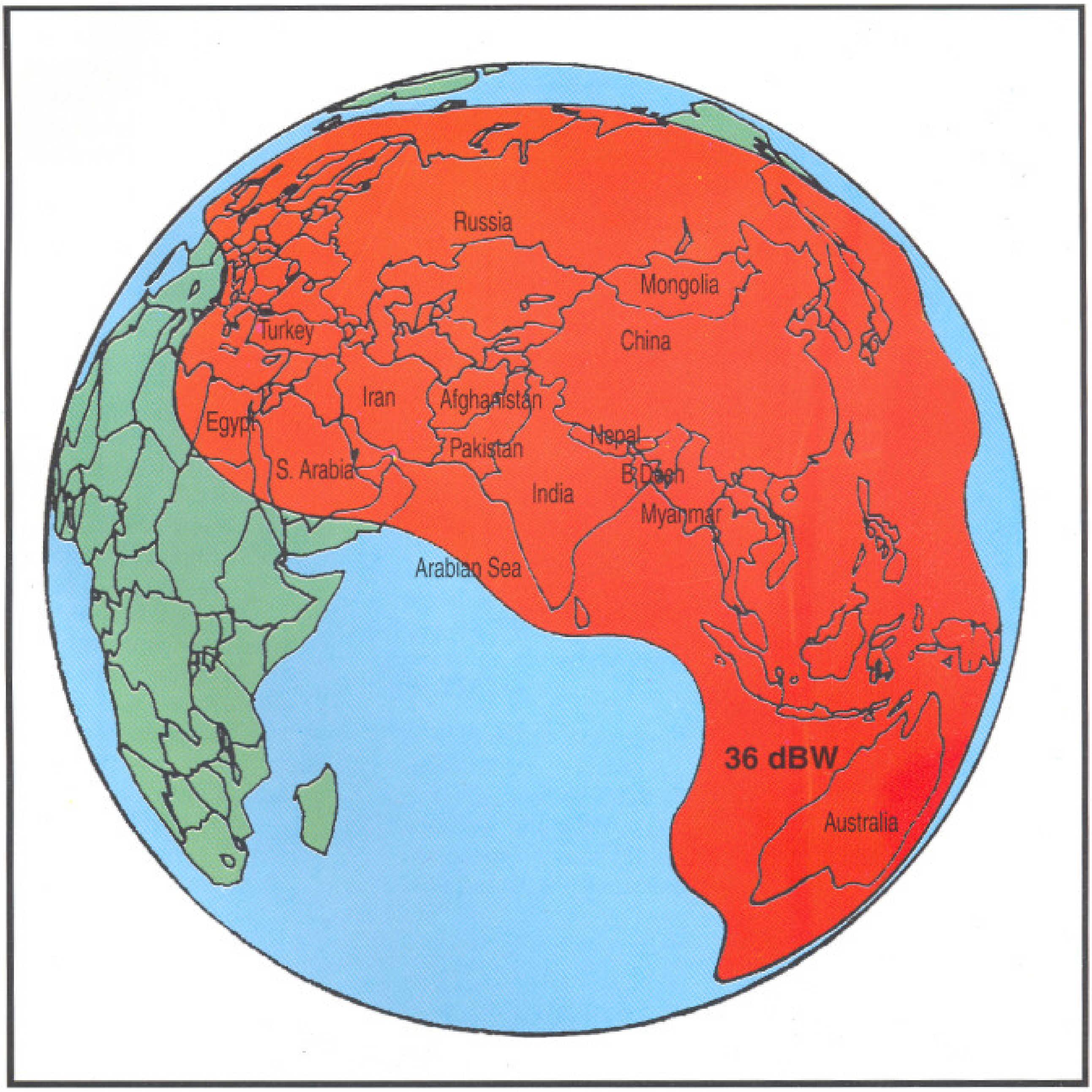
INSAT-2E Receive/Transmit Wide-Beam Coverage



Freq : Transmit : 4 GHz
Receive : 6 GHz

Sat. Location : 83° E

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Broadcast Satellite Service (BSS) Transponder:

* INSAT-2C and INSAT-2D have one CxS band (5.91 GHz in the uplink and 2.61 GHz in the downlink) transponder using 50 W S-band TWTA for broadcasting Television and Radio programmes over the Indian land mass including the off-shore islands. The EOC eirp over the Indian main land is 42 dBW.

* BSS Channel up/downlink frequency is 5870/2570 MHz for INSAT-2D and 5910/2610 MHz for INSAT-2C.

Mobile Satellite Service Transponder (MSS):

* The MSS has two communication links. The forward link between the Hub and the mobile station operates in CxS band (6.46 GHz in the uplink and 2.51 GHz in the downlink) and has 20 MHz bandwidth. The return link between the mobile station and the Hub operates in SxC band (2.68 GHz in the uplink and 3.69 GHz in the downlink) and is divided into two channels of 9 MHz each. Either of the channels in the return link is selectable by ground command. While 4 W SSPA is used for the C-band downlink transmit section (with EOC eirp of 30 dBW), 50 W TWTA is used for the S-band downlink to provide EOC eirp of 35 dBW. The coverage beam for both MSS transmit and receive functions is wide enough to cover from about 5^0 south latitude to 45^0 north latitude.

INSAT-2E, to be launched during 1998, has a configuration which is similar to INSAT-2A/2B with single sides solar array. INSAT-2E spacecraft will carry the following complement of payloads:

* 17 C and lower Ext. C-band 36 dBW transponder with zonal and global coverage. The zonal coverage channels use 32 TWTAs and global coverage channels use 60 W TWTAs.

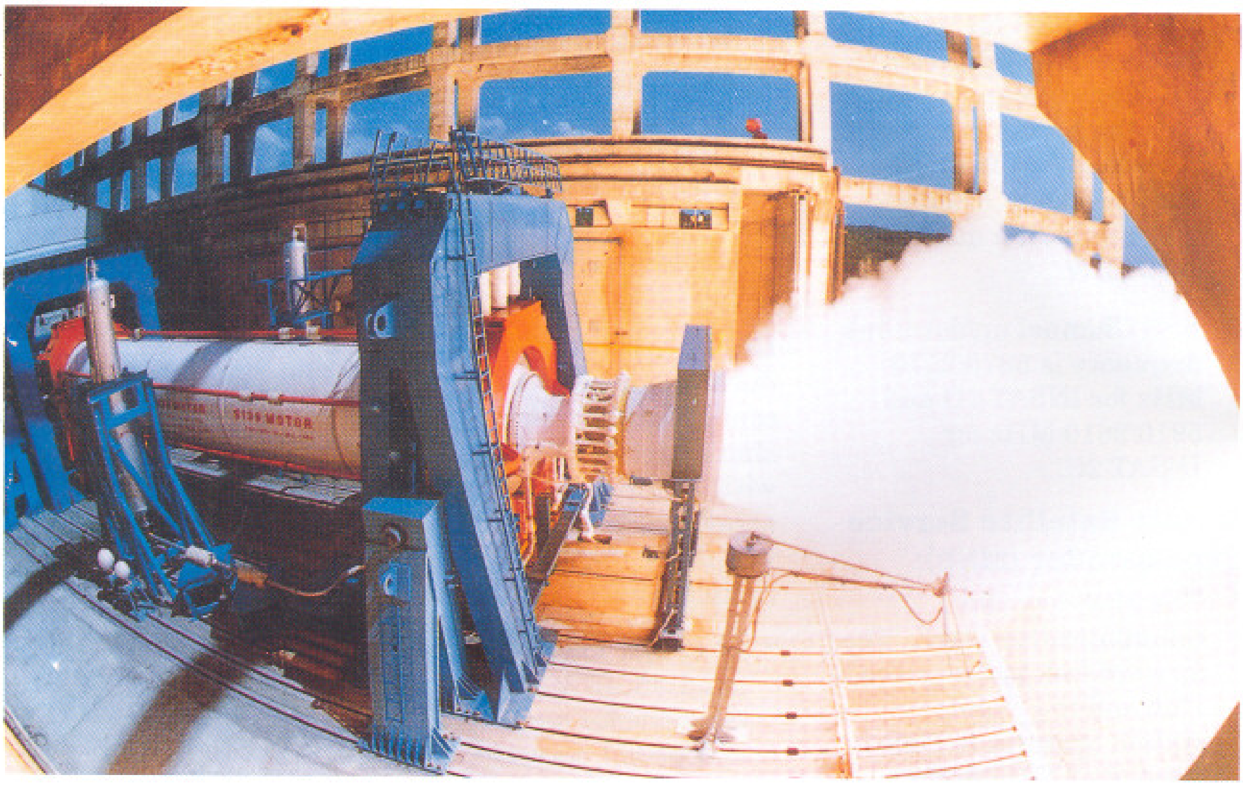
* A Very High Resolution Radiometer (VHRR) similar to INSAT-2A/2B satellite but with additional water vapour channel (5.7-7.1 microns) with 2 km resolution in visible and 8 km resolution in infrared and water-vapour bands.

* A Charged Coupled Device (CCD) camera in the visible (0.63-0.69 micron), Near Infrared (0.77-0.86 micron) and Short wave Infrared (1.55-1.70 micron) bands with 1 km resolution.

The Department of Space has signed an agreement with the International Telecommunication Satellite Organisation (INTELSAT) for leasing an equivalent of eleven 36 MHz C-band units of INSAT-2E to INTELSAT for 10 years.

Today, the INSAT system forms an important element of India's infrastructure playing a vital role in the telecommunication, television broadcasting, meteorology and disaster management, thus meeting the major objective of using space for national development. That INSAT system has four Indian-built satellites is a matter of great satisfaction to the Department of Space especially when it is celebrating its Silver Jubilee Year.

Improved Rocket Motors Tested



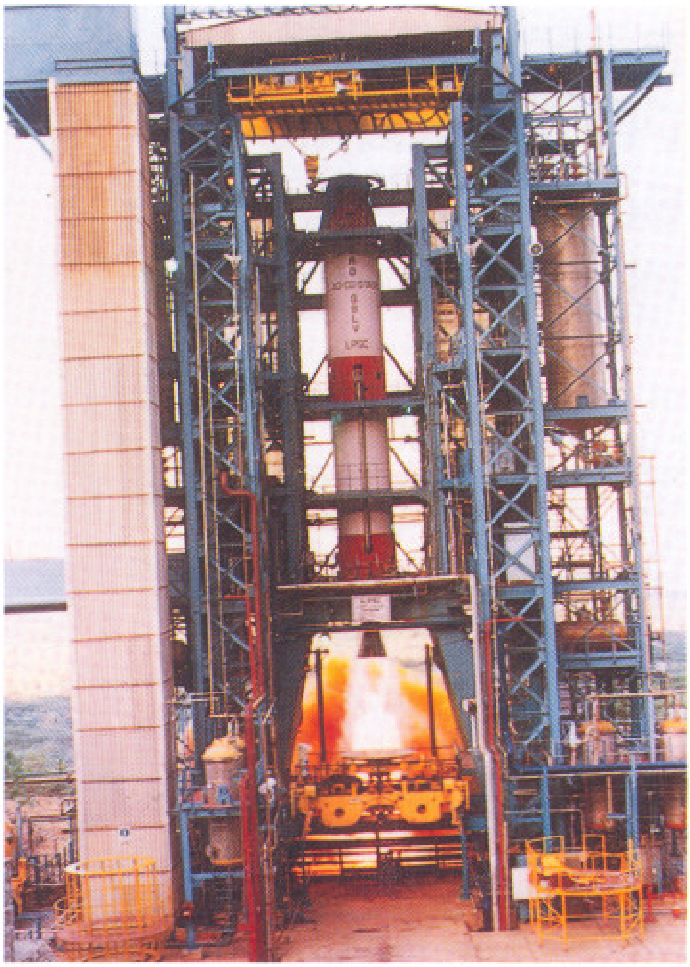
S-139 Solid Propellant Motor ground test

ISRO tested its largest solid booster on April 30, 1997 at SHAR Centre, Sriharikota. The booster, with a propellant loading of 138 tonne (S-139) is an improvement over the S-125 booster employed in ISRO's Polar Satellite Launch Vehicle (PSLV) so far. The booster has a diameter of 2.8 metre and a length of 20.2 metre.

The motor produced a peak thrust of 415 tonne and burned for a duration of 110 seconds during the test. The motor incorporates improvements such as use of composite insulation liner and optimisation of nozzle, besides, increase in the propellant loading by 9 tonne compared to the earlier version used in PSLV. The new booster will be used in the next flight of PSLV (PSLV-C1) which will place the 1,200 kg Indian remote sensing satellite, IRS-1D, into a 817 km polar sun-synchronous orbit later this year or early next year. The new booster will also be used as the first stage booster of ISRO's Geosynchronous Satellite Launch Vehicle (GSLV) later on.

The development of the booster was carried out by the Vikram Sarabhai Space Centre (VSSC), Liquid Propulsion Systems Centre (LPSC) and the SHAR Centre of ISRO. The motor case is of high strength maraging steel. The propellant is based on the HTPB (Hydroxyl terminated Poly Butadine) binder system. The propellant formulation, insulation and large scale processing was carried out by the propellant plants at SHAR Centre and VSSC. The rocket nozzle uses ablative thermal protection liners processed and cured at high pressure. The motor ignition is achieved by means of pyrogen igniter which is a motor of 300 mm diameter. The booster incorporates a secondary injection thrust vector control system developed by the LPSC.

The motor was tested on a specially designed six component test stand. Besides the main thrust of the motor and the side thrusts developed by the control system, nearly 300 parameters were monitored to evaluate the motor and the control system performance.



L-40, GSLV Strap-on Liquid Propellant Motor under test

Liquid Propellant Strap-on Stage of GSLV Tested

Another milestone in the development of propulsion technology was crossed on May 5, 1997, when the liquid propellant strap-on stage (L-40) of GSLV was successfully ground tested at the Liquid Propulsion Test Facility at Mahendragiri in Tamil Nadu. The L-40 stage, four of which are employed as strap-on booster of GSLV, is 2.1 metre in diameter and 19.6 metre in length. It uses 40 tonne of liquid propellants — Unsymmetrical Di-methyl Hydrazine (UDMH) as fuel and Nitrogen Tetroxide (N_2O_4) as oxidiser. The stage develops a thrust of 60 tonne and burns for 160 sec. The gimbal control actuation systems employed for controlling the vehicle in all the three axes (pitch, roll and yaw) during the operation of this stage, were also subjected to pre-programmed test cycles. The ISRO developed throat-insert was employed in the test.

The L-40 stage was developed by LPSC, the lead Centre for liquid propulsion technology in ISRO. VSSC developed the engine gimbal control system. Several Indian industries contributed to the fabrication of light alloy structures, engine fabrication and propellant production.

The L-40 test is an important milestone in the development of GSLV, which is now under development by ISRO, for launching INSAT class of satellites into geosynchronous transfer orbit. In the launch sequence, the four liquid propulsion strap-on stages are ignited on the ground along with the core solid propellant motor. The first developmental test flight of GSLV is planned next year.

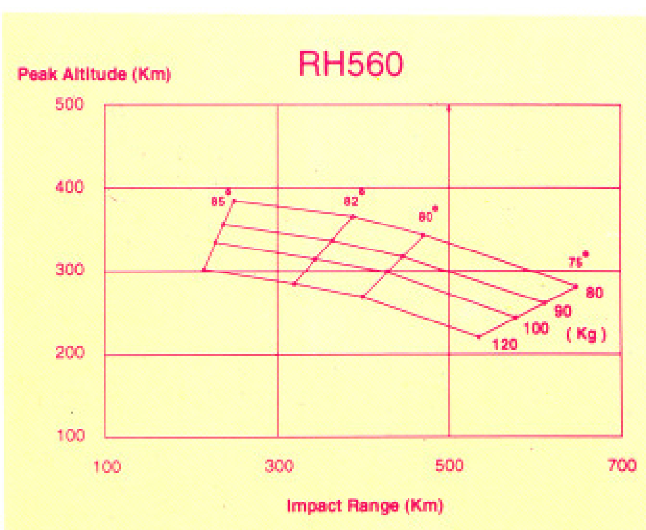
New High Performance Sounding Rocket Flown

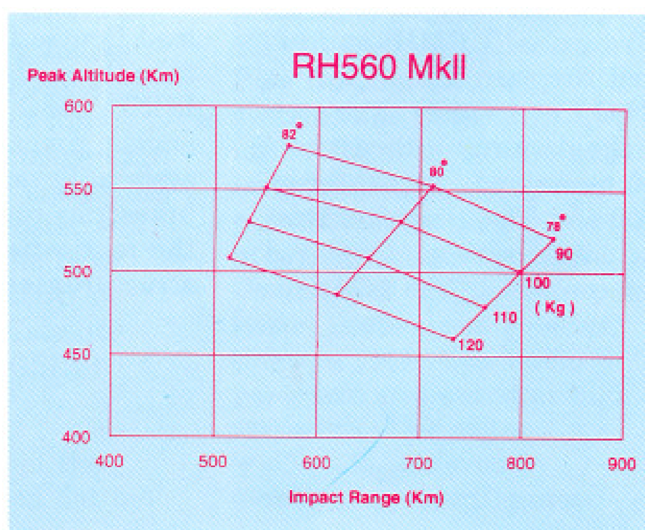
RH-560 on launch pad

RH-560 MK-II a new high performance sounding rocket in the ISRO's Rohini series was successfully flight tested from Sriharikota Range Centre (SHAR Centre) of ISRO on April 6, 1997. While, in this test flight, the rocket carried a payload of 102 kg to an altitude of 464 km, it is capable of reaching an altitude of 500 km when launched at a higher elevation.

The Rohini series of sounding rockets to launch scientific payloads to different altitudes has been an important contribution of ISRO for research in atmospheric and space science. RH-200, the smallest of the Rohini series, is used for launching 10 kg meteorological payloads of about 10 kg to about 75 km altitudes and this rocket has been extensively used in the last 20 years. RH-300 can launch a payload of about 50 kg to an altitude of 110 km for investigating middle atmosphere. RH-300 MK-II, capable of carrying a payload of 60 kg to 150 km, is used for D and E-region ionisation studies. The earlier version of RH-560 has a capability of launching 80 kg payload to height of 350 km and has been used for high altitude studies.

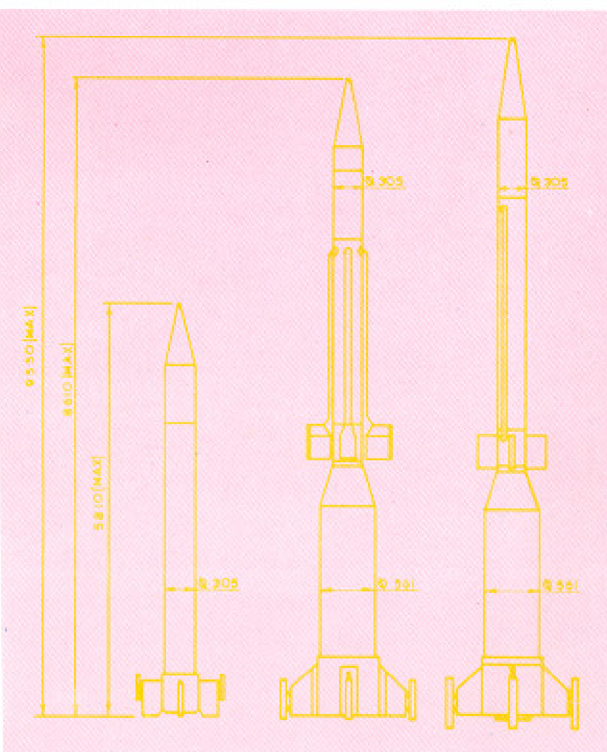
Payload Vs Altitude



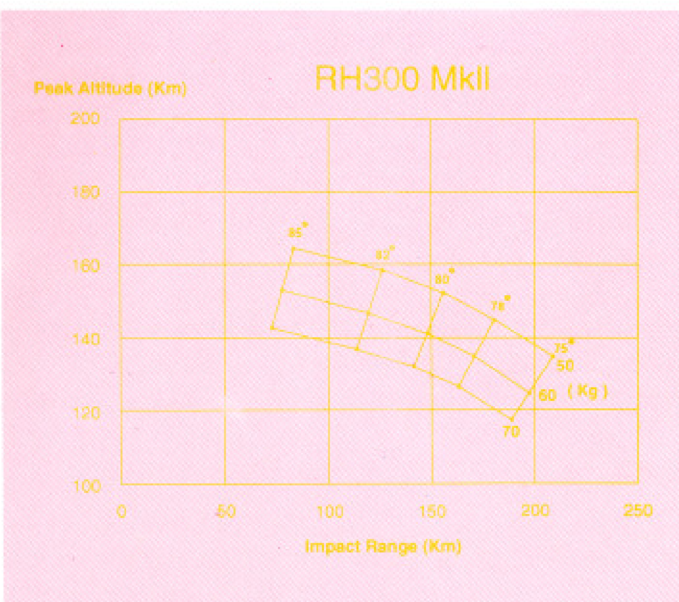


RH 300 Mk II on launch pad

Rohini Sounding Rockets of ISRO



ISRO's Vikram Sarabhai Space Centre (VSSC) at Thiruvananthapuram is the prime centre for the development of Sounding Rockets. Scientists from Germany, UK, Russia, France, Japan and Bulgaria have utilised these rockets for carrying scientific instruments. More than 500 technological and scientific studies including Indian Middle Atmospheric Programme (IMAP), ionospheric studies (SPREAD-F) jointly conducted by ISRO-DLR, Monsoon Experiment (MONEX) under the Global Atmospheric Research Programme (GARP), etc, have been conducted using the Rohini rockets. ISRO has also set up infrastructure for payload fabrication and integration facilities, telemetry and tracking, data acquistion and formatting. Two launch ranges, the TERLS which was dedicated to the UN in 1968 and another at Sriharikota (SHAR) on the east coast of India are available for conducting the launches.



The new Rohini rocket, RH-560 MK-II, launched on April 6, is the largest of ISRO's sounding rockets and it employs Hydroxyl Terminated Poly-Butadine (HTPB) propellant both in the booster and the sustainer stages. This rocket will enable scientists to probe various parameters relating to solar terrestrial physics, ionospheric electrodynamics such as electron and ion densities and their irregularities, electron and ion temperatures, electric and magnetic fields as well as neutral atmospheric parameters.

RANGE OF ROHINI SOUNDING ROCKETS

MODEL	RH 300 Mk II	RH 560	RH 560 Mk II
Overall Length (mm)	5810	8610	9550
No. of Stages	1	2	2
Lift-off Weight (kg)	510	1375	1635
Max. Dia (mm)	305	561	561
Payload Capability (kg)	70 90	100	
Spin Rate (rps)	6	6	6
Applications (Payload)	Scientific investigation of D/E regions of ionosphere	Scientific investigation of D/E regions of ionosphere	Scientific investigation of D/E regions of ionosphere
Launch Stations	TERLS/SHAR	SHAR	SHAR

India and Indonesia Sign MOU for Cooperation in Space - TT&C Station to be Set Up in Indonesia

India and Indonesia have signed a Memorandum of Understanding (MOU) for cooperation in space. The MOU was signed by Dr K Kasturirangan, Chairman of Indian Space Research Organisation (ISRO) and Prof Dr H Wiryosumartono, Chairman of National Institute of Aeronautics and Space (LAPAN) in Jakarta on April 25, 1997. The MOU envisages setting up of a telemetry, tracking and command (TT&C) station for satellites and launch vehicles at Biak, Indonesia.

The LAPAN-ISRO TT&C station will be located at the LAPAN premises at Biak which presently houses facilities for data reception from weather satellites and atmospheric science research. The station will have a full motion 10 m diameter antenna for receiving and transmitting signals from/ to space vehicles. This station will supplement the capability for ISRO's telemetry and tracking network for its communication, remote sensing and scientific satellites. The LAPAN-ISRO TT&C station is expected to be ready by early 1998.

The MOU is also expected to provide scope for cooperation between LAPAN and ISRO in different areas of space applications such as atmospheric studies and space environment monitoring using sounding rockets, remote sensing data interpretation, disaster warning systems, etc. The possibilities include use of Indian sounding rockets by LAPAN, reception and use of Indian Remote Sensing Satellite (IRS) data by LAPAN, reception of scientific data collected by the payloads of SROSS satellite in orbit, training of LAPAN personnel in space applications, etc.

Prof U R Rao Takes Over Chairmanship of United Nations Committee on Peaceful Uses of Outer Space (UN-COPUOS)

Prof U R Rao, Member of Indian Space Commission and Dr Vikram Sarabhai Distinguished Professor at ISRO, took over as Chairman of United Nations Committee on Peaceful Uses of Outer Space (UN-COPUOS) on June 2, 1997 during the 40th session of the committee. Prof Rao was chosen earlier to the post by consensus during the informal consultations held by the incumbent Chairman, Ambassador, Dr Peter Hohenfellner of Austria.

The 61 nation UN-COPUOS was set up by the UN General Assembly in 1959 to promote international cooperation in peaceful uses of outer space. Since its establishment, the Committee has made significant contribution to the development of international space law through evolution of several treaties and principles such as the outer space treaty (1968), the Rescue Agreement (1967), Liability Convention (1971), Registration Convention (1974), and Moon Agreement (1979), Direct Broadcasting Principles (1982), Remote Sensing Principles (1986) and Principles on the Use of Nuclear Power Sources (1982). India is a member of UN-COPUOS since its inception and has played an active role in the two UN conferences promoted by this committee in 1968 and 1982. India's proposal to hold a third conference as a special session of UNISPACE-III, open to all members of the UN, has been approved by the General Assembly and it is expected to be held in 1999.

Prof U R Rao's contribution to the development and application of space programme in India and his roles in many international space fora such as Vice President of International Astronautical Federation, Chairman of Eminent Experts Committee for UN-ESCAP and Chairman of Inter-Governmental Consultative Committee of Regional Remote Sensing Programme of UN-ESCAP, are noteworthy. His contribution to international cooperation has been recognised through the Allan D'Emil Award for International Cooperation, Frank J Malina Award of International Astronautical Federation and Dr Vikram Sarabhai Medal of the international Committee on Space Research.

The Chairmanship of UN-COPUOS has been held, since its establishment, by Austria. Prof Rao's Chairmanship will continue for three years beginning from June 1997. ❑

Department of Space Completes 25 Years

It is 25 years since the Indian space programme was formally organised by the Government of India by setting up the Space Commission and the Department of Space (DOS) and ISRO was brought under DOS. The Government of India resolution of June 1, 1972, said:

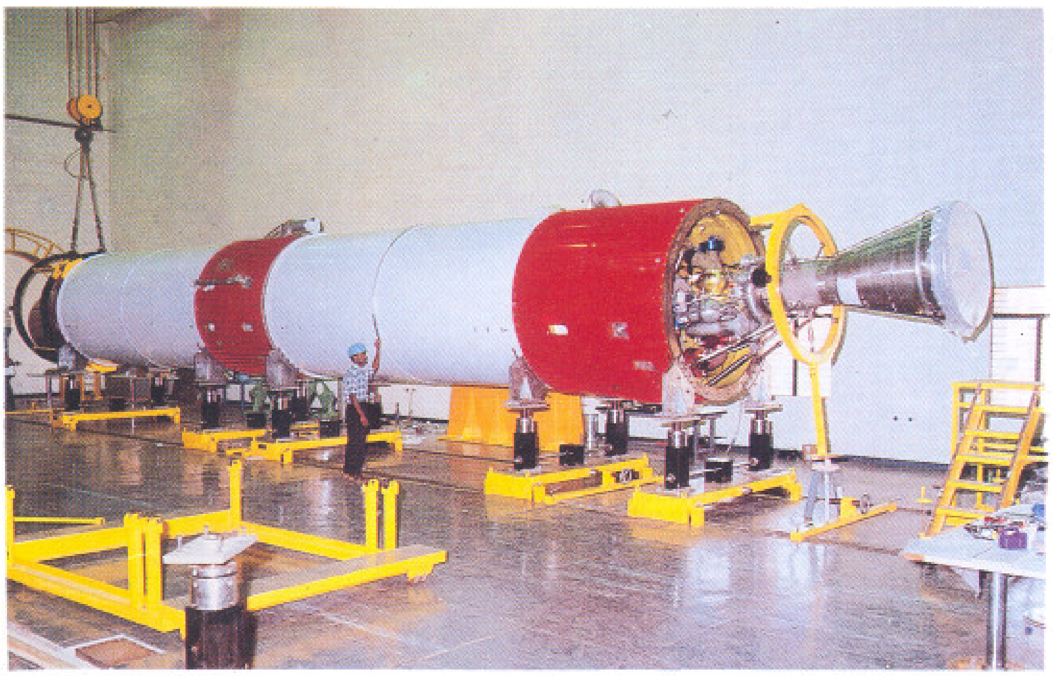
'In order to promote a rapid development of activities connected with the space science, space technology and space applications, the Government of India consider it necessary to set up an organisation, free from all non-essential restrictions or needlessly inelastic rules, which will have responsibility in the entire field of science and technology of outer space and their applications'.

The intention of the Government to provide a conducive environment for space research in the country and, at the same time, stress the need for undertaking activities not only in science and technology but also in applications so that the end benefits are not lost sight of, is brought out clearly in the resolution.

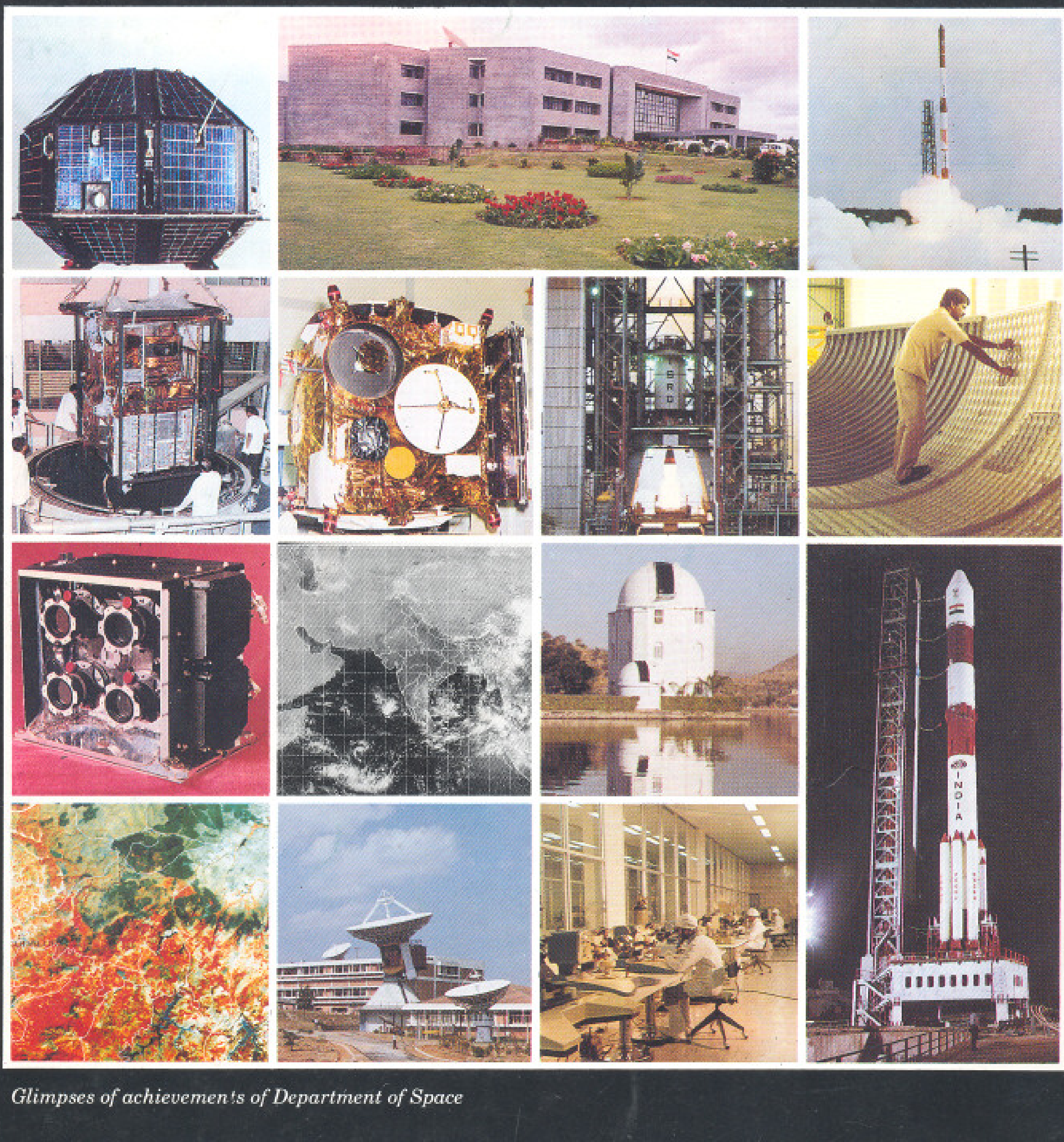
Space research in India had, in fact, started when the Department of Atomic Energy (DAE) was allocated the subject in August 1961. In 1962, the Indian National Committee for Space Research (INCOSPAR) was formed by DAE and in 1969 INCOSPAR was reconstituted under the Indian National Science Academy and a new organisation Indian Space Research Organisation (ISRO) was formed under DAE.

Looking back, it is easy to see that the government resolution of June 1972, has paid rich dividends, for, today, through a well-orchestrated programme, India has emerged as a frontranking nation, not only in the development of space technology but also in taking its benefits to the people. India has an end-to-end capability in the design, development and operation of state-of-art space-systems like the INSAT and Indian Remote Sensing (IRS) satellites. The four Indian-built INSAT satellites in orbit, INSAT-2A, INSAT-2B, INSAT-2C and INSAT-2D (launched recently) have brought in a revolution in telecommunication, television, meteorology and disaster warning services in the country. The Indian-built IRS series of satellites, four of which are in operation (IRS-1B, IRS-1C, IRS-P2 and IRS-P3) today form one of the largest constellation of remote sensing satellites in the world, the data from which is used for estimation of acreage and yield of important crops, forest survey, drought prediction, flood mapping, land use and land cover mapping for agro-climatic planning, waste land mapping for reclamation, ground water targeting, monitoring irrigation command areas, snow-cover and snow-melt run-off estimation, urban planning, mineral prospecting and, more importantly, in the Integrated Mission for Sustainable Development (IMSD) initiated in 1992 to generate locale-specific prescriptions for development at micro-level. A significant infrastructure for undertaking complex space missions has been set up and motivated, high-calibre human resources created. It is significant that data from IRS is also received by several other countries while a few transponders on board INSAT-2E to be launched by India next year will be leased to INTELSAT. In the launch vehicle development, India has the capability to launch its IRS class of satellites into polar sun-synchronous orbit through the Polar Satellite Launch Vehicle (PSLV) which has been successfully flown twice. The capability to launch INSAT class of communication satellites will be achieved with the Geosynchronous Satellite Launch Vehicle, GSLV, which is now under development.

All these achievements are cause for celebrating the Silver Jubilee of the Department of Space as well as to renew the commitment of the Department to the nation's development in the coming years.



L-40, the Liquid Propulsion Strap-on stage of GSLV which was successfully tested on May 5, 1997.



Glimpses of achievements of Department of Space