JULY-SEPT., 1992

SPACE india

INDIAN SPACE RESEARCH ORGANISATION

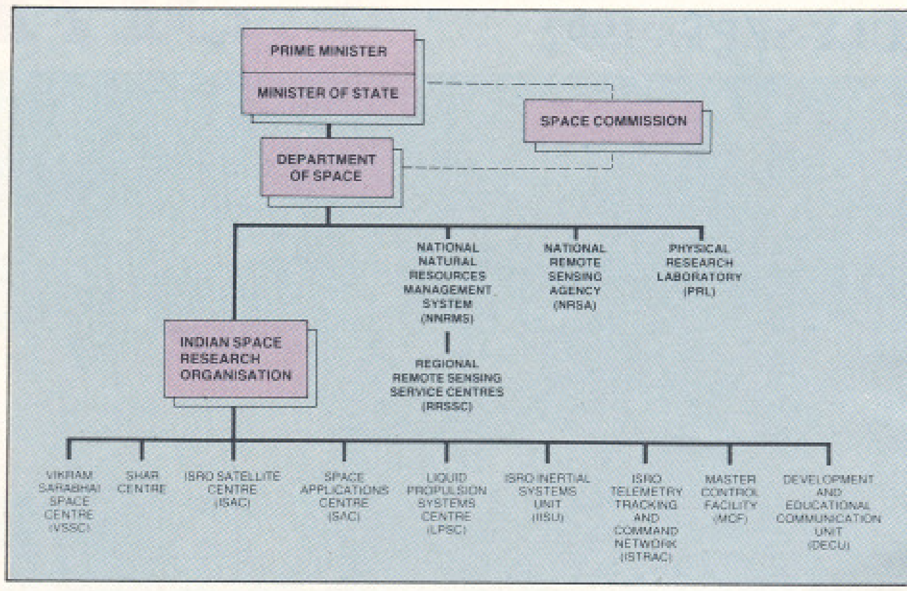
The Indian Space Programme

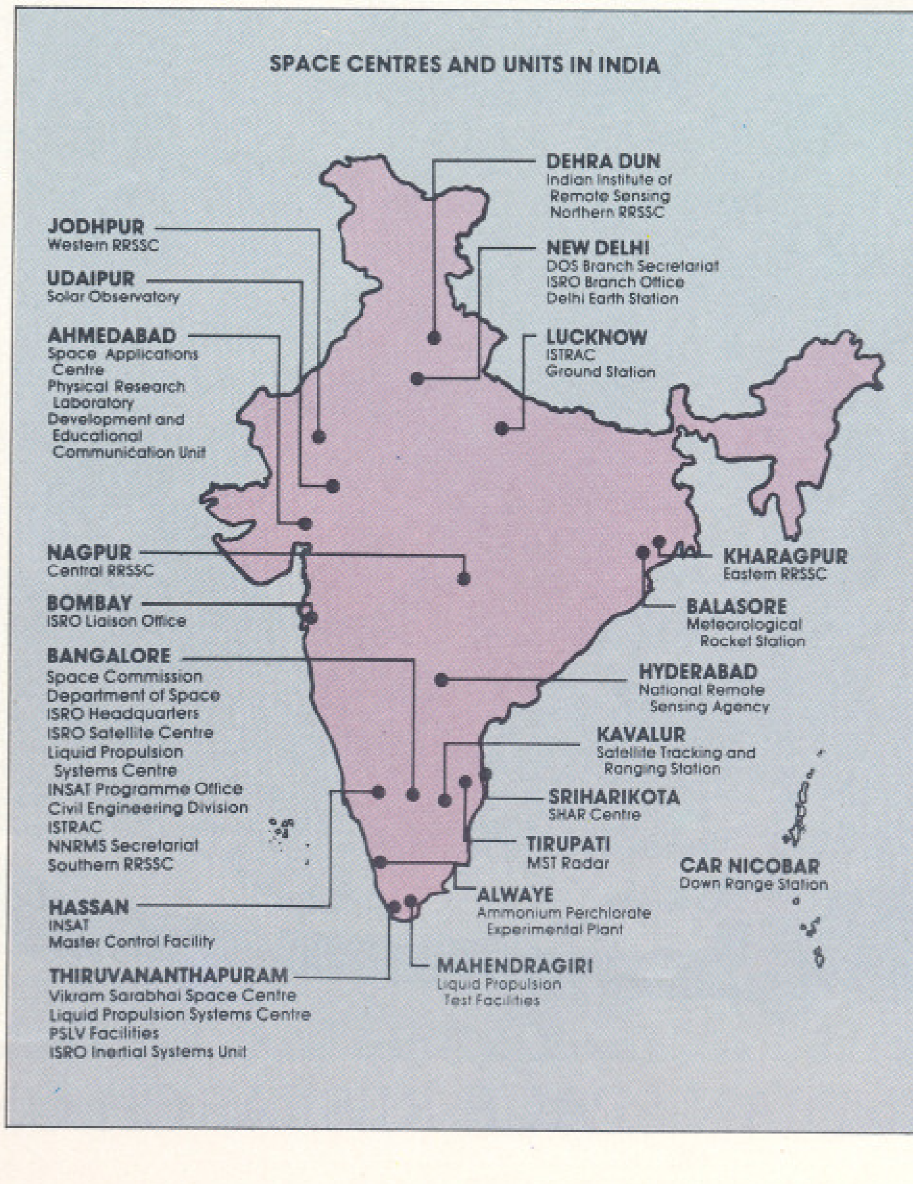
The setting up of the Thumba Equatorial Rocket Launching Station (TERLS) in 1963 marked the beginning of the Indian Space Programme. The Space Commission and the Department of Space (DOS) were established by the Government of India in 1972 to promote unified development and application of space science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

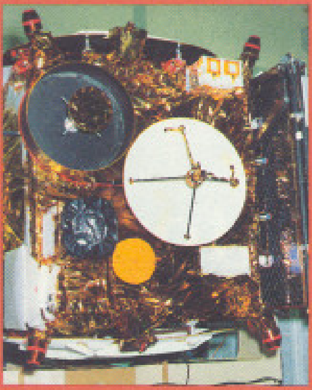
The Indian Space Programme is directed towards the goal of self-reliant use of space technology for national development, its main thrusts being: (a) satellite communications for various applications, (b) satellite remote sensing for resources survey and management, environmental monitoring and meteorological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







FRONT COVER
INSAT-2A

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Contents

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INSAT-2A – The Success Story

INSAT-2A, the first in the indigenously built second generation INSAT series, has become operational in August 1992. The excellent performance of the satellite represents the culmination of the efforts of ISRO to master the communication satellite technology which began with the design and development of the first experimental communication satellite, APPLE, a decade ago.

The Ariane-44L launch vehicle of Arianespace carrying the 1,906 kg INSAT-2A and the European EUTELSAT-F4 satellite, lifted off at 0412 hour IST on July 10, 1992, (22.42 hour GMT on July 9, 1992), from Kourou, French Guyana in South America. Nineteen minutes after the lift–off, INSAT-2A was put into a Geosynchronous Transfer Orbit (GTO) with a perigee of 198 km and an apogee of about 35,812 km, having an orbital period of about 10.5 hours.

The Master Control Facility (MCF) of ISRO at Hassan in Karnataka acquired the INSAT-2A satellite telemetry signal, as planned, about 10 minutes after its injection into the GTO. After immediately checking the health of the satellite, MCF commanded the satellite to orient its earth viewing face to look at earth and the outermost solar panel of the stowed solar array to face the sun.

The satellite was being tracked, apart from MCF at Hassan during the transfer orbit, by ground stations of the INTELSAT network located at Perth in Australia, Clarksberg in the USA and Raisting in Germany.

Before the satellite went out of radio visibility of MCF at 1430 hour IST on July 10, 1992, the satellite was manoeuvred for Apogee Motor Firing (AMF) orientation. After reacquiring the signal from the satellite at 0136 hour IST the next day MCF completed the tasks of earth acquisition and gyrocalibration were completed.

The 440 N Liquid Apogee Motor on board the INSAT-2A was successfully fired at 0617 hour IST on July 11, 1992, thereby placing the satellite in its first intermediate orbit. To plan the satellite in the near-geosynchronous orbit, MCF commanded two firings of AMF, one of 3900 seconds and the other of 806 seconds duration. After this, INSAT-2A remained continuously within the radio visibility of MCF.

Critical operations involving the deployment of the Solar Array on board the satellite were successfully completed by 1945 hour IST on July 14, 1992. The 15.5 sq. metre area solar array, comprising three panels of 3.9 sq. metre each and two panels of 1.9 sq. metre each, started generating 1,200 Watts of electrical power. The Solar Array Drive Assembly (SADA) was then turned on to enable the array continuously track the sun. Immediately after the deployment of the solar array and the slewing of the drive mechanism, the reaction wheel and one of the two momentum wheels were switched on, thus bringing the satellite into three-axis stabilised mode.

On July 15, 1992, the C/S band antenna reflector on the east face of INSAT-2A was deployed successfully around 1030 hour

INSAT-2A – Salient Features

Orbital Position	74 degrees East
Life	9 Years
Weight at Launch	1906 kg
Dry Mass	905 kg
Main Body Dimensions	1.9m x 1.7m x 1.6m
Length (Fully Deployed)	23 metre.
Liquid Apogee Motor	440 N bipropellant [Mixed oxides of Nitrogen (MON-3) and Monomethyl Hydrazine] motor for orbit raising
Control	16 Number of 22 N bipropellant thrusters and momentum/ reaction wheels for 3-axis stabilisation
Solar sail/boom	1.5 m diameter x 4.4 m high Solar sail attached to a 14.95 m deployable boom
Solar Array	15.5 sq m consisting of 3 panels of 3.9 sq m, and 2 panels of 1.9 sq m generating 1024 W.
Battery	Two 18 Ah Ni-Cd
Antennae	Two deployable 1.77 m parabolic C x C antenna, one 0.9 m diameter parabolic C x C antenna, 0.75 m UHF receive antenna, fixed TTC omni antenna and a 0.3 m diameter fixed global horn.
Payloads	
TV&Telecom	Two 42 dBW S-band channels Twelve 32 dBW C-band channels Four 32 dBW Ext.C.band channels Two 34 dBW Ext. C-band channels
Meteorology	Very High Resolution Radiometer (VHRR) Resolution : 2 km visible, 8 km IR Transmitter eirp 18.0 dBW
Data Collection System (DCS)	
One UHF/C-band Data Relay Transponder	
Receive G/T	-19.0 dB/deg K
eirp	18.0 dBW
Search & Rescue (S&R)	
406 MHz/C-band SAS&R distress alert transponder	
Receive G/T	-19.0 dB/deg.K
eirp	14.0 dBW

Spacecraft Control Centre at MCF, Hassan

IST. The INSAT-2A achieved its full in-orbit configuration and three-axis stabilised mode the same day, with the deployment of the west side antenna and solar boom and sail. The controlled deployment of the sail took exactly 16 minutes and 8 seconds as designed; the boom and sail smoothly latched in their deployed position.

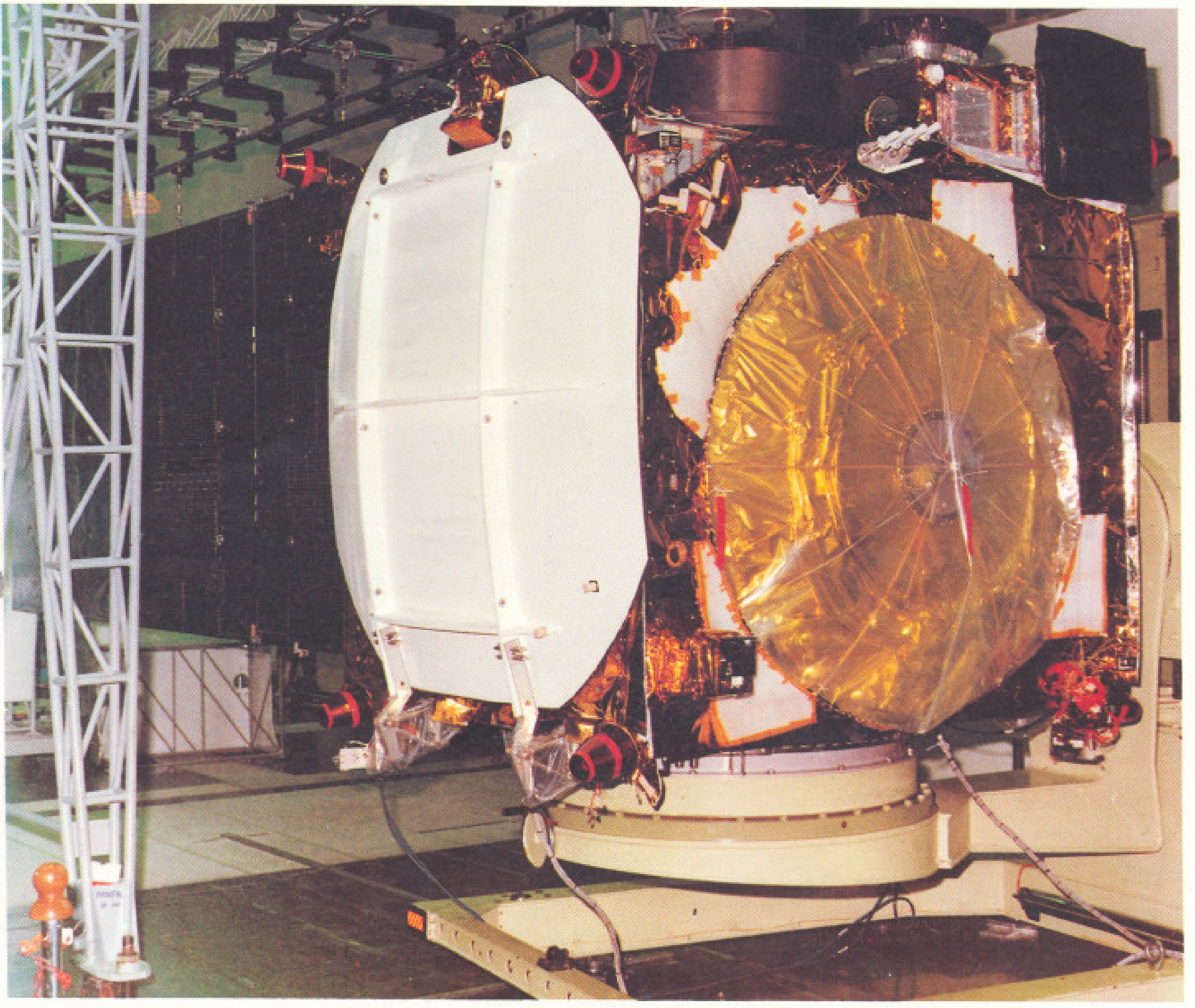
With all the deployments carried out flawlessly, the second momentum wheel was also switched on thus providing the needed attitude stability for the satellite.

As a result of the excellent performance of the Liquid Apogee Motor used for orbit raising and the very smooth deployment operations, the in-orbit configuration of INSAT- 2A was achieved two days ahead of schedule.

An orbit trimming manoeuvre, carried out on July 23, 1992 using the attitude control thrusters brought the spacecraft into a 35,776x35,207 km orbit with an orbital period of 23 hours and 44 minutes; the satellite started "drifting" towards its parking slot of 74 degree's East longitude at the rate of 3.8 degrees per day. Thus MCF settled down to carry out the task of exercising and checking the payloads one by one.

The VHRR instrument was commanded to take its first cloud cover imagery on July 27, 1992. The six extended C-band transponders including the two high power transponders were switched-on the same day. The next day, all the 12 normal C-band transponders, the data relay transponder and the Search and Rescue transponders were switched on. The next ten days were spent in carrying out detailed characterisation of all the communication transponders.

MCF brought the INSAT-2A into its allotted geostationary slot at 74 degrees East on July 29, 1992.

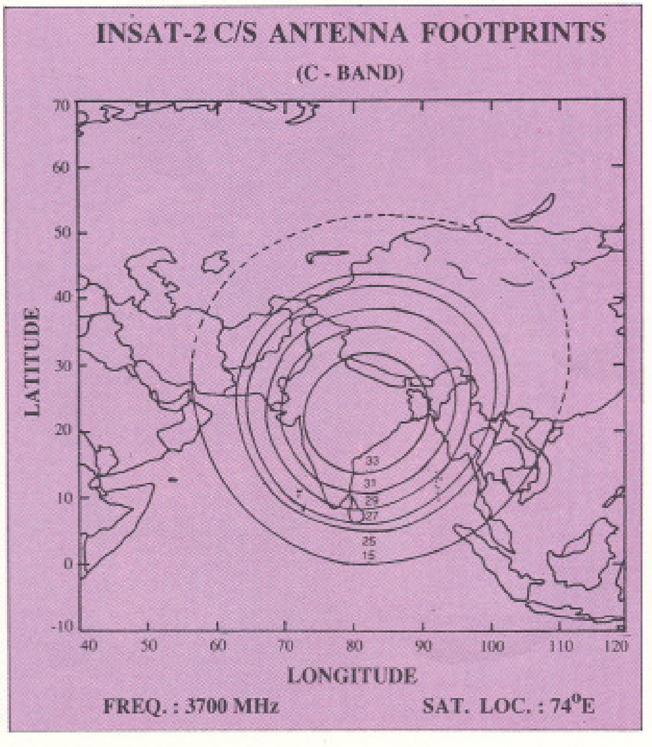


Solar panel deployment test on INSAT-2A

INSAT-2A is the first satellite in the world to use the extended C-band frequencies allotted by International Telecommunication Union (4500-4800 MHz for the down link and 6725-7025 MHz for the uplink).

Likewise, the 406 MHz Search and Rescue payload on board INSAT-2A is the first one to be used on a geostationary satellite in the Indian Ocean region.

While the success of the second Indian Remote Sensing satellite, IRS-1B, in August 1991,

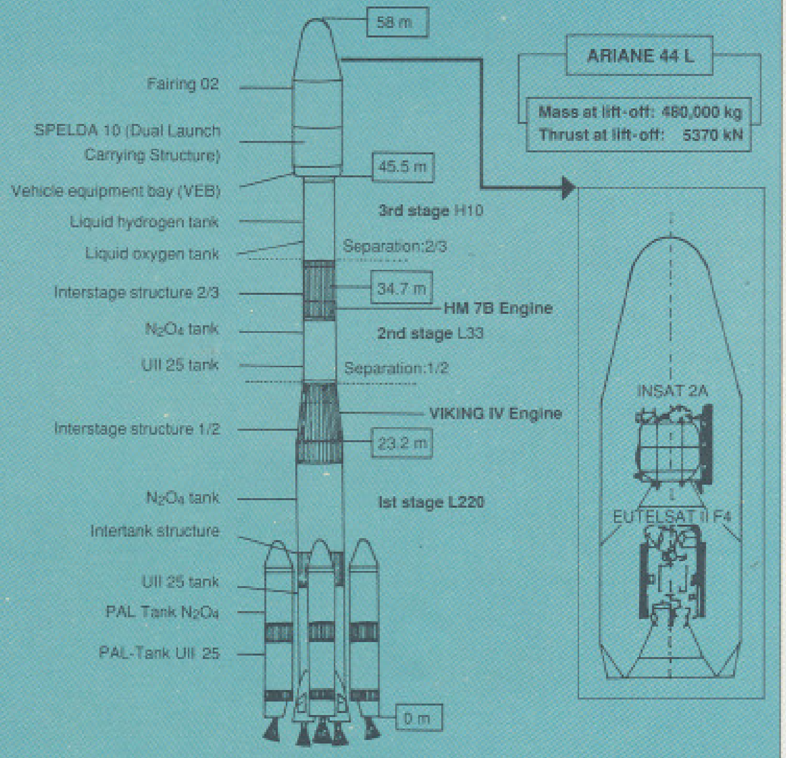


Ariane

It was the 51st launch of the Ariane which placed the INSAT- 2A and its copassenger, EUTELSAT-II F4, satellites into geostationary transfer orbits (GTO). It was the 23rd launch of Ariane-4 version and the 12th in the Ariane 44L configuration. The launch took place from launch complex nb2 (ELA2), in Kourou, French Guyana.

The EUTELSAT- II F4 is the fourth model of the second

ARIANE 44 L LAUNCH VEHICLE



	Length	Diameter	Dry mass	Propulsion Type/Mass-propellants/thrust
FAIRING	8.6m	4m	750kg	——
SPELDA	2.0M	4M	410 kg	——
VEB	1M	4M	530kg	——
3rd Stage	11.4m	2.6m	1.25t	Cryotechn /10.5t LH_2 & LO_2/63 kN
2nd Stage	11.6m	2.6m	3.2t	Biliquid/34t-UH25& N_2O_4/800 kN
Ist Stage	23.2 m	3.8 m	17.5t	Biliquid226t UH25& N_2O_4/3000 kN
PAL	19m	2.2m	4.5t	Biliquid/39t UH25 & N_2O_4/750 kN
VIKING IV, V, VI				Biliquid propulsion
HM 7B				Cryotechnic propulsion

Mass Break up (In kilograms) Up

INSAT-2A	*1,906*
EUTELSAT-II F4	*1,877*
*SPELDA**, Adaptors, Equipment Bay, etc.*	*1,333*
Third stage dry mass	*1,280*
Third stage propellants	*10,550*
Second stage dry mass+2/3 IS	*3,672*
Fairings	*747*
Second stage propellants	*35,534*
First stage dry mass+1/2 IS	*18,155*
First stage propellants	*2,30,204*
Liquid strap-on boosters dry mass	*18,100*
Liquid strap-on boosters propellants	*1,56704*
Total mass at lift-off	*4,80,062*

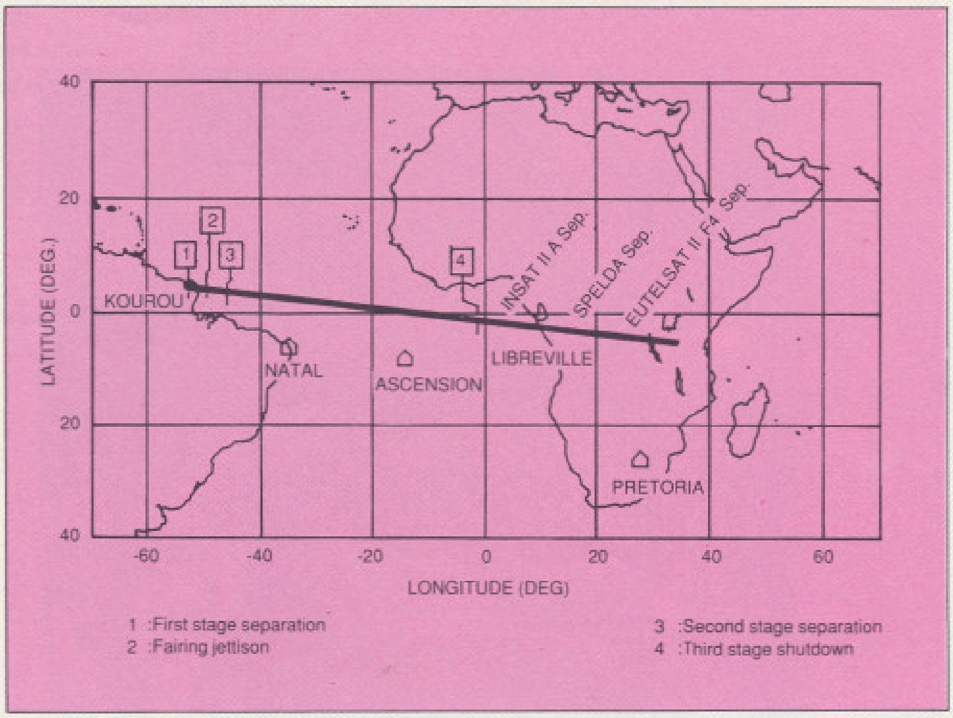
*** SPELDA (Structure Porteuse Pour Lancements Doubles Ariane) is a unique fairing assembly of Ariane-4 for launching multiple satellites.*

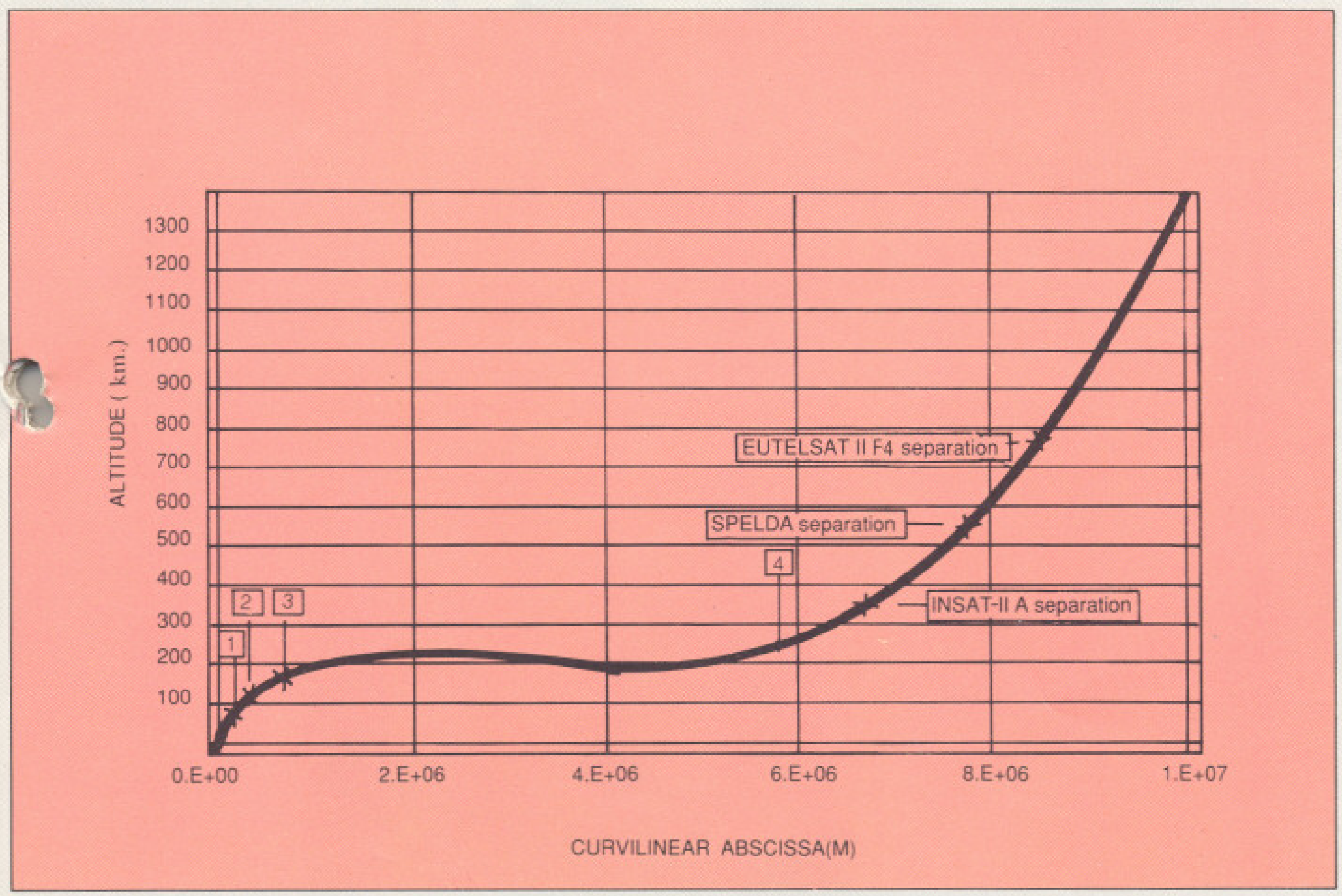
Flight - 51

generation telecommunications spacecraft of that organisation. While INSAT-2A is placed at 74 degrees East, EUTELSAT is placed at 7 degrees East.

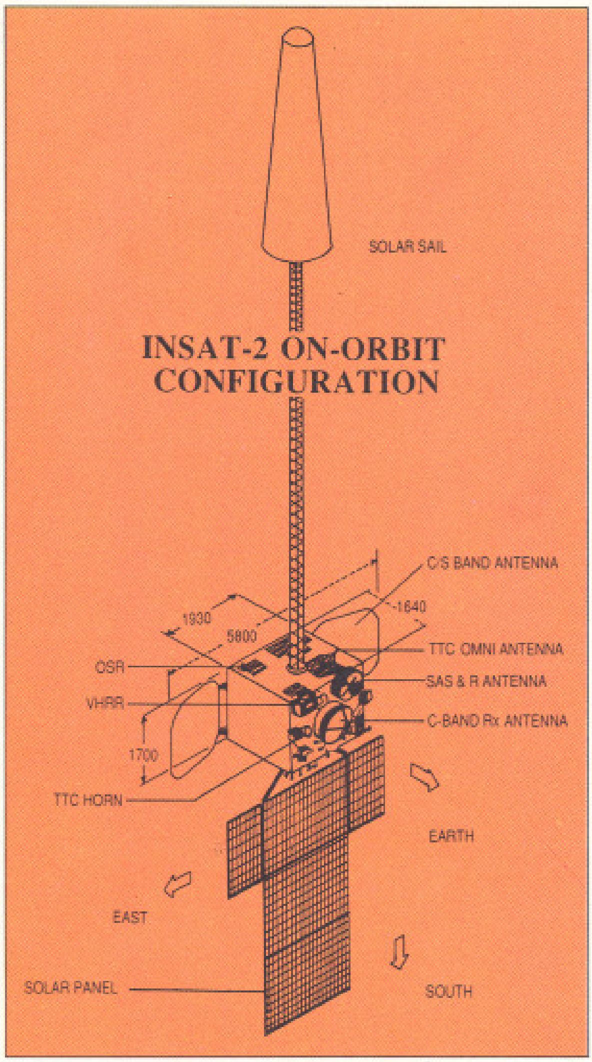
While the Master Control Facility (MCF) acquired the first signal from INSAT-2A after its injection into GTO, the ISRO Telemetry, Tracking and Command (ISTRAC) station at Bangalore acquired the first signals from EUTELSAT after injection into orbit.

ARIANE FLIGHT 51 TRAJECTORY





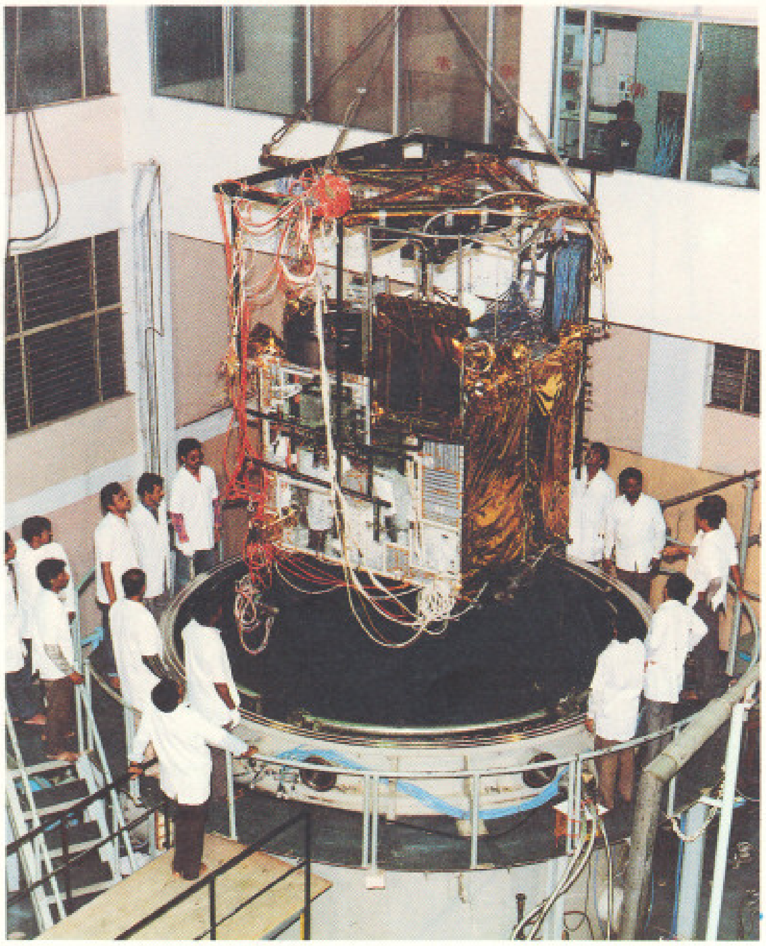
represented the maturity ISRO has achieved in building state-of-the-art remote sensing satellite, that of INSAT-2A demonstrates ISRO's capability in designing and building complex multipurpose communication satellite. □



A view of INSAT Master Control Facility at Hassan

The INSAT System

The INSAT system is a joint venture of Department of Space (DOS), Department of Telecommunications (DOT), India Meteorological Department (IMD), All India Radio (AIR) and Doordarshan. The INSAT system was commissioned in 1983 with operationalisation of INSAT-1B. The INSAT-1D (launched in June 1990), is the last of the first generation INSAT-1 series of satellites, procured from abroad. INSAT-1D took over all the functions of INSAT-1B at the end of its (INSAT- 1B) life. It is operating from 83 degrees East longitude in the geostationary orbit. INSAT-2A, the first in the INSAT-2 series of satellites designed and fabricated by the Indian Space Research Organisation (ISRO), is stationed at 74 degrees East longitude.



INSAT-2A being loaded for thermovac test

The INSAT satellites provide the following services:

- Domestic long-distance telecommunications
- Meteorological earth-observation and data relay
- Nationwide direct satellite TV broadcasting to community
- TV receivers in rural and remote areas.
- Radio and TV programme distribution.

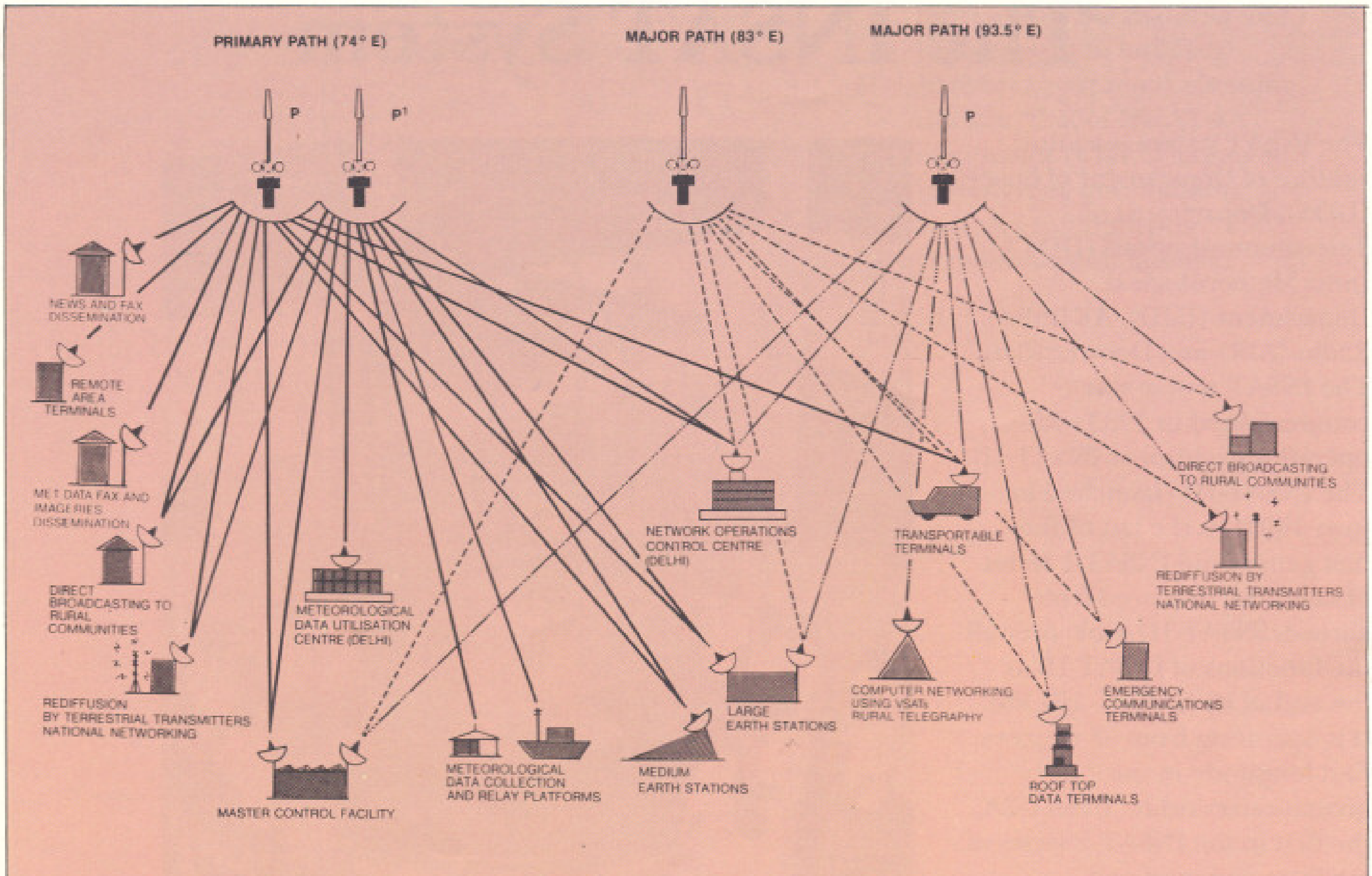
The INSAT Master Control Facility (MCF) at Hassan, Karnataka, provides telemetry, tracking and command (TT&C) support besides mission planning and analysis during orbit raising, orbit manoeuvres, on-orbit testing, eclipse operation, etc., throughout the life of the satellites. INSAT-MCF has four fully equipped Satellite Control Earth Stations (SCES) with computer system, recording and timing system, a complete range of TT&C and base band equipment. It is equipped with Uninterruptable Power Supply (UPS) system.

INSAT Services

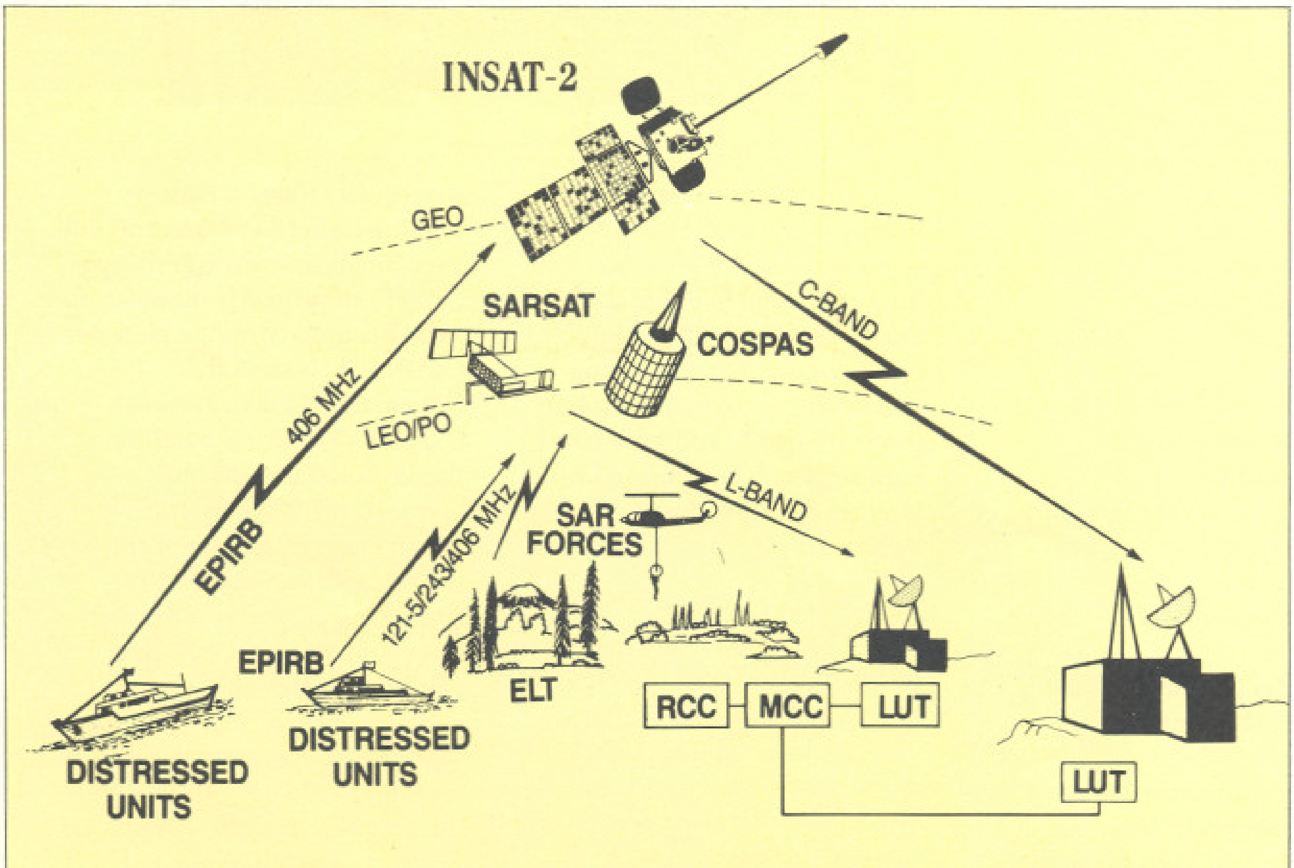
Telecom Services

The Department of Telecommunication (DOT) network provides for over 4,500 two-way speech circuits through 127 earth stations of various types and 141 point-to-point routes using the INSAT spacecraft. Several captive satellite-based networks and 600 Very Small Aperture Terminals (VSAT) deployed in Remote Area Business Message Network (RABMN), National Informatics Centre Network (NICNET) and the Satellite Based Rural Telegraphic Network (SBRTN) in the North-east are all part of the INSAT system. The VSATs communicate with each other through a two-hop link via a central hub station.

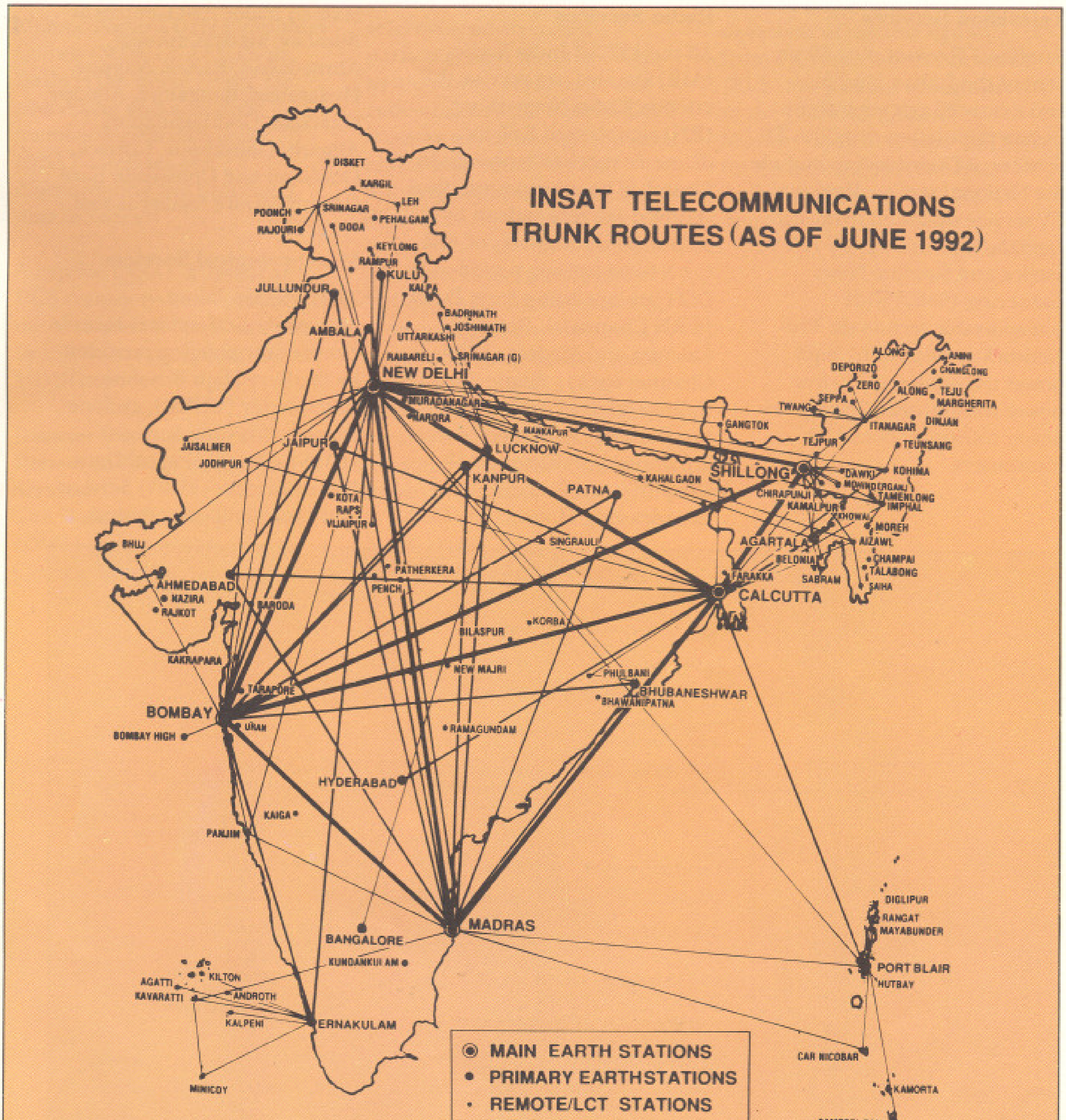
The DOT network and TV, AIR and IMD links are monitored by the INSAT Network Operation Control Centre (NOCC) situated at Sikanderabad in Uttar Pradesh.



INSAT 2 SPACE SEGMENT CONCEPT



SATELLITE-AIDED SEARCH AND RESCUE


INSAT TELECOMMUNICATIONS
TRUNK ROUTES (AS OF JUNE 1992)
DISKET
KARGIL
LEH
POONCH
SRINAGAR
RAJOURI
DODA
PEHALGAM
KEYLONG
RAMPUR
KULU
JULLUNDUR
KALPA
BADRINATH
JOSHIMATH
AMBALA
UTTARKASHI
RAIBARELI
SRINAGAR (G)
NEW DELHI
MURADANAGAR
NARORA
MANKAPUR
LUCKNOW
JAISALMER
JODHPUR
JAIPUR
KANPUR
PATNA
KAHALGAON
KOTA
RAPS
VIJAIPUR
SINGRAULI
BHUJ
AHMEDABAD
NAZIRA
RAJKOT
BARODA
PATHERKERA
PENCH
BILASPUR
KORBA
KAKRAPARA
NEW MAJRI
PHULBANI
TARAPORE
BHUBANESHWAR
BHAWANIPATNA
BOMBAY
BOMBAY HIGH
URAN
RAMAGUNDAM
HYDERABAD
KAIGA
PANJIM
BANGALORE
MADRAS
KUNDANKULAM
AGATTI
KILTON
KAVARATTI
ANDROTH
KALPENI
ERNAKULAM
MINICOY
ALONG
ANINI
DEPORIZO
ZERO
CHANGLONG
SEPPA
ALONG
TEJU
MARGHERITA
TWANG
ITANAGAR
DINJAN
GANGTOK
TEJPUR
TEUNSANG
SHILLONG
DAWKI
KOHIMA
MOHINDERGANJ
CHIRAPUNJI
TAMENLONG
KAMALPUR
IMPHAL
KHOWAI
MOREH
AGARTALA
AIZAWL
BELONIA
CHAMPAI
TALABONG
FARAKKA
SABRAM
SAIHA
CALCUTTA
DIGLIPUR
RANGAT
MAYABUNDER
PORT BLAIR
HUTBAY
CAR NICOBAR
KAMORTA
CAMPBEL BAY
MAIN EARTH STATIONS
PRIMARY EARTHSTATIONS
REMOTE/LCT STATIONS
SCPC ROUTES

Television Services

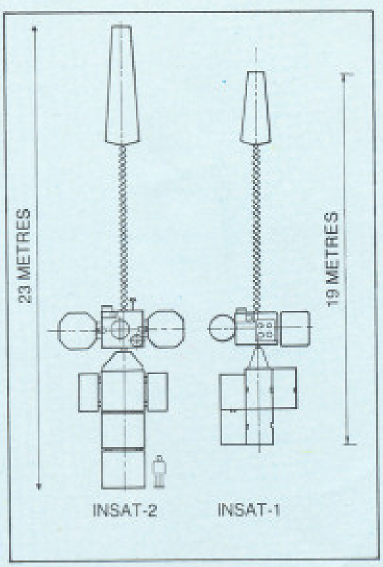
Satellite TV covers over 65 per cent of the Indian land-mass and nearly 80 per cent of the Indian population. Satellite TV services of Doordarshan include the National service, Regional TV service uplinked from state capitals, Educational TV (ETV) service and Satellite News Gathering (SNG) with transportable terminals. The Network consists of 61 high power transmitters, 370 low power transmitters, 76 very low power transmitters and 22 transposers.

Radio Services

All the 127 All India Radio (AIR) stations can receive the satellite Radio Networking (RN) signals with 3.66 m diameter receiver terminals in S-band. The programmes thus received are rebroadcast by terrestrial transmitters of AIR. C x S band uplinks provided by DOT are operating from Delhi (6 RN Channels), Bombay, Calcutta and Madras (1 RN Channel each). Single channel uplinks from 12 major programme producing centres are under installation. AIR has a captive up-link station at Broadcasting House, New Delhi. Sixteen major AIR Centres at Bombay, Madras, Bhopal, Ahmedabad, Rajkot, Nagpur, Hyderabad, Bangalore, Alleppy, Dharwad, Doddaballapur, Aligarh, Gorakhpur, Cuttack, Guwahati and Chinsurah have C-band receive facility as well.

Meteorological Services

The Satellite -based Meteorological services include cloud cover imaging provided by the Very High Resolution Radiometer (VHRR), cyclone Disaster Warning Service (DWS), Meteorological Data Dissemination (MDD) Service and Data Collection System



ON ORBIT CONFIGUARATIONS

	INSAT-1	INSAT-2
Length (m:fully deployed)	- 19 m	- 23 m
Dry Mass (kg)	- 550 kg	- 911 kg
EOL minimum power (W)	- 930 W	- 1024 W
Payload complement (in each spacecraft)		
C band FSS transponder channels	12(32 dbW EOC) Functional channel redundancy (10/12)	18 total - 16 (32 dbW EOC) and 2(34 dbW EOC). Functional redundancy in conventional C band (10/12) and 3.2 in output stages for 6 extended C band transponder channels
S band high power BSS	2(42 deW EOC)	2(42 dbW EOC)
Channels	3:2 TWTA redundancy	3:2 TWTA redundancy
VHRR and DRT	2.75 kms visible and 11 kms IR resolution: 2:1 redundancy in VHRR electronics, x mtr and DRT	VHRR (Improved resolution) - 2 kms visible and 8 kms IR resolution; S/C level VHRR and DRT redundancy as in INSAT - 1.6 dB improvement in VHRR x mtr eirp
406 MHz S&R transponder		Included
Eclipse operating capability for payload (in each s/c; equivalent at EOL)	150 W (approx.)	560 W (approx.)
Omni - TT&C	Yes, uses FSS transponder channel Nos. 4 and 5 TWTAs	An additional antenna added for improved coverage. Independent output stages, FSS channels not tied down
Deployments:		
Solar array	Asymmetrical; involves multiaxial deployments, partial deployment in transfer orbit	Asymmetrical accordion type; simpler deployment, no partial deployment in transfer orbit
Antenna	Two deployables on East and West faces. All 6 GHz receive functions on East face deployable Antenna	Two deployables on East and West faces but a third fixed antenna added for all 6 GHz receive and VHRR and DRT transmit functions. Greater mission functions saving in case of deployment anomalies.

INSAT-1 and INSAT-2 — a comparison

(DCS) Service. The Meteorological Data Utilization Centre (MDUC) of IMD at Delhi is the nerve centre for processing and analysing meteorological data from INSAT satellites and disseminating the processed data to users.

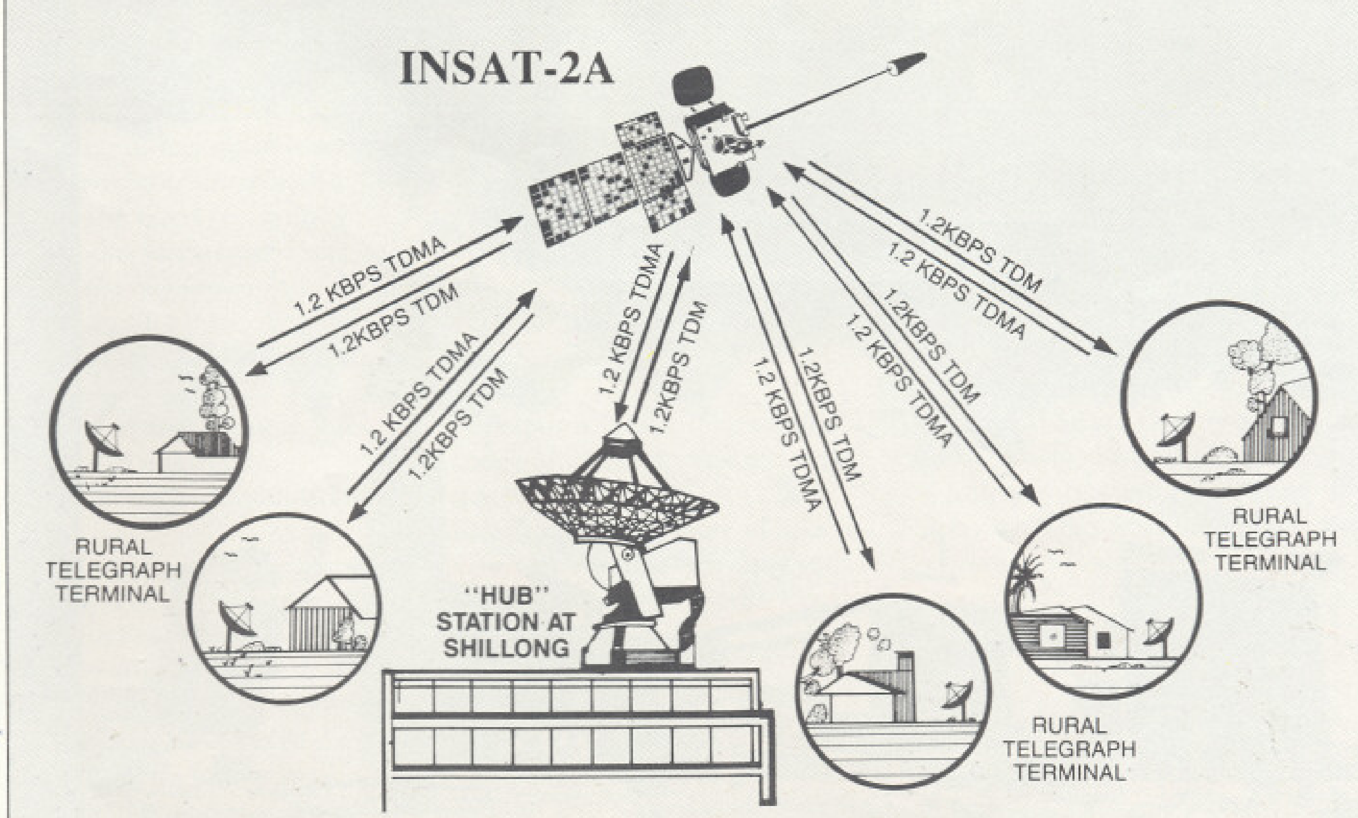
A captive INSAT-2 VHRR and DCS receive system operating in the extended C-band, designed by ISRO, has been installed at MDUC.

Disaster Warning, Search and Rescue and Data Collection Services

The Disaster Warning Service (DWS) system enables the Cyclone Warning Centre (CWC) to directly and selectively address any particular area likely to be hit by a cyclone. A pseudo-noise code activates the desired DWS receiver which energises a siren and is followed by an oral warning about the impending disaster.

The Data Collection System (DCS) is used for collection of meteorological, hydrological and oceanographic data from remote, unattended Data Collection Platforms (DCPs). Signals from the DCP are relayed by the INSAT Data Relay Transponder to MDUC.

A 406 MHz Search & Rescue (SAR) package on INSAT-2A satellite helps near real-time detection of distress signals from Personal Locater Beacons (PLB) for onward transmission to the COSPAS-SARSAT Mission Control Centre (MCC) for further action. (See *Space India* April-December 1989 for details). □



SATELLITE-BASED RURAL TELEGRAPH NETWORK (SBRTN)

ISTRAC Provides Support for EUTELSAT-II-F4

It was the ISRO Telemetry, Tracking and Command network (ISTRAC) station at Bangalore which first acquired the signal from the EUTELSAT-II-F4, the copassenger of INSAT-2A, about 28 minutes after lift-off of Ariane flight V-51. ISTRAC had also extended TTC support to earlier EUTELSAT-II missions, EUTELSAT-II F1, F2 and F3 under a commercial agreement with the German Space Operations Centre network (GSOC). The ISTRAC support is provided mainly during the launch and early orbit phase (LEOP).

The ISTRAC station at Bangalore provided the first acquisition and back up support for apogee boost manoeuvre of EUTELSAT-II F4. The first signals from the spacecraft were acquired using both east and west antennae at Bangalore station and the spacecraft was being tracked on a dedicated basis until acquisition of signal at the NASA station located in Canberra, Australia. Tracking data in terms of range, Doppler and angle, collected during the spacecraft visibility periods from Bangalore station, till the completion of apogee motor firings, were used for the orbit determination and manoeuvre planning.

The support was provided for 12 days in the LEOP □

ISTRAC Facilities at Bangalore

World Space Congress Held in Washington

Prof. U.R. Rao (left) receiving the Allan D. Emil award

The World Space Congress, the most important event of the International Space Year - 1992, was held in Washington DC, USA, from August 28 to September 5, 1992. The Congress, dedicated to discovery, exploration and cooperation, was a historic gathering of top space leaders from over 50 countries who shared the latest research results, discussed important new space initiatives and looked for expanding the opportunities for international cooperation in space. They also aimed charting a course for a new global era in space development and applications.

The World Space Congress was an unprecedented gathering. It combined two of the world's most prestigious space meetings; the science oriented 29th plenary meeting of the Committee on Space Research (COSPAR) and the engineering oriented 43rd Congress of the International Astronautical Federation (IAF). The annual colloquium on the law of outer space, organised by the International Institute of Space Law, also ran concurrently with the congress. The World Space Congress was organised by the American Institute of Aeronautics and Astronautics (AIAA), COSPAR, IAF, National Academy of Sciences of USA and National Aeronautics and Space Administration (NASA) of USA.

The World Space Congress featured over thirty concurrent technical and scientific sessions each day. Over 3000 technical papers were presented on topics such as developing a global programme to meet earth's needs, lunar and planetary exploration, competition and cooperation in space science and space application for earth's benefits. There were special joint sessions on space life sciences, space technology in developing countries and international aspects of the search for extra-terrestrial intelligence.

Prof. U R Rao, Chairman, Space Commission, led the Indian delegation consisting of seven senior scientists of ISRO/DOS. Several scientists from other Indian scientific/academic institutions also participated and presented papers during the Congress. Prof. U R Rao, Chairman, ISRO, and Vice President, IAF, chaired one of the important symposium "Space Technology in Developing Countries - Making it Happen" jointly sponsored by the UN, IAF, COSPAR and AIAA. Prof.U R Rao was also a member of the Distinguished Panel on 'Developing a Global Programme to Meet Earth's Needs'. Several papers were presented by the Indian scientists during the space congress.

The International Space Exhibition organised in connection with the World Space Congress displayed the most advanced space science and technology products and concepts from several industries and Governments.

On September 3, 1992, an awards ceremony was organised as part of the World Space Congress, during which several awards instituted by Space Fora like IAF, COSPAR, AIAA, etc., were presented. Prof. U R Rao, Chairman, ISRO, received the Allan D.Emil Award of the International Astronautical Federation for his outstanding contributions to International cooperation in Astronautics. The award was presented by Mr. Alvaro Azcarraga, President, IAF. □

Vikram Sarabhai Award for Prof. C Y Tu

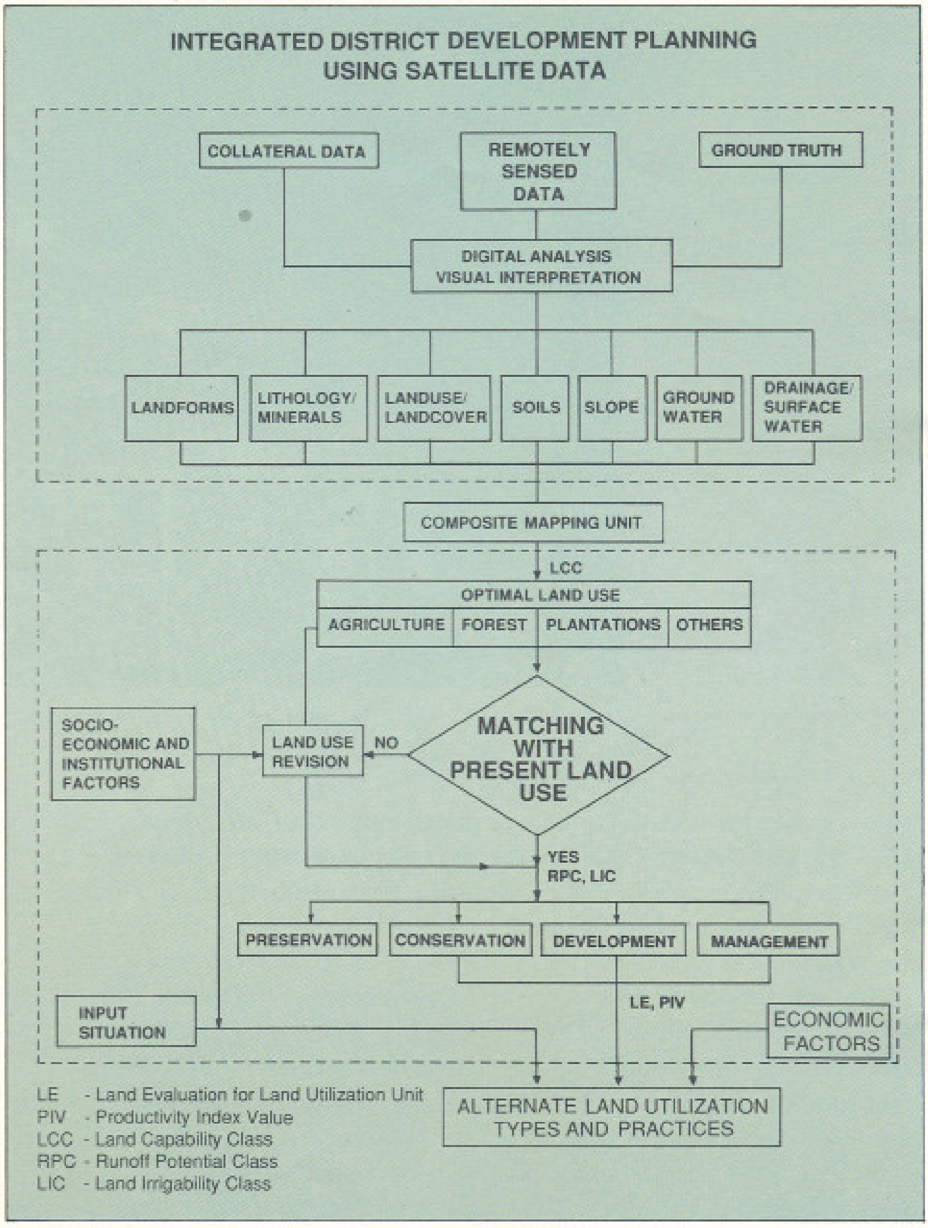
Prof. U.R. Rao (right) presenting the Vikram Sarabhai award to Prof. C.Y. Tu

Prof. C Y Tu of the Department of Geophysics, Peiking University, Beijing, People's Republic of China received the 1992 Vikram Sarabhai Award instituted by the Indian Space Research Organisation (ISRO) and Committee on Space Research (COSPAR), established by International Council of Scientific Unions (ISU) in October 1958 to provide a forum for the world scientific community pursuing space research. The award, consisting of a Gold Medal and an engraved citation plaque, was presented by Prof .U R Rao, Chairman, Space Commission, Government of India, on September 3, 1992 at the 29th Plenary Meeting of COSPAR held in Washington D.C. Prof. Tu was selected for the award for his outstanding contributions to the understanding of solar wind turbulence and magnetospheric phenomena during the past few years.

The international Vikram Sarabhai Award was instituted in 1990 to recognise outstanding contributions made by individual scientists to space research in developing countries. India is one of the earliest members of COSPAR. The Vikram Sarabhai Award is presented once in two years. It may be recalled that Academician Kotelnikov of Russia received the first award in 1990. □

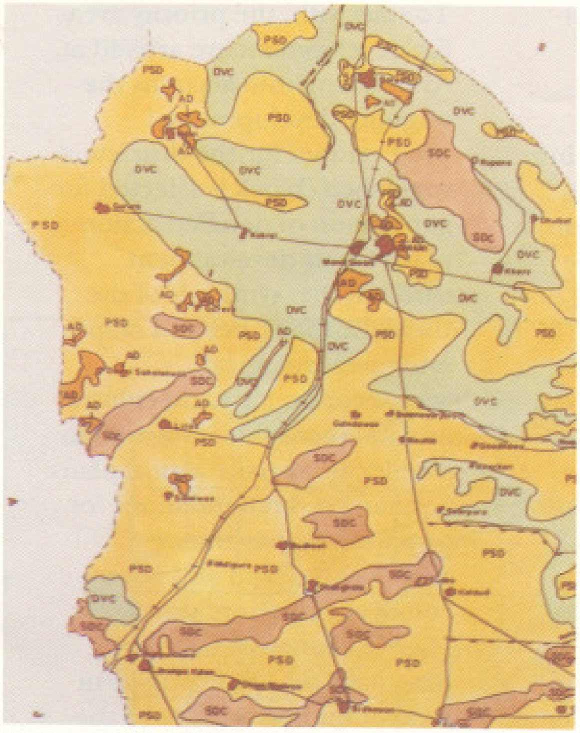
Satellite Data for Sustainable Integrated Development

The Planning Commission of India has decided to go ahead with the implementation of action plans generated for watershed areas located in six districts for which pilot studies on integrated sustainable development have been almost completed. These six form part of the 21 drought-prone districts for which pilot studies have been undertaken under the aegis of Department of Space with the participation of States and Union Territories, mainly using Indian Remote Sensing Satellites' (IRS-1A and IRS-1B) data. It is now recognised that the integrated development approach as envisaged by these pilot studies constitutes an important base for integrated planning. Further, this approach provides utmost economy in time and cost and ensures integration of various aspects for formulation of project proposals for sustainable development at microlevel.

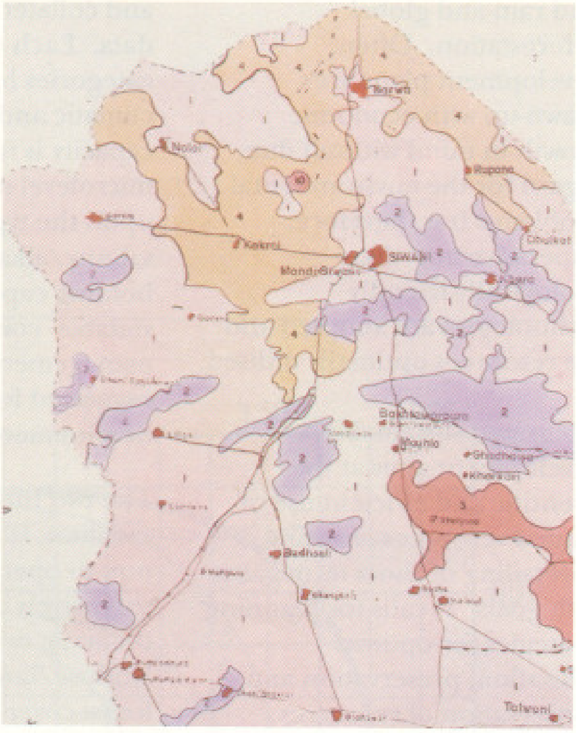


The six watershed areas which have now been selected for implementation of the action plans are located in Ahmednagar, Anantapur, Bhiwani, Dharmapuri, Jhabha and Kalahandi. The remaining fifteen districts, where the pilot studies are to be completed by the end of 1992, will be taken up later. Pilot studies for an additional 122 districts located in various states and union territories have been initiated.

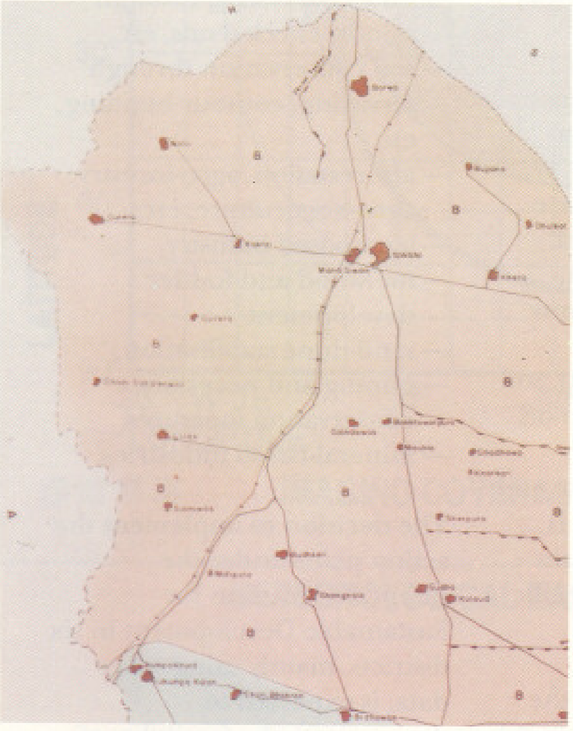
National prosperity and development depend primarily on the availability of natural resources and their proper utilisation. Though considerable progress has been made in the utilisation of natural resources like water, forests, land, ocean and marine resources, the benefits accrued are often shadowed by the resultant ecological degradation and environmental problems. These problems, related to over exploitation of the natural resources, have reached alarming proportions in several developing countries including India. The population growth and increasing consumerism have resulted in soil erosion, soil degradation, water logging, floods, drought and pollution; further, these have impact on certain global phenomena such as green house effect, El Nino,



Geomorphological map showing landforms — Active Dunes (AD), Partially Stablised Dunes (PSD), Stablised Dune Complex (SDC) and Dune-Vale Complex (DVC)



Soil map showing different soil series/associations. Typic Torripsamments (1), Typic Torripsamments (coated)/Typic Camborthids (2), Typic Camborthids/Typic Torropsamments (coated) (3), Typic Torripsamments/Camborthids/Calciorthids (4), Typic Ustipsamments (10)



Ground water quality map showing highly saline (8), fresh in shallow and sodic in deep depths (5)

Landuse/Land cover map showing wasteland (Desertic sandy area and scrub land) (Red) and double — cropped areas (yellow)

Typical Maps generated for Integrated Sustainable Development in parts of Bhiwani District acid rain and global deforestation. Often, development plans are drawn-up with economic growth in mind without due regard for the environmental problems. It is therefore, imperative now that ecologically-friendly technologies are adopted and the resources optimally utilised.

Integrated sustainable development aims at the scientific and efficient use of natural resources ensuring dovetailing of short term gains with goals. It calls for planning strategies for optimal utilisation, preservation and conservation of resources. Sustainable development plans will result in providing local solutions taking into account the global and regional factors thus assuring availability of these resources for the future generations.

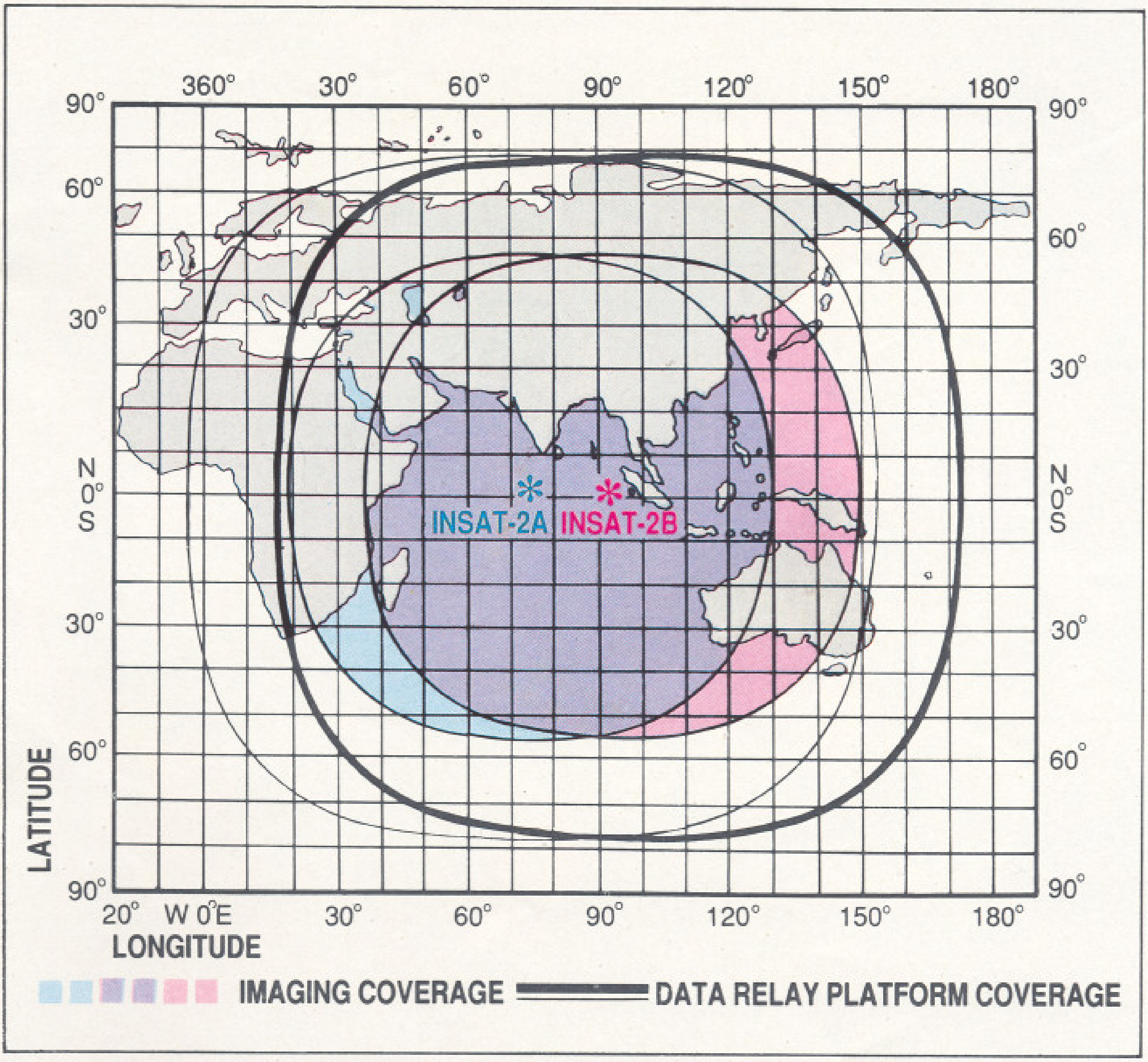
Space technology has a key role to play in the development of integrated sustainable development models. In India, satellite remote sensing is already playing an important role in many areas such as wasteland development, ground water harnessing, afforestation, drought combating, flood management and soil conservation. Pilot studies on the integrated approach for sustainable development have been taken up under the National Natural Resources Management System (NNRMS) for which the Department of Space is the nodal agency. The studies cover 21 districts in the country representing diverse terrains, agroclimatic zones and social and cultural practices. Site specific solutions are being evolved through integrated resources survey using satellites and collateral conventional data. Each of the land categories having similar climatic and productive capacity is further divided into microlevel units depending upon the type of soil-erosion, salinity/alkalinity, moisture holding capacity, etc., and suitable conservation/ management prescriptions suggested for their development.

The two Indian remote sensing satellites, IRS-1A and IRS-1B, now in operation, are being extensively used to generate thematic maps indicating landuse/landcover, wasteland, forest cover/type, surface water, drainage, ground water potential zones, geomorphology (landforms), geology (rock types) and soil types. Verification and validation of these thematic maps are carried out through ground checks. Survey of India topographs are used for generating information on slopes and other geographic details. Meteorological data (rainfall distribution, evapo-transpiration, etc.) are collected from existing data bases. Based on these data, maps such as slope-map, land capability map, priority watersheds, irrigability map, soil erosion status map and run-off potential area maps are generated. Socio-economic and demographic information is taken from the available data bases and also through specific surveys designed for the purpose. Socio-cultural information pertaining to the area is collected through special surveys.

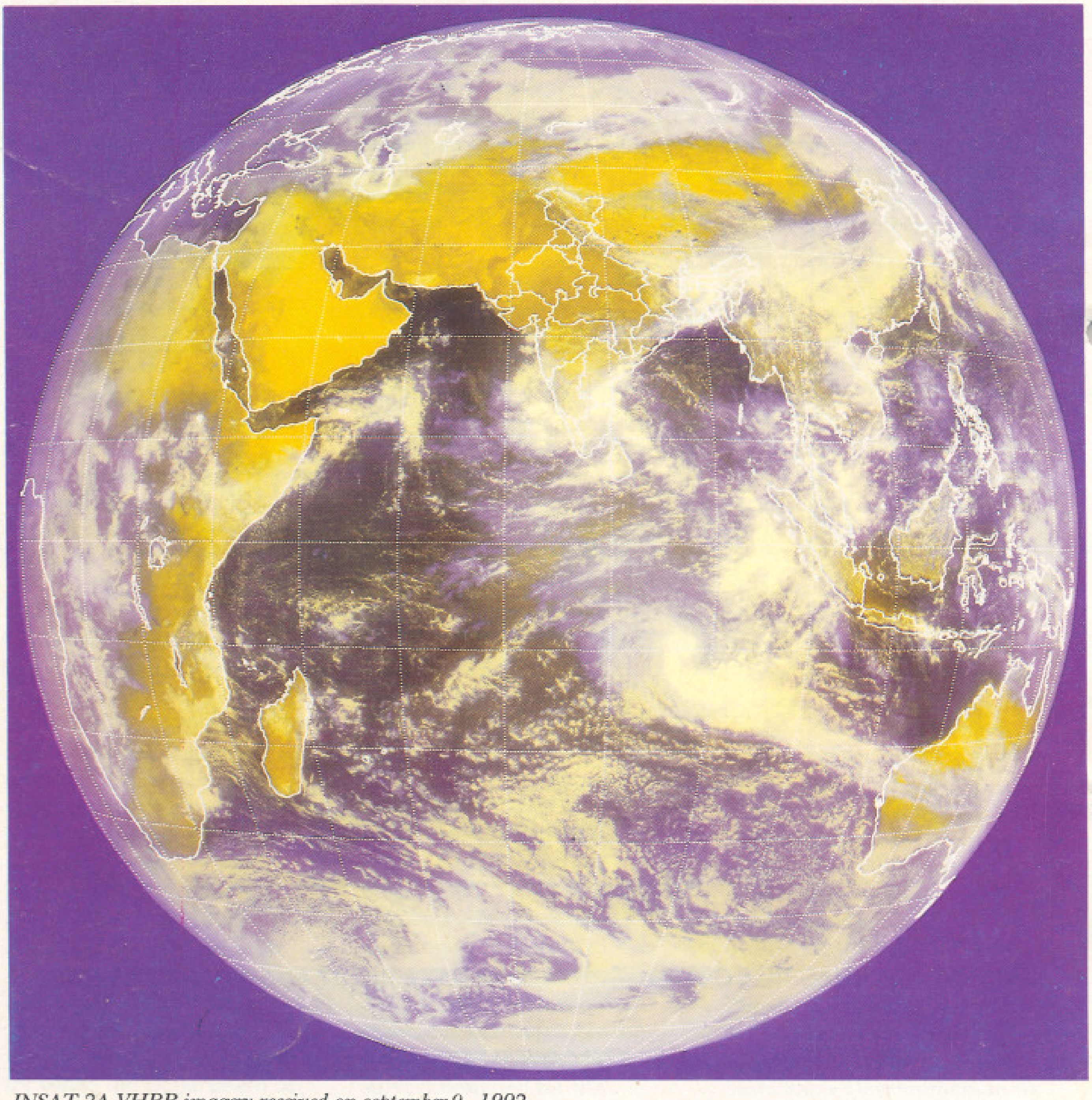
All this information is then integrated using Geographic Information System software. To start with, the priority areas for development are arrived at. Also, taking into account the ongoing developmental programmes for the districts, a watershed/block is selected for generation of detailed action plans for its development through the synthesis of the thematic maps, derived maps and meteorological socio-economic, socio-cultural and demographic information. The locale-specific action plans contain recommendations for optimum management practices for land and water resources, developmental efforts, change of existing practices, etc. The long-term environmental impacts of the developmental efforts are taken note of while generating such action plans for ensuring sustainable development. The recommendations include identification of sites for:

- water harvesting through ponds, check dams, etc.
- soil conservation through terracing, contour bunding, etc.
- afforestation, agro-forestry, agro-horticulture, etc.
- agro-based industry
- fuelwood and fodder development
- sand-dune stabilisation
- mining and necessary conservation measures
- mineral-based industries

The decision to implement the action plans under the Integrated Mission for Sustainable Development in six districts, mainly using space data, is expected to demonstrate the feasibility of achieving allround development at microlevel through the judicious use of natural resources without the degradation of environment. □



METEOROLOGICAL EARTH COVERAGE OF INSAT-2 SYSTEM



INSAT-2A VHRR imagery received on september 9, 1992