Indian Space Research Organisation (ISRO)

About the Organisation

- ISRO is the space agency under the Department of Space of Government of India, headquartered in the city of Bengaluru, Karnataka.
- Its vision is to harness space technology for national development, while pursuing space science research and planetary exploration.
- Antrix Corporation Limited (ACL) is a Marketing arm of ISRO for promotion and commercial exploitation of space products, technical consultancy services and transfer of technologies developed by ISRO.

Genesis

- The space research activities were initiated in India under Dr. Vikram Sarabhai, the founding father of Indian space programme, during 1960's.
- Since inception, the Indian space programme had three distinct elements such as, satellites for communication and remote sensing, the space transportation system and application programmes.
- The INCOSPAR (Indian National Committee for Space Research) was initiated under the leadership of Dr. Sarabhai and Dr. Ramanathan.
- During 1975-76, Satellite Instructional Television Experiment (SITE) was conducted. It was hailed as 'the largest sociological experiment in the world'. It was followed by the 'Kheda Communications Project (KCP)', which worked as a field laboratory for need-based and locale specific programme transmission in state of Gujarat State.
- During this period, the first Indian spacecraft 'Aryabhata' was developed and was launched using a Soviet Launcher. Another major landmark was the development of the first launch vehicle SLV-3 with a capability to place 40 kg in Low Earth Orbit (LEO), which had its first successful flight in 1980.
- In the experimental phase during 80's, Bhaskara-I & II missions were pioneering steps in the remote sensing area whereas 'Ariane Passenger Payload Experiment (APPLE)' became the forerunner for future communication satellite system.

- During the operational phase in 90's, major space infrastructure was created under two broad classes: one for the communication, broadcasting and meteorology through a multi-purpose Indian National Satellite system (INSAT), and the other for Indian Remote Sensing Satellite (IRS) system. The development and operationalisation of Polar Satellite Launch Vehicle (PSLV) and development of Geosynchronous Satellite Launch Vehicle (GSLV) were significant achievements during this phase.

Organisation Structure

Achievements

Communication Satellites

- Established in 1983 with commissioning of INSAT-1B, the Indian National Satellite (INSAT) system is one of the largest domestic communication satellite systems in Asia-Pacific region with nine operational communication satellites placed in Geostationary orbit.

- It initiated a major revolution in India's communications sector and sustained the same later. The INSAT system provides services to telecommunications, television broadcasting, satellite newsgathering, societal applications, weather forecasting, disaster warning and Search and Rescue operations.

List of important Communication Satellites

Satellite	Launch Date	Launch Vehicle	Application
GSAT-31	Feb 06, 2019	Ariane-5 VA-247	Communication
GSAT-7A	Dec 19, 2018	GSLV-F11 / GSAT-7A Mission	Communication
GSAT-11 Mission	Dec 05, 2018	Ariane-5 VA-246	Communication
GSAT-29	Nov 14, 2018	GSLV Mk III-D2 / GSAT-29 Mission	Communication
GSAT-6A	Mar 29, 2018	GSLV-F08/GSAT-6A Mission	Communication
GSAT-17	Jun 29, 2017	Ariane-5 VA-238	Communication
GSAT-19	Jun 05, 2017	GSLV Mk III-D1/GSAT-19 Mission	Communication
GSAT-9	May 05, 2017	GSLV-F09 / GSAT-9	Communication
GSAT-12	Jul 15, 2011	PSLV-C17/GSAT-12	Communication
GSAT-8	May 21, 2011	Ariane-5 VA-202	Communication, Navigation
EDUSAT	Sep 20, 2004	GSLV-F01 / EDUSAT(GSAT-3)	Communication

Earth Observation Satellites

- Starting with IRS-1A in 1988, ISRO has launched many operational remote sensing satellites. Today, India has one of the largest constellations of remote sensing satellites in operation.

- Varieties of instruments have been flown onboard these satellites to provide necessary data in a diversified spatial, spectral and temporal resolutions to cater to different user requirements in the country and for global usage.
- The data from these satellites are used for several applications covering agriculture, water resources, urban planning, rural development, mineral prospecting, environment, forestry, ocean resources and disaster management.

List of important Earth Observation Satellites

Satellite	Launch Date	Launch Vehicle	Application
HysIS	Nov 29, 2018	PSLV-C43 / HysIS Mission	Earth Observation
Cartosat-2 Series Satellite	Jan 12, 2018	PSLV-C40/Cartosat-2 Series Satellite Mission	Earth Observation
Cartosat-2 Series Satellite	Jun 23, 2017	PSLV-C38 / Cartosat-2 Series Satellite	Earth Observation
Cartosat-2 Series Satellite	Feb 15, 2017	PSLV-C37 / Cartosat -2 Series Satellite	Earth Observation
RESOURCESAT-2A	Dec 07, 2016	PSLV-C36 / RESOURCESAT-2A	Earth Observation
SCATSAT-1	Sep 26, 2016	PSLV-C35 / SCATSAT-1	Climate & Environment
INSAT-3DR	Sep 08, 2016	GSLV-F05 / INSAT-3DR	Climate & Environment, Disaster Management System
CARTOSAT-2 Series Satellite	Jun 22, 2016	PSLV-C34 / CARTOSAT-2 Series Satellite	Earth Observation
SARAL	Feb 25, 2013	PSLV-C20/SARAL	Climate & Environment, Earth Observation
RISAT-1	Apr 26, 2012	PSLV-C19/RISAT-1	Earth Observation
Megha-Tropiques	Oct 12, 2011	PSLV-C18/Megha-Tropiques	Climate & Environment, Earth Observation
RESOURCESAT-2	Apr 20, 2011	PSLV-C16/RESOURCESAT-2	Earth Observation
CARTOSAT-2B	Jul 12, 2010	PSLV-C15/CARTOSAT-2B	Earth Observation

Oceansat-2	Sep 23, 2009	PSLV-C14 / OCEANSAT-2	Climate & Environment, Earth Observation
RISAT-2	Apr 20, 2009	PSLV-C12 / RISAT-2	Earth Observation
CARTOSAT-1	May 05, 2005	PSLV-C6/CARTOSAT-1/ HAMSAT	Earth Observation
The Technology Experiment Satellite (TES)	Oct 22, 2001	PSLV-C3 / TES	Earth Observation
Oceansat (IRS-P4)	May 26, 1999	PSLV-C2/IRS-P4	Earth Observation
Rohini Satellite RS-D1	May 31, 1981	SLV-3D1	Earth Observation
Bhaskara-I	Jun 07, 1979	C-1 Intercosmos	Earth Observation, Experimental

Navigation Satellites

- Satellite is an emerging satellite based system with commercial and strategic applications. Navigation services are necessary to meet the emerging demands of the Civil Aviation requirements and to meet the user requirements of the positioning, navigation and timing based on the independent satellite navigation system.
- To meet the Civil Aviation requirements, ISRO is working jointly with Airport Authority of India (AAI) in establishing the **GPS Aided Geo Augmented Navigation (GAGAN)** system.
- To meet the user requirements of the positioning, navigation and timing services based on the indigenous system, ISRO is establishing a regional satellite navigation system called **Indian Regional Navigation Satellite System (IRNSS)**.

Space Science & Exploration Satellites

Indian space programme encompasses research in areas like astronomy, astrophysics, planetary and earth sciences, atmospheric sciences and theoretical physics. Satellites come under this category are:

1. **AstroSat,** was launched on September 28, 2015, by PSLV-C30 from Sriharikota. It is the first dedicated Indian astronomy mission aimed at studying celestial sources in X-ray, optical and UV spectral bands simultaneously. One of the unique features of AstroSat mission is that it enables the simultaneous multi-wavelength observations of various astronomical objects with a single satellite.
2. **Mars Orbiter Mission (MOM),** also known as (Mangalyaan),the truly maiden interplanetary mission of ISRO, launched on November 5, 2013, successfully got inserted into Martian orbit on September 24, 2014 in its first attempt. MOM completes 4 years in its orbit on September 24, 2018 though the designed mission life of MOM was six months. It was launched on board of PSLV C25 rocket with aim of studying Martian surface and mineral composition as well as scan its atmosphere for methane (an indicator of life on Mars). MOM is credited with many achievements like cost-effectiveness, short period of realization, economical weight-budget, miniaturization of five heterogeneous science payloads etc. Phobos and Deimos, the two moons of Mars were also imaged from close distances by Mars Colour Camera (MCC).
3. **Chandrayaan-1,** India's first mission to moon, was an unmanned spacecraft along with 11 scientific payloads built in India, UK, USA, Germany, Bulgaria and Sweden. The mission comprised an orbiter and an impactor. Launched aboard PSLV-C11 by ISRO on October 22, 2008, the spacecraft was designed to study the Moon orbiting around it at a height of 100 km from the lunar surface. It had operated much less than the intended two years, but achieved more than 90% of its planned objectives.
4. **Chandrayaan-2,** India's second mission to the Moon is a totally indigenous mission comprising of an Orbiter, Lander and Rover. Chandrayaan-2 is planned to launch in 2019 by GSLV-F10. After reaching the 100 km lunar orbit, the Lander housing the Rover will separate from the Orbiter. After a controlled descent, the Lander will soft land on the lunar surface at a specified site and deploy a Rover. The payloads will collect scientific information on lunar topography, mineralogy, elemental abundance, lunar exosphere and signatures of hydroxyl and water-ice.

Experimental Satellites

ISRO has launched many small satellites mainly for the experimental purposes. This experiment includes Remote Sensing, Atmospheric Studies, Payload Development, Orbit Controls, recovery technology etc.

List of important Experimental Satellites

Satellite	Launch Date	Launch Vehicle	Application
INS-1C	Jan 12, 2018	PSLV-C40/Cartosat-2 Series Satellite Mission	Experimental

YOUTHSAT	Apr 20, 2011	PSLV-C16/RESOURCESAT-2	Student Satellite
APPLE	Jun 19, 1981	Ariane-1(V-3)	Communication, Experimental
Rohini Technology Payload (RTP)	Aug 10, 1979	SLV-3E1	
Aryabhata	Apr 19, 1975	C-1 Intercosmos	Experimental

Small Satellites

The small satellite project is providing platform for stand-alone payloads for earth imaging and science missions within a quick turnaround time. For making the versatile platform for different kinds of payloads, two kinds of buses have been configured and developed i.e. Indian Mini Satellite -1 (IMS-1) and Indian Mini Satellite -2 (IMS-2).

List of Small Satellites

Satellite	Launch Date	Launch Mass	Launch Vehicle	Application
Microsat	Jan 12, 2018		PSLV-C40/Cartosat-2 Series Satellite Mission	Experimental
YOUTHSAT	Apr 20, 2011	92 kg	PSLV-C16/RESOURCESAT-2	Student Satellite

Academic Institute Satellites

ISRO has influenced educational institutions by its activities like making satellites for communication, remote sensing and astronomy. The launch of Chandrayaan-1 increased the interest of universities and institutions towards making experimental student satellites. Capable Universities and institution can venture into space technology on-orbit with guidance and support from ISRO by ways of Development of Payload and Design & Fabrication of Satellite.

List of important Academic Institute Satellites

1	Kalamsat-V2	Jan 24, 2019	PSLV-C44

4	PRATHAM	Sep 26, 2016	PSLV-C35 / SCATSAT-1
5	SATHYABAMASAT	Jun 22, 2016	PSLV-C34 / CARTOSAT-2 Series Satellite
6	SWAYAM	Jun 22, 2016	PSLV-C34 / CARTOSAT-2 Series Satellite
7	Jugnu	Oct 12, 2011	PSLV-C18/Megha-Tropiques
9	STUDSAT	Jul 12, 2010	PSLV-C15/CARTOSAT-2B
10	ANUSAT	Apr 20, 2009	PSLV-C12 / RISAT-2

India's Manned Mission to Space

- In December 2018, the Indian government has announced allocation of 100 billion rupees for first manned space mission, set to be launched by 2022. An unmanned test launch of the project is likely scheduled for December 2020.
- Also termed as Gaganyaan, this project is part of the government's ambition to make India a global low-cost provider of services in space.
- The launch vehicle for this mission will carry heavy payloads into space. For this purpose, GSLV Mk-III is being developed with cryogenic engine.
- ISRO has already tested the GSLV Mk-III with experimental crew module (Re-entry & Recovery technology) and Crew Escape System (CES).
- A manned space mission is very difficult to launch in terms of complexity and need of advance technology.

Scramjet (Supersonic Combusting Ramjet) engine

- In August 2016, ISRO has successfully conducted the Scramjet (Supersonic Combusting Ramjet) engine test.
- The Scramjet engine uses Hydrogen as fuel and the Oxygen from the atmospheric air as the oxidiser.
- This test was the maiden short duration experimental test of ISRO's Scramjet engine with a hypersonic flight at Mach 6.
- 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.
- The new propulsion system will complement ISRO's reusable launch vehicle that would have longer flight duration.

ISRO’s Launch Vehicles

- PSLV (Polar Satellite Launch Vehicle) and GSLV (Geosynchronous Satellite Launch Vehicle) are the satellite-launch vehicles developed by ISRO.
- PSLV delivers the “earth-observation” or “remote-sensing” satellites in polar orbit.
- Apart from launching the remote sensing satellites to Sun-synchronous polar orbits, the PSLV is also used to launch the satellites of lower mass of about 1400 Kg to the elliptical Geosynchronous Transfer Orbit (GTO).
- It is a four-staged launch vehicle with first and third stage using solid fuel and second and fourth stages using liquid fuel. Strap-on motors also used with PSLV to augment the thrust.
- PSLV is classified into its various versions like core-alone version (PSLV-CA) or PSLV-XL variants.
- GSLV delivers the communication-satellites to the Geosynchronous Transfer Orbit (GTO) of about 36000 Km altitude.
- Two versions of the GSLV are developed by ISRO and testing phase of third version is going on. The first version, GSLV Mk-II, has the capability to launch satellites of mass up to 2,500 kg to the GTO.
- GSLV MK-II is a three-staged vehicle with first stage using solid fuel, second stage using Liquid fuel and the third stage, called Cryogenic Upper Stage, using cryogenic engine.

Challenges and Opportunities in front of India's Space Program

- India is still is a developing country with vast developmental and security concerns. In this context it is very difficult to justify the allocations for space missions that do not have a direct bearing on development.
- Successful launched of MOM and a planned rover onto the moon surely boosted the Indian space program. But India’s reliance on satellites has created military vulnerabilities.
- An anti-satellite missile (ASAT) tested by China in 2007 has also elevated the threat of a slow-moving arms race in space.
- DRDO is working on development of missile defense but it is increasingly looking to partner with the United States and other countries.
- China has launched satellites for Pakistan and Sri Lanka in 2011 and 2012 respectively. This space cooperation may become another path for China to make inroads in South Asian countries.
- During the starting of this decade India was highly critical of the EU effort to develop a code of conduct for outer space but in last years it has been actively engaged with the United States and the EU in particular in discussing a code of conduct and other safeguarding mechanisms.

- India holds the view that reliance on the integration of outer space and cyber capabilities will only increase in future conflicts. But now beyond the maritime domain, India has been relying on foreign partners for many other satellite-based communications and data services. For instance, it continues to rely on NASA for deep space communications.
- Privatization may also allow India to increase its launch capacity, which is currently at four to five per year while China does on average twenty or so launches. India does not have an explicit space policy to guide private sector participation.
- ISRO also has internal constraints on its capacity to deliver.
- The announcement by U.S. President Donald Trump in June 2018 about the creation of a "space force" or a sixth branch of the American armed forces has worried many including India. While India is officially committed to PAROS, or the prevention of an arms race in outer space, it is yet to formulate a credible official response to such plans. India has yet to establish a credible space command of its own.
- In this context China's reaction could be much stronger than its seemingly muted official response and it does possess a formidable space military programme that far exceeds current Indian capabilities.
- Globally entrepreneurs like Elon Musk and Richard Branson began talking of space activities as independent profitable commercial ventures that can be termed as New Space revolution.

Now the time has come for a more structured approach that enables better incubation for young talent in India. Fortunately, Antrix is open to such ideas. Various policies and acts need to change from being restrictive to being enabling.