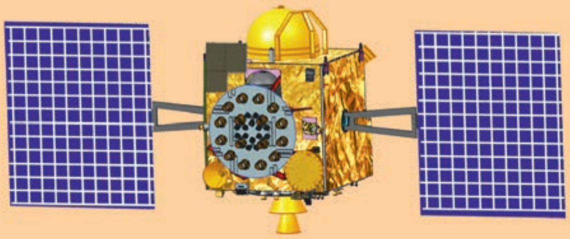


PSLV-C39/IRNSS-1H

PSLV-C39

PSLV-C39 at the Second Launch Pad

The main objective of PSLV-C39, the forty first flight of India's Polar Satellite Launch Vehicle, is the launch of IRNSS-1H, the eighth navigation satellite of India into an elliptical Sub-Geosynchronous Transfer Orbit (Sub-GTO).

PSLV-C39 launch will take place from the Second Launch Pad (SLP) of Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota. As in the previous seven launches of IRNSS satellites, PSLV-C39 will use 'XL' version of PSLV equipped with six strap-ons, each carrying 12 tons of propellant.

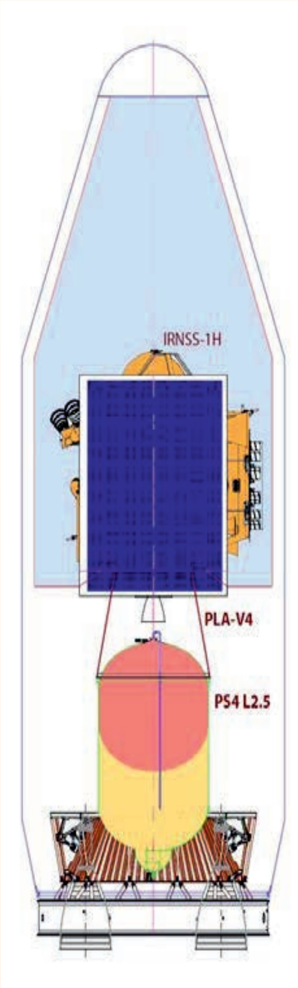
Besides seven IRNSS satellites, PSLV-XL has also launched many other spacecraft including India's Mars Orbiter spacecraft, the multi-wavelength observatory ASTROSAT, Radar Imaging satellite RISAT-1 and the Communication satellite GSAT-12. The launch of 104 satellites during a single mission by PSLV in February 2017 was the most prominent of its recent successes.

PSLV-C39 Vehicle Characteristics	
Vehicle Height	44.4 m
Lift off Mass	321 T

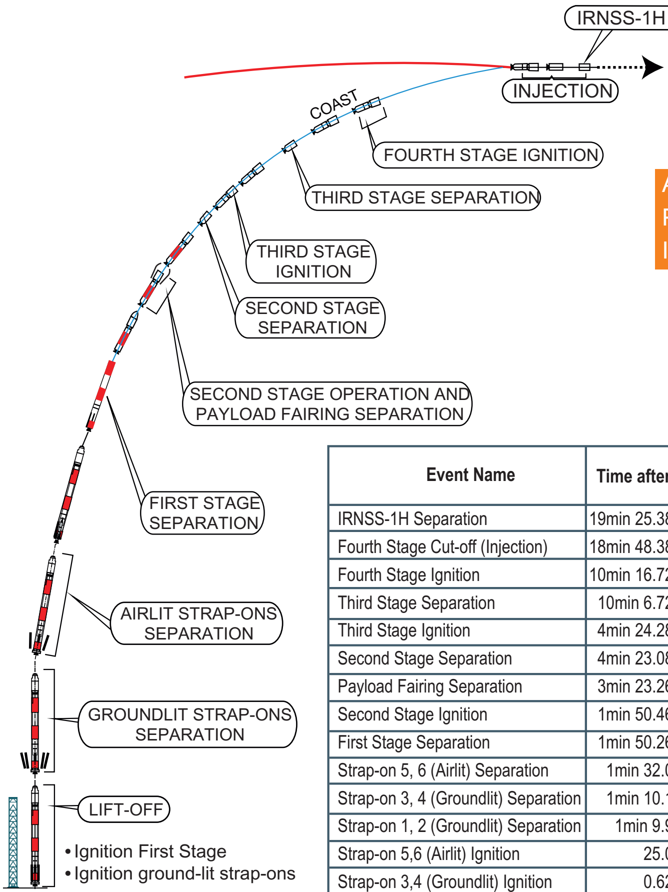
	Stage-1	Stage-2	Stage-3	Stage-4
Nomenclature	Core Stage PS1 + 6 Strap-on Motors	PS2	PS3	PS4
Propellant	Solid (HTPB based)	Liquid (UH25 + N_2O_4)	Solid (HTPB based)	Liquid (MMH + MON-3)
Propellant Mass(T)	138.2 (Core), 6 x 12.2 (Strap-on)	42.0	7.6	2.5
Stage Dia (m)	2.8 (Core), 1 (Strap-on)	2.8	2.0	1.34
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-C39



IRNSS-1H in PSLV-C39 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-1H Separation	19min 25.38 sec	507.555	9597.74
Fourth Stage Cut-off (Injection)	18min 48.38 sec	455.270	9638.79
Fourth Stage Ignition	10min 16.72 sec	187.312	7733.46
Third Stage Separation	10min 6.72 sec	185.537	7735.59
Third Stage Ignition	4min 24.28 sec	135.178	5384.76
Second Stage Separation	4min 23.08 sec	134.966	5385.13
Payload Fairing Separation	3min 23.26 sec	114.951	3705.42
Second Stage Ignition	1min 50.46 sec	55.683	2402.14
First Stage Separation	1min 50.26 sec	55.518	2402.64
Strap-on 5, 6 (Airlit) Separation	1min 32.0 sec	40.086	2061.57
Strap-on 3, 4 (Groundlit) Separation	1min 10.1 sec	24.113	1470.49
Strap-on 1, 2 (Groundlit) Separation	1min 9.9 sec	23.985	1465.55
Strap-on 5,6 (Airlit) Ignition	25.0 sec	2.747	622.47
Strap-on 3,4 (Groundlit) Ignition	0.62 sec	0.025	451.92
Strap-on 1,2 (Groundlit) Ignition	0.42 sec	0.025	451.92
First Stage Ignition	0.00	0.025	451.92

PSLV-C39 Typical Flight Profile

Nozzle End Segment of PSLV-C39 core stage being hoisted over the Mobile Launch Pedestal during vehicle integration

PSLV-C39 liquid second stage at the Vehicle Assembly Building during vehicle integration

IRNSS-1H

Hoisting of IRNSS-1H during its integration with conical adapter

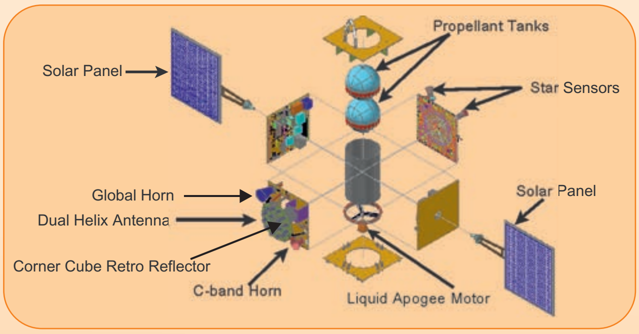
IRNSS-1H will be launched into a sub Geosynchronous Transfer Orbit (sub-GTO) with a 284 km perigee (nearest point to Earth) and 20,650 km apogee (farthest point to Earth) with an inclination of 19.2 deg with respect to the equatorial plane.

After injection into this preliminary orbit, the two solar panels of IRNSS-1H 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 using the Liquid Apogee Motor (LAM) of the satellite, thereby finally placing it in its designated slot in the inclined geosynchronous orbit.

IRNSS-1H Salient features

ORBIT	Geosynchronous with 29 deg inclination, at 55 deg East longitude
LIFT-OFF MASS	1425 kg
DRY MASS	598 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 and Star Sensors and Gyroscopes; Reaction Wheels, Magnetic Torquers and 22 Newton thrusters as actuators
MISSION LIFE	10 years

Payloads



IRNSS-1H Disassembled View

Like its other IRNSS predecessors, IRNSS-1H also carries two types of payloads – navigation payload and ranging payload. The navigation payload of IRNSS-1H 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). Highly accurate Rubidium atomic clocks are part of the navigation payload of the satellite. The ranging payload of IRNSS-1H consists of a C-band transponder which facilitates accurate determination of the range of the satellite. IRNSS-1H also carries Corner Cube Retro Reflectors for laser ranging.

NavIC (Navigation with Indian Constellation)

While IRNSS-1H joins the constellation for providing navigation services, IRNSS-1A will be used for messaging services. IRNSS 1H comes with more flexibility in service and it is compatible with the satellites which are in orbit.

In June 2014, the IRNSS Signal-in-Space Interface Control Document (ICD) for SPS version 1.0 was released in the ISRO website http://irnss.isro.gov.in. The updated ICD version 1.1, with the inclusion of IRNSS 1H satellite information, is now available on the ISRO website.

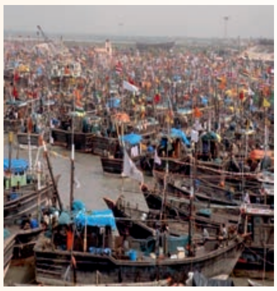
With the operationalisation of seven satellites in 2016, performance of the independent regional navigation satellite system over India was demonstrated for the targeted position accuracy which is better than 20 mtrs over 24 hours of the day.

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

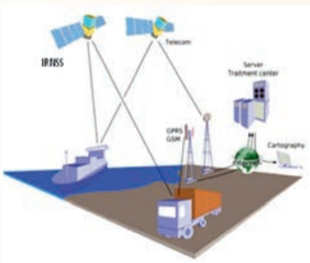
NavIC ground segment is operational 24 x 7. It has a number of Indian Range and Integrity Monitoring Stations, also called IRIMS, which are geographically spread across the country. The ground segment also has IRNSS CDMA Ranging Stations, IRNSS Network Timing Centers, ISRO Navigation Centres and Spacecraft Control Facilities. All of these are interconnected through a robust data communication network.

Important Applications of NavIC

Fisheries: The NavIC has many uses for fishermen going to sea. NavIC system, along with satellite based forecast on fish aggregation areas, helps fishermen to reach the potential fishing zones where they would get better fish catch. Using the messaging capabilities of NavIC, fishermen can receive alerts related to bad weather and high waves. Warning messages are also provided to fishermen when they approach international water boundaries preventing them from crossing inadvertently. All these services are provided through a fishermen app on a smart phone.



Shipping: NavIC helps the merchant ships to navigate to their destination in the ocean routes. It also aids them for search and rescue in disastrous situations using its current location.



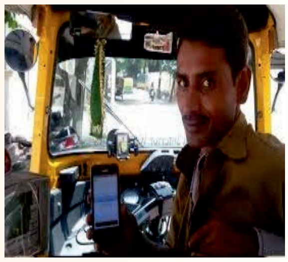
Transport: NavIC, with its position service, supports numerous applications in the road transport sector. It helps the travellers to go from one location to the other and enables transport operators to track their vehicles and goods so that they can manage their operations efficiently. NavIC also helps to monitor the movement of school vans and facilitates better traffic management in cities, towns and highways.

PSLV-C39/IRNSS-1H MISSION

Railways: NavIC is also very useful for railway operations in tracking trains movement, as well as informing the passengers about the time of arrival and departure. It is also useful in alerting the road users at Unmanned Level Crossings to avoid accidents by closely monitoring the approaching trains. The positions of trains are provided to a central monitoring center using communication links.

Resource Management: The position information derived from NavIC helps the Entrepreneurs and the Government Agencies to manage the resources efficiently using Geo-tagging and Geo-fencing techniques. The position of an object is linked with the virtual maps and alert messages are generated when there is a movement of object beyond permissible limits.

Location Based Services: By Linking position information from NavIC with Geo-Informatics Systems where several layers of information are linked on maps and satellite imagery, a host of location based services are offered to the general public. Using such features, one could easily locate a restaurant, shop, college, bus-stop, office, hospital, fuel pump, picnic spot, etc.



Survey and Alignment: Improved position accuracy can be obtained using NavIC signals in combination with Navigation constellations (multi-constellation), using both L5 and S channels. The use of NavIC with differential navigation technique provides much better position accuracies. Such accurate position information helps in applications like land survey, port operations, precision agriculture, road and rail alignments, etc.

Time Synchronised Services: NavIC, with its position and precise timing, significantly contributes in the areas of efficient telecom operations, power grid operations, disaster management, atmospheric studies, etc.

NavIC, when integrated with mobile phones, can bring a major transformation in the delivery of customised applications to the consumer segment.

Designed by: Solus Communication Resources, Bangalore. Aug 2017

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