INDIAN SPACE PROGRAM AT A GLANCE

(Article prepared by Er. Vipin Padmanabhan as narrated by Shri. M. Chandradathan**)**

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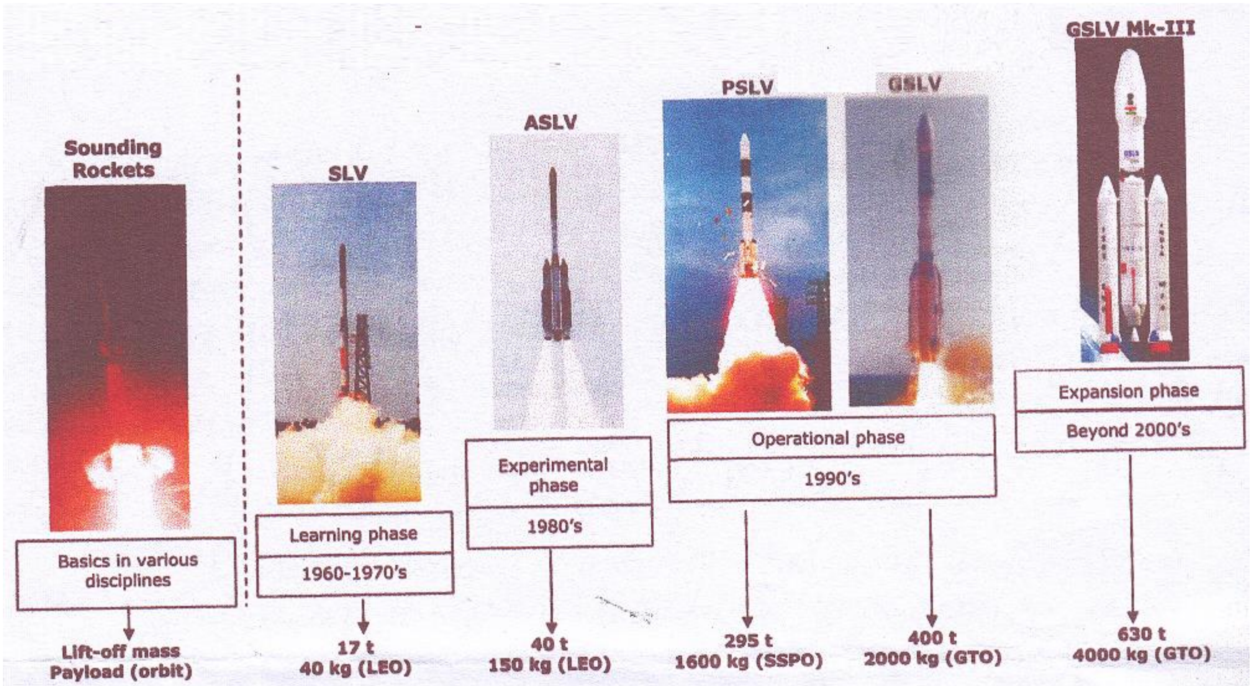
More than four decades old, India's space program started as a purely scientific endeavour, with the launching of Sounding Rockets from Thumba on the Arabian Sea Coast at the southern tip of India. During Nov 1963 the first rocket (Niche Apache of USA) was launched from Thumb Equitorial Rocket Launching Station (TERLS). Being on the geomagnetic equator, this location provided the opportunity to conduct interesting studies of upper atmosphere and isosphere by many other countries also via USA, France, Russia, Germany etc. It is to be noted that exactly after 50 years i.e Nov 2013 ISRO launched Mars Orbitor Mission (MOM) from Sriharikota using our proven work horse launcher vehicle PSLV.

Indian space pioneer Vikram Sarabhai gave the country a vision that is extra ordinary for its realism and pragmatism, unique for its deep insight into the socio economic context of the country, extensive in the level of details and identification of different dimensions and remarkable for the display of his own conviction. The vision recognized that promotion of space science besides contributing to social benefits and enrichment also results in intangible benefits coming out of the need to develop high technologies for economic development and security.

The Indian space program evolved through three major phases. The first phase – the learning phase – is related to initiation of activities with the objective of proof – of - concept evaluation (1960-1970). The initial lessons on sounding rockets launch facilities pyrotechnique payloads, radar tracking the rocket etc were learned during that period. This phase was followed by experimental phase of realizing end to end capability demonstration (1980s) and leading finally to the operational phase providing regular services (1990s and beyond). The experimental phase witnessed the development of first launch vehicle SLV-3 with a capability of orbiting 40 kg class of satellite to low earth orbit (LEO). Through SLV-3 and ASLV, anummber of launch vehicle critical technologies viz Propulsion, Aerodynamics and thermal, Structures and material, Navigation, guidance control & vehicle Avionics, Stage auxilary System vz Seperation, destruction & integration checkout and launch etc were learned through ground tests and high performance.



In the second phase that is the experimental phase a mojor exercise was undertaken to create an end to end capability in the design, development and in orbit management of space system, with the associated ground system needed for the users. Systems with limited capability realized with the stringent cost and time controls characterized this phase. Two experimental satellites Bhaskara I and Bhaskara II for remote sensing and Asian Passenger Pay Load Experiment (APPLE) communication represents mission undertaken in this phase.

Base on these experience, ISRO undertook successful development of Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite launch Vehicles to meet the national need of launching IRS and INSAT class of satellites. These satellites are providing diverse space service to the country, namely remote sensing, weather monitoring, Tele communication and TV broadcasting. PSLV has launched more than 15 Remote sensing satellites, the highest mass of 1600 kg in Sun Synchrous Polar Orbit (SSPO). PSLV has also demonstrated its versatility to launch satellite in the GTO. Further the GSLV has launched geostationary satellites, weighing upto 2000 kg. PSLV has demonstrated the capability of launching multiple satellites and many foreign satellites were also successfully launched.

Beyond 2000 kg ISRO concentrated in expansion phase to develop GSLV-MK-III vehicle (including a cryo upper stage) for launching heavier communication satellites of INSAT &GSAT series of 4T class. The development of cryo stages C12 for GSLV and C25 for GSLV-MK-III are taken up during this phase. Indegeneons Cryo stage C12 is used successfully twice in GSLV flights during 2014 and 2015. The experimental flight of GSLV-MK-III with passive cryostage during Dec 2014 was fully satisfactory. The bigger Indegeneons Cryo stage C25 is undergoing final qualification ground test ISRP's Propulsion Complex at Mahendragiri. The recovery of space capsule was also demonstrated successfully twice during 2007 and 2014.

Currently developments in launch vehicle technology all over the globe are directed towards the reduction in the cost of launch by an order of magnitude. Towards this, ISRO has taken up the developmet of Reusable Launch Vehicles (RLVs) including the p[ossible use of Air breathing engines. The first technology demonstrator flight of RLV is planned during the first quarter of 2016. The usage of semi cryo propulsion technology is another attempt in cost reduction for heavy lift launch vehicles for which studies and tests are going on in full effort at the Liquid Propulsion Centre (LPSC) for the last few years. In addition detailed feasibility studies have been carried out on manned mission to explore new scientific and technological frontiers, which call for man rating of the launch vehicle, for improved safety and reliability. A good amount of work has been already completed and a model of crew module is flight tested and recovered in GSLV MK- III experimental flight during Dec 2014.

In order to perform its defined functions in space, a satellite houses a variety of pay loads related to space based applications and observations. The envisaged utilization of a satellite determines its preferred orbit which in turn defines the performance characteristics of its launch vehicle. The cost effective utilization of space craft demands large duration of operation (long life) in space typically for a period ranging from 5 to 15 years.

The research and development in Indian space science had a very positive global impact. Initially other nations were using our launching pad at Thumba for launching smaller rockets. At the same time we depend on them for launching our bigger satellite. When comparing the European satellite, which weighs about one ton, our vehicle PSLV is better vehicle when cost is considered. Americans also are using our PSLV for launching their smaller satellites. Other countries like Malaysia, Singapore, Brazil and South Korea are always there because such countries don't have their own launch pad and launch vehicles. We have launched satellites of 20 nations (including USA, France, Japan, Germany etc)

One of the biggest milestones India has achieved is the success of Mangalyaan. Mangalyaan is the Mars Orbiter Mission (MOM). Mangalyaan has five different scientific instruments: Lyman-Alpha Photometer (LAP), Methane Sensors for Mars (MSM), Mars Exospheric Neutral Composition Analyser (MENCA), Thermal Infrared Imaging Spectrometer (TIS), and Mars Colour Camera (MCC). Enormous amount of data has been obtained through Mangalyaan. We nave got plenty of photographs of Mars' regions which are unique because our orbiter is moving and going on taking the photographs at different locations of Mars. The photographs taken shows deep cavities, volcanoes etc., which are useful for studying its surface. Temperature sensors are used to provide how temperature profile varies from one region to another. In MOM as of present condition, all instruments are functioning well and we are continuously collecting data from the photographs taken. The orbiter is still healthy and sufficient propellant is still available.

With the success of MOM, people have been eager to know whether there is any possibility for a human mission to Mars from ISRO. A manned mission to Mars needs huge amount of resources just to keep the astronauts safe and healthy in the crew module. Before we move to Mars we can send many un-manned missions to collect maximum data possible. Until we have obtained a positive symptom, it won't be a good idea to undertake such a mission. Such a mission should not be our top priority right now. At present our focus should be on improving our communication sector for which at least ten more satellites should be placed in orbit. Our country's economic situation is the primary reason why we mustn't give higher priority for manned Mars Mission.

There has been continuous effort between various organizations to work together for innovative developments in the field of space science. One such example is NISAR. NISAR is a combined project involving NASA and ISRO. It stands for NASA-ISRO Synthetic Aperture Radar. Usually we get images from satellites which are built with lenses in cameras installed on them. This can be possible only if light is involved which is ob-tained by reflection when the sun illuminates the Earth. This method is called optical imag-ing. Another method of obtaining data is by using radars which employ microwaves. This method is called radar imaging. NISAR functions by this method. Regular video conferences are conducted between NASA and ISRO teams and valuable information is obtained. This is one of the best combined projects between two nations.

In the Navigation sector, India has made various successful developments.The IRNSS is Indian Regional Navigation Satellite System.IRNSS-1 G will be the seventh satellite that will be released by the first quarter of 2016 and last of the IRNSS series. The seven satellites are placed in seven respective locations. It will give India its own indigenous air navigation system which would provide information on location and time in all weather conditions. Though not as accurate as GPS which would provide accuracy up to 20m range, IRNSS would provide the user with an overall picture of the Indian subcontinent and surrounding neighbouring countries like Bangladesh, Pakistan, Myanmar. `

ISRO has definite plans for the next 2 decades and works are initiated at its various centres. The Reusable Launch Vehicle Technology will be demonstrated in the first quarter of 2016. The first developmental flight of GSLV MK III is also targeted during the end of 2016 or beginning of 2017. The work on Heavy Lift Launch Vehicle using semi cryo propulsion has already started for launching bigger satellites of up to 10 tons weight. The vehicle integration and launch facilities at Sriharikota also are being augmented for these programs. Initial works on crew module for human in space (HSP) is nearing completion.

Indian space science has foreseen several developments in the future where they can scale new heights. Revolutionary developments in the fields of communication, information and micro- electronics are driving greater convergence and forging new directions for aerospace programmes.

India’s experience has clearly shown that the investment in space always pays through remote sensing and telecommunications. By being fully self-reliant in space activities, it is certain that the resulting contribution from the space programme to the Indian GDP will be markedly significant.