OVERVIEW OF INDIAN SPACE PROGRAME (ISP) (OR)

MAJOR MILESTONES IN ISP (OR) ANALYSIS OF ISP

The Indian space programme was driven by the vision of Vikram Sarabhai, considered the father of the Indian Space Programme. Indian National Committee for Space Research (INCOSPAR) was set up by the Govt of India in 1962 with Dr. Vikram Sarabhai as its Chairman. INCOSPAR set up the Thumba Equatorial Rocket Launching Station (TERLS) in Thiruvanathapuram for upper atmospheric research.

The **Indian Space Research Organisation** (**ISRO**) was established in the year 1969 headquartered in the city of Bengaluru. Its vision is to harness space technology for national development while pursuing space science research and planetary exploration. India's economic progress has made its space program more visible and active as the country aims for greater self reliance in space technology.

India has established **two** operational space systems, viz. **INSAT system**, which is one of the largest domestic satellite communication systems in the world providing services for telecommunications, television broadcasting and meteorology including disaster warning **and the Indian Remote Sensing Satellite (IRS) system**, which has among the best satellites in the world for generating information on natural resources.

India uses its satellites communication network for applications such as land management, water resources management, natural disaster forecasting, radio networking, weather forecasting, meteorological imaging and computer communication. Business, administrative services, and schemes such as the National Informatics Centre (NIC) are direct beneficiaries of applied satellite technology.

MAJOR MILESTONES IN ISP

- A Sounding Rocket is a rocket, which is used for assessing physical parameter of the upper atmosphere. In 1962 first sounding rocket was launched from TERLS in 1962.
- Satellite communication earth Station (SCES) was get up at Ahmadabad in 1967.
- India's first indigenous Sounding rocket RH-75 was launched in 1967.
- The Department of Space (DOS) was set up in 1972 and ISRO was brought under the control of DOS.
- Aryabhata, first Indian Satellite was launched in 1975 from USSR (Russia).
- In 1975 ISRO along with NASA-USA developed Space communication system for TV Broadcasting. It results in the creation of the project Satellite Instructional Television Experiment (SITE). The aim of SITE was to use satellite broadcasting to educate the masses.
- In 1979, Satellite Telecommunication Experiment project (STEP) was established.
- Bhaskara-1 Satellite for earth observation was launched in 1979.
- SLV-3 was launched in 1979.
- SLV-3 was launched & put in orbit in 1980.
- Ariane passenger payload experiment (APPLE) a geo-satellite was launched in 1981.
- Indian National Satellite System (INSAT)-1A was launched in 1982.
- In 1984 first Indian Cosmonant put in space by USSR Soyuz T-11 rocket.
- First Indian remote sensing satellite IRS-1A was launched in 1988.
- In 1987, Augments Satellite launch Vehicle (ASLV) was launched.
- Geosynchronous satellite launch vehicle (GSLV) with GSAT-1 was launched from Sriharikota in 2001.

- PSLV-C11 successfully launched CHANDRAYAN from Sriharikota in 2008 for the moon.
- In 2008, India launched as many as eleven satellites, including nine from other countries and went on to become the first nation to launch ten satellites on one rocket
- Mars Orbiter Mission, on 5 November 2013, which entered Mars orbit on 24 September 2014, making India the first nation to succeed on its first attempt to Mars, and ISRO the fourth space agency in the world as well as the first space agency in Asia to reach Mars orbit.
- On 18 June 2016, ISRO set a record with a launch of twenty satellites in a single payload, one being a satellite from Google.
- On 15 February 2017, ISRO launched one hundred and four satellites in a single rocket (PSLV-C37) and created a world record.
- ISRO launched its heaviest rocket, Geosynchronous Satellite Launch Vehicle-Mark III (GSLV-Mk III), on 5 June 2017 and placed a communications satellite GSAT-19 in orbit. With this launch, ISRO became capable of launching 4-ton heavy satellites into GTO.

EXTRATERRESTRIAL EXPLORATION

PSLV-C11 successfully launched CHANDRAYAN from Sriharikota in 2008 for the moon. It carried high resolution remote sensing equipment for visible, near infrared, and soft and hard x ray frequencies. During its 312 days operational period (2 years planned), it surveyed the lunar surface to produce a complete map of its chemical characteristics and 3-dimensional topography. The Polar Regions were of special interest, as they possibly had ice deposits. Chandrayaan-1 became the first lunar mission to discover existence of water on the Moon.

MARS ORBITER MISSION (MANGALAYAAN)

The Mars Orbiter Mission (MOM), informally known as *Mangalayaan*, was launched into Earth orbit on 5 November 2013 by the Indian Space Research Organisation (ISRO) and has entered Mars orbit on 24 September 2014. India thus became the first country to enter Mars orbit on its first attempt.

FUTURE PLANS

ISRO plans to launch a number of Earth observation satellites in the near future include the development of Unified Launch Vehicle, Small Satellite Launch Vehicle, development of a reusable launch vehicle, human spaceflight, controlled soft lunar landing, interplanetary probes, and a solar spacecraft mission. ISRO plans to follow up with Chandrayaan-2, Mars Orbiter Mission 2, and is assessing missions to Venus, Jupiter, the Sun, and near- Earth objects such as asteroids and comets. ISRO plans to carry out a mission to the Sun. The probe is named Aditya-1 ISRO is in the process of conducting conceptual studies to send a spacecraft to Jupiter or Venus.

METHODOLOGICAL ISSUES IN COST BENEFICIAL ANALYSIS OF SPACE PROGRAMME

INDIA has developed world-class satellites and launch vehicles and mastered the technology of utilizing the space systems in several areas relevant to national development. The focus of the Indian space programme has been on (a) application of space technology as a tool for socioeconomic development of the country, and (b) to achieve 'self-reliance' in this strategic area.

As investments in space programme grew, it was necessary to justify the budgetary requirements in terms of economic returns and social benefits.

COMMERCIALIZATION

SPACE COMMERCE – GLOBAL SCENARIO

Globally viewing several products and services based on space technology have been successfully commercialized in all major space-exploring countries as well as those

which utilize the services derived from space. The most prominent among such items are communication satellites and remote sensing satellites which offer services for television/video, telephony, radio data communications and infromations on natural resources respectively.

EVOLUTION AND GROWTH OF COMMERCIAL SPACE ACTIVITIES IN INDIA

The evolution towards commercial activities in space in India has taken a slightly different path as compared to the model followed in the western part of the globe. Indian space effort, implemented by ISRO evolved as a purely civilian programme, with the objective of using modern space technology towards accelerating the nation's socio-economic development.

During the early stages of space programme in India, ISRO directly undertook almost all the necessary process such as design, development, manufacturing, assembly and testing of the space systems. In the mid-1970s, ISRO initiated a technology transfer programme to empower Indian industry to undertake manufacture of various products and services for national space projects.

Industry started providing ISRO centres with a variety of hardware and software including the propellants, structures for satellites and launch vehicle systems, electrical modules and subsystems, a variety of materials, components, ground systems and test equipment. The technology transfer programme was highly successful.

The economic reforms adopted by the Government of India expanded the role of private industry in services related to telecommunications, television broadcasting and information generated from remote sensing from space. The Government in 1992 approved formation of **Antrix Corporation** as a commercial arm under the Department of Space.

Antrix established alliances with the global leaders, namely EOSAT Corporation of USA, European satellite manufacturer EADS for globally marketing remote sensing data and to jointly manufacture and market commercial communications satellites in the global market.

A contract was made with INTELSAT, one of the largest satellite service providers in the world, to lease-out a part of capacity of INSAT-2E, over a period of ten years and worth a hundred million US dollars. This brought the recognition of maturity of Indian satellite technology by international standards.

The policy also permitted establishment and ownership of Indian satellite systems (for communication and broadcasting) by private sector companies. At present the space infrastructure for services such as TV distribution, DTH and VSAT services are leased by Antrix from the capacity available from INSAT system, thus providing critical support to this economically and socially important sector.

METHODOLOGICAL ISSUES

Space programmes in all space-faring nations are either in the public sector or in the private sector with government financial support. Government ownership or financial support for the private firms is necessary for the following reasons.

1. The objectives of space programmes include not only achieving and maintaining technical excellence in the exploration and use of outer space and creating a strong industrial base in space-related activities but also in ensuring a country's independence in this area and maintaining national security.
2. Investments in space activities are lumpy, involve long gestation periods and are risky. Hence, state support is needed at least in the experimental and development phases.
3. As an investment in the future, space technologies become an important tool of social and economic development.
4. The output basket of a space programme consists of a private goods, social goods, public goods and intangibles.

The output of space technology is a mixed basket of private good, public good and social good and therefore measurement of benefit is a complex exercise. The measurement of benefits of the satellite technology in the exploitation stage depends on

the superiority of the technique and the cost savings in comparison with the existing technology.

INSAT COMMUNICATION PAYLOADS

As communication transponders are traded goods and there is an international market for the transponders, it is possible to assess the cost effectiveness of manufacture of these payloads by comparison with market prices. INSAT-2E, INSAT-3C and 3E satellites provide service at a cheaper rate in comparison with some other global service providers Thaicom, Loral and Lyngemark sat-1.

INDIAN REMOTE SENSING

Ideally, in a social cost benefit analysis, the benefits should be measured in terms of outcomes in long run, i.e. the benefits occurring to consumers (increase in utility), producers (increase in profit) or society as a whole (increase in social welfare).

As of now, most applications based on the IRS data have been in government projects and these projects have objectives such as development of backward areas, equity and generation of information base for evaluation and monitoring of natural resources.

Considering the above facts, in long run the cost benefit is many fold than the expenditure for production and launching IRS satellites.

LAUNCHING VEHICLES

The development cost of India's PSLV and GSLV is observed to be in the range of US$ 1.3–1.5 billion as compared to about US $ 4 billion for the European and USA.

Satellites from Germany, Belgium, Korea, Indonesia and Argentina were successfully launched in this mode by PSLV.As the capacity for launches by India will increase through new variants like GSLVMk III, there will be a greater scope for commerce in this segment.

Note: If this question (Methodological issues) is asked in 10 marks write all the materials.

But if asked in 5 marks **start from** the sub heading METHODOLOGICAL ISSUES.

THE INSAT SYSTEM

[BROADCASTING – TELECOMMUNICATIONS – METEOROLOGY]

INSAT, is a series of multipurpose geostationary satellites launched by ISRO to satisfy the telecommunications, broadcasting and meteorology needs of our country. Commissioned in 1983, INSAT is the largest domestic communication system in the Indo-Pacific Region. It is a joint venture of the Department of Space, Department of Telecommunications, India Meteorological Department, All India Radio and Doordarshan.

INSAT system made a revolution in India's television and radio broadcasting, telecommunications and meteorological sectors. It enabled the rapid expansion of TV and modern telecommunication facilities to even the remote areas and off-shore islands. INSAT System consisting 15 operational satellites, namely - INSAT-3A, 3C, 4A, 4B, 4CR and GSAT-6, 7, 8, 9, 10, 12, 14, 15, 16 and 18.

The INSAT system with more than 200 transponders in the C, Extended C and Ku-bands provides services to telecommunications, television broadcasting, satellite newsgathering, societal applications, weather forecasting, disaster warning and Search and Rescue operations.

BROADCASTING

RADIO NETWORKING

Radio Networkmg (RN) through INSAT provides reliable high-fidelity programme channels for national as well as regional networking. At present 213 (AIR) stations have been equipped with S-band receive terminals and around 100 AIR stations upgraded with C band terminals.

Twenty-three RN carriers are operating in INSAT-2C and nine RN carriers operating in INSAT-2B S-1 and S-2. Seven RN channels are uplinked from Broadcasting

House Delhi, to operate with CXC transponder of INSAT-2B. These programmes are being received by sixteen major AIR stations.

At present, AIR has 21 radio channels on DTH platform in Ku-band being uplinked with TV carriers from Todapur, New Delhi on INSAT-4B. Efforts are underway to augment this to 40 channels, and installation is in progress to uplink 6 radio channels on DTH C-Band to cover Andaman and Nicobar areas.

TELEVISION

The INSAT satellites provide broadcast satellite services, used by India's state-owned television agency as well as commercial television channels. All The Doordarshan Satellite Television Services are benefited through INSATs: National networking service (DD-1), DD-News (DD2), DD-Bharathi and Digital Satellite News Gathering (DSNG) service and regional services for all the states. INSAT 4B boosts the Direct To Home (DTH) services.

TELE-EDUCATION

In the 1990s Educational TV (ETV) services were started. INSAT is being used to provide ETV service for primary-school children in Tamil, Marathi, Oriya, Telugu and Hindi. A general enrichment programme on higher education (college sector) is telecasted on the national network. These are produced by the University Grants Commission (UGC) and Indira Gandhi National Open University (IGNOU).

In 2004 EDUSAT was launched from SHAR. ‘EDUSAT’, India’s first satellite dedicated exclusively for educational services, was used extensively to cater a wide range of interactive educational delivery modes like one-way TV broadcast, video conferencing, computer conferencing, web-based instructions, etc.

EDUSAT provided connectivity to schools, colleges and higher levels of education and also supported non-formal education including development communication. About 15 million students are getting benefited through EDUSAT programme every year.

TELECOMMUNICATION

The INSAT satellites provide telephone links to remote areas; data transmission for organisations such as the National Stock Exchange; mobile satellite service communications for private operators, railways, and road transport; INSAT satellites have been traditionally supporting telecommunication applications for providing voice and data communications.

Telecom services are being provided by BSNL to remote and inland through satellite media in C-band and Ku-band from main earth stations as backhaul point to point connections. BSNL is also providing GSM connectivity, ATM/Banking connectivity through around 20,000 IPSTAR VSATs.

INSAT services has been widely utilized by the government and quasi government establishments such as NTPC, GAIL, Oil and Natural Gas Corporation Ltd., National Fertilizer Ltd., Coal India Ltd., IOCL, BPCL, Indian Railway Project Management Unit, BSE., etc. A number of other captive government networks like Indian Coast Guard, Ministry of Defence, Cabinet Secretariat, DRDO, etc., are also working with INSAT satellites.

MOBILE COMMUNICATION

With the launch of INSAT-2C in December 1995 and INSAT-2D in June 1997, mobile satellite service (MSS) started in the Indian landmass and the adjoining maritime area. An S-band Mobile Satellite Service (MSS) was added to INSAT system with the launch of INSAT-3C in 2002 and GSAT-2 in 2003.

A small portable satellite terminal that works with INSAT for voice/data communication has been developed. The terminal is useful for voice communication. It can be used from any location in India for emergency communication. Transmit and receive frequencies of the terminal are in S-Band.

The satellite networks of modern age - Very Small Aperture Terminals (VSATs) are designed to support all kinds of applications supporting video, voice and data, with a wide range of data rates from few kilobits per second (kbps) to 8 megabits per seconds (mbps). A VSAT network works out to be a cheaper option while establishing a network to cover a wide geographical area, state wide or nationwide. VSAT networks operate in C, Extended C and Ku-bands.

METEOROLOGY

The implementation of the INSAT meteorological programme will bring much needed improvements to the meteorological observation system. The system was designed to provide round-the-clock half-hourly synoptic images of the weather conditions including cyclones, sea-surface and cloud-top temperatures, water bodies and snow over the entire country and the adjoining sea areas. The availability of INSAT data to the weather forecasters will help to improve weather forecasting services of the India Meteorological Department.

India Meteorological Department (IMD) in collaboration with ISRO under takes many projects. The meteorological data from the satellite is processed and disseminated by INSAT meteorological Data Processing System (IMDPS). At present KALPANA – 1 and INSAT – 3A are supporting the meteorological imaging and data collections. METSAT later renamed as KALPANA – takes images of cloud, sea surface temperature, and atmospheric humidity. INSAT VHRR images and data are made available. The satellites are used to monitoring and predicting cyclones.

The major benefits will be in the form of improved weather forecasting services which are important to agriculture, fishing, aviation, hydroelectric projects, oceanography, shipping etc.

From the satellite data it is possible to derive sea-surface temperature (SST) which is an important meteorological parameter for understanding the air-sea interaction and for

meteorological research. Precise information on SST is also important for the fishing industry.

DISASTER MANAGEMENT

India is prone to many natural disasters like floods, landslides, cyclones, forest fires, earthquakes, drought, etc. Satellites provide synoptic observations of the natural disasters at regular intervals that helps in better planning and management of disasters. Disaster Management Support (DMS) Programme, comprehensively addresses various aspects of natural disasters in the country, using space based inputs. Availability of more frequent observations over the oceans will improve our capability to issue timely and accurate cyclone warnings. The receipt of timely warnings against approaching cyclonic storms will help local authorities to take action on cyclone mitigation.

INDIAN REMOTE SENSING PROGRAMME

Following the successful demonstration flights of Bhaskara-1 and Bhaskara-2 satellites launched in 1979 and 1981, respectively, India began to develop the indigenous Indian Remote Sensing (IRS) satellite program to support the national economy in the areas of agriculture, water resources, forestry and ecology, geology, water sheds, marine fisheries and coastal management. The Indian Remote Sensing Satellite system is **the largest** collection of remote sensing satellites for civilian use in operation today in the world.

Indian Remote Sensing satellites (IRS) are a series of earth observation satellites, built, launched and maintained by ISRO. All the satellites are placed in polar Sun synchronous orbit and provide data in a variety of spatial, spectral and temporal resolutions to enable several programmes to be undertaken relevant to national development. Currently (2019) **thirteen** operational REMOTE SENSING satellites are in Sun synchronous orbit

India had established the National Natural Resources Management System (NNRMS) for which the Department of Space (DOS) is the nodal agency, providing operational remote sensing data services. Data from the IRS satellites is received and disseminated by several countries all over the world.

TYPES OF IRS SATELLITES:

(i) Land/water resources applications Satellites (RESOURCESAT series and RISAT series)
(ii) Ocean/atmospheric studies Satellites (OCEANSAT series, INSAT-VHRR, INSAT-3D, and SARAL) and
(iii) Large scale mapping applications Satellites (CARTOSAT series).

Today, the array of Indian Earth Observation (EO) Satellites with imaging capabilities in visible, infrared, thermal and microwave regions of the electromagnetic spectrum, including hyper-spectral sensors, have helped the country in realising major operational applications.

IRS DATA APPLICATIONS

Data from Indian Remote Sensing satellites are used for various applications of resources survey and management under the National Natural Resources Management System (NNRMS). Following is the list of few applications:

- ISRO Disaster Management Support Programme (ISRO-DMSP)
- Biodiversity Characterizations
- Pre harvest crop area and production estimation of major crops.
- Drought monitoring and assessment.
- Flood risk zone mapping and flood damage assessment.
- Locating underground water resources for drilling well.

- Land use and land cover mapping
- Urban planning
- Forest survey
- Wetland mapping
- Environmental impact analysis
- Mineral Prospecting
- Coastal studies

RESOURCE MANAGEMENT

Timely and accurate informations on various natural resources both renewable and non renewable are very important for the planned development of any country. For a country of India's size and population the necessity of generating continuous and updated information on terrestrial resources and environment needs are very important. In this connection space based earth observation systems offer unique possibilities in their ability of acquisition of data and present to the resource managers and planners in a very short time.

BIODIVERSITY INFORMATION SYSTEM

Based on intensive field sampling and mapping using satellite remote sensing and geospatial modeling tools, maps have been made of vegetation cover on a 1: 250,000 scale. This has been put together in a web-enabled database that links gene-level information of plant species with spatial information in a BIOSPEC database of the ecological hot spot regions, namely northeastern India, Western Ghats, Western Himalayas and Andaman and Nicobar Islands.

RURAL DEVELOPMENT

Various programmes are carried out by ISRO addressing the developmental priorities of the country for planning, monitoring and impact assessment viz. Monitoring of Integrated Watershed Management Programme (IWMP), Space Based Information Support for Decentralized Planning (SISDP), and GIS implementation of MGNREGA.

URBAN DEVELOPMENT

Satellite-based remote sensing holds certain advantages in monitoring the dynamics of urban land use because of the large spatial coverage for mapping applications, more frequent revisit periods and wide availability. IRS satellites provide accurate information for carrying out various urban planning, planning alternatives and management activities to the urban planners and policy makers.

WATER RESOURCES

Proper management of water resources is very important for the country and there are multiple challenges with regard to Water resources that can be effectively addressed using space inputs. ISRO is actively involved in several projects to make inventory and monitoring of the water resources in the country.

GEOINFORMATICS

The GIS is a computer based information system used to digitally represent and analyze the geospatial data (or) geographic data GIS is much more advanced than Computer Aided Design (CAD) or any other spatial data system.

GIS Definition:

GIS is a systematic integration of computer hardware, software, and spatial data, for capturing, storing, displaying, updating, manipulating and analyzing in order to solve complex management problems.

A GIS is a facility for preparing, presenting & interpreting (understanding) facts that pertain (related) to the surface of the earth.

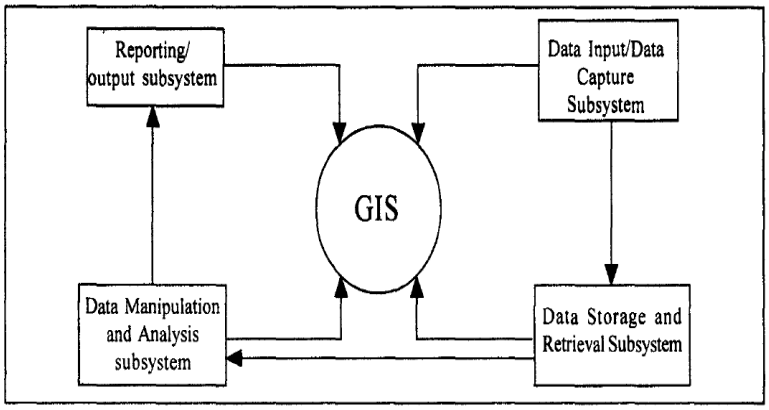


Figure: Subsystem nature of GIS (structural perspective).

GIS has 4 generic subsystems.

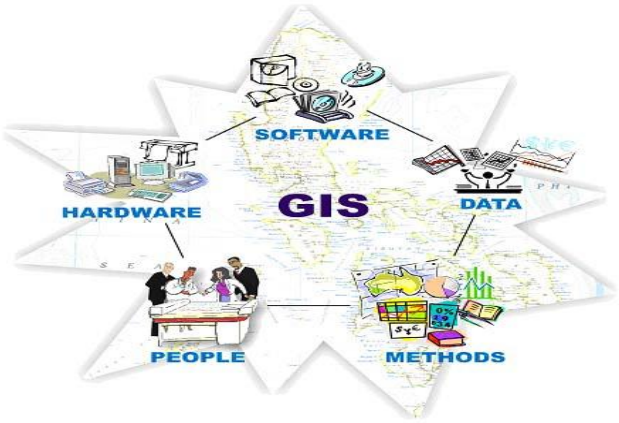
(i)A data input subsystem which is also called data capture subsystem

(ii) A data storage and retrieval subsystem

(iii)A data manipulation and analysis subsystem

(iv)A reporting subsystem.

COMPONENTS OF A GIS:



DATA

- Data consist of various kinds of inputs that the system takes to produce informations
- Data are named as geospatial data in GIS.
- The source of spatial data are digitalizes maps, aerial photographs, satellite images.
- The digital map forms are the basic data input for GIS.

The collected data are processed by the software and the methods formulated will be implemented with the help of equipments(hardware).

APPLICATIONS OF REMOTE SENSING AND GIS:

GIS and Remote Sensing are used in the following fields

1.Agriculture and soils
2. Geology
3. Ocean resources
4. Forestry and environment
5. Major river valley projects
6. Street network based applications
7. Natural resource based applications.
8. Facilities management.

THE LAUNCHING PROGRAMME

LAUNCHING VEHICLES

1) Sounding Rockets
2) SLV – Satellite Launch Vehicle
3) ASLV – Augmented Satellite Launch Vehicle
4) PSLV – Polar Satellite Launch Vehicle
5) GSLV – Geosynchronous Satellite Launch Vehicle

6) RLV – Reusable Launch Vehicle
7) SSLV - Small Satellite Launch Vehicle

TYPES OF SATELLITES

1) Communication Satellites
2) Earth Observation Satellites
3) Scientific Spacecraft
4) Navigation Satellites
5) Experimental Satellites
6) Small Satellites
7) Educational Satellites

SOUNDING ROCKETS

Sounding rockets are one or two stage solid propellant rockets used for probing the upper atmospheric regions and for space research. The launch of the first sounding rocket from Thumba near Thiruvananthapuram, Kerala on 21 November 1963, marked the beginning of the Indian Space Programme. The first rockets were two-stage rockets imported from Russia (M-100) and France (Centaure).

SLV - SATELLITE LAUNCH VEHICLE

Satellite Launch Vehicle-3 (SLV-3) was India's first experimental satellite launch vehicle, which was an all **solid,** four stage vehicle capable of placing 40 kg class payloads in Low Earth Orbit (LEO). SLV-3 was successfully launched on July 18, 1980 from Sriharikota Range (SHAR), when Rohini satellite, RS-1, was placed in orbit, thereby making India the sixth member of an exclusive club of space-faring nations. The success of the SLV-3 project showed the way to advanced launch vehicle projects such as the Augmented Satellite Launch Vehicle (ASLV), Polar Satellite Launch Vehicle (PSLV) and the Geosynchronous satellite Launch Vehicle (GSLV).

ASLV - AUGMENTED SATELLITE LAUNCH VEHICLE

The Augmented Satellite Launch Vehicle (ASLV) Programme was designed to augment the payload capacity to 150 kg, thrice that of SLV-3, for Low Earth Orbits (LEO). ASLV proved to be a low cost intermediate vehicle to demonstrate and validate critical technologies that would be needed for the future launch vehicles like strap-on technology, inertial navigation, bulbous heat shield, vertical integration and closed loop guidance.

Under the ASLV programme four developmental flights were conducted. The fourth developmental flight took ASLV-D4 put SROSS-C2 into orbit which had two payloads, Gamma Ray Burst (GRB) Experiment and Retarding Potentio Analyser (RPA).

PSLV - POLAR SATELLITE LAUNCH VEHICLE

Polar Satellite Launch Vehicle (PSLV) is the third generation launch vehicle of India. It is the first Indian launch vehicle to be equipped with **liquid s**tages. After its first successful launch in October 1994, 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 – to Moon and Mars respectively

GSLV - GEOSYNCHRONOUS SATELLITE LAUNCH VEHICLE

Geosynchronous Satellite Launch Vehicle (GSLV) is a space launch vehicle designed, developed, and operated by the Indian Space Research Organization (ISRO) to launch satellites and other space objects into Geosynchronous Transfer Orbits. GSLV has the capability to put a heavier payload in the orbit than the Polar Satellite Launch Vehicle (PSLV).

GSLV-D5 - launched on January 5, 2014 - was the first successful flight of the GSLV using the indigenous cryogenic engine, the CE-7.5. The engine CE-7.5 can generate a maximum thrust of 75 kilo Newton.

The current configuration of GSLV with a cryogenic engine, CE-7.5, can put a payload of up to 2500 kilogram in the Geostationary Transfer Orbit (GTO). Further GSLV with cryogenic engine, CE-7.5, has the capability of placing payloads up to 5 tonnes in Low Earth Orbits (LEO).

Geosynchronous Satellite Launch Vehicle Mark II (GSLV Mk II) and GSLV Mk III are two types of GSLV vehicles

RLV - REUSABLE LAUNCH VEHICLE

Reusable Launch Vehicle – Technology Demonstrator (RLV-TD) is one of the most technologically challenging endeavors of ISRO towards developing essential technologies for a fully reusable launch vehicle to enable low cost access to space. The configuration of RLV-TD is similar to that of an aircraft and combines the complexity of both launch vehicles and aircraft. The winged RLV-TD has been configured to act as a flying test bed to evaluate various technologies, namely, hypersonic flight, autonomous landing and powered cruise flight.

SMALL SATELLITE LAUNCH VEHICLE SSLV

Small Satellite Launch Vehicle SSLV is a launch vehicle being developed by the Indian Space Research Organisation (ISRO) with payload capacity of 500 kg to Low Earth orbit or 300 kg to Sun synchronous orbit for launching small satellites.

PSLV stands for Polar Satellite Launch Vehicle and **GSLV** stands for Geosynchronous Satellite Launch Vehicle. **PSLV** is used to send satellites to the lower orbits. Whereas, **GSLV** is used to send satellites to the higher orbits and also higher loads.

COMMUNICATION SATELLITES

The satellites which support telecommunication, television broadcasting, satellite news gathering, societal applications, weather forecasting, disaster warning and Search and Rescue operation services.

EARTH OBSERVATION SATELLITES

The series of satellites supporting multitude of applications in the areas of land and water resources; cartography; and ocean & atmosphere are called Earth Observation satellites. Indian IRS is the largest civilian remote sensing satellite constellation in the world

.SCIENTIFIC SPACECRAFT

Spacecraft for research in areas like astronomy, astrophysics, planetary and earth sciences, atmospheric sciences and theoretical physics.

NAVIGATION SATELLITES

Satellites for navigation services 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.

EXPERIMENTAL SATELLITES

A host of small satellites mainly for the experimental purposes. These experiments include Remote Sensing, Atmospheric Studies, Payload Development, Orbit Controls, recovery technology etc.

SMALL SATELLITES

The satellites which are sub(below) 500 kg class satellites - a platform for stand-alone payloads for earth imaging and science missions within a quick turnaround time.

EDUCATIONAL SATELLITES

The satellites which are launched exclusively for educational services are called educational satellites.