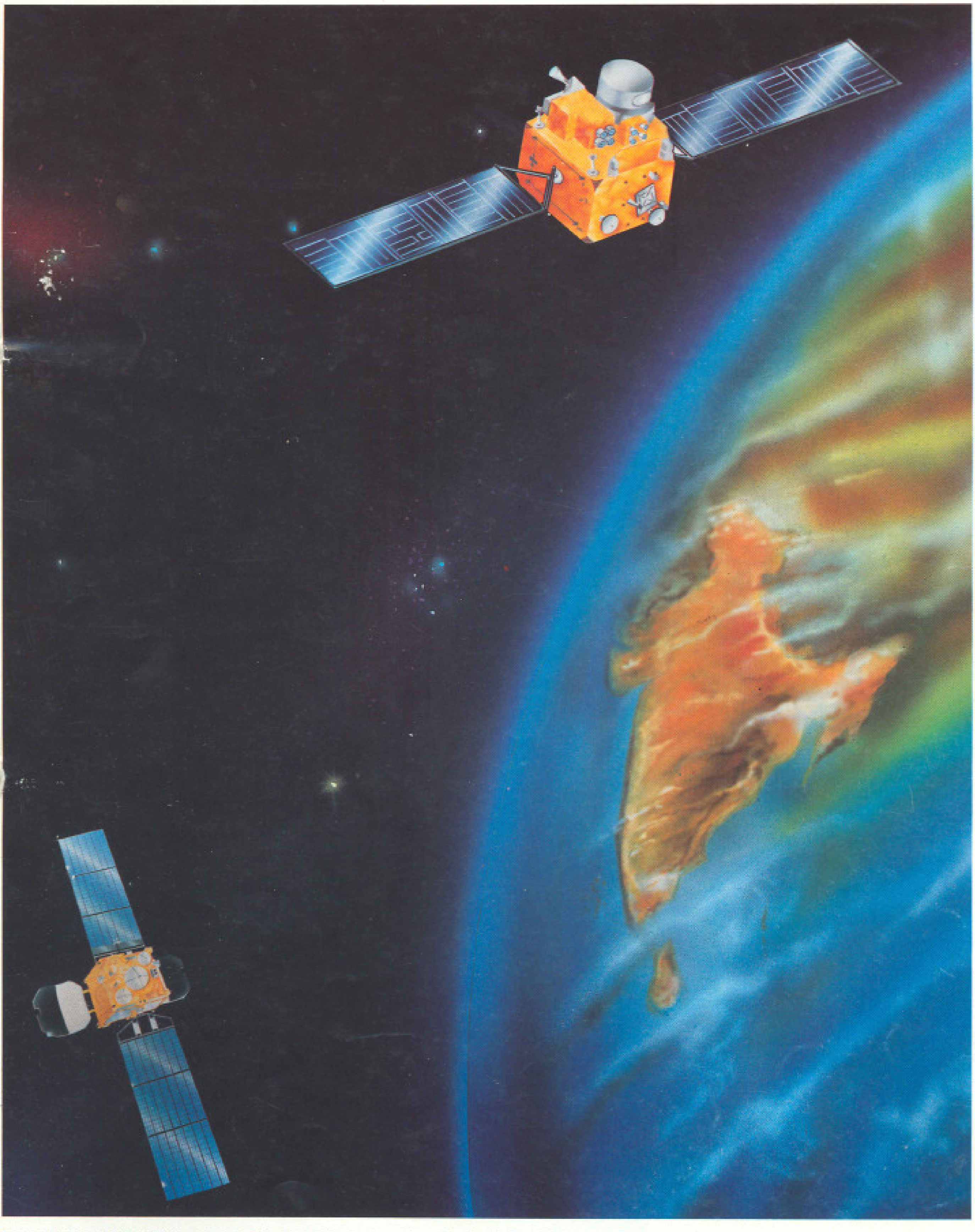
JULY-DEC. '95

SPACE india



INDIAN SPACE RESEARCH ORGANISATION

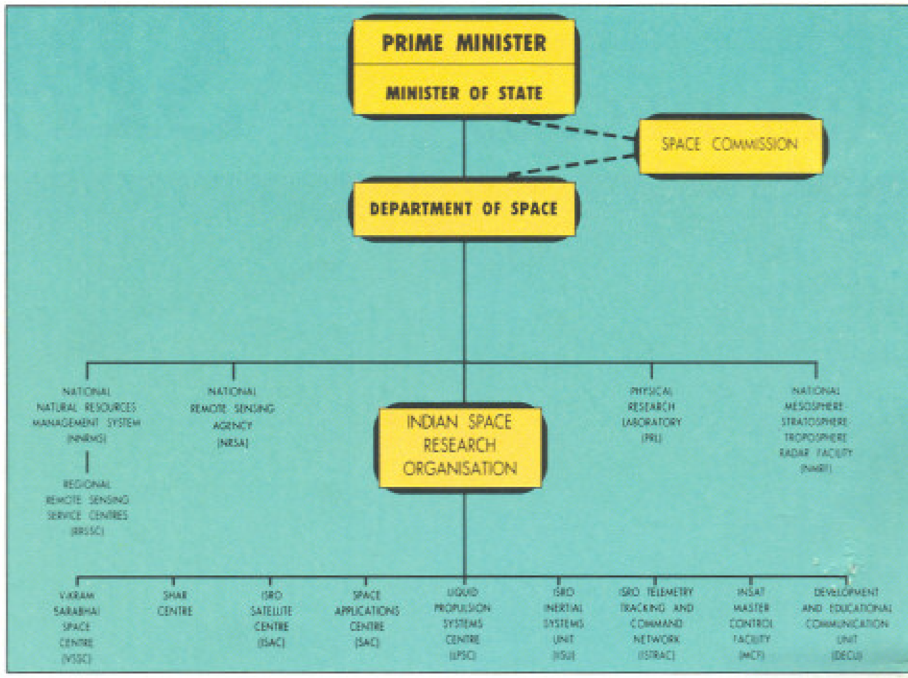
The Indian Space Programme

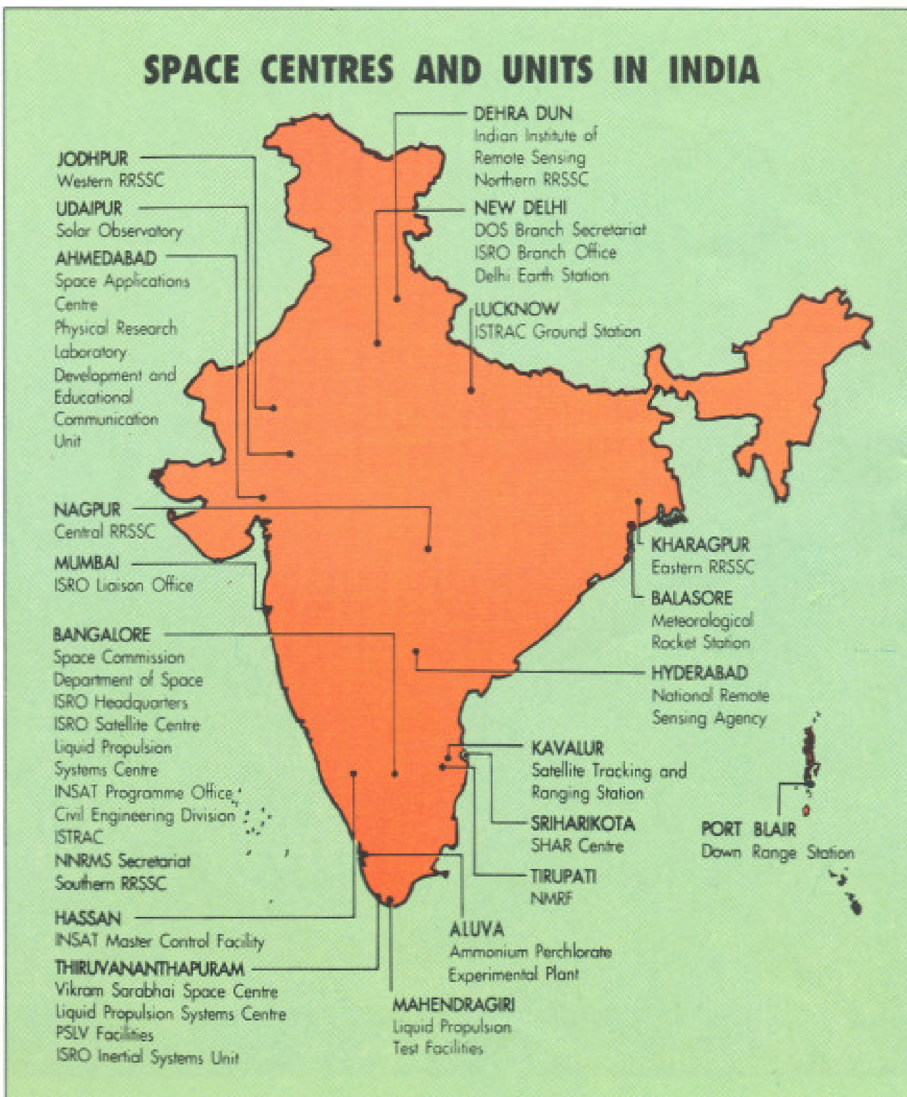
The setting up of the Thumba Equatorial Rocket Launching Station (TERLS) in 1963 marked the beginning of the Indian Space Programme. The Space Commission and the Department of Space (DOS) were established by the Government of India in 1972 to promote unified development and application of space science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

Remarkable Double!

INSAT-2C and IRS-1C, both launched in December 1995, are now orbiting the earth – IRS-1C in Polar orbit and INSAT-2C in Geostationary equatorial orbit. An artist's view

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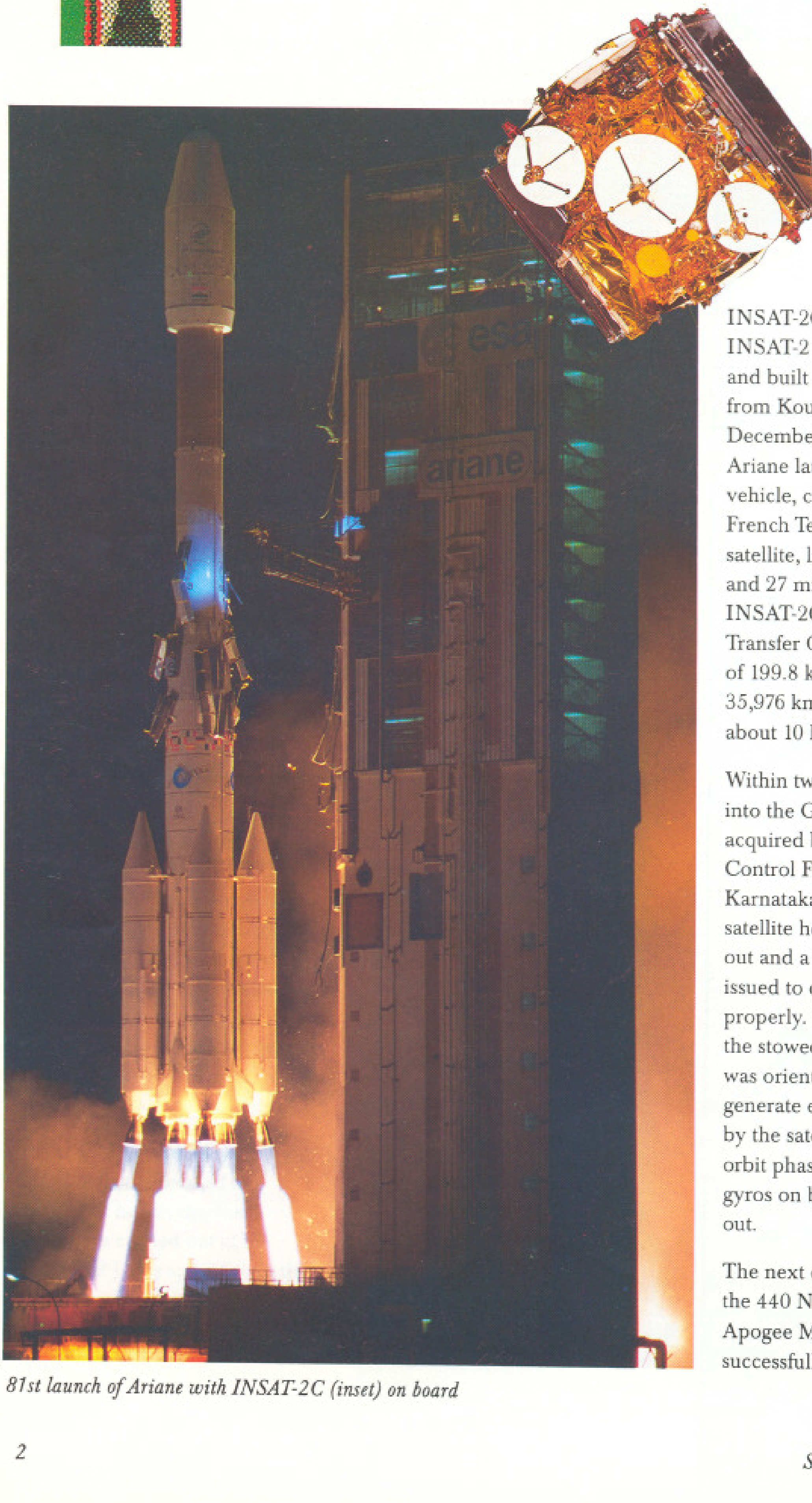
INSAT-2C
L A U N C H E D



81st launch of Ariane with INSAT-2C (inset) on board

INSAT-2C, the third in the INSAT-2 series of satellites designed and built by ISRO, was launched from Kourou, French Guyana, on December 7, 1995 on board an Ariane launch vehicle. The Ariane vehicle, carrying INSAT-2C and a French Telecom-2C communication satellite, lifted off at 0453 hours IST and 27 minutes later, injected INSAT-2C into a Geosynchronous Transfer Orbit (GTO) with a perigee of 199.8 km and an apogee of 35,976 km with an orbital period of about 10 hrs 30 min.

Within two minutes of its injection into the GTO, the satellite was acquired by the INSAT Master Control Facility (MCF) at Hassan in Karnataka. Immediately thereafter, satellite health checks were carried out and a series of commands issued to orient earth-viewing face properly. The outermost panel of the stowed solar array on the south was oriented towards the sun to generate electrical power required by the satellite during its transfer orbit phase. The calibration of the gyros on board was also carried out.

The next day, at 0658 hours IST, the 440 Newton thrust Liquid Apogee Motor (LAM) on board was successfully fired for a duration of

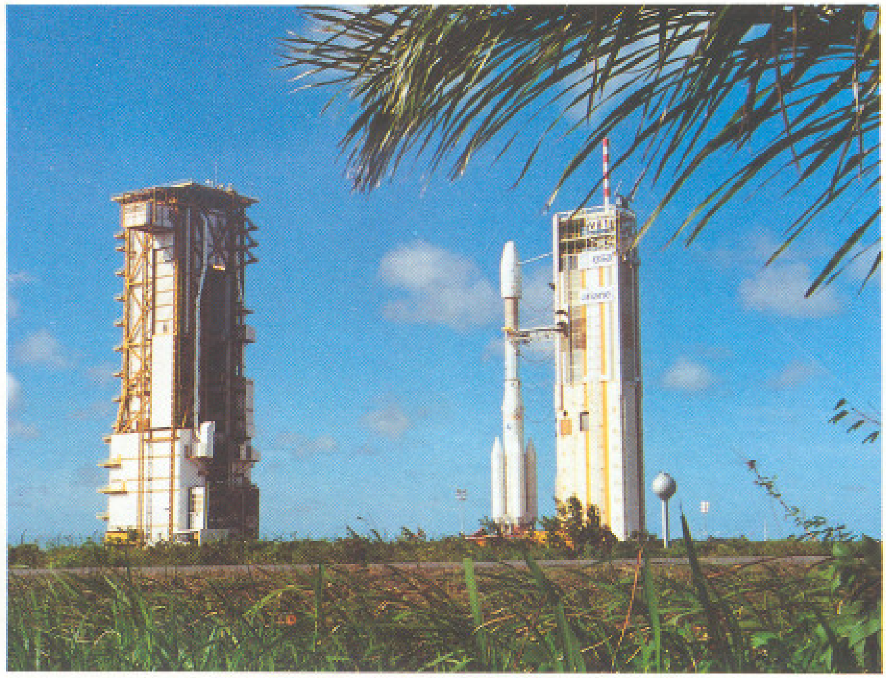
64 min to place the satellite in its first intermediate orbit with its perigee raised to about 14,420 km. The second orbit raising operation was carried out on December 9, 1995 at 1402 hours IST. This operation which was for a duration of 29 min 30 sec, put the satellite in its second intermediate orbit with an apogee of 35,786 km and a perigee of about 31,894 km with an orbital period of about 22 hrs 20 min. From then on the satellite has remained within the radio visibility of MCF.

Precise orbit determination was carried out over the next two days and, on December 11, 1995 at 1050 hours IST, the third orbit raising manoeuvre was carried out by firing the LAM for 186 seconds placing the spacecraft in a circular geosynchronous orbit. The spacecraft, which was at that time located at 78° E longitude, was drifting slowly towards its final orbital location of 93.5° E longitude.

Deployment of solar arrays and antennas of the satellite was successfully completed on December 12, 1995. The operation was carried out in four steps: solar array on the south side at 0950 hours IST, antenna reflector on the west side at 1225 hours IST, solar array on the north side at 1436 hours IST and east side antenna at 1548 hours IST.

The following day the satellite was configured in the 3-axis stabilisation mode and subsequently initial switch-on of communications payloads was taken up in a phased manner.

INSAT-2C will be put into operation in February 1996 after it is finally colocated with INSAT-2B at 93.5° E longitude and all the payloads are checked out in orbit.



Ariane ready for lift-off

The Indian National Satellite System, INSAT, is a multi-purpose system for long distance telecommunications, meteorological earth observation and data relay, TV broadcasting and radio networking. Currently, the INSAT system consists of INSAT-1D, the last of the INSAT-1 series built by the Ford Aerospace Corporation, USA, and two indigenously built second generation satellites, INSAT-2A and INSAT-2B. The first of the INSAT-1 series, namely, INSAT-1A was launched by a Delta vehicle of USA in April 1982 but the satellite was deactivated in September 1982 due to propellant depletion. The second satellite, INSAT-1B, which was launched by US Space Shuttle in August 1983, worked well for its entire design life of 7 years. The third satellite, INSAT-1C, launched by Ariane in July 1988, was abandoned in November 1989 following a power anomaly. INSAT-1D was launched in June 1990 from Kennedy Space Centre, USA on a Delta vehicle. INSAT-1D, located at 83° E longitude, is the last in the INSAT-1 series and is still in operation.

The first satellite in the indigenously built second generation series, INSAT-2A, was launched by Ariane from Kourou, French Guyana, on July 10, 1992. The satellite, located at 74° E longitude is working satisfactorily since its commissioning. INSAT-2B, the second satellite, was also launched by Ariane on July 23, 1993 and is functioning satisfactorily. It is located at 93.5° East longitude. INSAT-2A and INSAT-2B are identical satellites, each of them carrying 18 C-band/extended C-band Fixed Satellite Service (FSS) transponders, two high-power S-band transponders, a Data Relay Transponder, a 406 MHz search and rescue transponder and a Very High Resolution Radiometer (VHRR) with a resolution of 2 km in visible and 8 km in infrared bands.

INSAT-2C, when commissioned, will further enhance the INSAT system capacity. It will enable TV programme outreach Indian boundaries catering to the population in countries stretching from South East Asia to West Asia.

Salient Features

Orbit :	Geostationary
Location :	93.5 ° E longitude (colocated with INSAT-2B)
Mass at lift-off :	2,070 kg
Dry Mass :	980 kg
Main Body :	Dimension: 2.3 m x 2.5 m x 2.7 m Fully deployed Length: 14.6 m
Apogee Motor :	440 N, Liquid Engine
Attitude and Orbit Control	3-axis body stabilised using momentum wheels, magnetic torquer and reaction control thrusters
Antennas	1.8 m dia C/S band (two nos. in-orbit deployed) 0.9 m dia MSS Receive and Transmit 0.7 m dia S/C band Receive and C-band Transmit 0.6 m dia Ku-band Receive and Transmit and Global Horn
Power	1455 W using 23 sq m solar array Two 24 Ah Ni-Cd batteries back-up

In addition, it incorporates payloads for services like mobile satellite service and transponders in Ku-band for business communication. However INSAT-2C does not carry meteorological payloads.

The INSAT-2C payloads comprise the following:

A) Fixed Satellite Services (FSS):

- Two 50 W, seven 10 W and three 4 W transponders in C-band.
- Two 10 W and four 4 W transponders in extended C-band.
- Three 20 W Ku-band transponders and a Ku-band beacon.

B) Broadcast Satellite Services (BSS):

One transponder operating in C-band for the up-link and S-band for the down-link employing a 50 W S-band TWTA for broadcasting television and radio programmes.

C) Mobile Satellite Services (MSS):

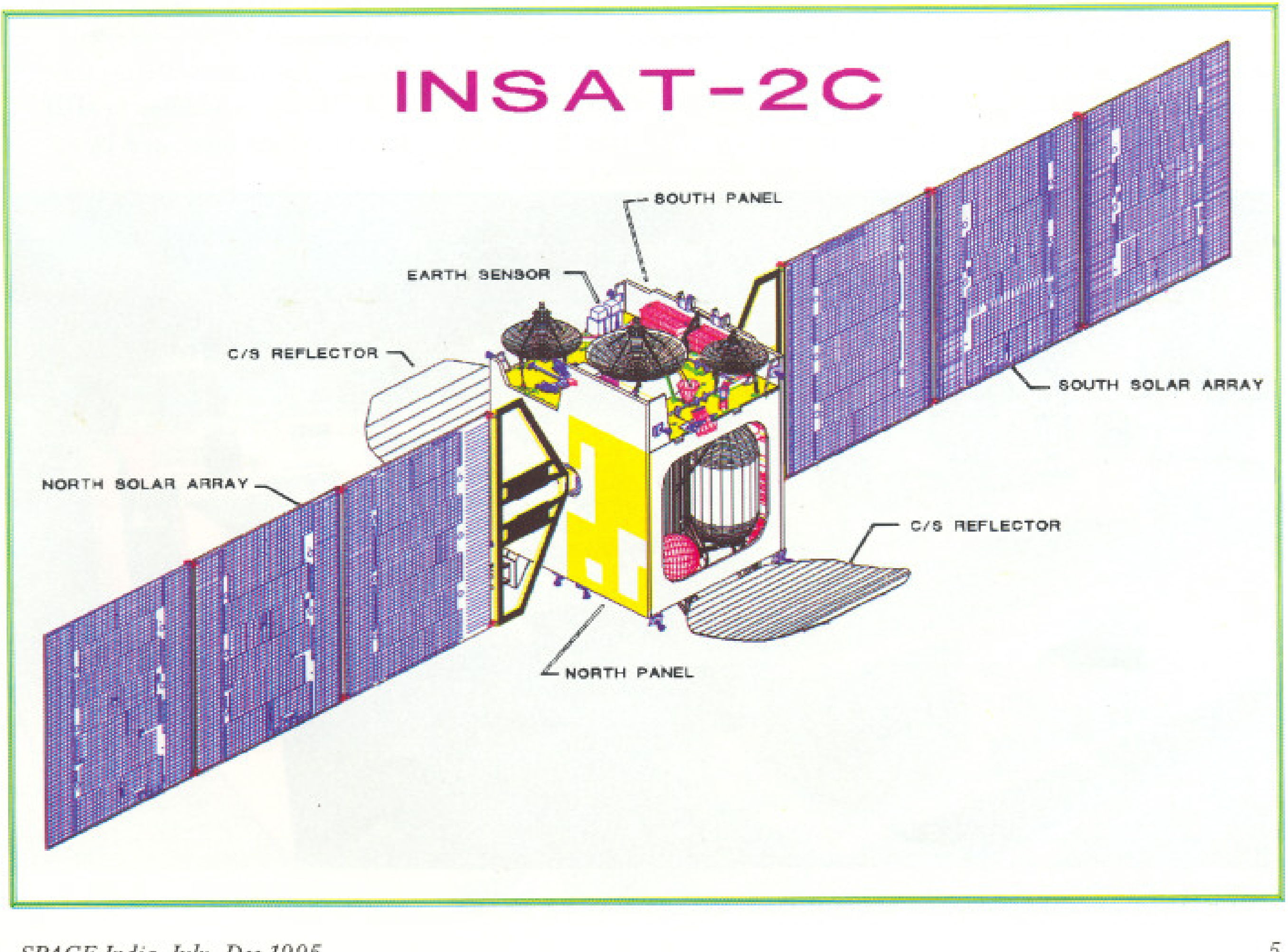
- Forward Link Transponder (CxS) and a Return Link Transponder (SxC).

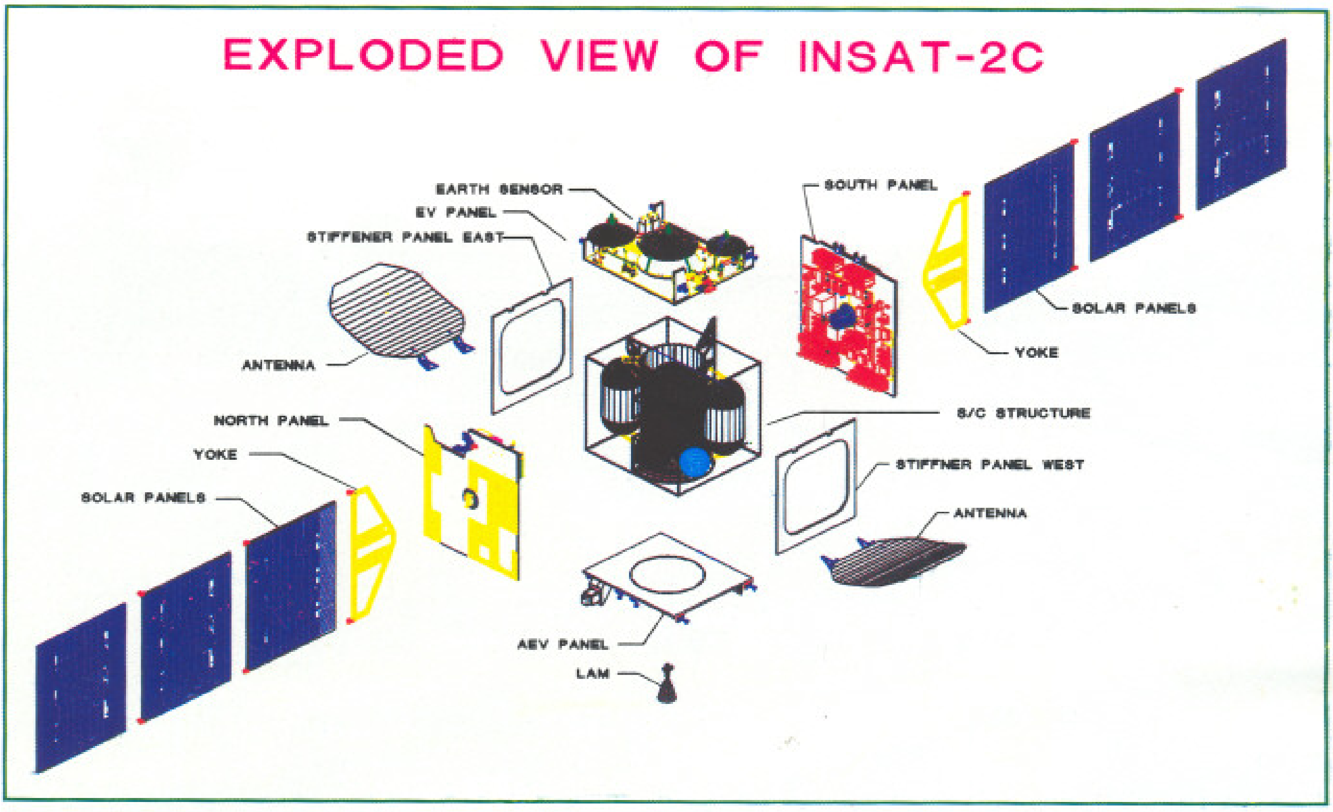
The configuration of INSAT-2C is significantly different from that of INSAT-2A and INSAT-2B because of the absence of the long boom and the solar sail consequent to the removal of the meteorology payload, the Very High Resolution Radiometer. Unlike its predecessors, the configuration is symmetric with three solar panels each on the north and south sides of the spacecraft.

The INSAT Master Control Facility (MCF) at Hassan in Karnataka supports operations during all

INSAT-2C being loaded into aircraft at Bangalore airport for transport to Kourou

INSAT Master Control Facility at Hassan, Karnataka





phases – early orbit, orbit raising, station acquisition and in-orbit. These include: tracking, telemetry, commanding, health monitoring and analysis, orbit determination and manoeuvres, eclipse operations and mission management. MCF now has five Satellite Control Earth Stations (SCES), besides the Satellite Control Centre (SCC), a network of computers and communications systems. SCES-1 has a fully steerable 14 m dia parabolic antenna and a 7.5 m dia limited-steerable antenna; SCES-2 is similar to SCES-1; SCES-3 has a 11 m dia fully steerable antenna; SCES-4 with multiple antennae to support Search and Rescue payloads, VHRR, DCP and MSS payloads and SCES-5 supports Ku-band operations. During the initial phases, in addition to MCF, INSAT-2C was supported by

INSAT Master Control Room at Hassan, Karnataka

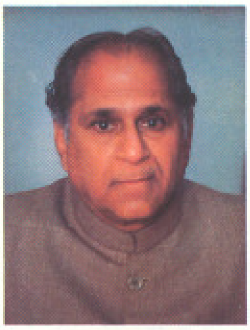
INTELSAT Organisation's ground stations at Perth (Australia), Fucino (Italy) and Clarksburg (USA).

The ISRO Satellite Centre, Bangalore, as the lead centre for the INSAT-2 project, was responsible for the design, development and integration and testing of the INSAT-2C. The payload, namely, the communication transponders has been developed by the Space Applications Centre, Ahmedabad. The Liquid Propulsion Systems Centre of ISRO developed and supplied the Liquid Apogee Motor and the reaction control systems. The Vikram Sarabhai Space Centre supplied the various composite element subsystems such as CFRP antenna and the pyro system. The ISRO Inertial Systems Unit, Thiruvananthapuram, was responsible for the design and development of the gyros, momentum wheels and the solar array drive and power transfer mechanisms. MCF, Hassan is responsible for the on-orbit operations of the satellite.

The INSAT system will soon be further augmented by INSAT-2D in 1996-97 and INSAT-2E in 1998 thus ensuring uninterrupted services. □

Prime Minister Congratulates ISRO

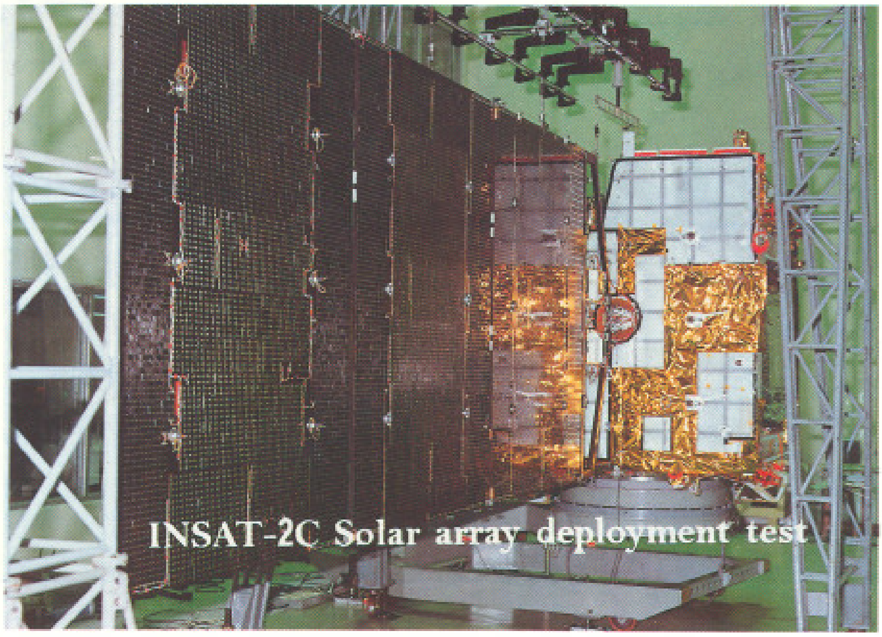
Prime Minister, Shri P V Narasimha Rao, in a message over telephone to Dr K Kasturirangan, Chairman, ISRO, congratulated all the personnel involved in INSAT-2C immediately after its successful launch on December 7, 1995. The Prime Minister said that the excellent team work among the scientists, engineers and others had made it possible for India to build the state-of-the-art satellite. He wished the scientists complete success in all the remaining operations on the satellite in the next few days.



Message from Minister of State

Shri Bhuvnesh Chaturvedi, Minister of State (In charge of Space) sent the following message to Dr K Kasturirangan, Chairman, ISRO :

"I am very happy to learn that INSAT-2C has been successfully launched this morning. I congratulate all your team members for this brilliant success. It is their dedication and team work that made it possible. The entire nation is proud of this achievement".



INSAT-2C Solar array deployment test

INSAT

TELECOMMUNICATION

OPERATIONAL

- 4410 Two-way voice circuits or equivalent 162 routes
- 210 Earth stations including 129 fixed and captive networks and 20 transportable terminals
- Over 700 micro-terminals in NICNET
- RABMN (543 terminals)
  - SBRTN (5 terminals)
  - MCPC VSAT (30)

UNDER IMPLEMENTATION

- Remote Area Communication
- Digitalisation of Satellite Earth Stations using IDR technology
- 64 Kbps TDM-TDMA network
- Provision of long distance telephone to remotely located subscriber using extended C-Band
- Crisis management with fly away terminals
- HVNET (High-speed VSAT Network)
- Ku-band IDR
- Ku-band NICNET operations

PTI

OPERATIONAL

Direct dissemination of news, stories & Fax to newspapers

NPL

COMMISSIONED

Standard time and frequent signals dissemination

SEARCH AND RESCUE

OPERATIONAL

- 406 MHz receiver on board INSAT-2A and 2B to receive distress alert signals from beacons
- Ground station receiver and processor located at Hassan and connected to COSPAS/SARSAT RCC/MCC

METEOROLOGY

OPERATIONAL

- Half-hourly synoptic full disc & sector scan
- 25 Meteorological Data Dissemination Centres (MDDs)
- 100 DCPs
- 15 DCPs in Yamuna catchment area
- 209 DWS deployed
- CxS broadcast of Met Imageries & data
- Transmission of processed VHRR imagery and other Met data on one carrier to SDUCs and any location in the country
- Over 75 MDD DRSs

UNDER IMPLEMENTATION

- Anchored buoy DCPs by NIO
- More DWS Receivers
- DCPs by SASE, NCA

TELEVISION

OPERATIONAL

- National service covering over 700 TV stations
- About 100,000 DRSs
- Regional services for 13 states, AP, TN, Karnataka, Maharashtra, West Bengal, Orissa, Gujarat, Assam & NE, MP, UP, Rajasthan, Kerala & J&K
- Three Metro channels

UNDER IMPLEMENTATION

- Additional Regional Services
- Satellite news gathering (SNG)
- Expanded coverage (West, Central, and South East Asia)
- Ku-band SNG

RADIO

OPERATIONAL

- 26 RN channels-II from Delhi
- Uplinking facilities from Delhi, Bombay, Calcutta and Madras and 13 major programme producing centres.
- Multi channel receive only terminals at over 182 Air stations
- National Service channel feed
- 17 C-band receive only terminals

UNDER IMPLEMENTATION

- Additional RN channels
- Uplink facility from N.E.

Mobile Satellite C[illegible]on Services from INSAT-2

Mobile Satellite Communications (MSC) is a new service that will be available from INSAT-2C and its follow-on satellite, INSAT-2D. Along with Very Small Aperture Terminal systems and Broadcast Satellite Services this service is one of the fastest growing sectors in the satellite communications.

The MSC system consists of three major components, space segment (mobile communications payload) the Hub station and its interface with Public Switched Telephone Network (PSTN), and user segment (consisting of mobile and transportable terminals). The space-segment consists of two transponders, a Forward Link Transponder (CxS) and a Return Link Transponder (SxC). The forward link transponder receives the up-link signals from the Hub Station translates, amplifies and transmits them to mobile terminals. The return link transponder receives the up-link signals from the mobile terminals and translates them before transmission. The system covers India and surrounding seas.

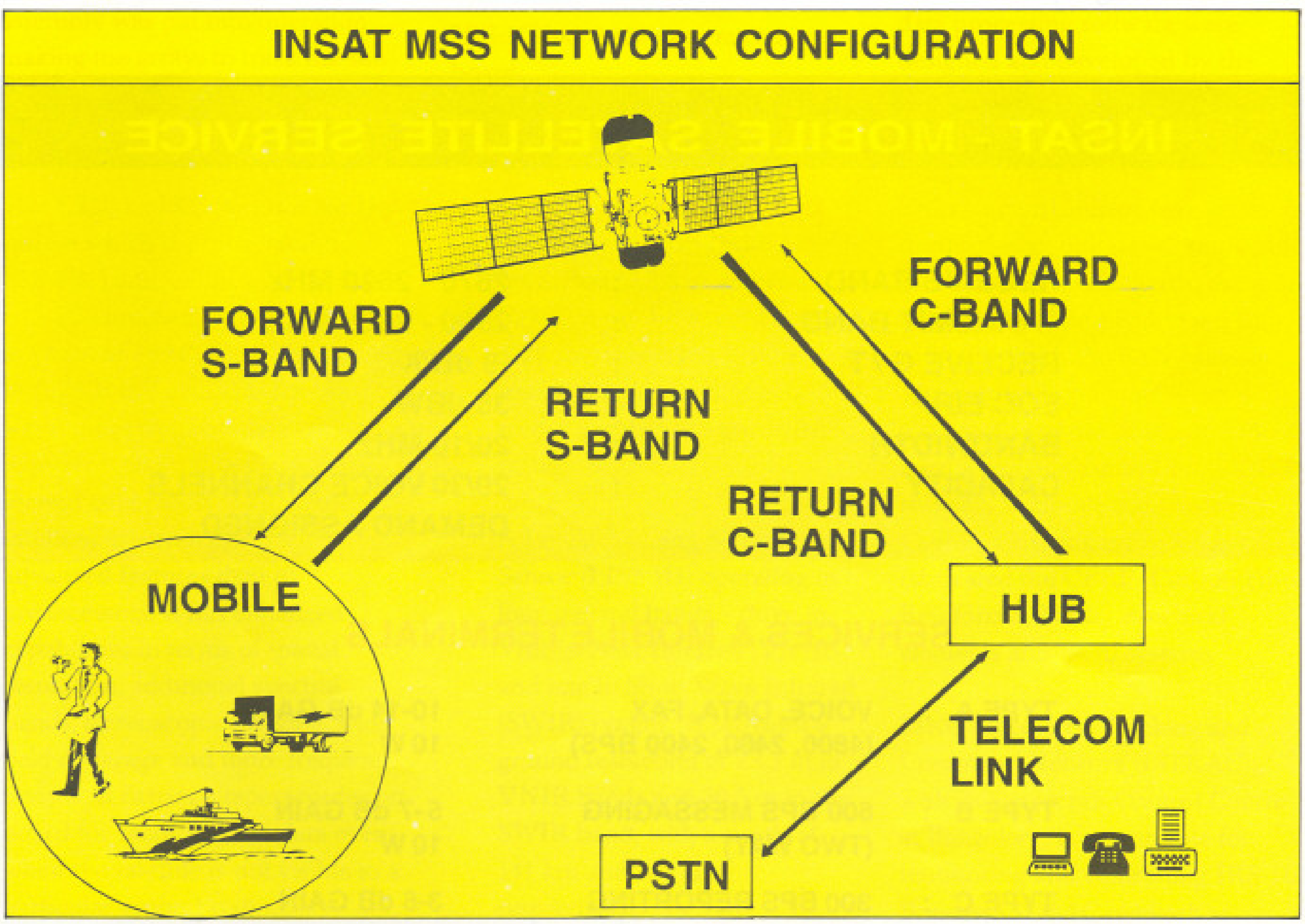
INSAT-MSC system provides three classes of services:

Class-A : Voice, data and fax

The system allows direct dial telephone (voice) interconnection between mobile terminals and PSTN subscribers and between one mobile terminal and the other. Data service provides connection between the mobile terminal and PSTN. Facsimile service is provided between mobile terminal and PSTN. It is also possible to provide broadcast type 'group call services' to a selected group of mobile terminals. Type-A terminals providing these services can be vehicle-mounted for land mobile applications, ship-borne operating in the marine environment or portable which can be deployed in the field.

Class-B : Messaging

This is a store and forward



messagin[...] shared b[...] Station a[...] unit for message transfers between mobile and terrestrial end user and, between mobile users. The communication between the Hub Station and the terrestrial-end user is via telex or PSTN data lines. As in the case of Class-A, this service also has three types of terminals.

Class-C : Reporting

Class-C service is a one-way "reporting" service from a mobile to a terrestrial user. In this service also the Hub Station acts as the store and forward unit for forwarding the messages via either telex or PSTN circuits. Type-C terminals providing this service are portable type with low gain antennas and do not require any elaborate deployment in the field. As there is no return acknowledgement, the system is designed for high probability of success for message transfer.

[...] Class-C services also [...]ail Box service at [...]. Priority is accorded for distress messages originating from any mobile terminal.

All the three classes of services will be available for land mobile and maritime users under a clear line-of-sight environment. Land mobile services will be restricted to rural areas, highways and open areas where the link availability is better than 90 per cent.

The Hub Station serves as the link between mobile terminals and PSTN. It stores all telex messages originating from Type-A and Type-B terminals and forward them to telex subscribers. Similarly, the incoming telexes are forwarded to mobile users. It gives priority to distress messages over others. It receives and recovers "reporting" messages from Type-C terminals and forwards them to PSTN and telex subscribers. Hub Station can be used for Mailbox service.

Being new, the demand for mobile satellite service in the country is expected to pick-up sharply only in due course. Thus, initially only a limited capacity of 30 voice circuits and three messaging carriers is planned using INSAT-2C and with similar capacity from INSAT-2D. The capacity will be enhanced by increasing the on-board RF power as well as through multiple beams in the INSAT-3 series of satellites. □

INSAT - MOBILE SATELLITE SERVICE

PAYLOAD PARAMETERS

RECEIVE BAND	:	2670 - 2690 MHz
TRANSMIT BAND	:	2500 - 2520 MHz
RECEIVE G / T	:	-9 dB/K
EOC EIRP	:	35 dBW
BANDWIDTH	:	20/10 MHz
CAPACITY	:	20/30 VOICE CHANNELS DEMAND ASSIGNED

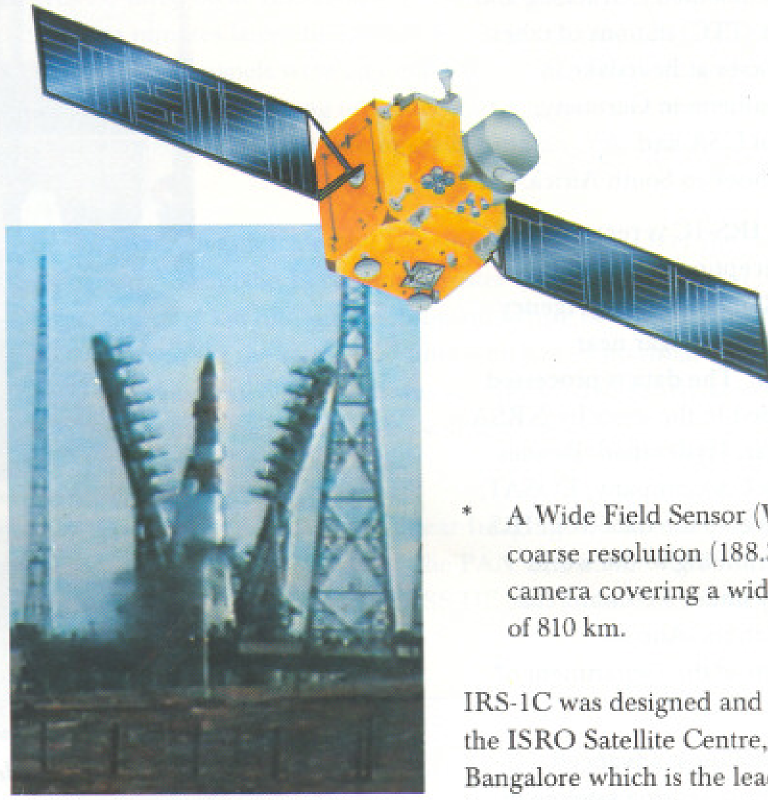
SERVICES & MOBILE TERMINALS

TYPE A :	VOICE, DATA, FAX (4800, 2400, 2400 BPS)	10-14 dB GAIN 10 W
TYPE B :	600 BPS MESSAGING (TWO WAY)	5-7 dB GAIN 10 W
TYPE C :	300 BPS REPORTING	3-6 dB GAIN

IRS-1C Launched

The third of the Indian remote sensing satellite, IRS-1C, was launched by a Russian Molniya rocket from Baikonur Cosmodrome in Kazakhstan on December 28, 1995. The rocket carrying the satellite lifted off at 1215 hours IST and 15 minutes later, IRS-1C was injected into a 817 km polar orbit. About 93 seconds after injection, the two solar panels were automatically deployed by an on-board sequencer. Subsequently, sun-acquisition (the process of aligning the spacecraft negative yaw axis towards the sun) was carried out and the solar array drive assembly was put into operation making the arrays to track the sun and generate the required electrical power.

The 1,250 kg IRS-1C joins the IRS system which is now served by IRS-1B, launched in 1991 and IRS-P2 launched by India's PSLV in October 1994 (IRS-1A launched in 1988 is still available for use when more frequent data is required). IRS-1C belongs to the second generation of IRS series of satellites incorporating more advanced features than its predecessors. It has enhanced capabilities in terms of spatial resolution, additional spectral bands, stereoscopic imaging, wide field coverage and more frequent revisits. It carries a taperecorder on board for recording the data even when the satellite is not visible to a particular ground station.



Molniya lifts off with IRS-1C (inset) on board

IRS-1C has three cameras on board:

* A Panchromatic camera (PAN), which is a high resolution camera operating in Panchromatic band with a resolution of 5.8 m and swath of 70 km; it can be steered up to ± 26 deg across-track, thus enabling revisit and stereoscopic imaging of a particular scene.

* A Linear Imaging Self-scanning Sensor (LISS-III) operating in four spectral bands - three in Visible/Near Infrared (VNIR) and one in Short Wave Infrared (SWIR) ranges. It provides a ground resolution of 23.5 m in VNIR bands and 70.5 m in the SWIR band, with a swath of 141 km and 148 km, respectively.

* A Wide Field Sensor (WiFS), a coarse resolution (188.3 m) camera covering a wide swath of 810 km.

IRS-1C was designed and built by the ISRO Satellite Centre, Bangalore which is the lead Centre for all ISRO satellite projects. The three camera payloads and camera data processing software were designed and developed by the Space Applications Centre (SAC), Ahmedabad. The ISRO Inertial Systems Unit (IISU) at Thiruvananthapuram is responsible for the design and development of the reaction wheels, gyros, the solar array drive assembly and steering mechanism for the PAN camera. The Liquid Propulsion Systems Centre, Bangalore, is responsible for the reaction control propulsion systems. Vikram Sarabhai Space Centre, Thiruvananthapuram fabricated the CFRP (Carbon Fibre Reinforced Plastic) structural elements and pyro systems.

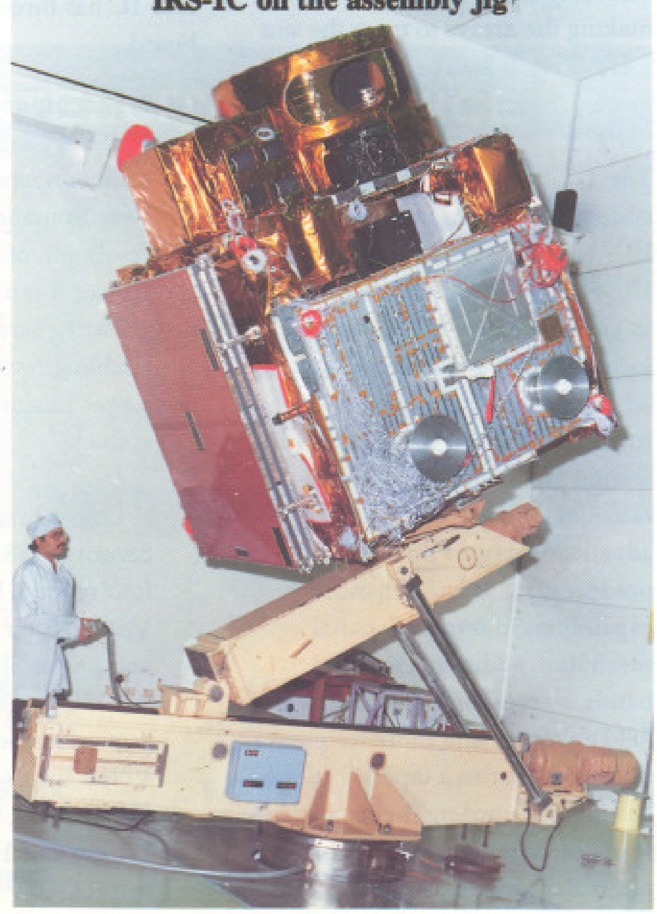
ISRO Telemetry, Tracking and Command Network (ISTRAC), with its Spacecraft Control Centre at Bangalore, is responsible for monitoring and controlling IRS-1C. Besides, ISTRAC network of stations at Bangalore, Lucknow and Mauritius, IRS-1C is supported during the initial phases of the mission by Telemetry, Tracking and Command (TTC) stations of other space agencies at Bearslake in Russia, Weilheim in Germany, Pokerflat in USA and Hartebeeshoek in South Africa.

Data from IRS-1C is received by the data reception centre of National Remote Sensing Agency (NRSA) at Shadnagar near Hyderabad. The data is processed and provided to the users by NRSA at Balanagar, Hyderabad. Besides NRSA, the US Company, EOSAT, will also receive the data from IRS-1C for distributing to the world community under a commercial contract with the Antrix Corporation of the Department of Space.

IRS-1C is the most advanced civilian remote sensing satellite in the world. The unique combination of payloads makes the satellite a very useful tool for micro and macro level management of resources, particularly in crop acreage and yield estimation, drought monitoring and assessment, flood mapping, landuse and land cover mapping, wasteland mapping, urban mapping and forest resources survey. It is also expected to open up several new areas of remote sensing applications like environmental monitoring and disaster management. The Integrated Mission for Sustainable Development (IMSD), initiated in 1992, will receive further fillip with the availability of high resolution data for generating locale specific prescriptions for micro level planning; especially, the availability of data at cadastral level can enable farmers to implement long term measures for sustainable development of their individual land holdings.

IRS-1C being loaded for thermovac test

IRS-1C on the assembly jig

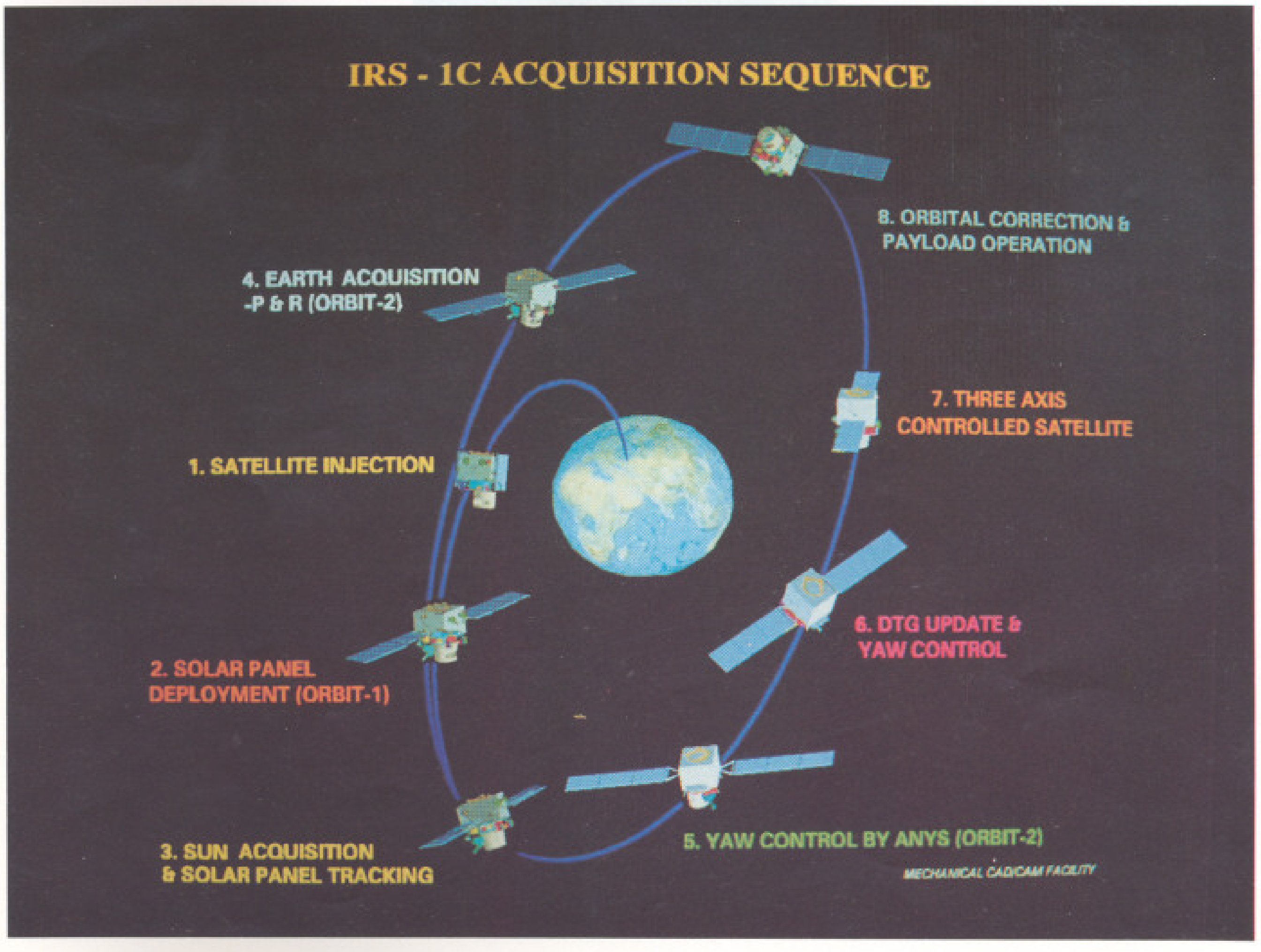


Sequence of Operations

The Russian Molniya rocket carrying IRS-1C lifted off at 1215 hours IST on December 28, 1995 from the Baikonur Cosmodrome in Kazakhstan. Fifteen minutes later, the satellite was injected into a 817 km polar orbit. About 93 seconds after injection, the two solar panels were automatically deployed by an on-board sequencer. Subsequently, sun-acquisition (the process of aligning the spacecraft negative yaw axis towards the sun) was carried out and the solar array drive assembly was put into operation making the arrays to track the sun and generate the required electrical power.

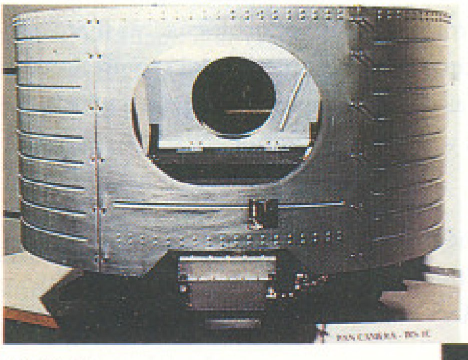
The steering hold-down mechanism of PAN camera was released on December 29, 1995. Over the next few days precise orbit corrections were carried out by firing the 11 Newton thruster of the satellite to put it into the desired sunsynchronous orbit at an altitude of 817 km (the sunsynchronism nature of orbit ensures that imageries taken from the satellite cameras are always at the same local time which is an essential requirement for this type of remote sensing satellites). The eccentricity of the orbit was also reduced to nearly zero with a frozen perigee to ensures that the imageries taken over various latitudes will have no significant scale variations due to orbital apsidal motions.

The high resolution Panchromatic Camera (PAN), the multi-spectral Linear Imaging Self Scanner (LISS-III) and the Wide Field Sensor (WiFS), were switched on January 5, 1996; the PAN at 9.25 am (IST) during the 113th orbit and the other two cameras, Linear Imaging Self Scanner (LISS-III) and Wide Field Sensor (WiFS) during the subsequent orbit.

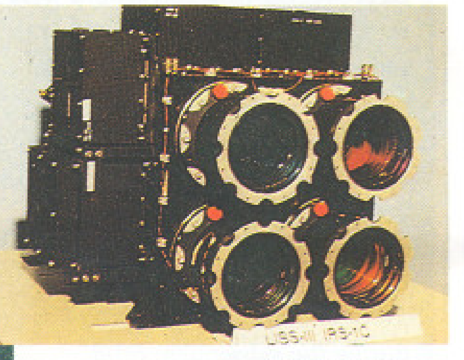


Payloads

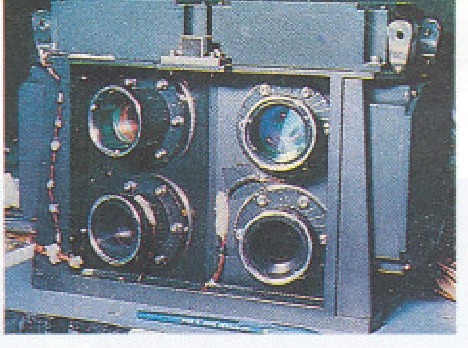
	PAN	LISS-3		WIFS
		VNIR	SWIR	
Spatial Resolution (m) :	<10	23.6	70.8	189
Swath (km) :	70	142	148	810
Spectral Band (Microns) :	0.5-0.75	0.52-0.59 0.62-0.68 0.77-0.86	1.55-1.7	0.62-0.68 0.77-0.86
No. of Gray Levels :	64	128	128	128



PAN Camera



LISS-III Camera



Wide Field Sensor

Salient Features

Orbit	:	Polar sun-synchronous circular
Altitude	:	817 km
Inclination	:	98.69 deg.
Eccentricity	:	0.0004
Period	:	101.35 minutes
Local time of Equatorial Crossing	:	10.30 a.m. (descending node)
Repetitivity cycle	:	24 days (for LISS-3)
	:	5 days (for WiFS)
Revisit	:	5 days (for PAN)
Weight at Lift-off	:	1,250 kg
Physical Dimensions Stowed	:	Length - 1650 mm Width - 1500 mm Height - 2100 mm
Attitude and Orbit Control	:	3-axis body-stabilised using Reaction Wheels, Magnetic Torquers and Hydrazine Thrusters
Power	:	809 W generated by 9.6 sq m in-orbit deployed solar panels, two 21 Ah Ni-Cd Battery back-up

IRS-1C Data Products

A variety of data products are available to users from IRS-1C. The raw data received by data reception station is subjected to different levels of processing as follows:

Level 0 (Raw Data):	Uncorrected
Level 1 (Browse Product):	Radiometrically and Geometrically corrected for earth rotation
Level 2 (Standard Product):	Both Radiometrically and Geometrically corrected
Level 3 (Special Product):	Processed Level-2 (like merging, enhancement, etc)

Data Products are supplied to users on both photographic and digital media. Black and White and False Colour Composite photographic products will be available on films and paper prints. Digital products will be supplied on Computer Compatible Tapes, Cartridges and floppy discs.

Types Of Data Products

Product	Sub-Type	Sensor	Scene Size
Standard	Path based, Fix/Float	LISS-III	141 x 141 km
			141 x 148 km for SWIR band
	Quadrant, Fix/Float	LISS-III	72 x 72 km
	Geocoded	LISS-III	Toposheet size
	Scene based	WiFS	810 x 810 km
	Path based, Fix/Float	PAN	23.9 x 23.9 km
			23.9 x 30.5 km at maximum tilt
	Geocoded (no mosaic)	PAN	Toposheet size
Stereo	Basic stereo pair	PAN	As per input
	Derived Stereo pair	PAN	As per input
	Ortho image	PAN	As per input
Special	System corrected raw data	All sensors	As per input
	Merged	LISS-III +PAN	23.9x23.9 km
	City Geocoded	PAN	As per input
	Three Strip mosaic		70 x 70 km(nadir)
			90 x 70 km(off nadir)
	District Geocoded	LISS-III	Variable
	Vegetation Index Map	WiFS	Full India Zonal

IRS-1C data will be available from:

In India

NRSA Data Centre
National Remote Sensing Agency
Balanagar
Hyderabad - 500 037, INDIA
Phone :91-040-278560
Fax : 91-040-278664

Outside India

EOSAT
4300, Farbes Boulevard
Lanham
Maryland 20707-9954, USA
Phone: 01-301-552-0537
Fax : 01-301-552-3762

IRS-1C Applications

Agriculture	:	Mixed-crop discrimination and inventory Large-area crop inventory Crop stress Detection/Monitoring
Forests	:	Type and species discrimination Forest stock mapping, Bio-mass estimation
Urban	;	Town and city mapping, Facility mapping
Landuse	:	Landuse/Landcover mapping change detection
Soil	:	Soil Mapping, Erosion Prone area mapping
Geology	:	Geological mapping, Geomorphological mapping
Terrain	:	Cadastral mapping
Water Resources	:	Surface Water Inventory, Ground Water Targeting, Command Area Management
Digital Elevation model	:	Contours Slope/Aspect Visualisation/Perspective
Environment	:	Environmental Impact Assessment/Monitoring Siting application
Disasters	:	Flood damage assessment Flood relief measures

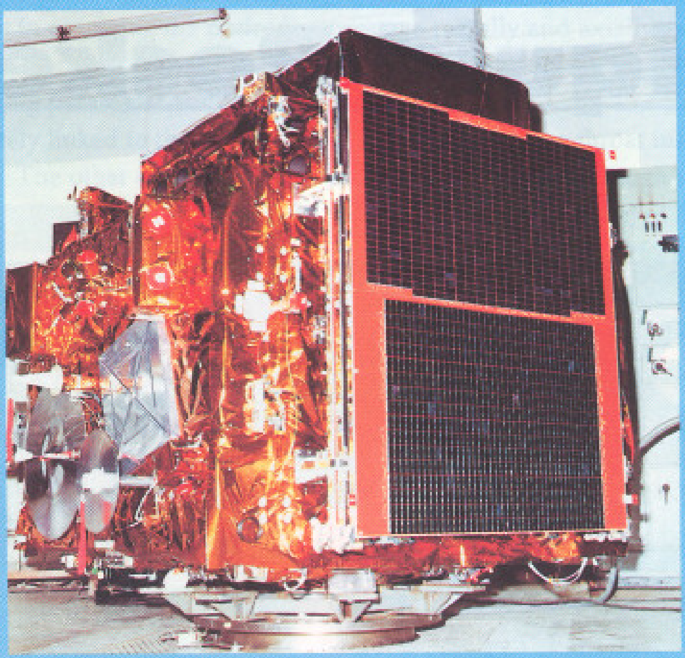
Prime Minister's Message

In a message to Dr K Kasturirangan, Chairman, ISRO, the Prime Minister Shri P V Narasimha Rao has said "I am delighted to hear that the Indian Remote Sensing Satellite IRS-1C has been successfully launched from Baikonur and that the satellite is functioning normally.

The launch of this second generation, indigenously built, state-of-the-art remote sensing satellite marks a major milestone in the country's satellite remote sensing programme, which has made a vital contribution to our developmental efforts by providing invaluable data on our natural resources.

On this occasion, I convey to you and all scientists, engineers and staff of the Indian Space Research Organisation felicitations on behalf of the Government and people of India on yet another successful mission."

IRS-1B Completes Four Years of Operation



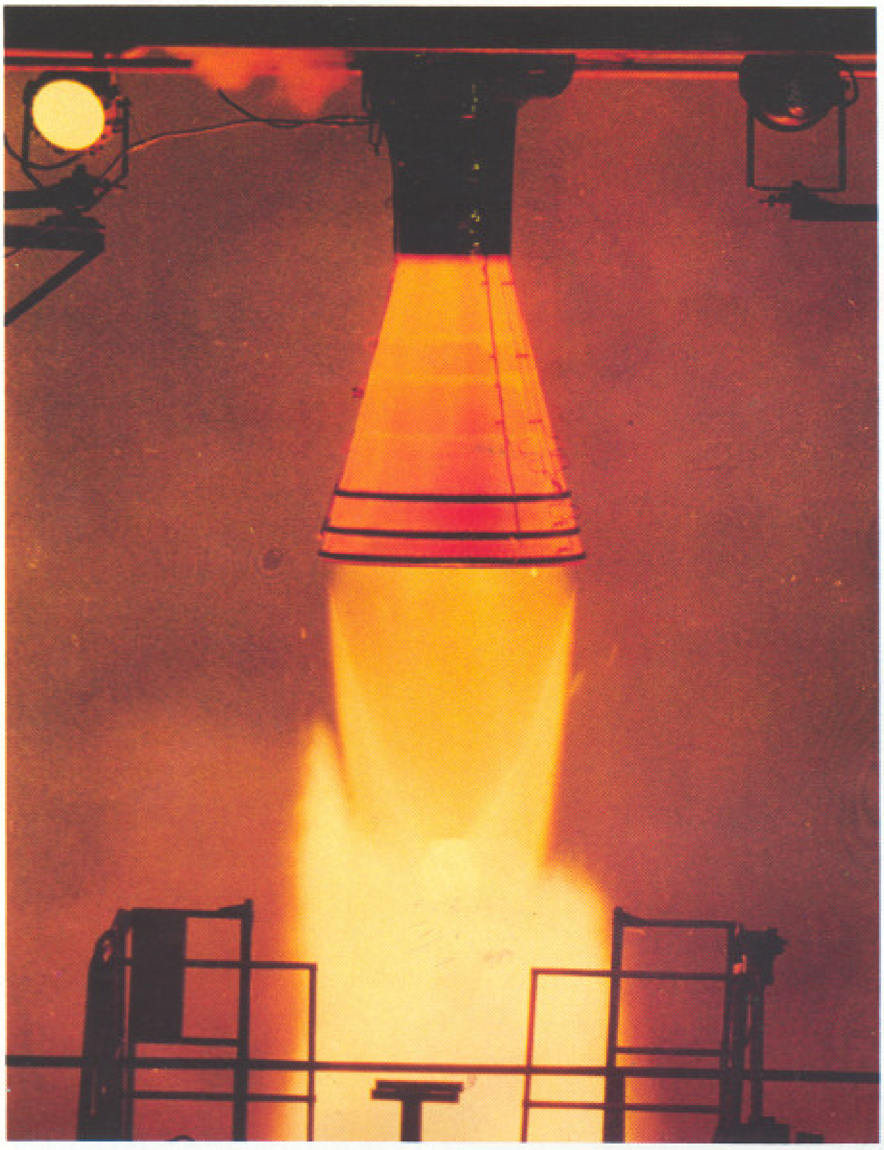
The second in the Indian Remote Sensing (IRS) satellite series, IRS-1B, has completed four years of successful operation. Launched on August 29, 1991, IRS-1B was designed for three years mission but continues to perform well providing valuable data to the various users. Its predecessor, IRS-1A has also exceeded its mission life by completing seven and a half years; it is still used whenever data is required more frequently.

Placed in a 900 km sun-synchronous polar orbit, the 975 kg IRS-1B, carries two types of cameras, Linear Imaging Self Scanner, LISS-I and LISS-II, having spatial resolutions of 72.5 m and 36.25 m, respectively. LISS-I has a swath of 148 km while the two LISS-II cameras have a composite swath of 148 km. IRS-1B has a repetitivity cycle of 22 days.

Outside India, the data from IRS-1B is received by EOSAT Co. USA, at its Norman Station in Oklahoma, USA and distributed to the world community under a commercial agreement with the Antrix Corporation of the Department of Space.

Thus today, IRS-1B, together with IRS-1C and IRS-P2 (launched by India's own PSLV in October 1994) form the main stay of the National Natural Resources Management System providing data for a number of applications - crop acreage and yield estimation, drought monitoring and assessment, flood mapping, land use and land-cover mapping, wasteland management, forest survey, mineral prospecting, ground water targeting, snow-cover and run-off estimate, etc. One of the most important applications of IRS data has been in the Integrated Mission for Sustainable Development to generate locale-specific prescriptions for judicious exploitation of land and water resources. □

Throat Insert for Liquid Rocket Engines



The Engine test with indigenous silica phenolic throat

A major milestone was crossed by ISRO on July 24, 1995 with the successful ground firing of the liquid engine for use in the strap-on stage of Geosynchronous Satellite Launch Vehicle (GSLV) as well as the second stages of GSLV and PSLV. The main objective of the 200 sec test (longest duration so far) was to qualify the indigenously developed silica phenolic throat of the nozzle.

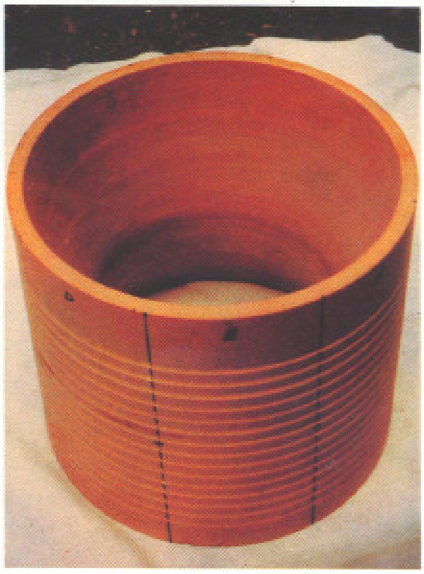
The 60 tonne thrust liquid engine with earth storable hypergolic propellants, employs a De Laval nozzle incorporating silica-phenolic throat insert at the critical region. The insert acts as an ablative in a high temperature and high pressure environment of combustion, while maintaining its dimensions. It protects the metallic hardware throughout the burn duration.

The product had to be engineered to conform to the already frozen dimensions and interfaces of the engine. The thermal and mechanical properties had to be matched to ensure performance and safety margins. The insert rests on a bottom seating ring and is kept in place by a top retainer ring. The annular space between the insert and the engine hardware is filled with a water mixed cement, which acts only as a gap filler and has no bond strength. The bottom seating ring being contiguous with the divergent hardware attains high temperatures, in excess of 1,000° C resulting in substantial charring of the insert. Thus the char has to possess sufficient strength to resist the compressive and shear loads acting on the insert during the operation of the engine.

The properties required of the insert were studied and trials were made with the available Resol type phenolic resin already being used for the solid propellant rocket nozzles. It was seen that the achieved properties were substantially deficient by as much as 55 percent and 24 percent in the compressive strength and inter-laminar shear stress respectively at room temperature. It was also seen that the mechanical properties did not improve beyond 600° thus not meeting the requirement. To upgrade the properties to match the requirements, it was found necessary to improve the char strength of the resin, which in turn depends upon the char yield and the char structure. Analysis showed that the preferred reactions during carbonisation are dehydrogenation and cyclisation/ring fusion. The controlling parameters for this reaction are:

* Molecular weight of the resin > 700
* Molecular chain with high bond energy
* Increased aromaticity
* Maximum ethylene bridge
* Minimum ether linkage in the chain.

Having deciphered the controlling attributes of the resin, the next important step was to evolve the process and cure conditions which would assist in obtaining the desired properties. The resin content was one governing parameter and this was intimately linked to the process conditions. The other challenge lay in the design of the tooling to transmit the hydroclave cure pressure radially and axially over the wound component.



The Throat Insert

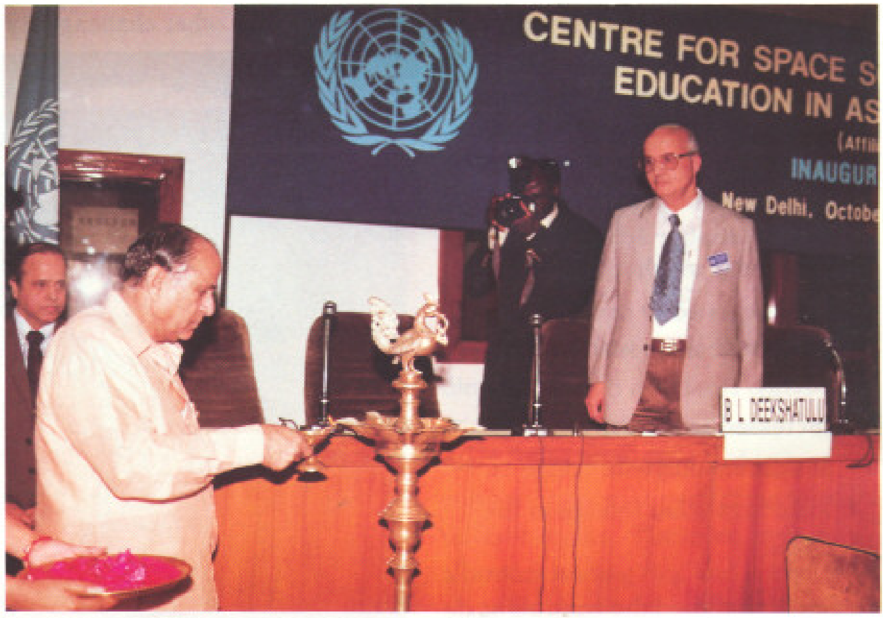
The capability of the throat insert has been ascertained through two full duration tests (200 sec) of the engine. The insert has performed to expectations.

Prime Minister, Shri P V Narasimha Rao, in a message dated July 26, 1995, conveyed his happiness on the successful ground firing of the Liquid Engine to be used in Geostationary Satellite Launch Vehicle (GSLV). The Prime Minister said "it is a matter of great satisfaction that our scientists have qualified, through this test, the indigenously developed silica phenolic throat of the nozzle". □

UN-Asia Pacific Regional Centre for Space Education Established

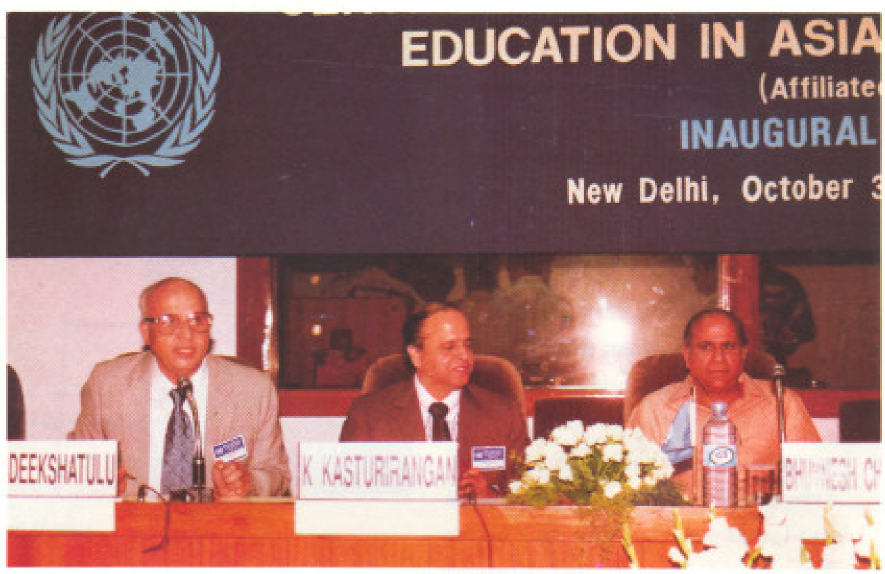
In a ceremony held at Vigyan Bhavan, New Delhi, on November 1, 1995, Mr Bhuvnesh Chaturvedi, Minister of State, (In-charge of Space), inaugurated the Regional Centre for Space Science and Technology Education in Asia and the Pacific Region. The function was presided over by Dr K Kasturirangan, Secretary, Department of Space.

A prerequisite to any successful space programme, is trained manpower capable of absorbing high levels of knowledge and expertise in various fields of space science and technology. This is especially so in developing countries where efforts must be made, preferably at locals, to develop such human resource. Thus in 1990, the UN General Assembly called for the establishment of centres for space science and technology education at regional level.



Mr Bhuvnesh Chaturvedi, Minister of State, inaugurating the UN Centre by lighting a lamp

Based on a detailed evaluation of the infrastructure and expertise available in different countries of the Asia Pacific region for development and practical application of space technology for societal needs, a high-level United Nations experts team selected India for the setting up of the UN Centre catering to this region.



At the Ceremony. (Left to right) Prof B L Deekshatulu, Director, NRSA, Hyderabad, Dr K Kasturirangan, Secretary, DOS and Mr Bhuvnesh Chaturvedi

An intensive discussion was held by senior officials of several member states of the Asia Pacific region on October 31, 1995 and an agreement on the Centre was opened for signature by member states of the Asia Pacific region. The agreement was initially signed by several countries including India, Indonesia, Kazakhstan, Kyrghyzstan, Mongolia, Nepal, Nauru, Republic of Korea, Sri Lanka and Uzbekistanin. More countries are expected to sign the agreement in due course. The agreement establishes the status and statutes of the regional Centre, which will be affiliated to the United Nations. The signing ceremony was also participated by representatives of several countries

Dr Adigun Ade Abiodun, Expert on Space Applications Office for Outer Space Affairs, United Nations giving background for establishment of UN Centre.

Delegates participating in the discussion before the inaugaration

including Islamic Republic of Iran, Malaysia,
Philippines, Russian Federation, Democratic Peoples Republic of Korea, United States of America and the United Kingdom besides a number of international organisations including UNESCO, WMO, UNDP and United Nations Office for Outer Space Affairs.

The UN Centre, the first regional Centre to be set up, is being established in India around the facilities of Indian Institute of Remote Sensing in Dehradun and Space Applications Centre in Ahmedabad. It is expected to grow into a network of nodes in other countries, in order to fully utilise the resources and potentials of the region. Similar UN Centres are expected to be established in the near future in other regions like Latin America, the Caribbean and Africa.

The first Governing Board of the Centre met the following day of the inauguration to finalise the details of activities including academic programmes which would focus on remote sensing, geographical information systems, satellite communication, space science and global change studies.

A number of dignitaries around the globe had sent their greetings and messages on the occasion of the inauguration of the UN Centre. In his message, Mr Peter Hohenfellner, Chairman of United Nations Committee on Peaceful Uses of Outer Space, stated " I send my congratulations to India as the host country and to all countries in the Asia-Pacific region for their diligent efforts over the past several years which have made the Centre a reality. Its establishment is indeed a testament to the commitment of the countries of this region to further international and regional cooperation in outer space activities". Mr Adrianus Mooy, Executive Secretary, ESCAP, while felicitating Government of India on the occasion, felt that the Centre will contribute significantly to the overall development of space technology and its applications in the region. □

India and Hungary
Sign Agreement for Cooperation in Space

Dr K Kasturirangan (third from left) and Dr Gyula Tofalvi, exchanging document after signing the agreement

India and Hungary signed an agreement on October 27, 1995, for cooperation in the fields of exploration and utilisation of Outer Space for peaceful purposes. The agreement was signed at Antariksh Bhavan, Bangalore, by Dr K Kasturirangan, Chairman, ISRO, on behalf of India and Dr Gyula Tofalvi, Director, Hungarian Space Office, on behalf of Hungary.

This agreement envisages cooperation, specifically in the fields of earth observation systems including remote sensing of natural resources, meteorology, global warming, environmental pollution, geodesy and cartography, and space physics related to solar system studies, interplanetary space, astronomy and solar terrestrial physics. Specific projects are being identified in the above areas.

The Agreement is a result of detailed discussion between officials of ISRO, led by its Chairman and Hungarian Space Office led by its Director, at Antariksh Bhavan, the Headquarters of ISRO. During their stay in India, the Hungarian team also visited Space Applications Centre and Physical Research Laboratory at Ahmedabad and, ISRO Satellite Centre at Bangalore. □

ISRO and IMD to Develop Doppler Weather Radar

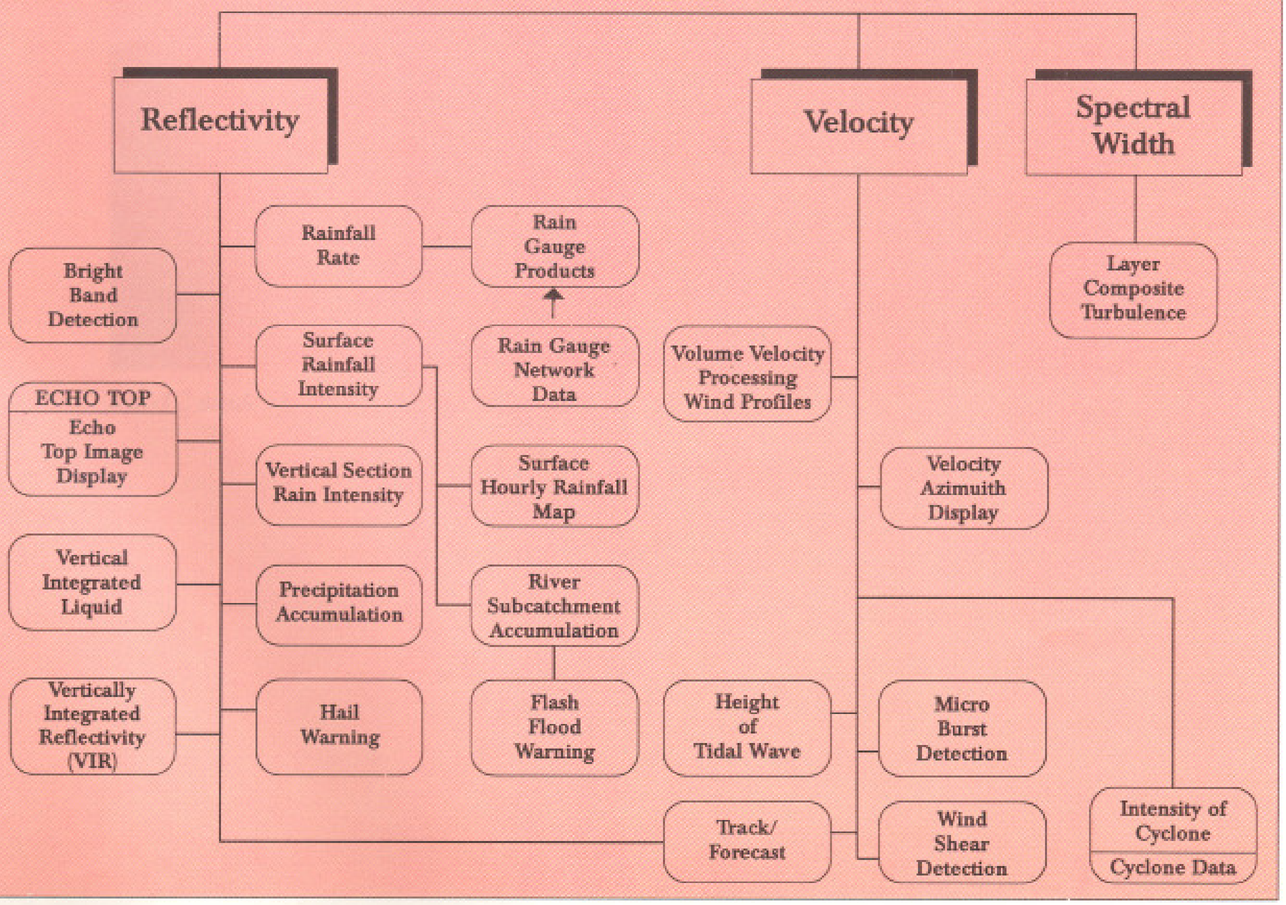
Indian Space Research Organisation and India Meteorological Department (IMD) signed a Memorandum of Understanding on September 12, 1995 for the design and development of a Doppler Weather Radar (DWR) System.

Radars have been used for atmospheric studies for a long time. Microwave radars are used for studying cloud coverage, precipitation, storm location and its intensity. Currently, Pulse Doppler techniques are employed in weather radars to map storms and make measurements on their intensity in real time. These radars are known as Doppler Weather Radars (DWR). Though conventional radars are able to track and predict cyclones, DWR provides detailed information on storm's structure including internal wind flow patterns. The severity of the cyclone can thus be measured more accurately than ever before enabling more precise warning. These radars have the following advantages:

* Improve and sharpen the forecast of location and severity of cyclones.
* Provides sufficiently advance notice for taking precautionary measures following a cyclone warning.
* Improve the accuracy of rainfall estimates needed for issuing flash flood warning
* Improve the understanding of the processes associated with weather systems.

IMD has established a cyclone detection radar network covering the entire coast of the country. As part of upgrading this radar network, IMD is replacing some of

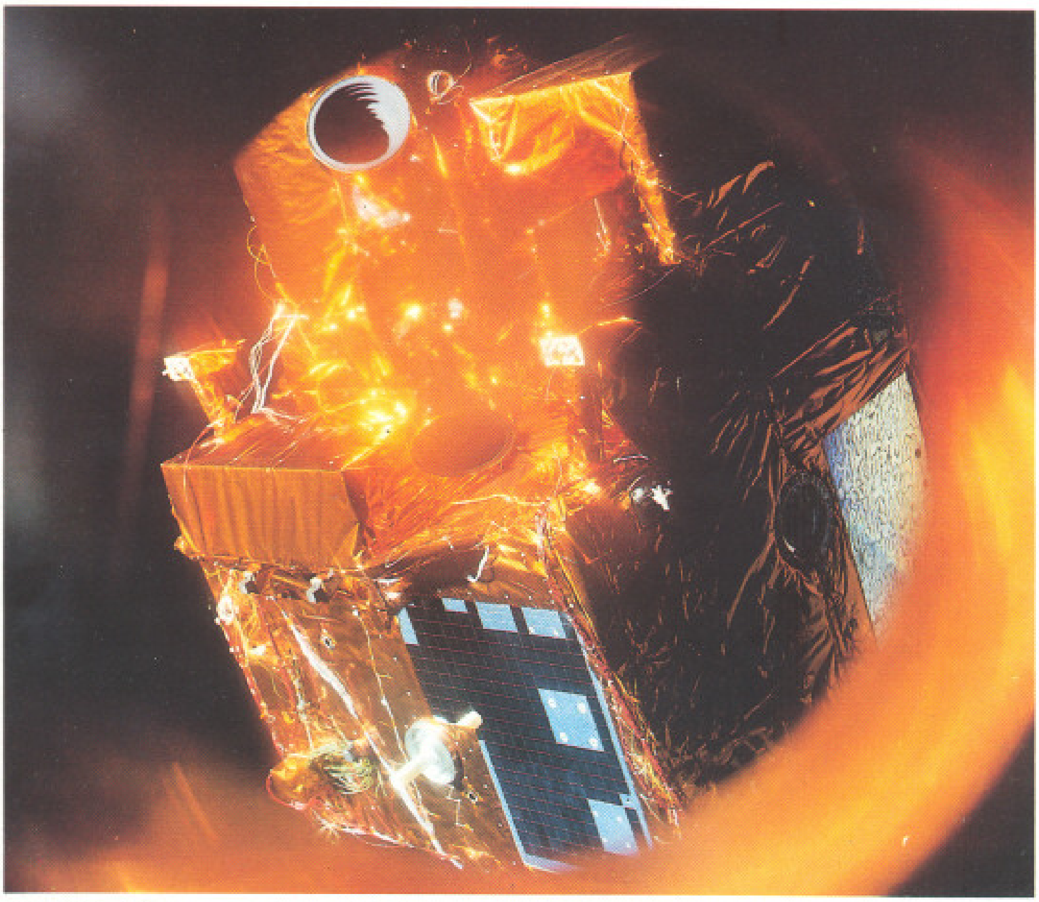
WEATHER RADAR DERIVED PRODUCTS



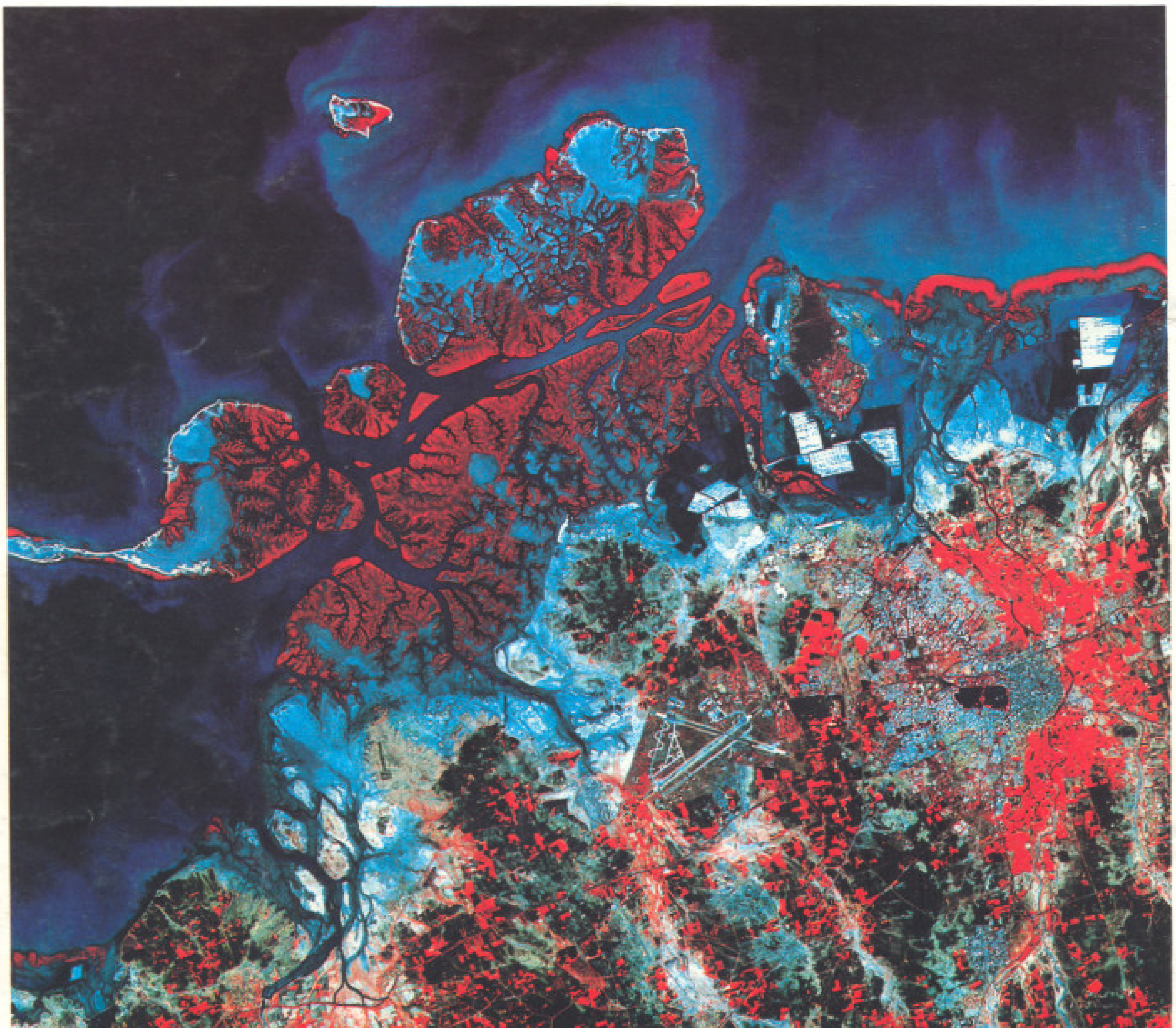
the conventional radars by Doppler versions. The MOU signed between IMD and ISRO is a major step towards self-reliance in this important field.

With a transmitting power of 500 kW (peak) and operating in S-band (2.7-2.9 GHz). the radar will have a maximum range of 500 km.

ISRO has proven capability in the design and development of modern radar systems used widely in the Indian space programme. They include a network of precision C-band radars used for tracking rockets and MST (Mesosphere, Stratosphere, Troposphere) radar used for atmospheric research. Thus, joining hands with ISRO under the present MOU, IMD is expected to benefit from the former's expertise. □



IRS-1C inside Space simulation chamber



Part of Gujarat State as seen by LISS-III of IRS-1C