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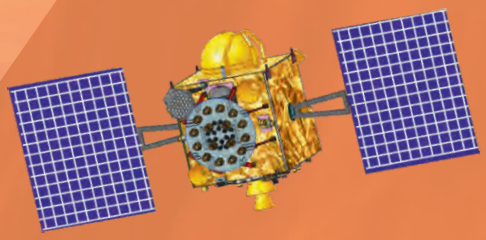
PSLV-C27
IRNSS-1D



PSLV-C27

PSLV-C27 at Second Launch Pad

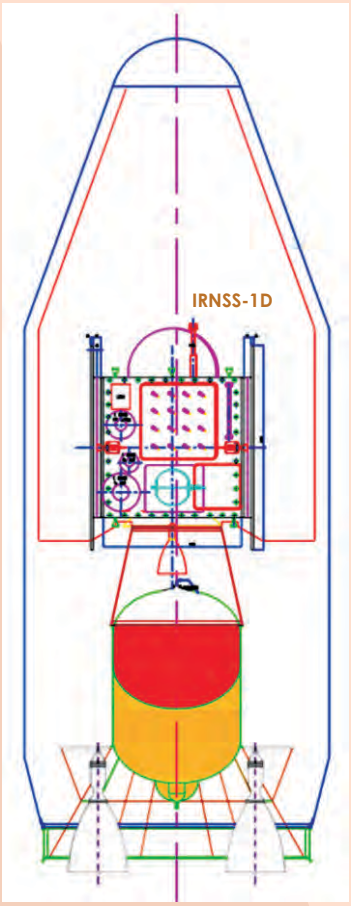
Polar Satellite Launch Vehicle, in its twenty ninth flight (PSLV-C27), will launch IRNSS-1D, the fourth satellite of the Indian Regional Navigation Satellite System (IRNSS). The launch will take place from the Second Launch Pad (SLP) of Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota. As in the previous three launches of IRNSS satellites, PSLV-C27 will use 'XL' version of PSLV. This is the eighth time 'XL' configuration is being flown, earlier seven being PSLV-C11/Chandrayaan-1, PSLV-C17/GSAT-12, PSLV-C19/RISAT-1, PSLV-C22/IRNSS-1A, PSLV-C25/Mars Orbiter Spacecraft, PSLV-C24/IRNSS-1B and PSLV-C26/IRNSS-1C missions.

PSLV-C27 at a glance (Vehicle lift-off Mass: 320 tonne Height: 44.4 m)

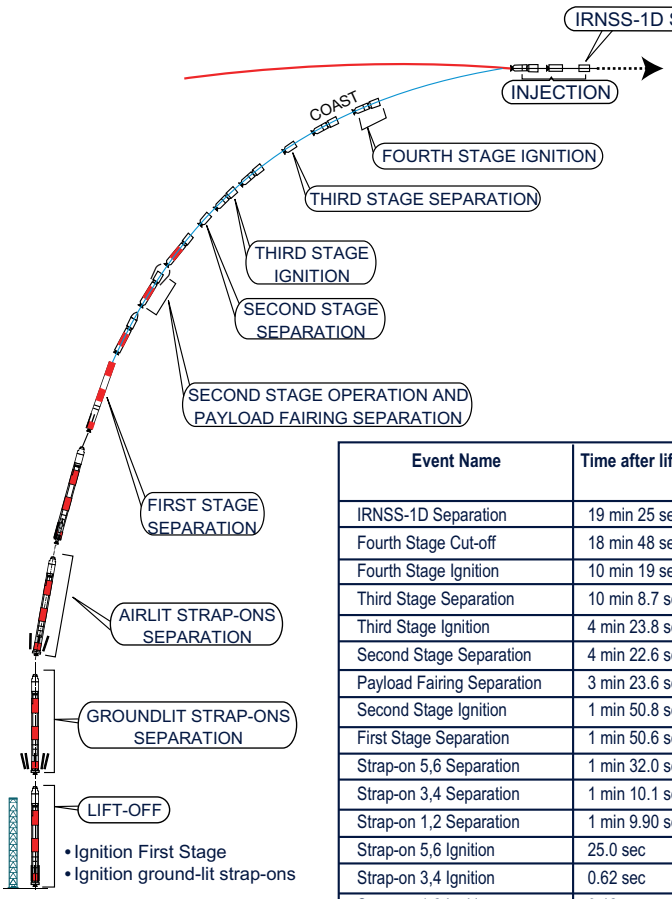
	Stage-1	*Stage-2*	*Stage-3*	*Stage-4*
Nomenclature	Core Stage PS1 + 6 Strap-on Motors	PS2	PS3	PS4
Propellant	Solid (HTPB based)	Liquid (UH25 + N_2O_4)	Solid (HTPB based)	Liquid (MMH + MON-3)
Propellant Mass(T)	138.2 (Core), 6 x 12.2 (Strap-on)	42.0	7.6	2.5
Max Thrust (kN)	4819 (Core), 6 x 716 (Strap-on)	804	240	7.3 x 2
Stage Dia (m)	2.8 (Core), 1 (Strap-on)	2.8	2.0	1.3
Stage Length (m)	20 (Core), 12 (Strap-on)	12.8	3.6	3.0

HTPB : Hydroxyl Terminated Poly Butadiene
UH25 : Unsymmetrical Dimethyl Hydrazine + 25% Hydrazine Hydrate
N_2O_4 : Nitrogen Tetroxide
MMH : Mono Methyl Hydrazine, MON-3: Mixed Oxides of Nitrogen

PSLV-C27



IRNSS-1D in PSLV-C27 Envelope



Apogee 20,650 ± 675 km
Perigee 284 ± 5 km
Inclination 19.2 ± 0.2 deg

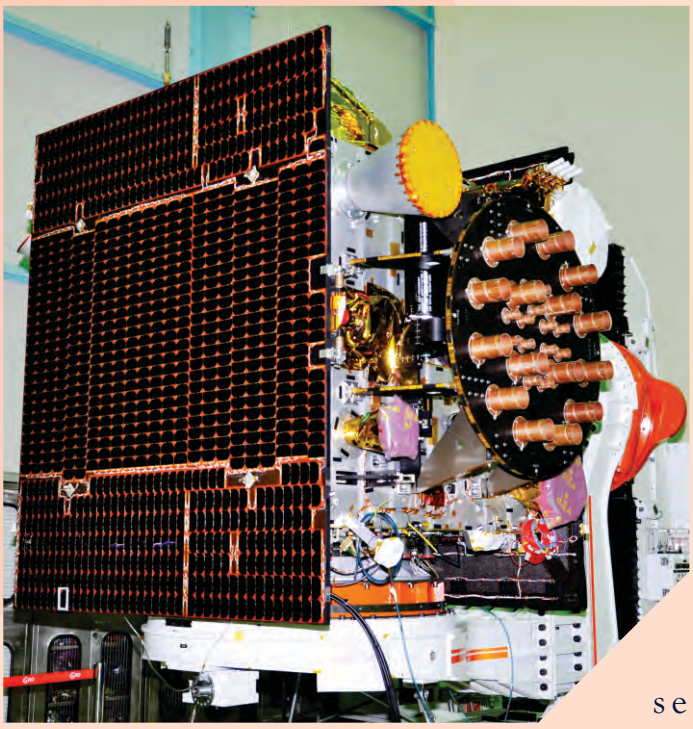
Event Name	Time after lift-off	Altitude (kilometre)	Velocity (metre per second)
IRNSS-1D Separation	19 min 25 sec	506.83	9598.39
Fourth Stage Cut-off	18 min 48 sec	454.63	9638.05
Fourth Stage Ignition	10 min 19 sec	186.43	7732.00
Third Stage Separation	10 min 8.7 sec	184.63	7734.17
Third Stage Ignition	4 min 23.8 sec	131.34	5377.04
Second Stage Separation	4 min 22.6 sec	131.10	5377.46
Payload Fairing Separation	3 min 23.6 sec	113.02	3712.24
Second Stage Ignition	1 min 50.8 sec	56.21	2391.98
First Stage Separation	1 min 50.6 sec	56.04	2392.48
Strap-on 5,6 Separation	1 min 32.0 sec	40.02	2073.68
Strap-on 3,4 Separation	1 min 10.1 sec	23.89	1472.12
Strap-on 1,2 Separation	1 min 9.90 sec	23.76	1467.11
Strap-on 5,6 Ignition	25.0 sec	2.71	619.69
Strap-on 3,4 Ignition	0.62 sec	0.03	451.92
Strap-on 1,2 Ignition	0.42 sec	0.03	451.92
First Stage Ignition	0 sec	0.03	451.92

PSLV-C27 Typical Flight Profile

Placement of Nozzle End Segment of PSLV-C27 first stage over Launch Pedestal in progress

PSLV-C27 second stage during Vehicle Assembly

IRNSS-1D



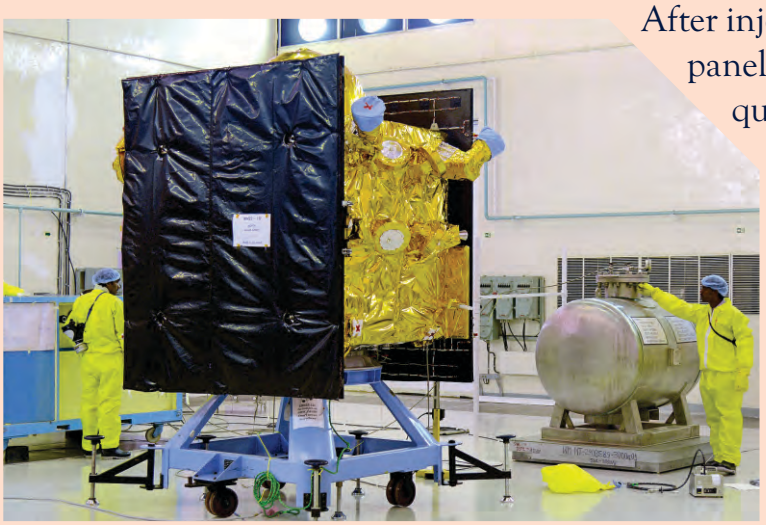
Closeup view of IRNSS-1D at Clean Room

IRNSS-1D is the fourth navigation satellite of the seven satellites constituting the IRNSS space segment. Its predecessors, IRNSS-1A, 1B and 1C were launched by PSLV-C22, PSLV-C24 and PSLV-C26 in July 2013, April 2014 and October 2014 respectively. IRNSS-1D has a lift-off mass of 1425 kg. The configuration of IRNSS-1D is similar to that of IRNSS-1A, 1B and 1C. The satellite has been realised in less than four months after the launch of its predecessor.

The two solar panels of IRNSS-1D consisting of Ultra Triple Junction solar cells generate about 1660 Watts of electrical power. Sun and Star sensors as well as gyroscopes provide orientation reference for the satellite. Special thermal control schemes have been designed and implemented for some of the critical elements such as atomic clocks. The Attitude and Orbit Control System (AOCS) of IRNSS-1D maintains the satellite's orientation with the help of reaction wheels, magnetic torquers and thrusters. Its propulsion system consists of a Liquid Apogee Motor (LAM) and thrusters.

IRNSS-1D undergoing solar panel deployment test

IRNSS-1D will be launched into a sub Geosynchronous Transfer Orbit (sub GTO) with a 284 km perigee (nearest point to Earth) and 20,650 km apogee (farthest point to Earth) with an inclination of 19.2 deg with respect to the equatorial plane.

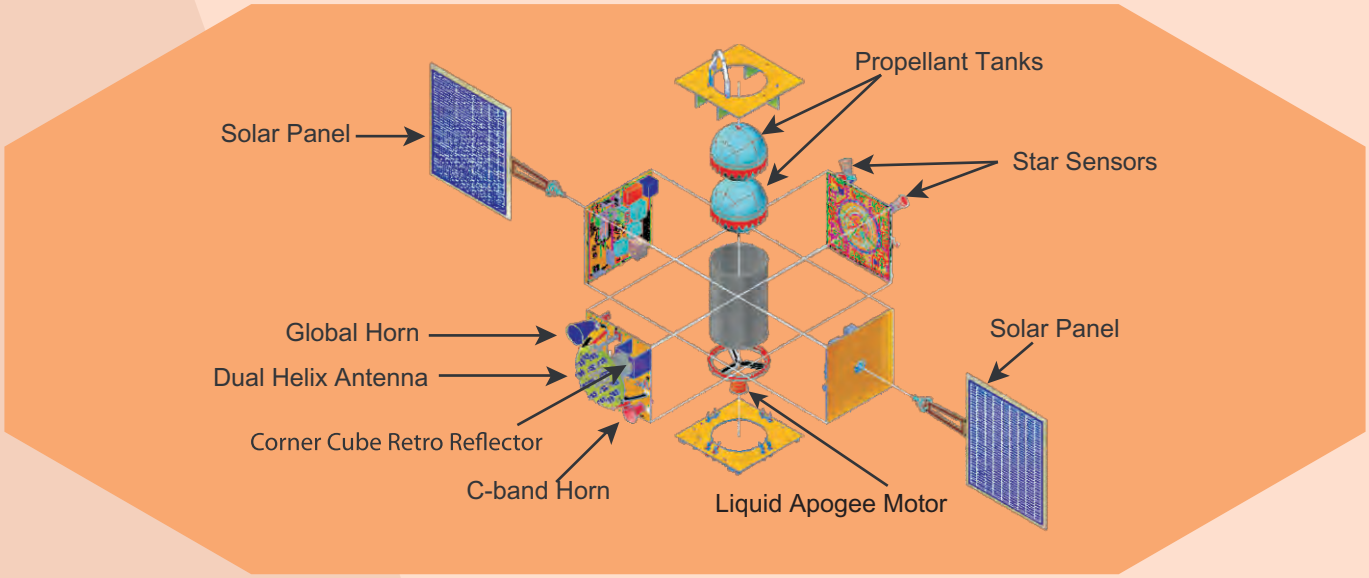


IRNSS-1D propellant filling operation in progress

After injection into this preliminary orbit, the two solar panels of IRNSS-1D are automatically deployed in quick succession and the Master Control Facility (MCF) at Hassan takes control of the satellite and performs the initial orbit raising manoeuvres consisting of one manoeuvre at perigee (nearest point to earth) and three at apogee (farthest point to earth). For these manoeuvres, the Liquid Apogee Motor (LAM) of the satellite is used, thereby finally placing it in the geosynchronous orbit at its designated location.

IRNSS-1D Salient features

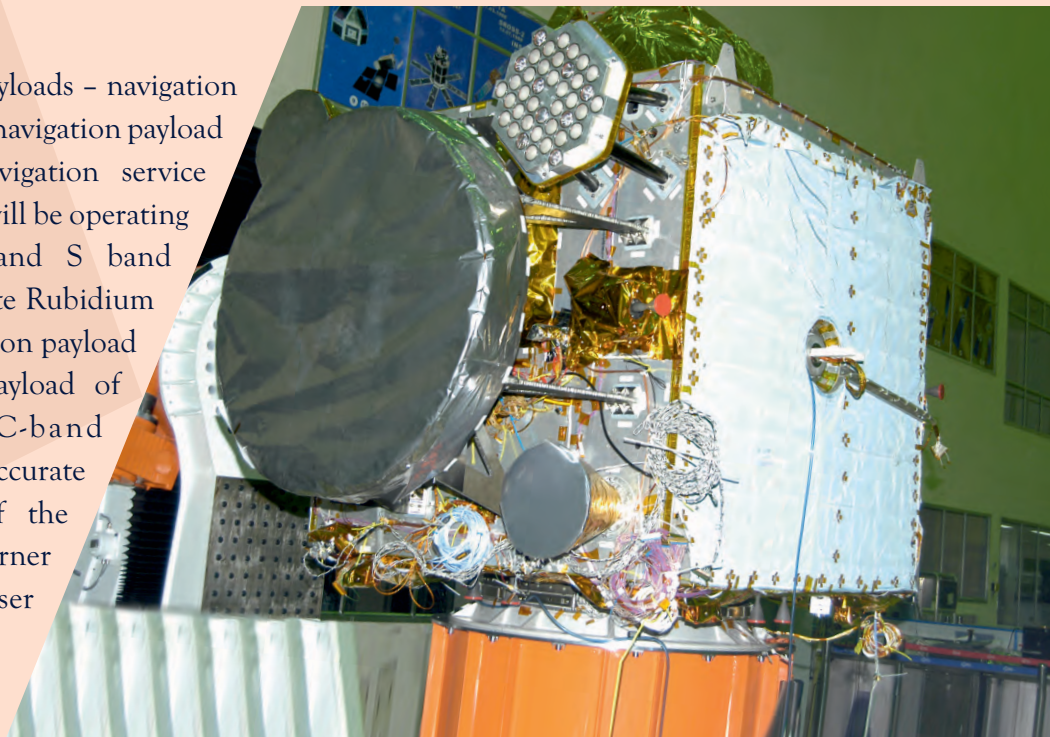
ORBIT	Geosynchronous, at 111.75 deg East longitude with 30.5 deg inclination
LIFT-OFF MASS	1425 kg
DRY MASS	603 kg
PHYSICAL DIMENSIONS	1.58 metre x 1.50 metre x 1.50 metre
POWER	Two solar panels generating 1660 W, one Lithium-ion battery of 90 Ampere-Hour capacity
PROPULSION	440 Newton Liquid Apogee Motor, twelve 22 Newton Thrusters
CONTROL SYSTEM	Zero momentum system, orientation input from Sun & Star Sensors and Gyroscopes; Reaction Wheels, Magnetic Torquers and 22 Newton thrusters as actuators
MISSION LIFE	10 years



IRNSS-1D Disassembled View

PAYLOADS:

IRNSS -1D carries two types of payloads – navigation payload and ranging payload. The navigation payload of IRNSS-1D will transmit navigation service signals to the users. This payload will be operating in L5 band (1176.45 MHz) and S band (2492.028 MHz). A highly accurate Rubidium atomic clock is part of the navigation payload of the satellite. The ranging payload of IRNSS-1D consists of a C-band transponder which facilitates accurate determination of the range of the satellite. IRNSS-1D also carries Corner Cube Retro Reflectors for laser ranging.



IRNSS Overview:

IRNSS is an independent regional navigation satellite system being developed by India. It is designed to provide accurate position information service to users in India as well as the region extending up to 1500 km from its boundary, which is the primary service area of IRNSS. The Extended Service Area lies between primary service area and area enclosed by the rectangle from Latitude 30 deg South to 50 deg North, Longitude 30 deg East to 130 deg East.

IRNSS will provide two types of services, namely, Standard Positioning Service (SPS), which is provided to all the users and Restricted Service (RS), which is an encrypted service provided only to the authorised users. The IRNSS System is expected to provide a position accuracy of better than 20 m in the primary service area.

IRNSS comprises of a space segment and a ground segment. The IRNSS space segment consists of seven satellites, with three satellites in geostationary orbit and four satellites in inclined geosynchronous orbit. IRNSS-1A, 1B and 1C, the first three satellites of the IRNSS constellation, have already started functioning from their designated orbital slot after extensive on-orbit test and evaluation to confirm their satisfactory performance.

The IRNSS Signal-in-Space Interface Control Document (ICD) for SPS version 1.0 has been released in the official ISRO website http://irnss.isro.gov.in in October 2014. The information for a user to acquire, track and utilise the SPS navigation signals are provided in the ICD. The signal-in-space of three IRNSS satellites has been validated by various agencies within and outside the country.

With the operationalisation of IRNSS-1D, four active IRNSS satellites will be transmitting navigation signals. This meets the minimum number of satellites necessary for enabling a navigation receiver to compute its position. Thus, with IRNSS-1D functioning in orbit, proof-of-concept of an independent regional navigation satellite system over India can be established.

IRNSS ground segment is responsible for navigation parameter generation and transmission, satellite control, ranging and integrity monitoring as well as time keeping.

ISRO Navigation Centre at (INC) at Byalalu, the Nerve Centre of the IRNSS ground segment

Currently, IRNSS ground segment is operational on 24/7 basis with 12 Indian Range and Integrity Monitoring Stations (IRIMS), one IRNSS Network Timing Centre (IRNWT), one ISRO Navigation Centre (INC) and one Spacecraft Control Facility (SCF) with its data communication network. Along with the deployment of seven satellite constellation, the entire ground segment with three more IRIMS and one each of IRNWT, INC and SCF is planned to be established.

Applications of IRNSS:

- Terrestrial, Aerial and Marine Navigation
- Vehicle tracking and fleet management
- Precise Timing
- Terrestrial navigation aid for hikers and travellers
- Disaster Management
- Integration with mobile phones
- Mapping and Geodetic data capture
- Visual and voice navigation for drivers

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