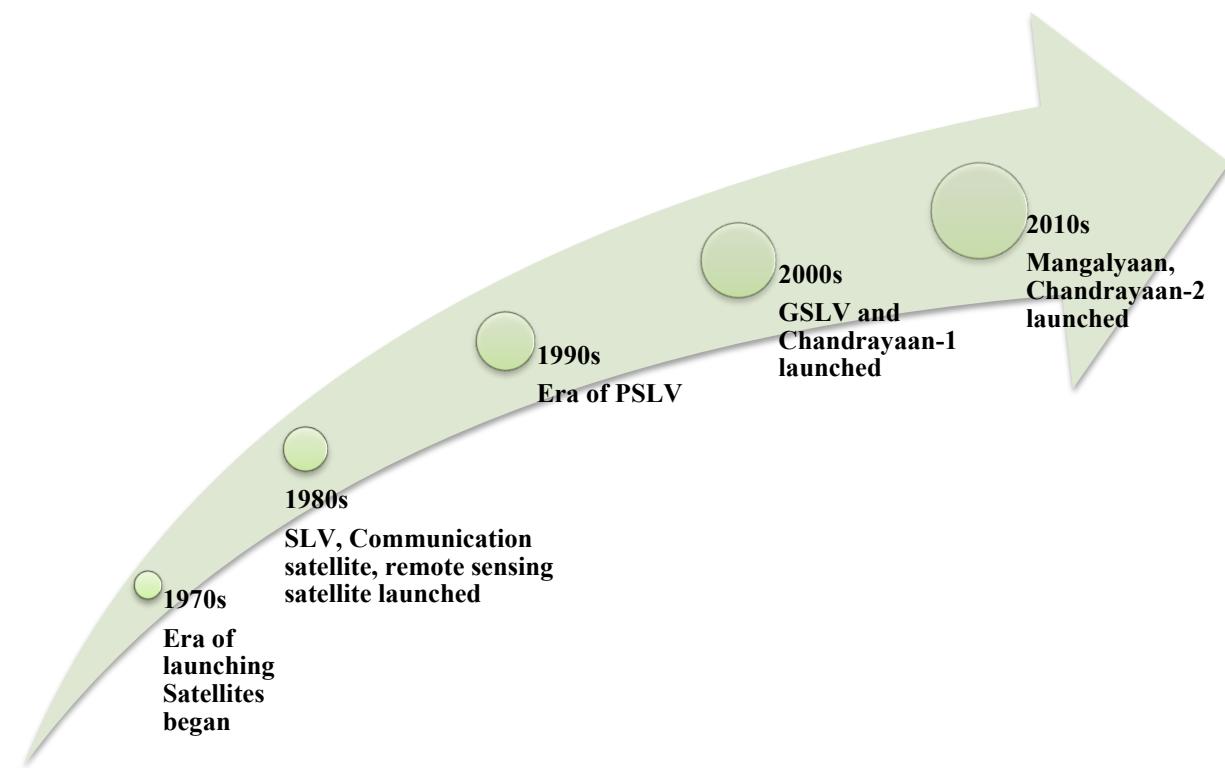


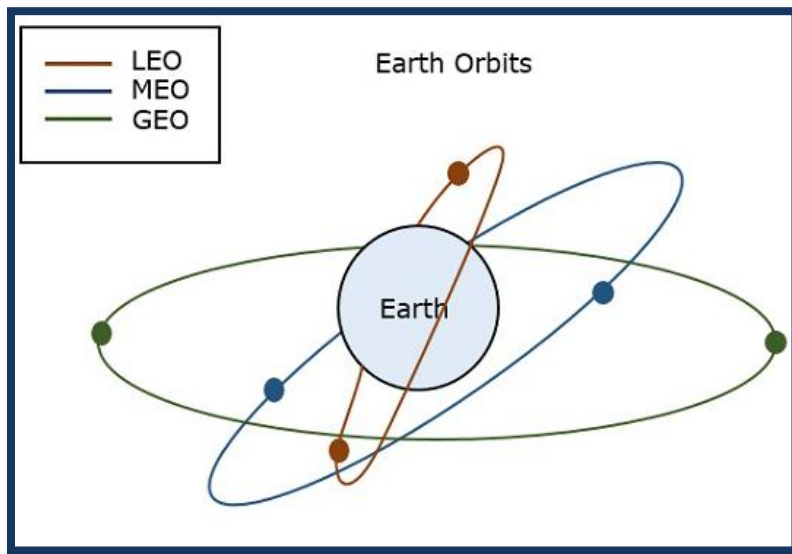
Indigenous Launching Vehicles for Space Expedition

In India, space research began in 1920s with the studies conducted by the scientists S K Mitra, C V Raman and Meghnad Saha. Dr Vikram Sarabhai also known as founding father of space programme recognized the benefits of space technologies in India. Further, in 1963, the first rocket was launched from India in November 1963 with establishment of ISRO in 1969. Geopolitical and economic considerations during the 1960s and 1970s compelled India to initiate its own launch vehicle programme. During the first phase (1960s–1970s) the country successfully developed a sounding rockets programme, and by the 1980s, research had yielded the Satellite Launch Vehicle-3 (SLV) and the more advanced Augmented Satellite Launch Vehicle (ASLV), complete with operational supporting infrastructure. ISRO further applied its energies to the advancement of launch vehicle technology resulting in the creation of Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch Vehicle (GSLV) technologies.

Five Decade of Indian Space Research Organization



Unlike Earth Orbits for Satellites



Three categories of satellites - LEO, MEO and GEO/GSO - refer to different orbits that a satellite can be placed in.

Abbreviation	Orbit Name	Altitude [km]
LEO	Low Earth Orbit	160 to 2000
MEO	Medium Earth Orbit	2000 to <35786
GSO	Geosynchronous Orbit	35786
GEO	Geostationary Equatorial Orbit	35786

Evolution of Launching Vehicles



Source ISRO

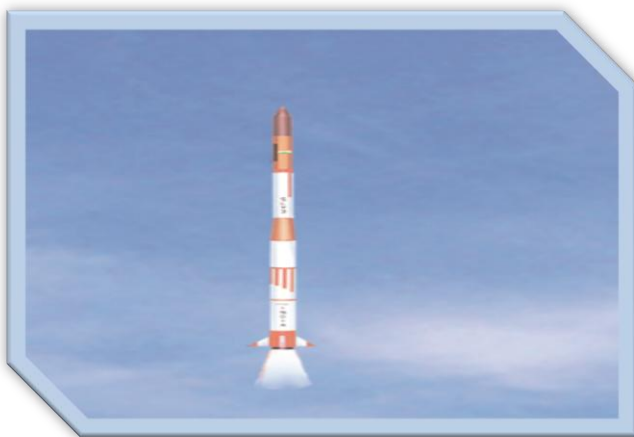
Left to right: SLV, ASLV, PSLV, GSLV II, GSLV III

Sounding rockets



Sounding rockets are one or two stage solid propellant rockets used for probing the upper atmospheric regions and for space research. They also serve as platforms to test or prove prototypes of new components or subsystems intended for use in launch vehicles and satellites.

Satellite Launch Vehicle (SLV)



SLV-3 was India's first experimental satellite launch vehicle, which was an all solid, four stage vehicle weighing 17 tonnes with a height of 22m and capable of placing 40 kg class payloads in Low Earth Orbit.

Augmented Satellite Launch Vehicle (ASLV)



ASLV was designed to augment the payload capacity to 150 kg, thrice that of SLV-3, for Low Earth Orbits (LEO). With a lift off weight of 40 tonnes, the 24 m tall ASLV was configured as a five stage, all-solid propellant vehicle, with a mission of orbiting 150 kg class satellites into 400 km circular orbits.

Polar Satellite Launch Vehicle (PSLV)

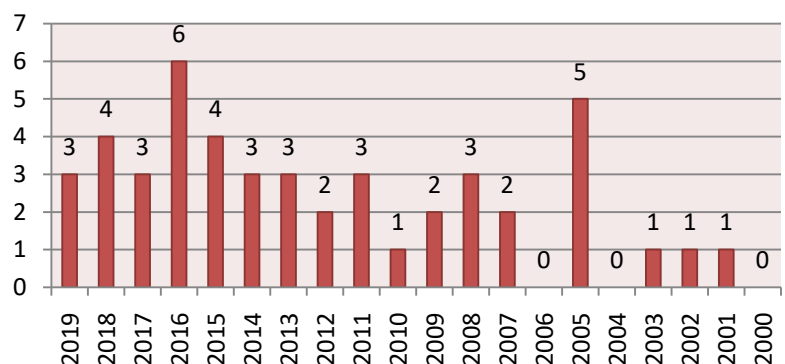


- Height: 44 m
- Diameter: 2.8 m
- Number of Stages: 4
- Lift Off Mass: 320 tonnes (XL)
- Variants: 3 (PSLV-G, PSLV - CA, PSLV - XL)
- First Flight: September 20, 1993

PSLV is used for delivering various satellites to Low Earth Orbits. It is designed mainly to deliver the “earth-observation” or “remote-sensing” satellites with lift-off mass of up to about 1750 Kg to Sun-Synchronous circular polar orbits of 600-900 Km altitude.

PSLV emerged as the reliable and versatile workhorse launch vehicle of India with 39 consecutively successful missions by June 2017. During 1994-2017 period, the vehicle has launched 48 Indian satellites and 209 satellites for customers from abroad. Besides, the vehicle successfully launched two spacecraft – Chandrayaan-1 in 2008 and Mars Orbiter Spacecraft in 2013 – that later traveled to Moon and Mars respectively.

No. of Missions Using PSLV



Geosynchronous Satellite Launch Vehicle (GSLV)

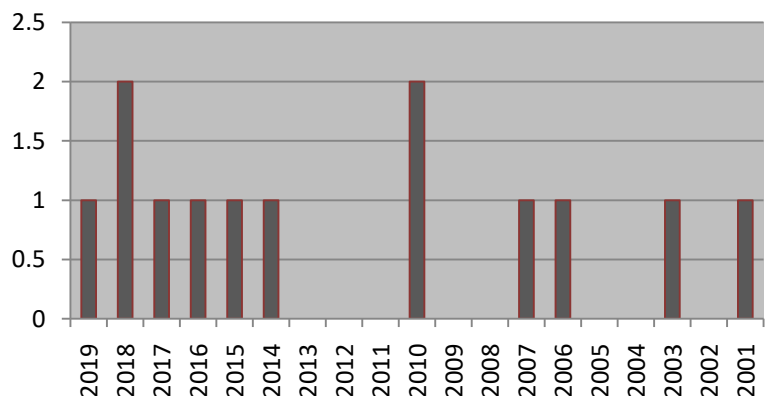


- Height : 49.13 m
- Number of Stages: 3
- Lift Off Mass: 414.75 tonnes
- First Flight: April 18, 2001

Geosynchronous Satellite Launch Vehicle Mark II (GSLV Mk II) is the largest launch vehicle developed by India, which is currently in operation. This fourth generation launch vehicle is a three stage vehicle with four liquid strap-ons. The indigenously developed cryogenic Upper Stage (CUS), which is flight proven, forms the third stage of GSLV Mk II. From January 2014, the vehicle has achieved four consecutive successes.

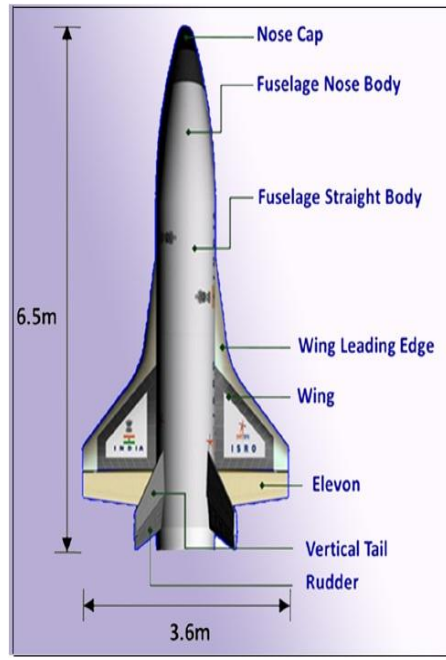
The next variant of GSLV is GSLV Mk III. It is a three-stage vehicle with a 110 tonne core liquid propellant stage (L-110) and a strap-on stage with two solid propellant motors, each with 200 tonne propellant (S-200). Chandrayaan 2 was launched on 22 July 2019 using Geosynchronous Satellite Launch Vehicle (GSLV) Mark III

No. of Missions Using GSLV



Upcoming Technology

Reusable Launch Vehicle



Objectives of RLV-TD:

- Hypersonic aero thermodynamic characterisation of wing body
- Evaluation of autonomous Navigation, Guidance and Control (NGC) schemes
- Integrated flight management
- Thermal Protection System Evaluation

RLV-TD was successfully flight tested on May 23, 2016 from SDSC SHAR Sriharikota validating the critical technologies such as autonomous navigation, guidance & control, reusable thermal protection system and re-entry mission management.

Reusable Launch Vehicle –The configuration of RLV-TD is similar to that of an aircraft and combines the complexity of both launch vehicles and aircraft.

The RLV-TD will act as a flying test bed to evaluate various technologies viz., hypersonic flight, autonomous landing, powered cruise flight and hypersonic flight using air-breathing propulsion.

Scramjet



The Scramjet engine designed by ISRO uses Hydrogen as fuel and the Oxygen from the atmospheric air as the oxidiser.

ISRO's Advanced Technology Vehicle (ATV), which is an advanced sounding rocket, was the solid rocket booster used for the test of Scramjet engines at supersonic conditions. ATV carrying Scramjet engines weighed 3277 kg at lift-off.

Future readiness is the key to maintaining an edge in technology and ISRO endeavours to optimise and enhance its technologies as the needs and ambitions of the country evolve. Thus, ISRO is moving forward with the development of indigenous heavy lift launchers.

Apart from technological capability, ISRO has also contributed to science and science education in the country. Various dedicated research centres and autonomous institutions for remote sensing, astronomy and astrophysics, atmospheric sciences and space sciences in general function under the aegis of Department of Space.