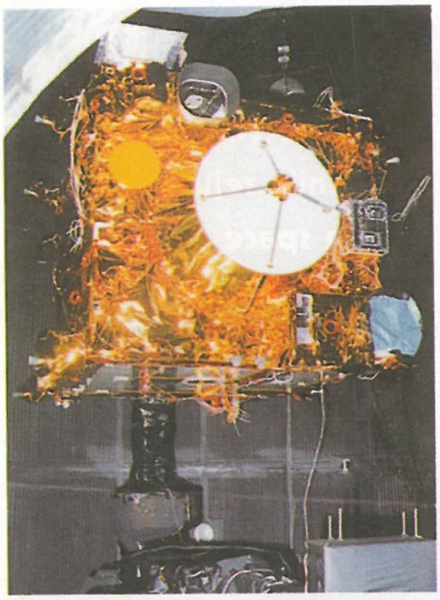
INSAT- 2E

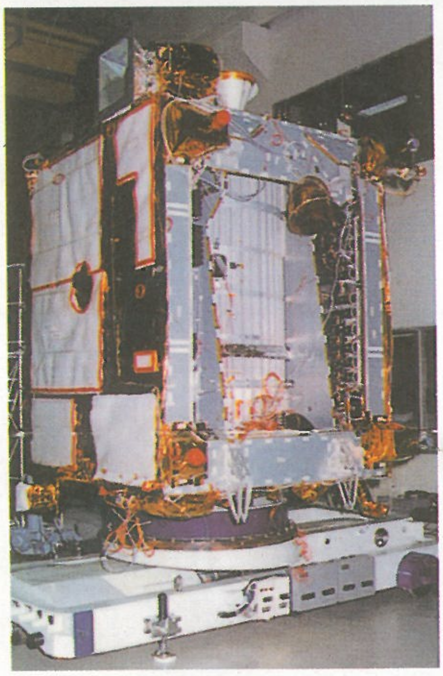
Success in Space

The success of INSAT-2E, while rejuvenating the Indian space establishment towards future challenges, has also provided a commercial edge to the Indian satellite program

By G.P. Vinaybabu

Within a matter of one and half years, the mood at ISRO has changed from one of despair and gloom to one of euphoria and upbeat. Just 18 months back the entire satellite establishment in India had sunk into a state of utter despair, what with the celebrated launch of INSAT-2D going waste due to a power failure. The very same scientists are now back in their elements with the successful placing of INSAT-2E in space orbit. INSAT-2E has not only rejuvenated our space scientists but has also provided commercial viability to their efforts.





Insat-2E Payload

two other payloads - a Korean satellite KITSAT and a German microsatellite TUBSAT as piggybacks.

The next major step for ISRO is the development of GSLV - Geo-synchronous Launch Vehicle scheduled for test launch in the year 2000, which would facilitate the launch of communication satellites from India. ●

PAYLOADS ON INSAT-3 SATELLITES

Payload	INSAT-3A	INSAT-3B	INSAT-3C	INSAT-3D
Normal C-band Transponder	12	-	24	-
Extended C-band Transponder	6	12	6	-
Ku-band Transponder	6	3	-	-
DRT-SAR	1	-	-	1
S-band Transponder	-	-	2	-
S-MSS Transponder	-	1	1	-
Very High Resolution Radiometer	1	-	-	-
CCD Camera	1	-	-	-
Meteorological Sounder	-	-	-	1
Meteorological Imager	-	-	-	1

Do we need a satellite program?

India is spending billions of dollars annually in developing communication and remote sensing satellites as also launch vehicles. Satellite launch is a highly unpredictable event. For the launch of every five satellites there is a chance of one satellite failing in the current scenario. Can a poor country like India afford such a large investment on satellite development? Are satellites helping the improvement of the underprivileged lot in the country? Are they contributing to the overall growth of Indian economy?

Consider this

- Fishermen who were until now venturing into the seas, unaware of what would be in store for them from rough weather can now confidently enter into the high seas fully aware of the weather conditions, courtesy INSAT.
- A tourist stranded in the middle of an alien island, can be assured of a helping hand from the skies via satellite aided search and rescue (SASR) equipment on board INSAT.
- India's international cricket campaign can be witnessed live from anywhere in the world from Toronto to Sharjah and from London to Melbourne again because of INSAT communication satellites.

Areas where satellite communication is serving the needs of the mass population are: ● Telecommunication ● Television broadcast ● Interactive Satellite Communication system ● Jhabua Development communication projects ● Radio Networking ● Meteorology ● Satellite aided search and rescue operations ● PTI's satellite news and facsimile dissemination project

Major utilisation of INSAT transponders has been in the telecommunications sector. Up to half of all the transponders are used by DoT. Next major beneficiary of INSAT system is the Doordarshan with 35 per cent of all the transponders put into use for television broadcast. The others including radio networking, search and rescue operations and meteorology make use of the remaining transponders.

Transponder Allocation

Telecommunications	-	31
Television distribution	-	22
Others	-	10

Isn't this enough reason for us to believe India is doing the right thing in pursuing its satellite program?

INSAT, in short for Indian National Satellite, was commissioned in the year 1983 with the successful launch of INSAT-1B satellite. Insat-1A launched prior to this was deactivated due to propellant depletion soon after its launch. ISRO has launched a total of nine INSAT satellites in the past 17 years out of which four satellites are still in service. Three satellites proved to be failures due to anomalies in power and propellant systems. The INSAT-2E launched in April 1999 is the ninth in the INSAT series. It was put into orbit successfully and since then has been functioning normally.

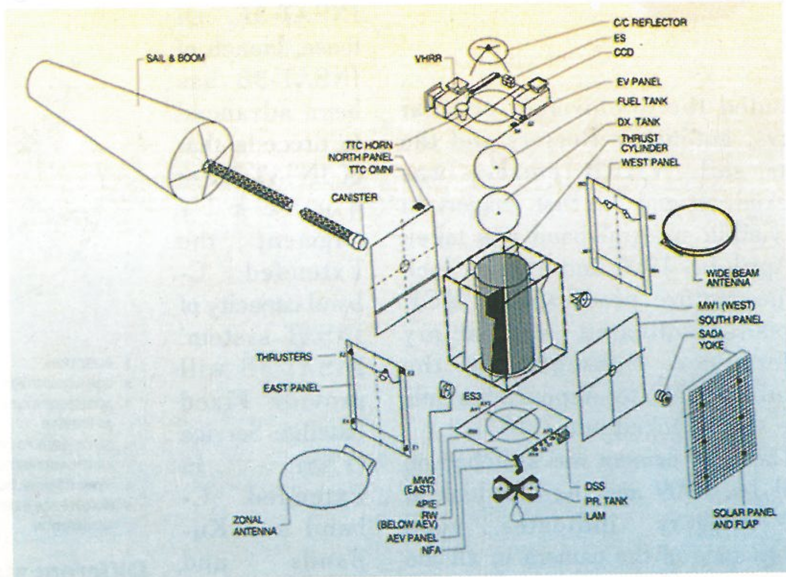
INSAT-2E is the fifth satellite in the second-generation INSAT-2 satellites. It is the heaviest and the most advanced satellite system built by ISRO till date. INSAT-2E combines both meteorological and communication functions. The meteorological pay-load consists of a very high-resolution radiometer (VHRR) and a charged couple device camera. The VHRR in Insat - 2E for the first time incorporates a new band called the water vapour band (5.7- 7.1 micrometers) in addition to the Visible band (0.55-0.75 micrometers) and Thermal Infrared (10.5 - 12.50 micrometers). The use of water vapour band greatly assist the meteorologists in the vapour content estimation of the clouds and rainfall forecast. The VHRR can produce a ground resolution of 2 by 2 kms. The CCD camera is a totally new meteorological payload and is being flown for the first time on INSAT-2E. It is designed to carry out earth imaging in three spactral bands

Visible - 0.62 - 0.68 µm
Infrared - 0.77 - 0.86 µm
Short Wave InfraRed - 1.55 - 1.69 µm

and is capable of providing a ground resolution of 1km by 1km.

The communications payloads of INSAT-2E includes seventeen high power transponders - ten capable of providing a zonal beam coverage and seven capable of providing a wide beam coverage.

It may be recalled that INSAT-2E was successfully launched on April 3, 1999 from Kourou, French Guyana by an Ariane-4 launch vehicle. Soon after lift off, the satellite signals were received at the INSAT Master Control Facility (MCF) at Hassan. The first of the major maneuvers involved the firing of the liquid apogee engine of the satellite in several steps to raise the satellite to its geo-synchronous orbit. The next set of maneuvers



Components of INSAT-2E

SALIENT FEATURES

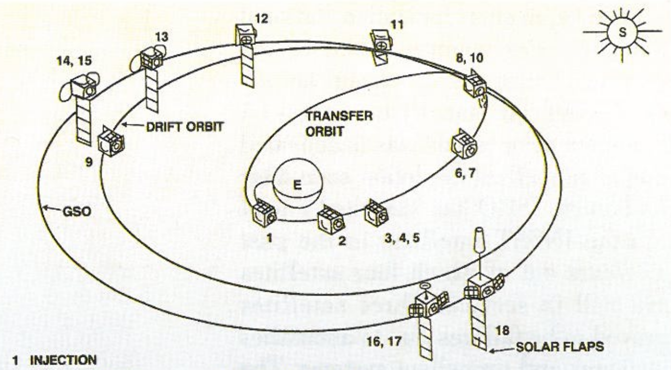
Orbit	: Geostationary (83°E Longitude).
Dry Mass	: 1,150 kg.
Mass at Lift-off	: 2,500 kg.
Size	: Cuboid 1.9m x 1.77m x 2.4m with solar array on the south and solar Sail & boom on the north.
Length when Fully deployed	: 26 m.
Spacecraft Propulsion And Control	: 440 N Liquid Apogee Motor with N_2O_4 (Nitrogen Tetroxide) and MMH (Mono Methl Hydrazine) for orbit raising, 3-axis body stabilised in orbit Using momentum wheels, sensors, solar flap, magnetic torquer and sixteen Reaction Control Thrusters of 22 Newton each.
Power	: Solar array generating 2,050 W. Two 60 Ah Ni-H2 batteries to support full Payload operation during eclipse period.
Mission life	: 12 years.

included the deployment of solar arrays, antenna reflectors and the solar sail. VHRR camera was checked out and the first imagery in the visible spectral band was taken on April 14, 1999 and a quick look of the picture processed at MCF, Hassan, indicated satisfactory performance. Subsequently, the Infrared and Water Vapour channels were also checked out.

The CCD camera was switched on April 16, 1999 and the first look at the imagery indicates good performance of the camera in all the three spectral bands in which the camera operates.

INSAT-3 Series

The third generation INSAT satellites will have five satellites, INSAT-3A, INSAT-3B, INSAT-3C, INSAT-3D and INSAT-3E. Of these, launch of INSAT-3B has been advanced to precede that of INSAT-3A to quickly augment the Extended C-band capacity of INSAT system. INSAT-3B will provide Fixed Satellite Service (FSS) in Extended C-band and Ku-Bands and Mobile Satellite Services (MSS) in S-band. ISRO has planned to launch this satellite in 1999. INSAT-3B will weigh about 2000 kg with a dry mass of 950 kg. It would generate about 1,650 W of power from a double sided solar array configuration.



1 INJECTION
2 SUN ACQUISITION
3 ACQUISITION OF SIGNAL AT HASSAN
4 EARTH VIEW FACE EARTH ACQUISITION
5 GYRO CALIBRATION
6 NORTH FACE EARTH ACQUISITION
7 LAM ATTITUDE CHANGE
8 APOGEE MOTOR FIRING I
9 SUN POINTING MODE
10 APOGEE MOTOR FIRING II
11 WEST FACE SUN ACQUISITION; SOLAR ARRAY DEPLOYMENT
12 EARTH ACQUISITION; SOLAR ARRAY TRACKING
13 WHEELS 'L' MODE
14 ANT. DEPLOYMENT (WEST)
15 ANT. DEPLOYMENT (EAST)
16 SAIL DEPLOYMENT
17 WHEELS 'V' MODE
18 GSO CONFIGURATION.

Different stages in the launch of INSAT-2E

Work on INSAT-3A and INSAT-3C has also commenced. INSAT-3A will be a multi-purpose satellite providing communication, meteorological and search and rescue services. It will provide Normal C-band, Extended C-band and Ku-band FSS communication services, meteorological services through Very High Resolution Radiometer (VHRR) and Charged Coupled Device (CCD) camera systems. It also carries a meteorological Data Relay Transponder DRT as well as Search and Rescue transponder (SASR). While some of the Normal C-band FSS transponders provide wide area coverage, the other channels operate through shaped India coverage contours. The satellite will generate about 3,700 W of power from its single sided solar array configuration. The satellite dry mass is about 1,300 kg and the mass at lift-off would be around 2,700 kg.

The INSAT-3C will be a communication satellite providing FSS services in normal and extended C-bands, Broadcast Satellite Service (BSS) and MSS in S-bands. The number of channels for the Normal C-FSS service is double than the usual due to the use of frequency reuse technique. The satellite generates about 3,000 W of power by adopting a double sided solar array configuration. The satellite dry mass will be about 1,170 kg and the lift-off mass will be around 2,570 kg.

INSAT-3D will be primarily configured as a Meteorological satellite. It will carry a six channel imager and a nineteen-channel sounder and transponder for meteorological data relay and satellite aided search and rescue over the Indian region including the oceans and weather forecast. The satellite also carries a DRT & SAS&R transponder as well as S-band BSS transponders. The satellite dry mass will be about 950 kg with a lift-off mass of 2,000 kg. Along with the INSAT-3 series, the development of GSAT, which will be launched as a test satellite piggy riding on GSLV, is also underway. With the above India is all set to scale greater heights in Satcom in the next millennium. ●

PAYLOADS

Communication payload

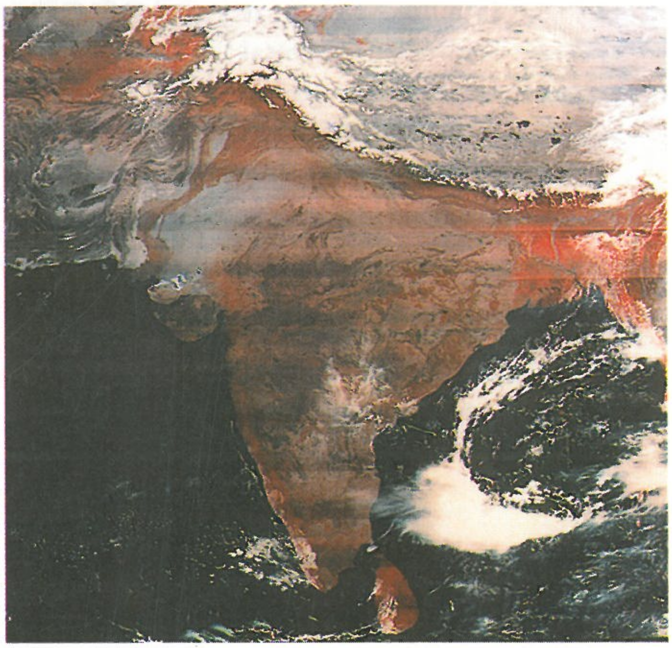
- 12 C-band transponders, seven of which have wide beam coverage and five zonal beam coverages.
- 5 lower extended C-band transponders with zonal beam coverage.
- All channels provide Edge Of Coverage-Effective Isotropic Radiated Power (EOC-EIRP) of 36 dBW.

Meteorological payload

- Very High Resolution Radiometer (VHRR) with 2 km resolution in visible band and 8 km resolution in infrared and water vapour band.
- Charge Coupled Device (CCD) camera operating in visible, near infrared and shortwave infrared band with 1 km resolution.

PICTURES TAKEN BY INSAT - 2E

Insat 2-E first image - 18th April '99



First day product of INSAT-2E CCD - 15th April '99

INSAT NOW A GLOBAL PLAYER

What is India's *locus standi* among the League of Nations on the science and technology front? Spare no thought. India is right up there among the best in the world. India's capability to build, operate and maintain communication satellites is more than ample proof to our technological enterprise. India is one of the very few countries in the world to have the requisite competence and technological initiative to build and operate both communication and remote sensing satellites.

India's satellite programs which began humbly with the launch of Aryabhata in 1975, has grown by leaps and bounds in the past two decades to enter into the third generation of communication satellites. Today, INSAT has around 60 active transponders on its satellites, one of the largest pool of transponders available with a single domestic operator. Indian Space Research Organization (ISRO) which is the developer of all INSAT satellites is now all set to launch INSAT-3B into space in August-September this year.

Even as ISRO is preparing itself to enter into the next millenium with a series of third generation communication satellites, the organization received a shot in the arm when INTELSAT came forward to formalise the in-orbit lease of a bulk capacity of INSAT-2E transponders. It was indeed a historic occasion for the scientific establishment of the country. It was a recognition of India's outstanding achievement in the frontier technology areas and accordance of commercial importance to India's efforts. Indian satellite user spectrum and ISRO scientific top brass was present in full strength during the handing over ceremony of 11 transponders of INSAT-2E to the INTELSAT. The leasing of transponders on INSAT- 2E is definitely one of great significance as INTELSAT is the largest provider of satellite services in the world.

Kullman, Director General of INTELSAT in his acceptance speech said that he was fully satisfied and highly impressed with ISRO's satellite maintenance setup while handing over the first installment cheque for US $ 0.68 million for the lease of INSAT transponders to INTELSAT.

The handing over of transponders was done under an agreement between Department of Space of Government of India and the INTELSAT signed in January 1995. As per the agreement, DOS is required to build and provide a bulk capacity of nine transponders (two transponders with 72 MHz bandwidth and seven with 36 Mhz bandwidth - thus adding upto an equivalent of eleven 36 MHz capacity) on an in-orbit lease basis.

The lease valid for a period of ten years (extendable by two more years) would fetch DOS nearly US$ 10 million per year. The inclusion of INSAT transponders into the INTELSAT fold would allow INTELSAT to utilise the wide array of services possible through Insat-2E in the areas of telecommunications, TV broadcasting, developmental communications, education, weather prediction and disaster warning.

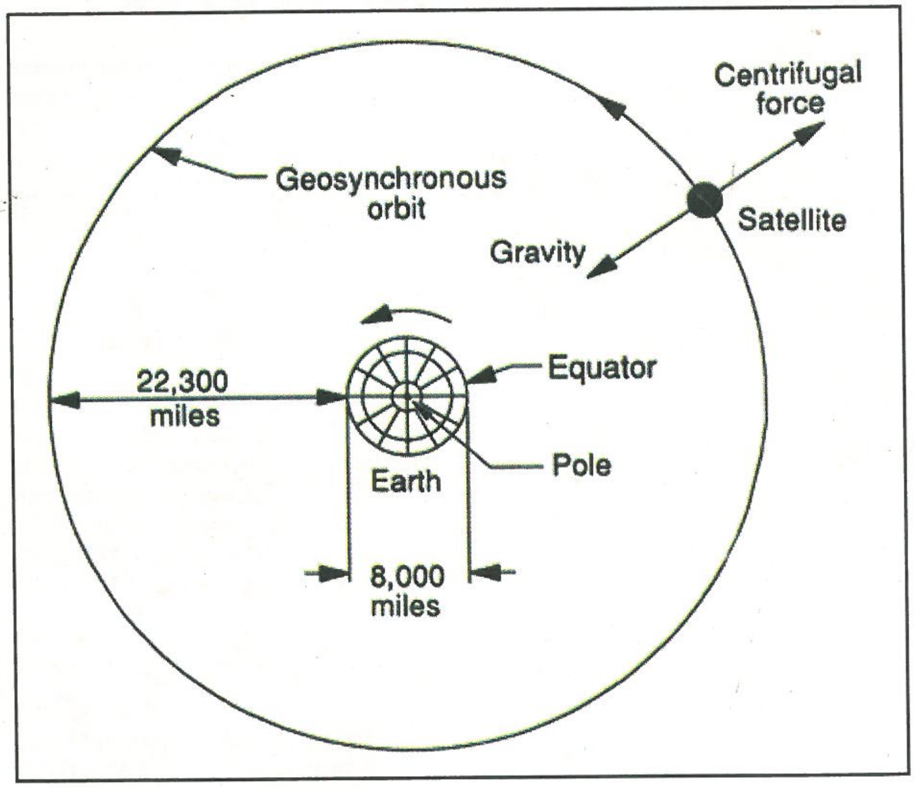
Satellites placed at different orbital positions in space serve different communication needs. This article provides an overview of the various satellite orbits and the frequencies and bands that make Satcom applications possible

Matching the Satellite wavelength

The three most commonly used satellite frequency bands are the C-band, Ku-band, and Ka-band. C-band and Ku-band are the two most common frequency spectrums used by today's satellites. To help understand the relationship between antenna diameter and transmission frequency, it is important to note that there is an inverse relationship between frequency and wavelength - when frequency increases, wavelength decreases. As wavelength increases, larger antennas (satellite dishes) are necessary to gather the signal.

Bands & frequencies

C-band satellite transmissions occupy the 4 to 8 GHz frequency range. These relatively low frequencies translate to larger wavelengths than Ku-band or Ka-band. These larger wavelengths of the C-band mean that a larger satellite antenna is required to gather the minimum signal strength, and therefore the minimum size of an average C-band antenna is approximately 2 to 3 meters in diameter. Ku-band satellite transmissions occupy the 11 to 17 GHz frequency range. These relatively high-frequency



Clarke's orbit