

INDIAN SPACE PROGRAMME- AN OVERVIEW

T.K. Alex*

Introduction

The Indian Space Programme has achieved notable progress in design, development and operation of space systems. The space programme has become largely self-reliant with capacity to design and build satellites for providing space services and also to launch them using indigenously designed and built launch vehicles. The space segment is providing vital services like telecommunication, television broadcasting, meteorology, disaster warning as well as natural resource survey and management.

The Indian space efforts started in 1963 in Thumba near Trivandrum with humble beginning. With successful launches of the Geo Synchronous Launch Vehicles and seven consecutive flights of the Polar Satellite Launch Vehicles (PSLV), the space programme has attained 2000-kg launch capability in the geo synchronous transfer orbit. Over the last three decades, India has operationalized 50 satellites catering to scientific, remote sensing, communications and meteorology using both indigenous and procured launches. Chandrayaan-1 was the latest mission which made the entire country proud of the development. The essential elements of space research and technology are related to launch vehicle, spacecraft technology, space Applications, and space science.

International Scenario

The space research in various levels has been undertaken by almost all countries. However eight countries (USA, Russia, China, Europe, India, Japan, Israel , Pakistan) have capability to launch their own launch vehicles into orbit. Korea, Brazil, South Africa and a few more countries will reach this stage soon. Manned space flights were carried out by USA, Russia and China. The present decade is witnessing the mission to the Mars, Pluto and Asteroids. USA is planning to revive the manned lunar flights and in the near future mission to the Mars for a possible manned colony there in the next 30 years.

Indian Scenario

India has been keeping pace with the developments in space activities within the limited budget available. How-

ever major achievements have been in all fields of space research. India has its own launch vehicles for Low earth orbit, Geostationary orbit and successfully accomplished a mission to the moon using its own launch vehicle. India developed and orbited more than 50 satellites for various applications and launched a number of satellites for other countries. The applications of space technology for improving the economy of the country has been exemplary for many developing countries. In the area of space science, Indian scientists made significant advancement using observations from various platforms and improved knowledge of the universe.

Launch Vehicles

Over the last four decades India has steadily consolidated the Multidisciplinary Technology base for designing and developing space transportation systems. Starting with the launch of small sounding rockets and developing and perfecting the ROHINI series of indigenous sounding rockets, the launch vehicle technology graduated through successful realization the Satellite Launch Vehicle SLV-3 and the Augmented Satellite Launch Vehicle (ASLV). With the emergence of Polar Satellite Launch Vehicle (PSLV) as a reliable versatile carrier and with the successful launches of the Geo Synchronous Launch Vehicles (GSLV), the Indian launch vehicle programme has come of age. These two vehicles are not only used to launch National Satellites but also utilized to carry spacecraft for International Customers. Development of more powerful Launch vehicle GSLV Mark III has been taken up to double the payload capacity of the current version.

Polar Satellite Launch Vehicle (PSLV)

One of the most successful launch vehicles of ISRO is the PSLV which was initially designed for launching a 900-kg Indian Remote Sensing Satellite into a 900-km polar sun-synchronous orbit. Since the first launch in 1993, PSLV has been successfully improved to enhance its capability. The 45m tall 300 T four stages PSLV is poised for major missions and it was successfully used for the launch of Chandrayaan-1, the mission to the Moon.

* Director, ISRO Satellite Centre (ISAC), Airport Road, Bangalore-560 017, India, Email : tkalex@vsnl.com

Geosynchronous Satellite Launch Vehicle (GSLV)

The GSLV has a lift off weight of above 400T. The maiden flight of the three-stage 49m tall GSLV-D1 on April 18, 2001 placed a 1540-kg experimental satellite, GSAT-1, in orbit. Thus India could claim that it has acquired the geo-stationary launch capability. On 8th May 2003, a 414 T GSLV-D2 placed the 1820-kg GSAT-2 precisely in the specified orbit. While the GSLV, uses the Russian supplied cryogenic upper stage, indigenous cryogenic engine has been tested successfully and the indigenous stage will be incorporated in future GSLV.

Development of advanced version of the GSLV, the Mark-III will have a capacity to launch 4T payloads to Geostationary Transfer Orbit.

Future Indian Launch Vehicles Technology

Space Capsule Recovery Experiment was a unique mission where a 500-kg recoverable capsule was launched and carried out micro-gravity experiments in-orbit. It was successfully recovered from the Bay of Bengal. A number of new technologies for missions such as GSLV-III and RLV are in the advanced stage of development. Technologies for Reusable Launch Vehicle (RLV) and Manned Missions which throw considerable challenges to the launch vehicle designers have been initiated at the preliminary stage.

The GSLV-III weighing 630T vehicle will have a launch capability of launching a 4400 Kg payload in GTO. Its improved version weighing 700T may carry 6500 Kg payload. The RLV demonstrator flight will establish fully re-usable technology. This will lead ultimately to the Two-Stage to Orbit (TSTO) vehicle for faster access to space at a substantially lower cost. ISRO is pursuing the development of scam jet flight test vehicle (DMRJ-FTD). This will lead ultimately to advanced RLV with air breathing propulsion of the future.

Spacecraft Technology

The success story of Indian Satellite Development started with the launch of Aryabhata in 1975 using a USSR launch vehicle. This was followed up with a number of experimental satellites; Bhaskara, Rohini, SROSS and APPLE satellites in the field of remote sensing, communication and space science. The satellite development activity matured into operational systems in the nineties.

Indian Communication Satellites

Space based communication experiments were successfully carried out using the SITE and SYMPHONY satellites followed by India's first geo-stationary communication satellite APPLE in 1981. ISRO-built satellites followed, which included INSAT-2A launched in July 1992, INSAT-2B launched in July 1993 and INSAT-2C launched on December 7, 1995. INSAT-2E launched on April 3, 1999. ISRO has leased eleven 36 MHz equivalent units of C-band capacity on board INSAT-2E to INTEL-SAT organization.

INSAT-3 series started with the launch of INSAT-3B on March 22nd 2000 which was followed by INSAT-3C launched on January 24th 2002 and INSAT-3A launched on April 10th 2003. The INSAT-4 series has seven satellites with a projected capacity of 250 transponders in various bands catering to a demand of upto 11 Giga Bits Per Second (GBPS). The GSAT series consists of technology experiment satellites launched on board India's GSLV for coverage through regional beams.

Indian Remote Sensing Satellites

With seven satellites in operation, India has a big constellation of remote sensing satellites providing data in a variety of spatial resolutions and spectral bands. The remote sensing instruments on-board provide spatial resolution of as high as one kilometer for meteorological applications and 70 to 170 meters for wide area coverage, 5 to 22 meters for a large number resource survey applications and 1 to 2.5 meters for cartography and terrain mapping. Space based remote sensing has augmented performance with the launch of the Resourcesat-1 and got further fillip with the launch of CARTOSAT-1 in 2005. CARTOSAT-2 exclusively for mapping applications and the Radar Imaging Satellite are slated for launch in the coming years.

Meteorological Satellites

The Meteorological applications got a boost with the launch of INSAT-1A with its VHRR (Very High Resolution Radiometer) in visible and Infrared bands. INSAT-3D will carry a further improved VHRR and an Atmospheric Sounder. These instruments and a large number of data collection platforms distributed at various parts of the country provide vital data for weather forecasting and cyclone warning.

Small Satellites

ISRO is pursuing the development of small satellites in tune with such developments elsewhere. HAMSAT launched in 2005 is used for Armature Communication. A small satellite is being developed by the Anna University. A remote sensing satellite is being developed for Third World Countries. In future, Nano satellites using MEMS technology is identified as a possibility.

Applications of Satellite Communication

The genesis of satellite applications in India can be traced back to the Satellite Instructional Television Experiments (SITE) of the mid-seventies followed by the Satellite Telecommunication Experiment Project (STEP) during 1977-79. The INSAT brought a revolution in India in the area of telecommunication and related areas. The ever-increasing number of telecommunication terminals of various sizes and capabilities provide a multitude of two-way speech circuits. Satellite television covers over 65% of the Indian landmass and 80% of the Indian population. Apart from the national networking services and regional services, educational TV has been one of the high priority areas of Doordarsan beamed through INSATs. The Satellite News gathering using INSAT system enables on-the-spot real time news coverage and dissemination. Radio networking through INSAT provides a reliable high fidelity programme channels for national and regional networking.

The GRAMSAT programmes are fresh initiatives to provide communication network at state level connecting the state capital to districts and blocs. The indigenous satellite-based regional GPS augmentation system known as Space Based Augmentation System (SBAS) is a part of satellite-based communications and navigation and surveillance in civil aviation. The ground segment of the Indian SBAS called GAGAN is under implementation. As a member of the international COSPAS-SARSAT programme for providing distress alert and position location service through LEOSTAR satellite system, India has established two local user terminals with coverage to large parts of Indian Ocean region.

Telemedicine has emerged as an application of the satellite communication that enables specialized medical facility to be available to remote and rural areas in the country. The present telemedicine network amply demonstrates the versatility of the services by connecting some of the super specialty hospitals with patient bases at far flung areas such as Port Blair, Car Nikobar, Kavarathy,

Tripura, Leh etc., in addition to local connectives with district and smaller hospitals.

Tele-Education (EDUSAT)

EDUSAT launched by GSLV-F01 is dedicated exclusively for educational services. It is specially configured to create interactive class rooms through relay of audio-visual medium employing multiple beams in Ku-Band. It is primarily meant for providing connectivity to school, college and higher levels of education. The indigenous realization of the system will boost the countrywide distance education system.

Space Science

Space science research in DOS encompasses the fields of astronomy and astrophysics, space and atmospheric sciences, planetary and geosciences studies, and theoretical physics. Major activities under laser physics and quantum optics are also under way. ISRO also provides opportunity for researchers to carry out research in the field of atmospheric dynamics related phenomena. Space Physics research programme includes atmospheric sciences, ionosphere-magnetosphere physics and planetary atmospheres.

In addition to in-house space science research activities, research in areas environment, climate, geosphere-biosphere interactions, aeronomy, planetary sciences, space astronomy, micro gravity sciences, life sciences etc. are supported by DOS in universities and other research institutions under space science promotion activities.

The ISRO-Geosphere Biosphere Programme (ISRO-GBP) strives to understand various issues related to climate change using space based and conventional systems. A balloon borne cryogenic sampler for studying the atmospheric chemistry has been developed as a part of the programme.

ASTROSAT mission is a national project involving several institutions to conduct multiwave length astronomical studies of a variety of celestial sources using X-ray, Ultraviolet and visible sensors. The **Megha-Tropiques** is a mission envisaged for investigating the tropical atmospheric phenomena. This is a joint mission of ISRO and European space agency. Aditya, a small satellite to study the corona of the Sun is an interesting project.

Mission to the Moon (Chandrayaan-1)

This first Indian mission to the Moon is aimed at expanding the scientific knowledge about the Moon, upgrading India's technological capability and providing challenging opportunities for planetary research. The scientific objectives are high resolution terrain mapping of the Moon, chemical mapping of the Moon using various scientific equipments. The launch took place on 22nd October, 2008 and the lunar orbit insertion was successfully carried out on 8th November. The mission accommodates a few complimentary scientific payloads from international scientific communities as well. A deep space communication network station is being established. One of the challenging experiment was the deployment and precise landing of the Moon impact probe carrying the Indian Flag. Large amount of data has been collected from the 11 scientific experiments on board Chandrayaan-1.

Future Lunar, Interplanetary and Manned Missions

ISRO has made significant progress for defining a continuation mission to the Moon, exploration of the solar system through interplanetary missions and feasibility studies on possible manned missions to fully utilize the potential of the space for widening our knowledge of the universe. The Chandrayaan-2 mission will contain an orbiter, Lander and a rover. Missions to Mars is in planning stage. To make these missions cost effective, it is imperative to have joint efforts with other countries who are engaged in the same field of space exploration.

Industry-Academic Interface

Considering that front-end knowledge exists with the academia, concentrated efforts have been put up by all the aerospace laboratories to interact with all the leading academic institutions.

Sponsored Research of ISRO (RESPOND) aims at strengthening the academic interaction with Colleges, Universities, and Institutes of Technology and Research Institutes.

Conclusion

India is probably the most active nation in the world as far as design, development and testing of various types of aerospace systems are concerned. India has continued to forge ahead not only in acquiring space technology capabilities, but also use them for various applications related to national development. New thrust areas for space explorations of our universe are being identified. Chandrayaan-1, the mission to the Moon is a major step in this direction. Participation of private agencies in this high technology area is projected as a major requirement in advanced technology development and management.

Reference

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