2/1988

SPACE india

INDIAN SPACE RESEARCH ORGANISATION

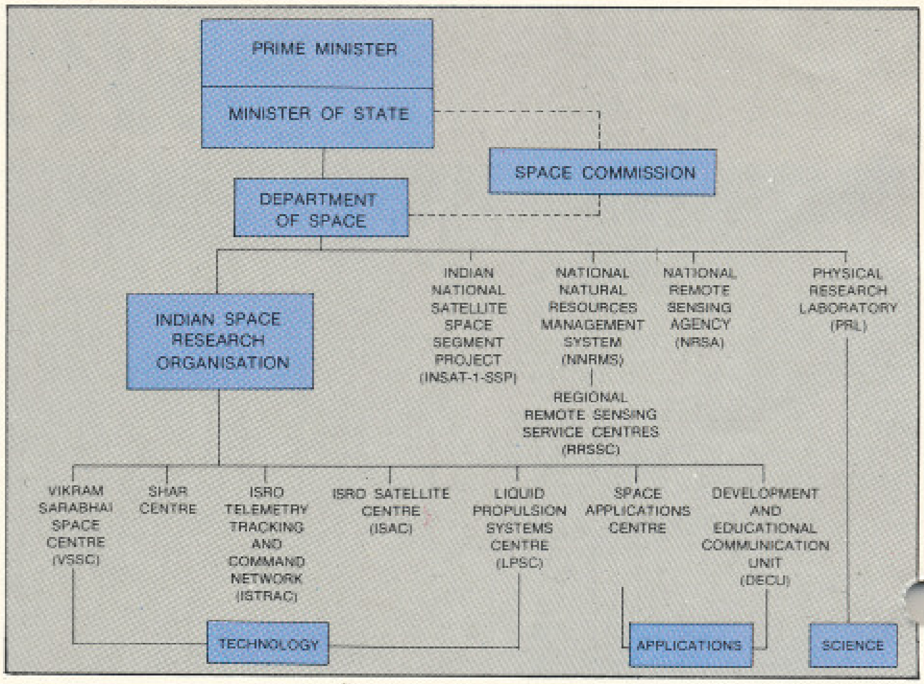
The Indian Space Programme

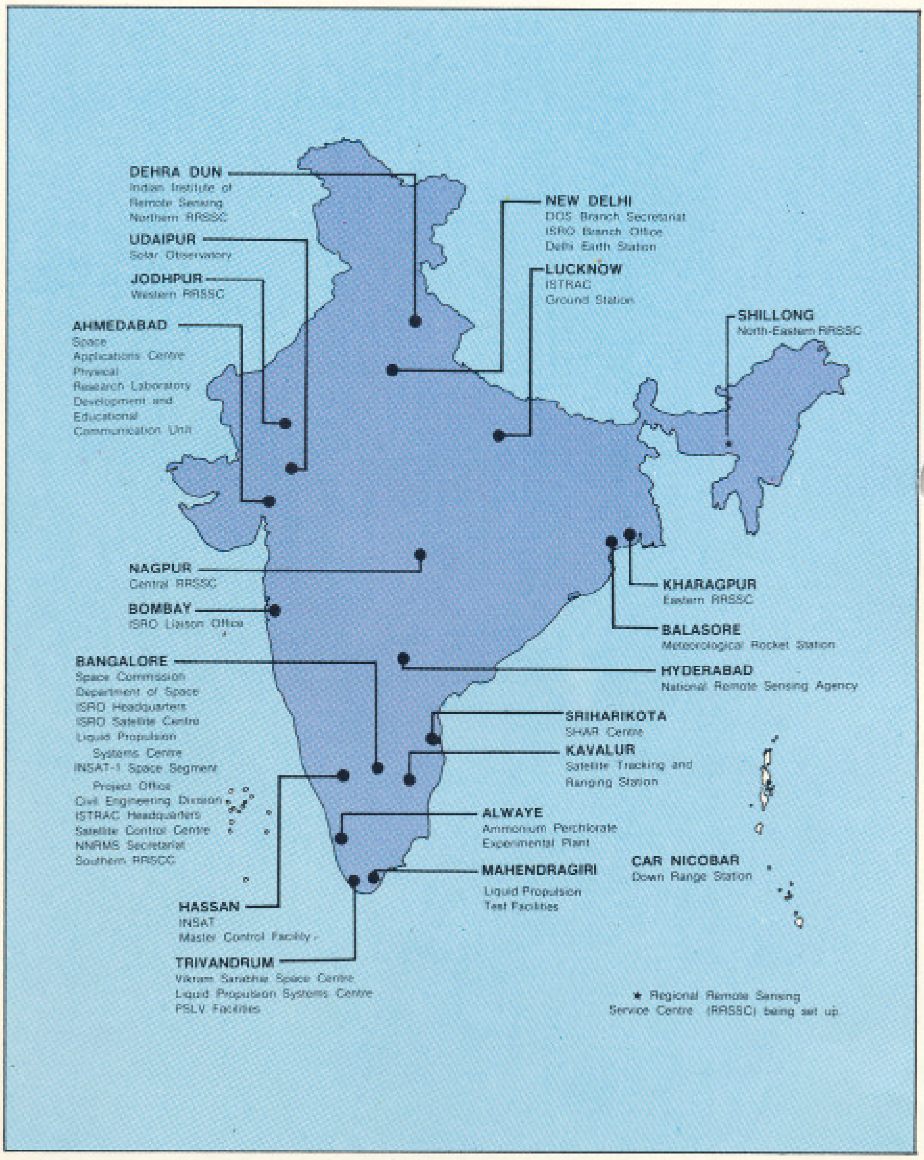
The setting up of the Thumba Equatorial Rocket Launching Station (TERLS) in 1963 marked the beginning of the Indian Space Programme. The Space Commission and the Department of Space (DOS) were established by the Government of India in 1972 to promote unified development and application of space science 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 satellites 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
The 14m antenna of the
INSAT Master Control Facility

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April-June, 1988

SPACE India is published quarterly by the Indian Space Research Organisation for limited circulation.

Editorial/Circulation Office:
Publications & Public Relations Unit,
ISRO Headquarters, Cauvery Bhavan,
Kempegowda Road, Bangalore-560 009,
India.

Printed at Thomson Press, Faridabad, India.

इन्सैट INSAT

INDIAN NATIONAL SATELLITE SYSTEM

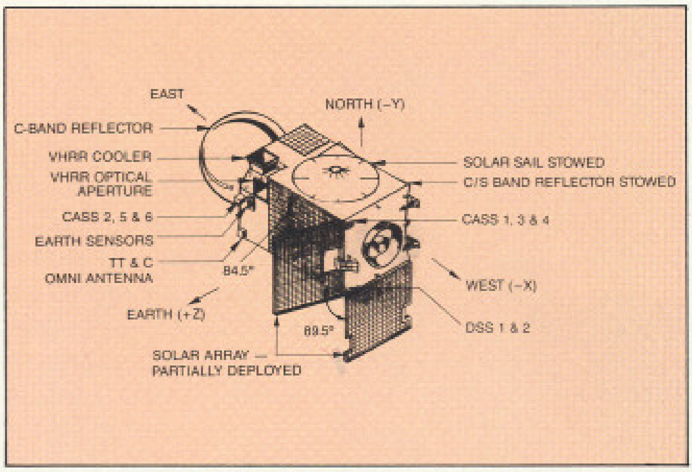
The space segment of the Indian National Satellite System, INSAT-I, is to consist of two identical satellites - one as the primary spacecraft and the other providing back-up capability. Designed specifically to meet India's requirements, the INSAT-1 satellites are built by the Ford Aerospace Corporation (FAC) of the United States of America to Indian specifications. These satellites weigh about 1200 kg each in the Geostationary transfer orbit (GTO) and roughly 650 kg in the geostationary orbit at the time of initial station acquisition. An asymmetrical solar array of five panels of roughly 11.5 sq.m area provides 1200 W of power at the beginning of life (BOL) and about 930 W at the end of life (EOL). The design life of INSAT-I satellites is 7 years minimum.

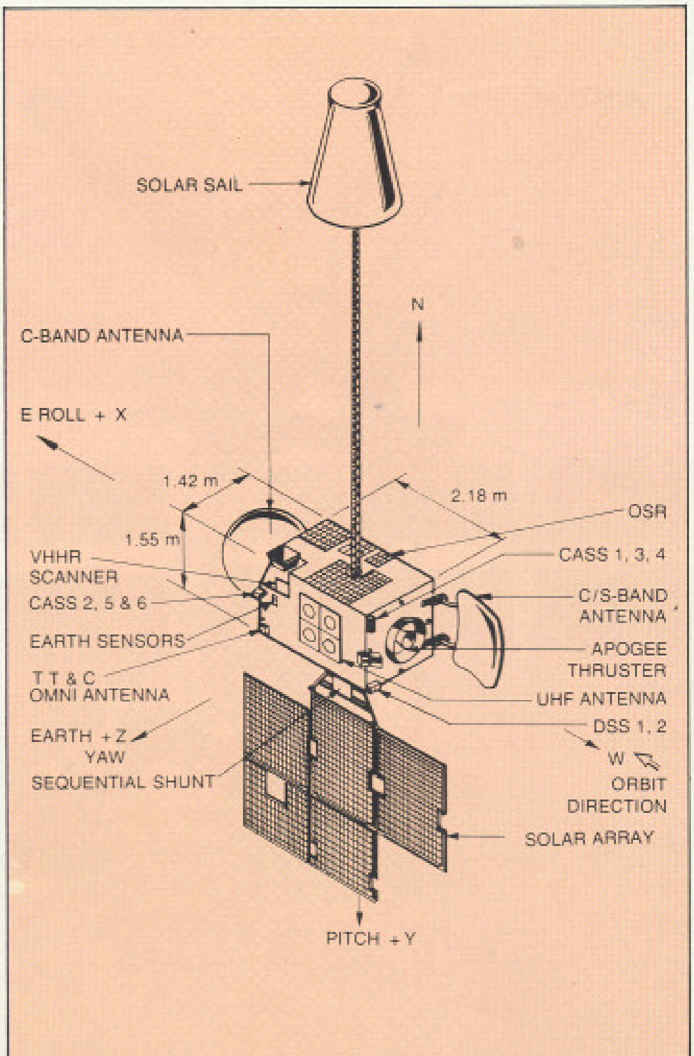
In its fully deployed configuration in the geostationary orbit, the length of the INSAT-I satellite from the tip of the solar sail to the extreme end of the solar array is 19.4 m. The INSAT-I satellites are three-axis stabilized with a precision attitude control system providing attitude stability required for the meteorological imaging mission. To ensure an

The INSAT Master Control Facility (MCF) at Hassan, Karnataka is ready to handle the twin satellite space segment.

INSAT-IC

The twin in Orbit





The INSAT-I transfer orbit (above) and on-orbit configurations (below).

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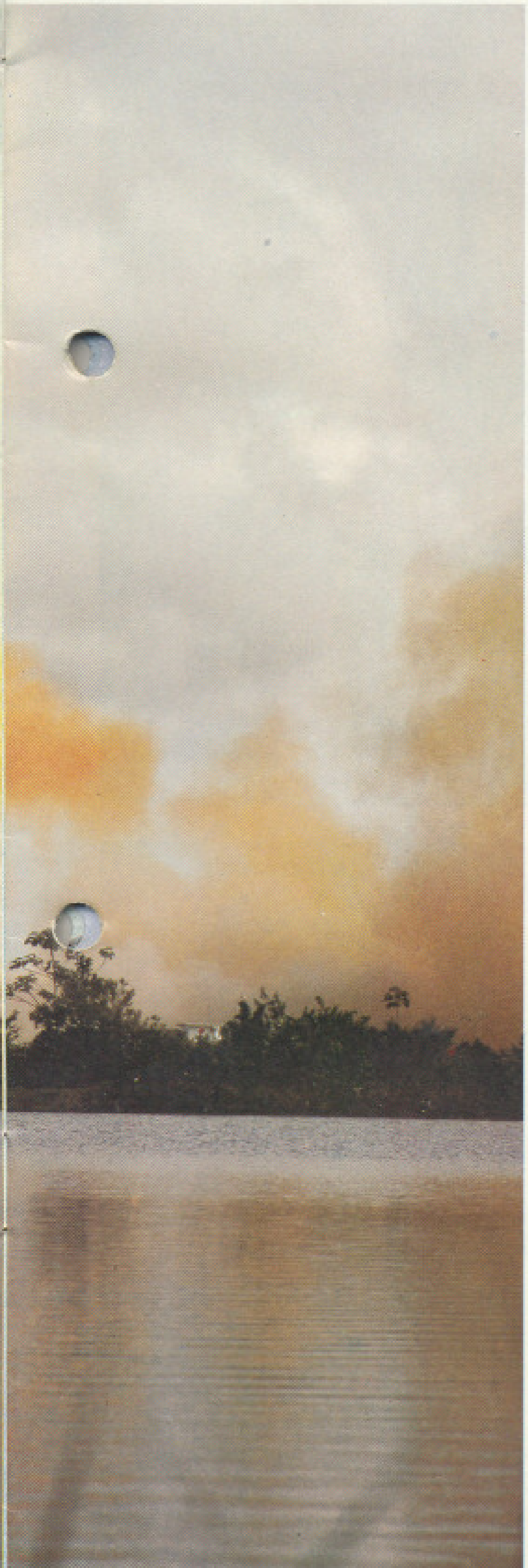

unobstructed field of view into the cold space for the radiation cooler of the Very High Resolution Radiometer (VHRR) earth imaging instrument, the satellites use the asymmetrical solar array. A solar sail is used to offset the imbalance due to solar pressure on the asymmetrical array. A magnetic torquer with a current coil placed around the periphery of the satellite body provides fine control. The satellite has a unified bipropellant propulsion system for orbit transfer, station keeping and attitude maintenance.

The first INSAT-I satellite, INSAT-IA, was launched by a Delta vehicle in April 1982. The solar sail of INSAT-IA did not deploy and following a series of events which led to total depletion of on-board propellants, the satellite was deactivated in September. The second satellite, INSAT-1B, launched by the U.S. Space Shuttle on 30th August 1983 and successfully operationalized in October that year, is now in its fifth year of operation.

INSAT-IC, the back-up spacecraft was to have joined its companion in orbit sometime in 1986. But the loss of the US space shuttle 'Challenger' in January 1986 and the resulting suspension of shuttle flights prevented the planned launch of INSAT-IC. Consequently, an agreement was signed with the Arianespace for launch of INSAT-1C on the Ariane rocket. Because of the change in the launch vehicle from Space Shuttle to the Ariane some minor changes are carried out on the spacecraft. These were successfully completed in early 1987. Since then the spacecraft has been placed in a temporary storage under controlled environment at the manufacturer's plant. While in storage it was also periodically exercised and tested as per a predetermined 'storage plan'.

The European Ariane-3 launch vehicle will place INSAT-IC into a geosynchronous transfer orbit.

INSAT-IC was transported on May 10,1988 to the launch base in Kourou in the French Guyana. On May 24, the launch campaign of the 24th flight of Ariane began and soon INSAT-IC will join its companion 36,000 km above the earth. The INSAT-IC will be located in the geostationary orbit at 93.5 degrees East longitude. INSAT-IB is located at 74 degrees East longitude.

The Ariane which will carry the INSAT-IC will be the ninth flight of the Ariane-3 version. This rocket will deliver the spacecraft into a 35786 × 200 km geosynchronous transfer orbit. From this orbit the spacecraft will be raised to a circular geosynchronous orbit in a series of orbit raising phases using its own propellants. In about a week or so from the launch, INSAT-IC would have reached its designated slot in space.

Meanwhile the Master Control Facility (MCF) at Hassan in Karnataka is geared up to meet the twin satellite operations. MCF has been augmented with a new stand-alone telemetry and telecommand console, a back-up command generator and a new 7.5m diameter antenna along with its associated earth station equipment. In effect, it is now ready to take on launch-phase and orbit-raising operations of INSAT-IC, while simultaneously continuing on-orbit control operations of INSAT-IB□

INSAT-IC being assembled on to the launch vehicle adaptor.

INSAT-I Capabilities

* 12 national coverage telecommunications transponders of 36 MHz bandwidth each, operating in 5935-6425 MHz (earth-to-satellite) and 3710-4200 MHz (satellite-to-earth) frequency bands with 32 dBW (min) EOL eirp over the primary coverage area.
* Two high-power national coverage TV broadcast transponders operating in 5855-5935 MHz (earth-to-space) and 2555-2635 MHz (space-to-earth) frequency bands, each capable of handling one direct broadcast (community reception) TV channel and several low-level carriers for radio programme distribution with a 42 dBW (min) EOL eirp over the primary coverage area. These transponders also support the dissemination of certain disaster warning messages, standard time and frequency signals, meteorological data dissemination, news and facsimile dissemination, etc.
* A VHRR instrument for meteorological earth imaging with visible (0.55-0.75 μm) and infrared (10.5-12.5 μm) band channels with resolutions of 2.75 and 11 km, respectively, with half-hourly full earth coverage and sector scan capability.
* A data relay transponder with global receive coverage with a 402.75 MHz earth-to-satellite link for relay of meteorological, hydrological, and oceanographic data from unattended land and ocean-based automatic collection-cum-tranmission platforms.

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An interview with Dr. S. Vasantha

On the eve of INSAT-IC launch SPACE India interviewed Dr. Sastri Vasantha, Project Director, INSAT-I Space Segment Project Excerpts:

Q: *Could you please describe the role of INSAT-1C in the INSAT System?*

A: The initial INSAT-1 system is envisaged as a two satellite system, one as a primary satellite and the other as a major path satellite providing both additional and back-up capabilities to the first one. In that sense, INSAT-1C is an active on-orbit back up to INSAT-1B.

Q: *How does the design of 1C compare with that of 1B? Are there any changes – for example in the payload complement or in the materials used?*

A: There is no change in the functional capabilities between 1B and 1C. The design is also identical except for the minor difference that INSAT-1C unlike INSAT-1A or 1B has now no constraint on the time of launch or the period when manoeuver can be performed. This is because it is now equipped with a Digital Integrating Rate Assembly (DIRA). INSAT-1C has also the capability to do simultaneous ranging and telemetry.

Q: *Is 1C designed to augment 1B functions besides being an on-orbit spare?*

A: Yes. INSAT-1C will be used to provide additional capacities in the INSAT System in addition to its being an on-orbit spare to INSAT-1B.

Q: *What is the minimum life expected of 1C?*

A: The minimum life is now expected to be slightly more than 10 years. This is because measures have been taken to load additional propellants over and above the minimum 7 year life requirement.

Q: *What is the cost of INSAT-1C?*

A: The Spacecraft is expected to be around Rs.80 crores. The total cost for the Procurement and the Launching of INSAT-1C is expected to be around Rs.154 crores.

Q: *When the life of 1B is over, is it planned to be lifted out of the geostationary orbit?*

A: This is under serious consideration. The primary reason for deorbiting a useless satellite is to avoid contamination of space with dead satellites. The geosynchronous band is already getting crowded with useless satellites and if we do not start planning to keep the geostationary orbit clean, it may become too expensive later to scavenge.

The main difficulty in taking a decision regarding the instant in time when the satellite has to be deactivated and deorbited is the capability to precisely estimate the residual life. As of

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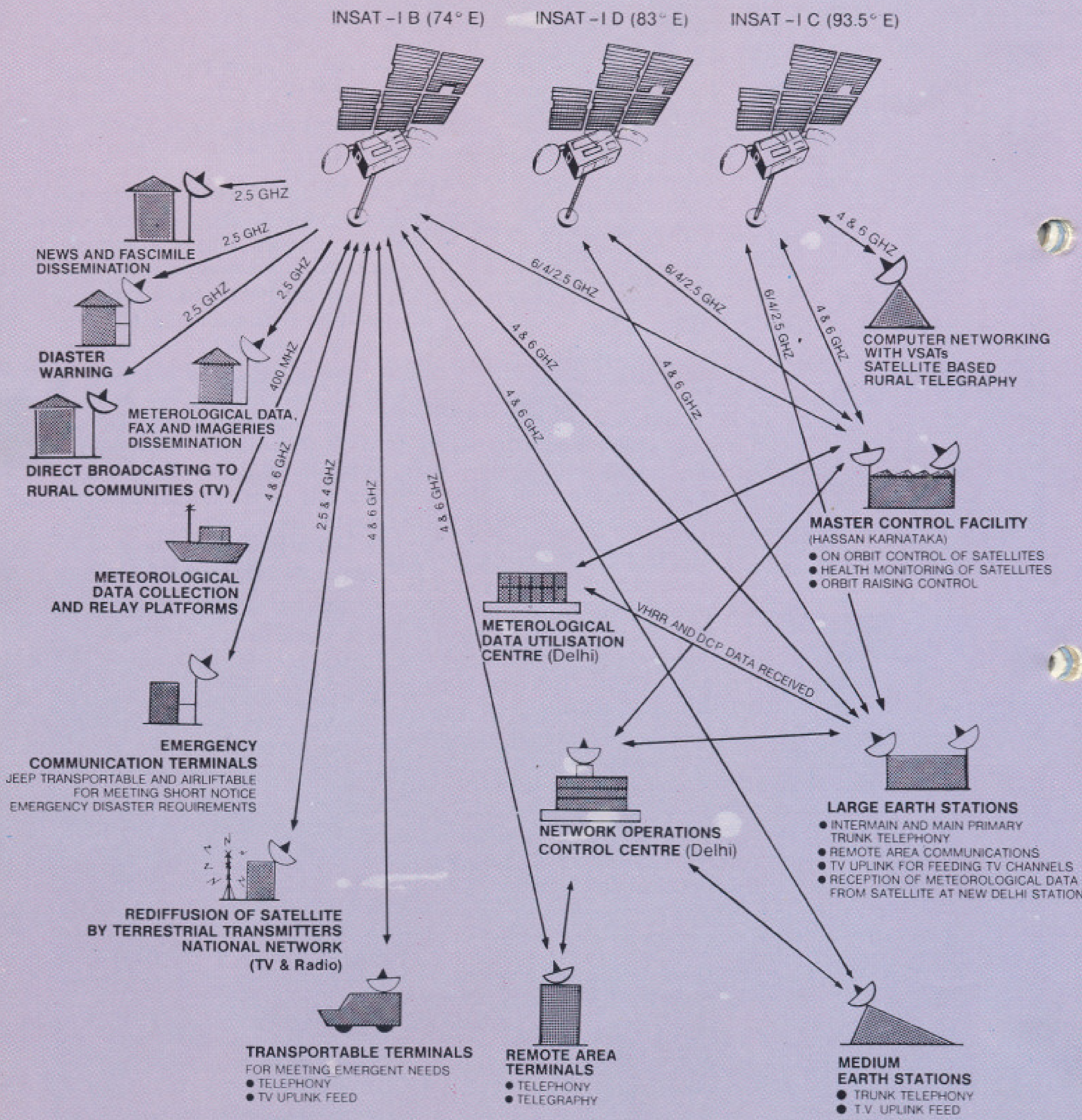

now, one could commit an error as large as 4 – 6 months on a satellite of INSAT-1 type. Efforts are now underway to improve this accuracy to about a month or two.

Q: *After the end of life of 1B, will 1C become the main spacecraft with 1D as the spare?*

A: The plans will be firmed up immediately after the INSAT-1C launch. Presently, INSAT-1D is planned to be located at 83°E longitude for the initial phase.

Q: *How does 1D compare with 1C?*

A: They are identical in design with 1D having a higher eclipse payload capability and also an additional spare TWT for 2 of the transponders.

Q: *Is 1D the last of the first generation INSAT satellites – in other words – will 1C be replaced at the end of its life by an indigenous INSAT-II satellite?*

A: Yes. However there is expected to be large overlap period when 1C, 1D and one or two INSAT-II will operate together.

Q: *We understand that the INSAT-II satellites will have a small additional payload with search and rescue functions. Is any such function planned for 1D?*

A: No. 1D does not have a SAR payload.

The INSAT-I System Concept.

Q: *Has the Master Control Facility been augmented to the INSAT-1C operations?*

A: Yes. An additional 7.5 m antenna has been added to monitor 1B satellite during the orbit raising phase of 1C.

Q: *What is the contribution of Indian Industry to the INSAT-1 Programme?*

A: The design, development and construction of MCF, Hassan is an indigenous effort. The fact that the facility has operated without interruption and faults through two launch in last seven years is a proof of the quality of work done by our industry.

Q: *The INSAT spacecraft are built by the Ford Aerospace Communications Corporation and they are launched by a commercial rocket carrier. What is the role of the Department of Space in the INSAT programme?*

A: The very definition of the payload is our responsibility. For the first time in the world the three-in-one concept is introduced in the INSAT. These are telecom, met and TV payloads. Our other responsibilities include monitoring progress of work done by the spacecraft contractor, procuring launch services, ensuring that the product delivered adheres to specifications laid down etc. The establishment of the ground segment as well as the on-orbit operation and maintenance of the spacecraft from MCF are also the responsibilities of DOS. Finally DOS is the nodal agency for coordinating INSAT utilisation with all user Ministries and Departments.

Q: *During the last 5 years of operation were there any major technical problems faced by the INSAT system?*

A: Except for the brief loss of Earth-lock on August 1984, the INSAT-1B has been performing satisfactorily so far.

Q: *Could you describe some of the lessons learnt from the INSAT programme?*

A: Yes. In a Project of this magnitude there are a number of things one gets to learn. The learning has been in the areas like Systems Management, Contract Management and Project Management. Apart from the various interactions with ISRO/DOS, we have had the opportunity to interact with other user ministries and also various space agencies in France, USA etc. This has resulted in plenty of cross fertilisation of ideas, knowledge, working culture etc. All in all it has been a good team work by all the players concerned☐

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In June this year INSAT-1B, which is operating as the primary spacecraft in the INSAT system, completed over 56 months of operational service. The overwhelming demand for INSAT services during this period has necessitated pressing into use even the functional spare C-band transponder on-board. For a developing nation, striving to build up the basic infrastructure in several areas including communications, the INSAT-I system has created a tool that helps to knit the country together with a modern telecommunications network, to reach the far flung areas with electronic mass media, to bring quality education to rural class rooms and to keep an eye on the weather.

INSAT is not a straw in the wind; it is a carefully planned and nurtured space programme with applications for development as its central theme to serve telecommunications, broadcasting and meteorological needs of the country.

INSAT is a large system with substantial investments in space and on ground. The programme is a multiagency cooperative venture. The space-segment is established and operated by the Department of

The Spacecraft Control Centre at the INSAT Master Control Facility will keep a constant vigil on the satellites' performance and health.

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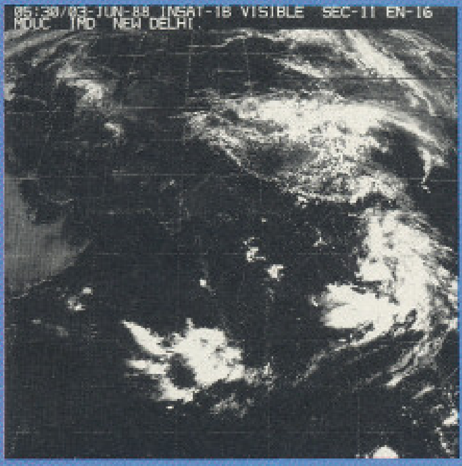
INSAT-I

Serving from Space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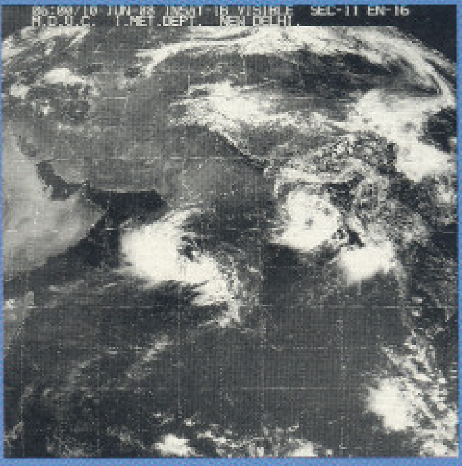
MDUC IMD NEW DELHI.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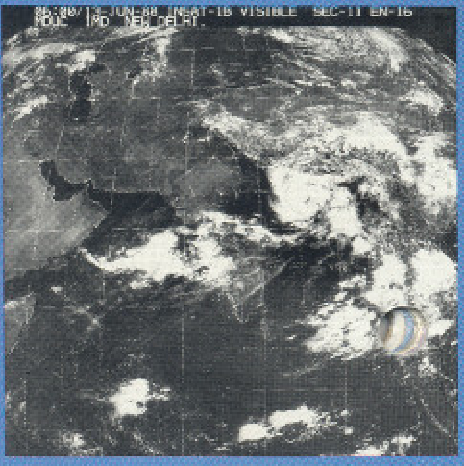
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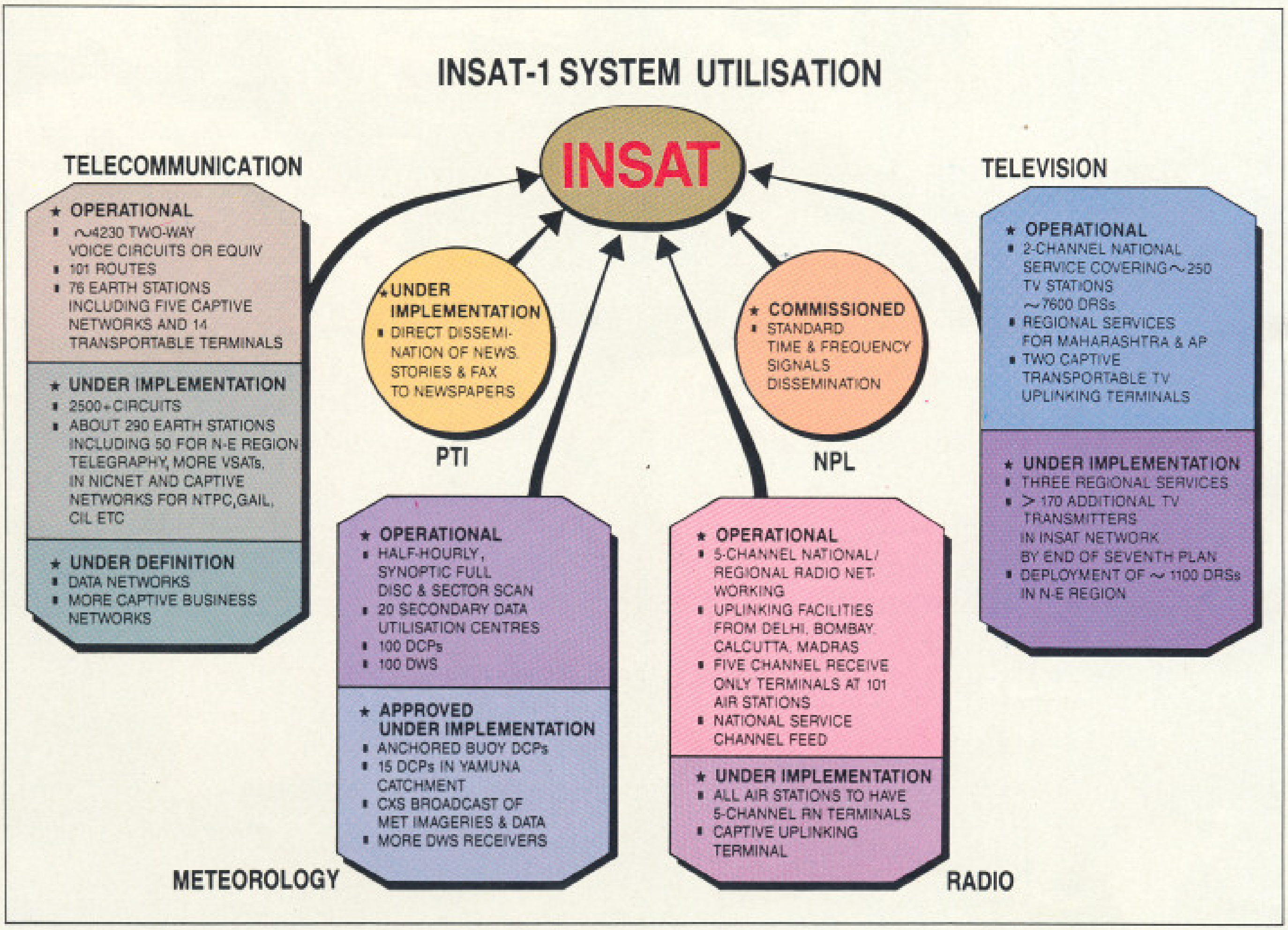
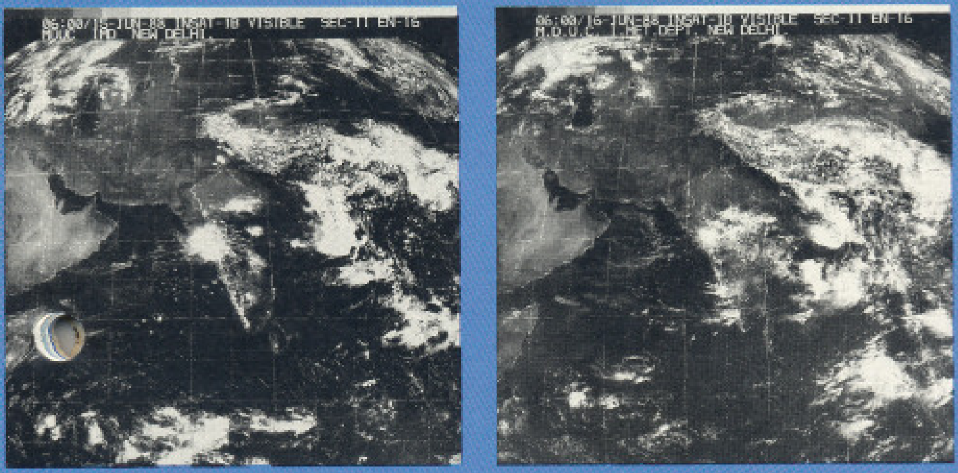
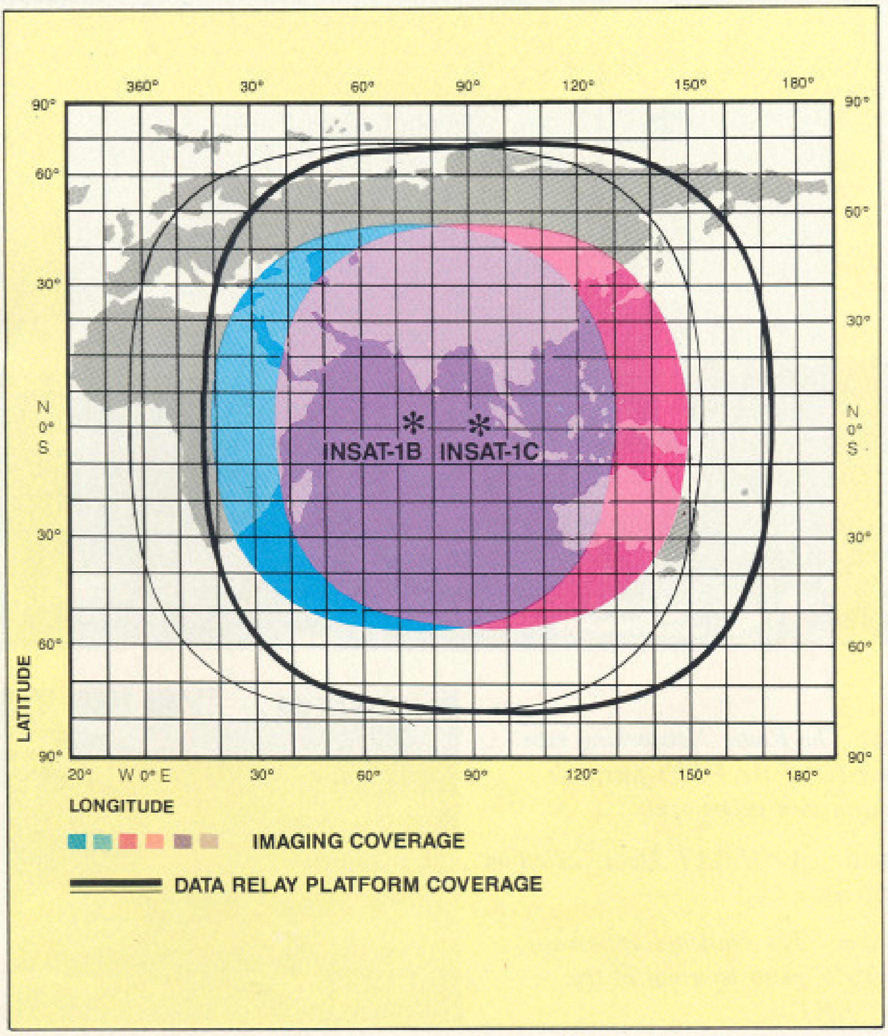

INSAT-1 SYSTEM UTILISATION
INSAT
TELECOMMUNICATION
★ OPERATIONAL
▪ ~4230 TWO-WAY VOICE CIRCUITS OR EQUIV
▪ 101 ROUTES
▪ 76 EARTH STATIONS INCLUDING FIVE CAPTIVE NETWORKS AND 14 TRANSPORTABLE TERMINALS
★ UNDER IMPLEMENTATION
▪ 2500+CIRCUITS
▪ ABOUT 290 EARTH STATIONS INCLUDING 50 FOR N-E REGION TELEGRAPHY, MORE VSATs, IN NICNET AND CAPTIVE NETWORKS FOR NTPC, GAIL, CIL ETC
★ UNDER DEFINITION
▪ DATA NETWORKS
▪ MORE CAPTIVE BUSINESS NETWORKS
★ UNDER IMPLEMENTATION
▪ DIRECT DISSEMINATION OF NEWS. STORIES & FAX TO NEWSPAPERS
PTI
★ COMMISSIONED
▪ STANDARD TIME & FREQUENCY SIGNALS DISSEMINATION
NPL
TELEVISION
★ OPERATIONAL
▪ 2-CHANNEL NATIONAL SERVICE COVERING ~250 TV STATIONS ~7600 DRSs
▪ REGIONAL SERVICES FOR MAHARASHTRA & AP
▪ TWO CAPTIVE TRANSPORTABLE TV UPLINKING TERMINALS
★ UNDER IMPLEMENTATION
▪ THREE REGIONAL SERVICES
▪ > 170 ADDITIONAL TV TRANSMITTERS IN INSAT NETWORK BY END OF SEVENTH PLAN
▪ DEPLOYMENT OF ~ 1100 DRSs IN N-E REGION
★ OPERATIONAL
▪ HALF-HOURLY, SYNOPTIC FULL DISC & SECTOR SCAN
▪ 20 SECONDARY DATA UTILISATION CENTRES
▪ 100 DCPs
▪ 100 DWS
★ APPROVED UNDER IMPLEMENTATION
▪ ANCHORED BUOY DCPs
▪ 15 DCPs IN YAMUNA CATCHMENT
▪ CXS BROADCAST OF MET IMAGERIES & DATA
▪ MORE DWS RECEIVERS
METEOROLOGY
★ OPERATIONAL
▪ 5-CHANNEL NATIONAL/REGIONAL RADIO NETWORKING
▪ UPLINKING FACILITIES FROM DELHI, BOMBAY, CALCUTTA, MADRAS
▪ FIVE CHANNEL RECEIVE ONLY TERMINALS AT 101 AIR STATIONS
▪ NATIONAL SERVICE CHANNEL FEED
★ UNDER IMPLEMENTATION
▪ ALL AIR STATIONS TO HAVE 5-CHANNEL RN TERMINALS
▪ CAPTIVE UPLINKING TERMINAL
RADIO



The INSAT-I VHRR imageries of June 3-16, 1988 showing the progress of the South-West monsoon over the country.



Imaging coverage of INSAT IB and IC.

Space. The Master Control Facility at Hassan in the state of Karnataka controls and maintains the INSAT satellites in orbit.

The use of the satellite and establishment and operations of the required ground segment are the responsibility of the respective agencies. The Department of Telecommunications operates a large network of satellite earth-stations providing long distance trunk telephony and remote area communications, bringing even the remotest areas into the main stream of national life. It has also pioneered the concept of business communications in India with SATCOM terminals at user premises and networks owned and operated by corporations concerned with off-shore oil exploration, electrical power generation, coal mining etc.

But the most dramatic and visible impact of INSAT is on television broadcasting which was, only four years ago, limited to a few major cities. To-day thanks to INSAT, Doordarshan, the Television arm of the Ministry of Information and Broadcasting, operates a network of over 250 transmitters through the satellite bringing entertainment and education to the remotest parts of the country. This network which already covers over 70 percent of the population will soon expand further. Additionally the INSAT system also supports a large number of direct community reception sets serving remote and backward areas.

INSAT helps broadcast programmes in higher education for university students and training programmes to school teachers opening up access to a variety of teaching aids to the entire nation.

All India Radio links up all its transmitters located all over the country through the satellite. The networking is done both at the regional and national levels.

The Meteorological Data Utilisation Centre (MDUC) of India Meteorological Department processes, utilises and disseminates the cloud cover imageries obtained from INSAT. This is a unique source of meteorological information in this part of the

Top: The Radio Networking type terminals of the PTI's facsimile transmission experiment.

Middle: An INSAT Data Collection Platform.

Bottom: The National Informatics Centre's micro terminal of the NICNET.

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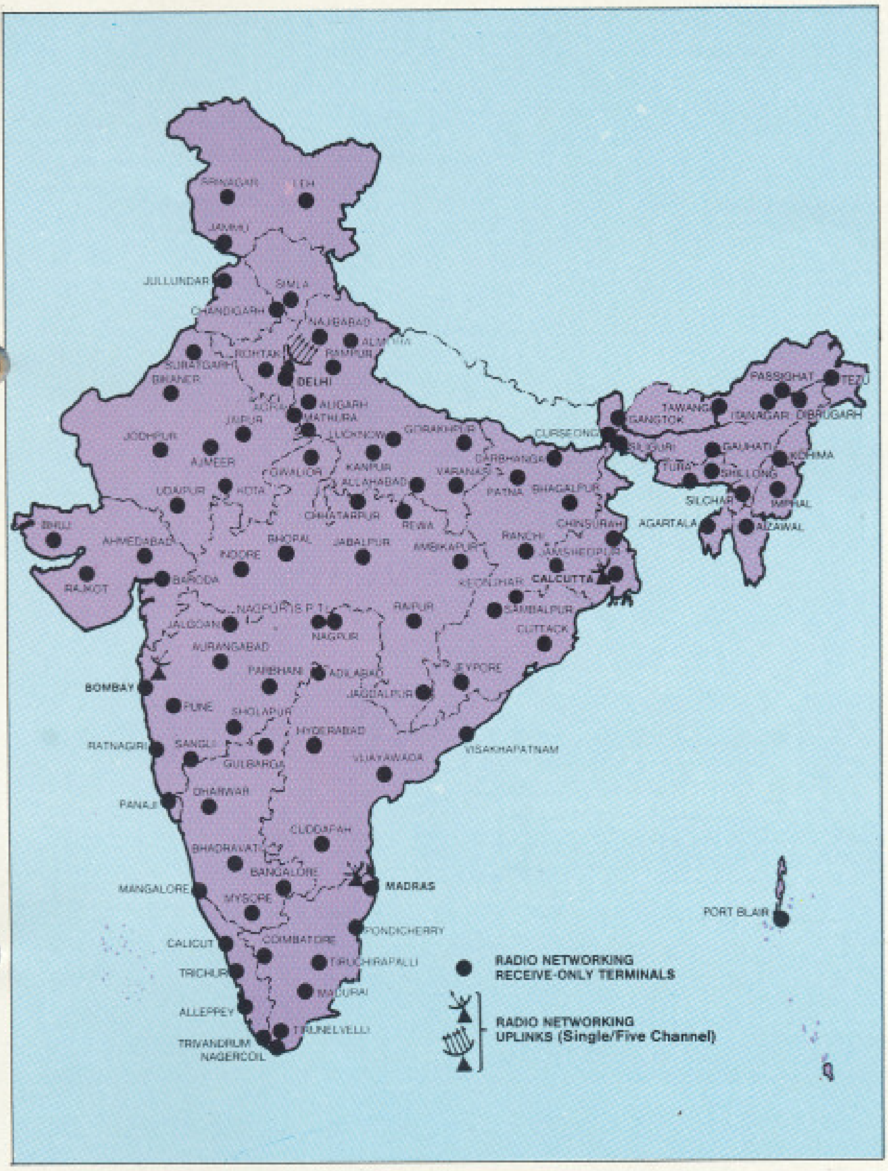
globe. The data relay transponder on board INSAT transmits back to MDUC the meteorological data on rain fall, wind velocity etc., collected by unattended data collection platforms located in remote points. A Disaster Warning System (DWS) with receivers installed in selected cyclone-prone coastal areas provides instantaneous warning messages to the affected areas directly through the satellite.

Several new services using innovative concepts have been introduced and are in the process of implementation. News and picture-FAX dissemination by news agencies, weather data broadcasting, time and frequency signal broadcasting and distant printing of newspapers are a few examples. A satellite based rural telegraphy service will be started in remote hilly regions early next year.

INSAT-1C will be a participant in all these exiciting developments by augmenting the system capacity and in some cases providing the backup□



Ground segment for INSAT Radio Networking Scheme as of March 1988.

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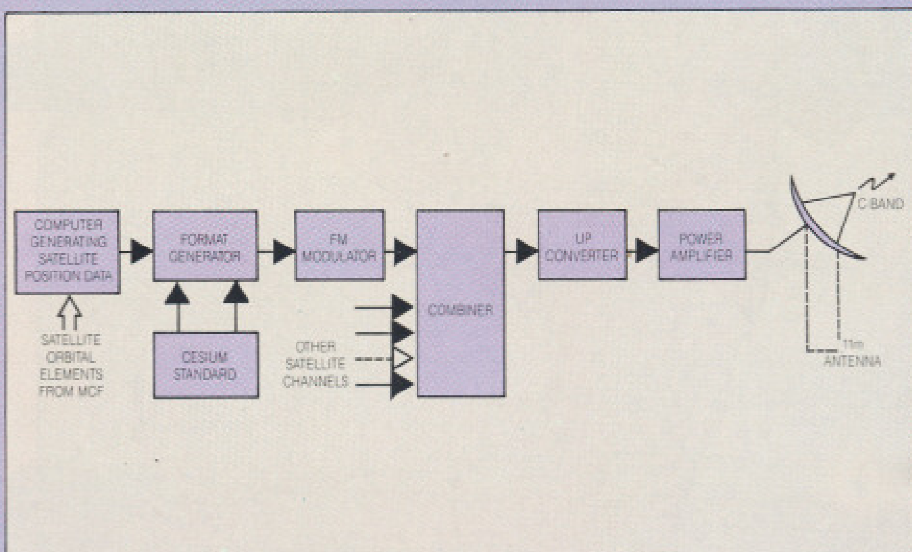
Set your time through INSAT

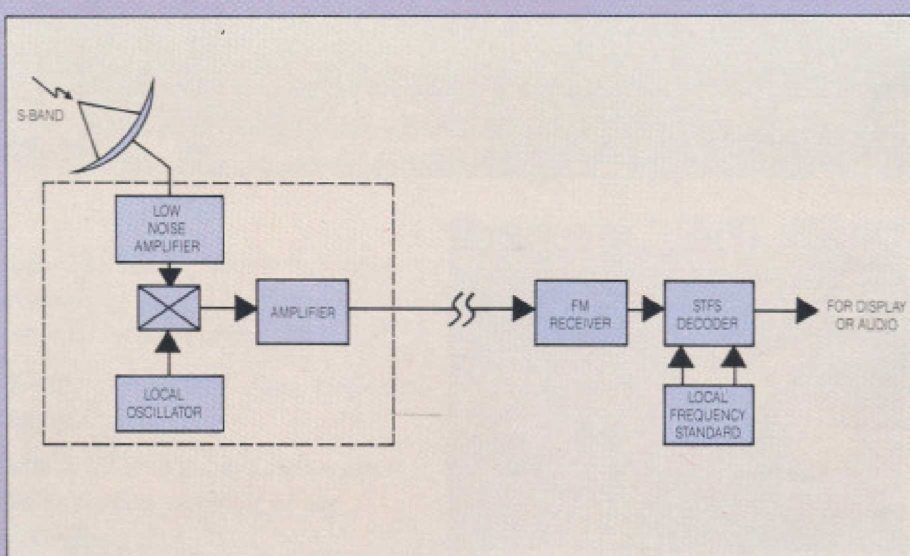
The National Physical Laboratory (NPL) has been operating a Standard Time and Frequency Signal (STFS) service for over 30 years for the benefit of myriad users. This broadcast service has now achieved new dimensions in accuracy and reliability using a Radio Networking (RN) type channel through the INSAT-IB.

The STFS consists of a train of 5 kHz bursts (packets) which frequency-modulate the carrier of the transponder. The coded information containing the time of the day and the satellite position coordinates is transmitted by binary modulation of the 5 kHz packets. At the receivers' end this coded signal is received using a small and relatively inexpensive Direct Reception Set (DRS) and decoded to recover and display directly the time. There is, ofcourse, a delay in the received time signal due to the propagation of the signal to and from a satellite. This delay is accounted for automatically from the accurate knowledge of the locations of the transmitting and receiving earth stations, along with the satellite position coordinates. The satellite position data is obtained from the INSAT Master Control Facility (MCF) at Hassan and is updated every ten minutes.

The transmission equipment consists of an STFS format generator driven by a Cesium clock standard kept synchronised with Indian Standard Time. This equipment is interfaced with the satellite uplink channel from the Delhi Earth Station. At the receiving end this round-the-clock broadcast can be received in the S-band using a set-up which is commercially available in the country. It consists of an 8 ft diameter chicken mesh antenna, a front-end converter, an FM demodulator and a microprocessor controlled signal decoder.

This standard time and frequency signal dissemination service is fully operational now. □





Block scheme of the transmitting set-up.(above)

Block scheme of the receiving set-up. (below)

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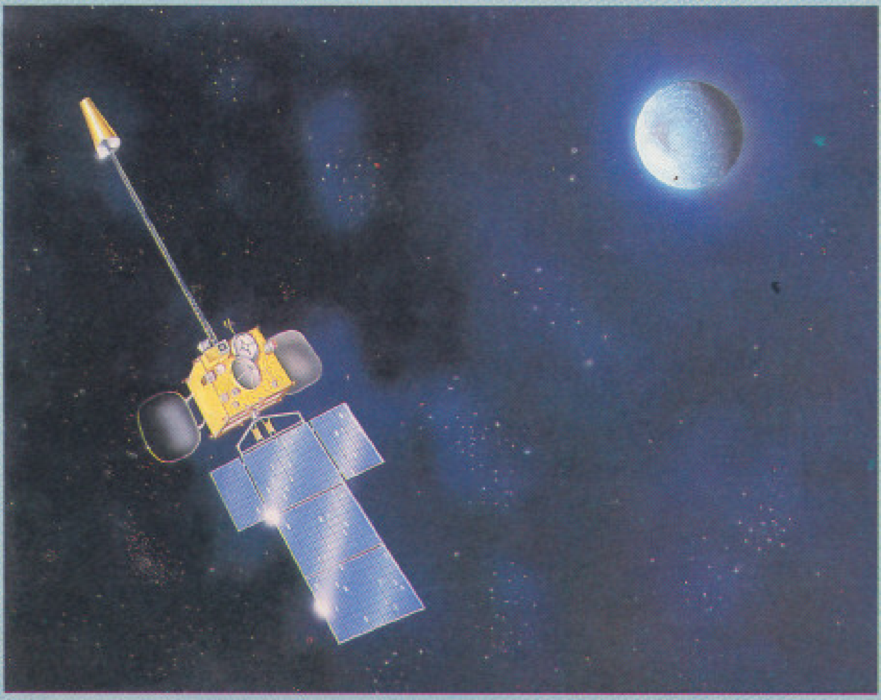
INSAT-II Launch Agreement Signed

The INSAT-I satellites will be gradually replaced during the 1990's by indigenously developed second generation INSAT-II satellites. The space-segment configuration of the INSAT-II system has already been defined, taking into account the service requirements of the user agencies. An INSAT-II Test Spacecraft (TS) project has been approved for the design, development, qualification on ground and operation and testing in space. The Test Spacecraft will be identical in all respects to the operational INSAT-II systems envisaged. The TS concept is aimed at establishing and demonstrating the indigenous capability to meet the operational requirements of the 90's.

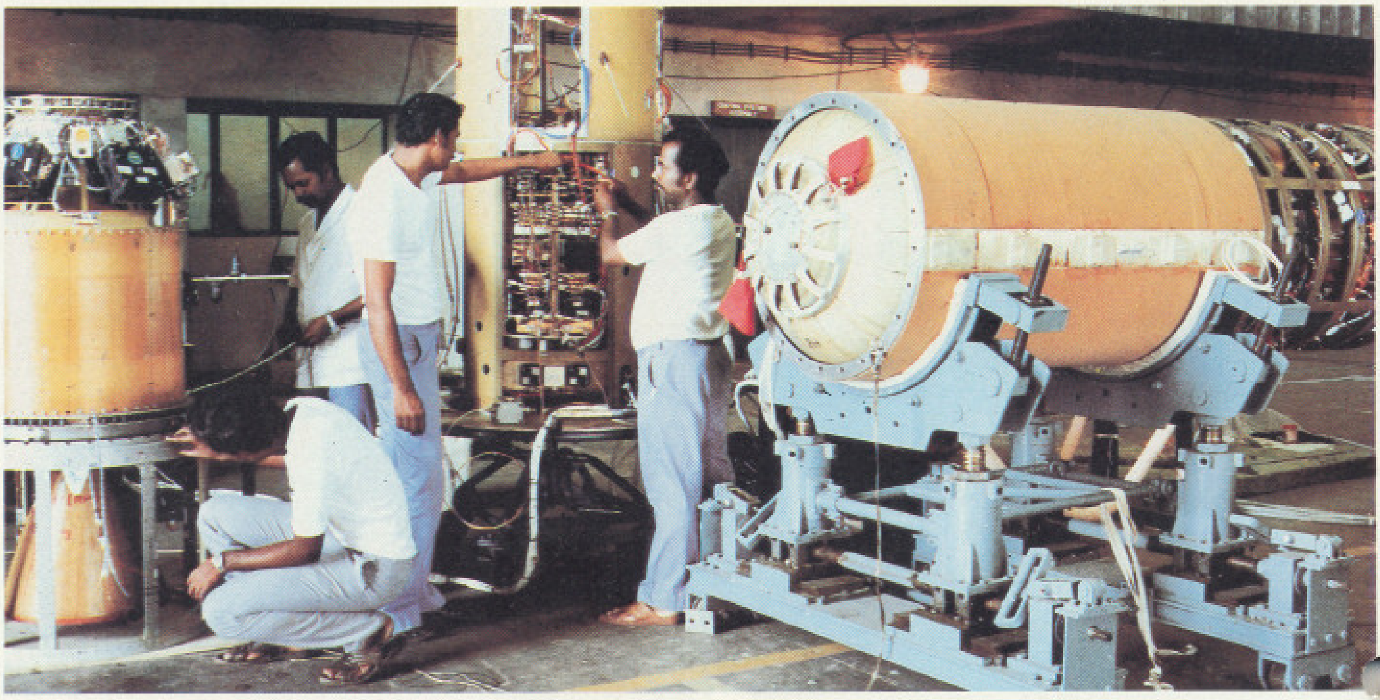
The European Ariane launcher has been selected for launching the first two of the INSAT-II satellites. This selection is a result of a year long competitive procurement process which culminated into signing of the launch services agreement in April 1988.

A lift-off mass of about 1900 kg has been estimated for the launching. The INSAT-II satellite will be placed into geostationary transfer orbit (GTO) by an Ariane-4 rocket, the newest and the most powerful version of the Ariane family. The first Ariane-4 flight successfully placed three satellites in orbit on June 15, 1988. For GTO to geostationary orbit raising the satellites will use their own apogee boost motors (ABM).

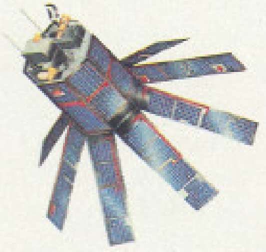
The Ariane launches for the first two INSAT-II satellites are scheduled for the last quarter of 1990 and 1991 respectively. □



Prof. U.R. Rao (left extreme), Chairman, ISRO and Secretary, Department of Space signing the INSAT-II launch agreement with Arianespace (top). An artist's concept of the INSAT-II satellite (left).



The ASLV-D2 System undergoing electrical checks at the SHAR Centre prior to integration of the vehicle.



SROSS-2

ASLV-D2

ASLV is an augmented version of India's first satellite launch vehicle SLV-3. It is designed to augment the indigenous satellite launch capability, as also to validate a number of advanced technologies needed for the future launch vehicles of the country. When operational, it would serve as a work-horse launcher for scientific and technological missions in the near-earth orbit.

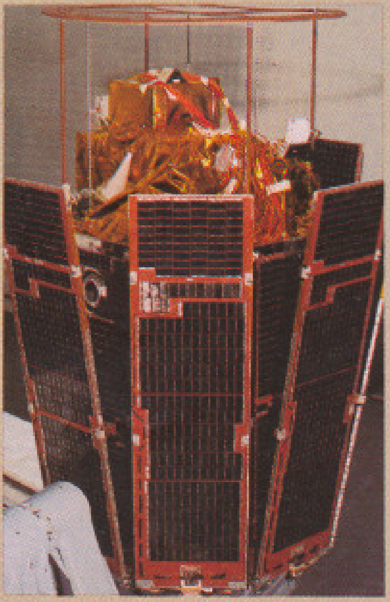
ASLV uses the SLV-3 core vehicle with two strap-on booster motors to enable orbiting 150 kg class satellites in 400km earth orbits.

The first developmental flight of ASLV took place on March 24, 1987. This flight, ASLV-D1, did not accomplish the mission objectives due to non-ignition of the first stage motor. However, a number of new technology elements such as vertical integration of the launch vehicle, canted nozzles, S-band TTC systems and the strap-on booster were validated.

An exhaustive and in-depth analysis of all flight data was carried out by the ASLV-D1 Failure Analysis Committee (FAC). Extensive simultation studies and a host of confirmatory tests were also carried out to aid the failure investigations. The conclusions of the FAC indicated that the non-ignition of the first stage could have been only due to a probable random failure in the ignition chain. The FAC, however, made a comprehensive set of recommendations to further improve reliability of performance.

The recommendations of the FAC were quickly incorporated into the vehicle design and in about a year's time preparations for the second developmental flight have been made. ASLV-D2 will be launched from the SHAR range in July 1988 carrying the SROSS-2 satellite.

SROSS-2 will have two payloads, the Monocular Electro Optical Stereo Scanner (MEOSS) and the Gamma



Features of SROSS-2

Shape and size:
Octagonal prismoidal, 850 × 1100mm

Weight:
150 Kg

Solar Array:
Four units of body-mounted panels and eight deployable panels.

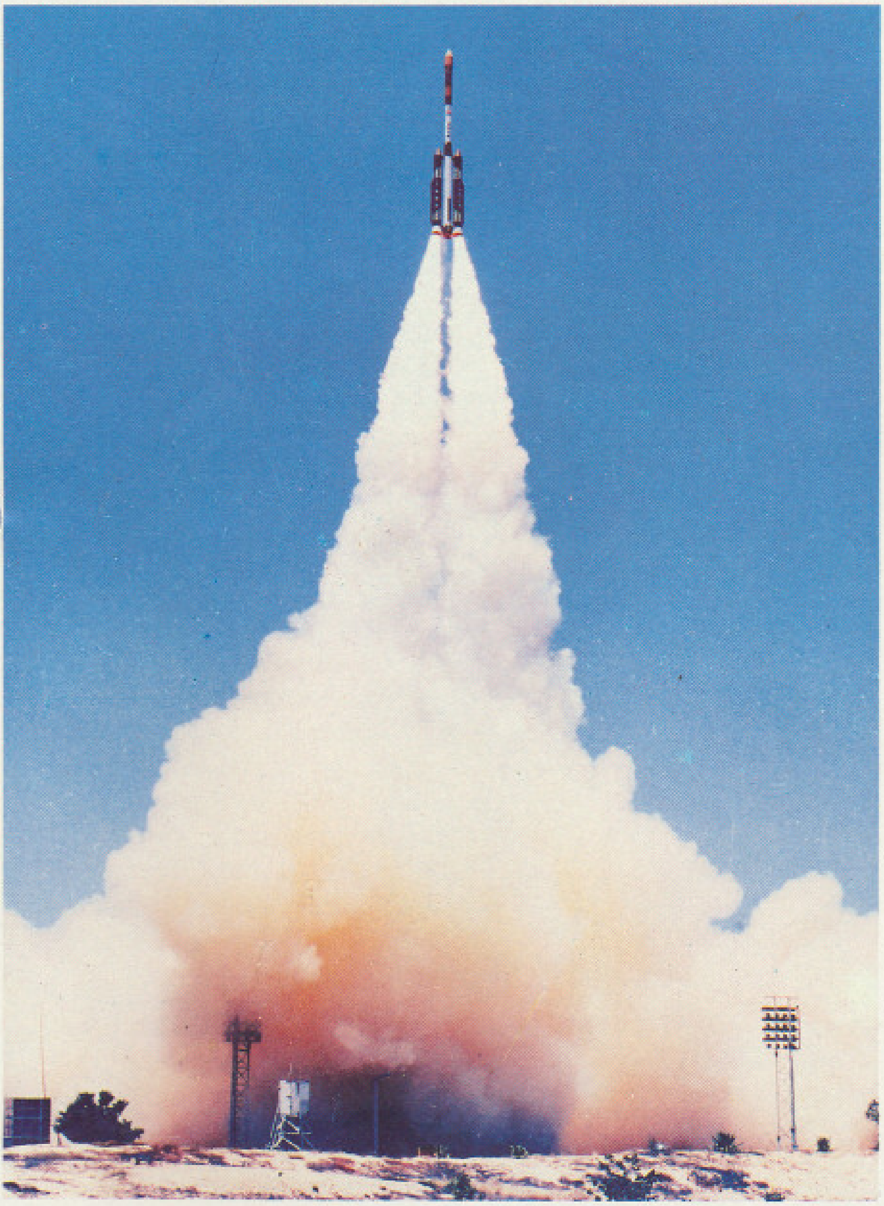
Power:
100W

Battery:
12Ah, Nickel Cadmium

Mission life:
6 months (min)

TTC frequency:
S-band and VHF

Payloads:
1. Monocular Electro Optical Stereo Scanner (MEOSS),
2. Gamma Ray Burst Experiment (GRBE)□



Ray Burst Experiment (GRBE). MEOSS is an experimental remote sensing mission being conducted in collaboration with the West German Space Agency, DFVLR. GRBE is an experiment to monitor celestial gamma ray bursts in the energy range of 20keV to 3000keV. It will study the radiation from strong solar flares, measure temporal variation in gamma ray bursts with high time resolution and measure temporal evolution of burst energy spectrum□

The Two strap-on motors (zero stage) of the ASLV-D1 worked flawlessly but the first stage failed to ignite.

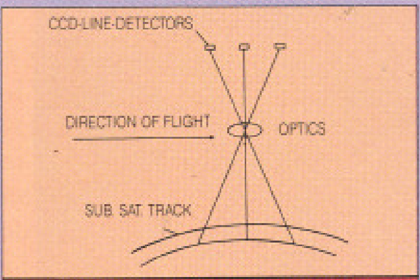
MEOSS: Stereo Images from Space

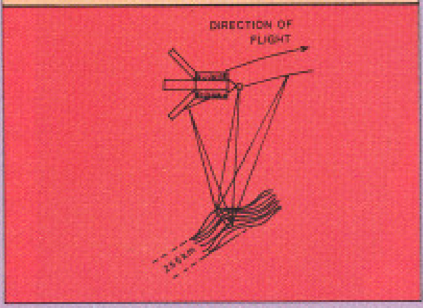
The imageries obtained through cameras on board remote sensing spacecraft ordinarily lack information on the height of the terrain photographed. For accurate studies of geomorphological and cartographic features, three-dimensional cloud distribution etc., it is essential to incorporate the height information in the remote sensing imageries.

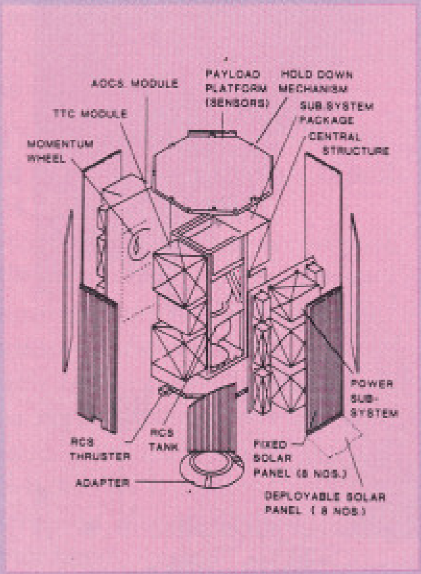
This is precisely what the Monocular Electro Optic Stereo Scanner (MEOSS), developed by the West German Space Agency DFVLR attempts to achieve. The uniqueness of MEOSS is that it does this stereo scanning using single optics - a feature that can be considered as a trend setter in this field.

The basic principle of stereoscopic imaging consists in simultaneously viewing the same object (or scenery) from different look angles; the resultant overlapping image contains the needed information on the third dimension. The human eyes (binocular vision) achieve the stereoscopic imaging by simultaneously viewing objects from two different look angles. The MEOSS, which is a monocular system, achieves only near simultaneity by viewing a given scene at different instants of time; but it generates a three-fold stereoscopic image by using three arrays of CCDs suitably. The near-simultaneity in MEOSS amounts to a time difference of about 29 seconds between adjacent CCD arrays. This is short enough to ensure reasonably constant solar illumination conditions.

The MEOSS Camera mounted on the payload deck of SROSS-2.



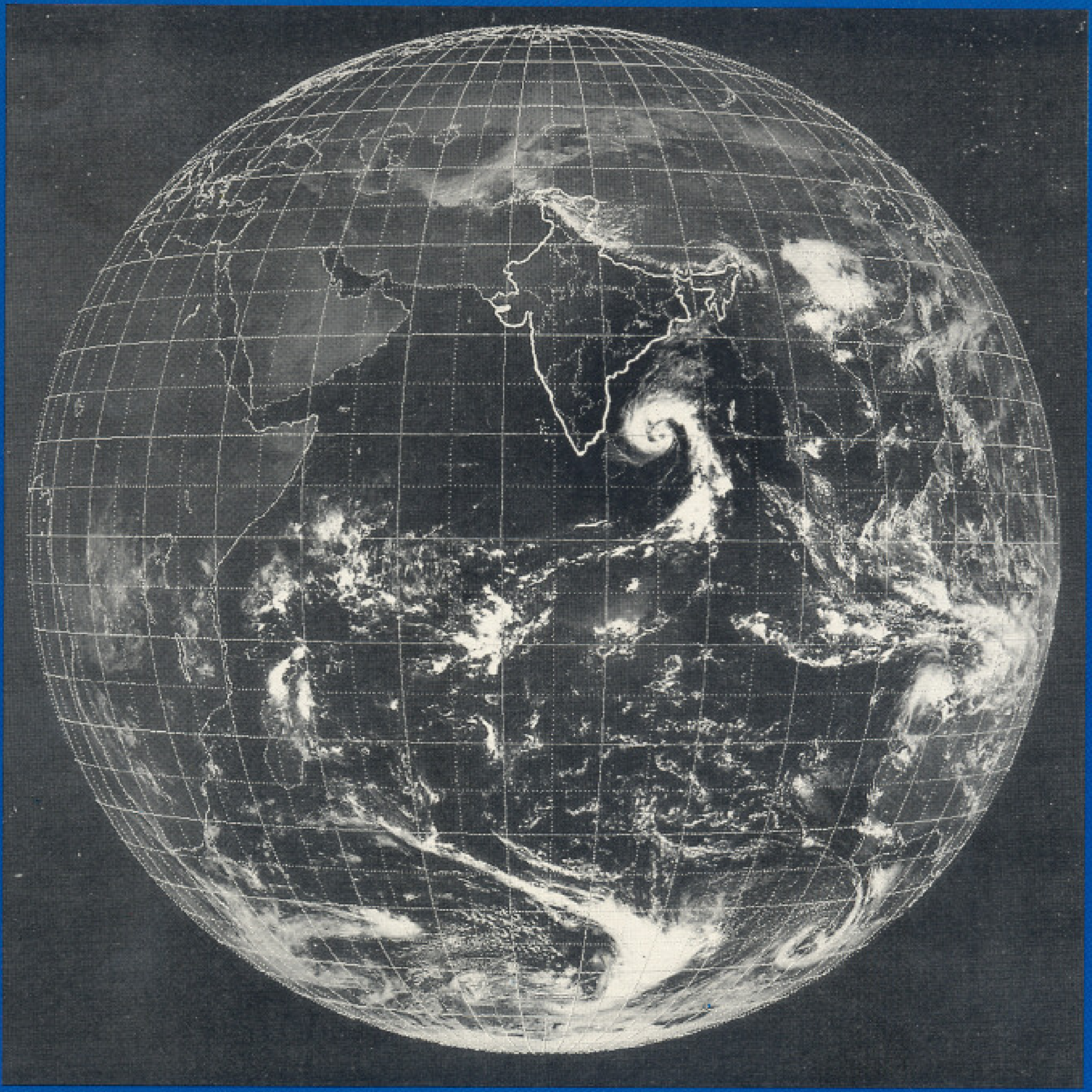




MEOSS is a single optics, single spectral-band camera. Three CCD arrays, made up of 3456 elements and working in push broom mode are mounted perpendicular to the flight direction on a common focal plane. Their oblique views at ± 23 deg. and at nadir lead to three-fold stereoscopic images. MEOSS has a swath width of 255km and a height resolution of 55m.

Among the various applications envisaged for MEOSS are: development of correlation techniques for stereoscopic images over land surfaces and cloud fields, updating of topographical maps, detection of tectonical and stratigraphical features, and analysis of three dimensional cloud distribution. □

Middle: MEOSS imaging scene.
Bottom: 150 Kg. RS Configuration exploded view.



Full disc INSAT-I VHRR imagery of the earth.

An artist's concept of the INSAT-1C satellite in Space.