

**OUTCOME BUDGET  
OF THE  
DEPARTMENT OF SPACE  
GOVERNMENT OF INDIA  
2009-2010**

## CONTENTS

**Page Nos.**

	Executive Summary	(i) - (iv)
Chapter I	Introduction (Organisational Set-up, Major Projects/ Programmes of Department of Space, Overview of 11 <sup>th</sup> Five Year Plan 2007-2012 proposals, Mandate and Policy framework of Department of Space)	1 - 25
Chapter II	Outcome Budget 2009-2010	26 - 63
Chapter III	Reform measures and Policy initiatives	64 - 66
Chapter IV	Review of Performance of the Major ongoing Projects/Programmes/Centres of DOS/ISRO	67 - 119
Chapter V	Financial Review	120 - 127
Chapter VI	Autonomous Bodies of DOS/ISRO	128 - 141
Annexure	Major Indian Space Missions – 2002-2011	

## EXECUTIVE SUMMARY

The Indian Space Programme has the primary objective of developing Space Technology and applications programme to meet the developmental needs of the country in a self reliant manner. Towards meeting this objective, two major operational space systems have been established – the Indian National Satellite (INSAT) for telecommunication, television broadcasting and meteorological service and the Indian Remote Sensing Satellite (IRS) for natural resource monitoring and management. Two operational launch vehicle, Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch Vehicle (GSLV) provide self reliance in launching IRS & INSAT Satellites respectively.

2. The Department of Space (DOS) and Space Commission was set up in 1972 to formulate and implement Space policies and programmes in the country. The Indian Space Research Organisation (ISRO) is the research and development wing of the Department of Space and is responsible for executing the programmes and schemes of the Department in accordance with the directives and policies laid down by the Space Commission and the DOS. The Space programme is executed through the ISRO Centre/Units and the Grant-in-aid Institutions.

3. The overall thrust of the Space programme during 11<sup>th</sup> plan will be to sustain and strengthen the already established space based services towards socio-economic development of the country and undertake advanced space missions including Human Space Flight Programme and Planetary Exploration. The details of the programmes envisaged in the 11<sup>th</sup> five year plan is dealt in para 4 of Chapter 1.

4. The Budget proposals for the Department of Space for 2009-2010 have been formulated under the frame work of Decade Profile 2010-2020 and proposals for Eleventh Five Year plan (2007-2012). The BE 2009-2010 for Department of Space stands at Rs.4959.00 crores comprising of Rs.4100 crores 'Plan' outlay and Rs.859.00 crores 'Non-plan' outlay. The outlay has been arrived at taking into account the Programmatic targets set for 2009-2010.

5. The Department has prepared “**Outcome Budget 2009-2010**” based on the guidelines contained on the subject in the Ministry of Finance, Department of Expenditure, Office Memorandum No.2 (1) Pers/E-Coord/OB/2005 dated: May 6, 2009. The Table 2.1 annexed to Chapter II gives the Outcome Budget for 2009-2010 in the prescribed format.

6. The Department of Space is largely project and mission oriented. The nature of Outcome of the Space Programmes will be mainly in the form of (a) Indigenous capability to develop and realise complex space systems such as satellites and launch vehicles. (b) Creating infrastructure in Space by launching and operationalisation of satellites including Space operations, which are utilised by various user agencies for national development (c) Capacity building in terms of critical technologies and ground technical infrastructure of relevance for future and (d) Benefits to the society arising from application of space technology/systems such as IRS satellites, INSAT satellites in various fronts. These have been appropriately reflected in the Table 2.1, Chapter II of the Outcome budget against various programmes/schemes.

7. The major programmatic targets for 2009-2010 are the following:-

- Launch and operationalisation of RISAT-2 and ANUSAT onboard PSLV-C12 launch vehicle. Radar Imaging Satellite (RISAT-2) with the capability to take images of the earth during day and night as well as cloudy conditions will enhance ISRO’s capability for earth observation, especially during floods, cyclones, landslides and in management of disasters in a more effective way. ANUSAT is the first experimental communication satellite built by an Indian University (Anna University)

under the over all guidance of ISRO to demonstrate the technologies related to message store and forward operations;

- Launch and operationalisation of Oceansat-2 Satellite onboard PSLV-C14 from Sriharikota. Oceansat-2 carries Scatterometer and Ocean Color Monitor for Ocean/Coastal studies and provides continuity of data hitherto provided by Oceansat-1. The data from Oceansat-2 is also used for providing advisories to Fishermen on potential fishing zones. Oceansat-2 also carries Radio Occultation Sounder for Atmospheric Studies (ROSA) developed by Italian Space Agency;
- Launch of GSAT-4 Satellite onboard third development flight of GSLV-D3 employing indigenously developed Cryogenic Stage. GSAT-4 is a low cost experimental communication satellite in Ka band. It also carries Navigation Payload and Scientific experiment developed by Tel Aviv University and Israel Space Agency;
- Assembly, Integration and Testing of Resourcesat-2 and GSAT-5/INSAT-4D satellites and progress towards launch from Sriharikota. Resourcesat-2 with enhanced imaging capabilities will provide data for crop applications, vegetation dynamics and natural resource census and will eventually provide continuity of data hitherto provided by Resourcesat-1. GSAT-5/INSAT-4D will augment the INSAT capacity with additional C band Transponders;
- Initiate/progress work on Human Space flight programme, Semi cryogenic Engine development, GSLV Mk-III, Advanced Communication Satellite, Chandrayaan-2 and other ongoing space missions and application programmes;

8. The Department has five Grant-in-aid Institutions under its fold viz., Physical Research Laboratory, National Atmospheric Research Laboratory, Semi-conductors Laboratory, North-East Space Applications Centre and Indian Institute of Space Science and Technology. A review of the performance of these institutions is presented in Chapter VI.

9. The Department has taken several policy initiatives and pro-active measures to enhance the effectiveness and outreach of the Space programme. The Policy framework of the Department encompasses the areas of Satellite Communications, Remote Sensing Data distribution, Industry participation, Commercialization, Human Resource Development, Extra-mural research, International Co-operation, effective user participation and continuous upgradation of technological capabilities. Societal applications has been a thrust area of the Space programme and the Department has initiated several programmes such as Tele-education, Tele-medicine, Village Resource Centres to take the benefits of space technology to the door-steps of common man.

10. Periodical review of the physical and financial performance of all the projects/schemes is an integral part of the planning and implementation strategy in DOS/ISRO. Quarterly targets are fixed for each major project/scheme during the beginning of the year and Additional Secretary & IFA of the Department periodically takes a rigorous review of the expenditure/commitment status to ensure that the financial and programmatic targets are realized. With this, the Department has been able to meet most of the programmatic targets and also utilize more than 99% of the budget allocated in RE.

11. The Indian Space Programme, over the years, has paved the way for creating cost-effective space infrastructure for the country in a self-reliant manner and the economic and social benefits brought in by the application of space technology to the national development have been significant. The Space Programme is poised to play a pivotal role in the national development in the coming years.

\* \* \* \* \*

# **CHAPTER-I**

---

## **INTRODUCTION**

1.1 The Space activities in India started in November 1963 with the establishment of Thumba Equatorial Rocket Launching Station (TERLS), an obscure fishing village near Thiruvananthapuram for the investigation of ionosphere using sounding rockets. The efforts were consolidated with the formation of Indian Space Research Organisation (ISRO) in 1969. The Space programme got further fillip in June 1972, when the Government of India constituted the Space Commission and established the Department of Space (DOS). The ISRO was also brought under the newly formed DOS in September 1972. Over the last four decades, India has come a long way in mastering the complex space technology and using it for various developmental activities in a self-reliant manner. The ever challenging task of space technology development and utilisation, has not only graduated from experimental and demonstration phases to an operation era, but also provided its potential to address the national needs. Notable progress has been made in the design, development and operation of space systems, as well as, using them for vital services like telecommunications, television broadcasting, meteorology, disaster management support and natural resources survey and management. The space programme has become largely self-reliant with capability to design and build satellites for providing space services and to launch them using indigenously designed

and developed launch vehicles. The end-to-end capability in space for vital applications in communications, broadcasting, meteorology and natural resource information are of direct relevance for national development. The diverse roles of space technology & services in various fronts – social, economic, commercial and strategic – have made the space systems an important component of our national infrastructure.

1.2 The primary objective of the Indian Space Programme is to achieve self-reliance in Space Technology and to evolve application programme to meet the developmental needs of the country. Towards meeting this objective, two major operational space systems have been established – the Indian National Satellite (INSAT) for telecommunication, television broadcasting and meteorological service and the Indian Remote Sensing Satellite (IRS) for resource monitoring and management. Two operational launch vehicles, Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch Vehicle (GSLV) provide self-reliance in launching IRS & INSAT Satellites respectively.

## 2. **Organisational Set-up**

2.1 The Indian Space Programme has its genesis in the Indian National Committee for Space Research (INCOSPAR) that was formed by the Department of Atomic Energy in 1962. The Indian Space Research Organisation (ISRO) was established under the Department of Atomic Energy in August 1969. The Government of India passed a resolution in

1972 for setting up Space Commission and the Department of Space (DOS) to formulate and implement space policies in the country and brought the Indian Space Research Organisation (ISRO) under the Department of Space in June 1972.

2.2 The primary objective of DOS is to promote the development and application of Space Science and Technology for socio-economic benefit of the nation. The Indian Space Research Organisation (ISRO) is the research and development wing of the Department of Space and is responsible for executing the research and development programmes and schemes of the Department in accordance with the directives and policies laid down by the Space Commission and the DOS. The Space programme is executed through the ISRO Centre/Units and its Grant-in-aid Institutions i.e., the Physical Research Laboratory (PRL), the National Atmospheric Research Laboratory (NARL), the North-Eastern Space Applications Centre (NE-SAC) and Semi-conductor Laboratory (SCL). The Antrix Corporation Limited (ACL), a wholly-owned Government Company established in 1992, is the apex marketing agency under DOS with access to resources of DOS as well as Indian Space industries. The establishment of space systems and their utilization are co-ordinated by national Committees, namely the INSAT Co-ordination Committee (ICC), the Planning Committee of National Natural Resources Management System (PC-NNRMS) and the Advisory Committee on Space Sciences (ADCOS). Five Regional Remote Sensing Service Centres (RRSSCs) undertake remote sensing application projects relevant to the concerned region. The ISRO Headquarters co-ordinates the overall programmes

like launch vehicle, satellite communication, earth observation, space science, atmospheric science, space-industry development, disaster management support, international co-operation etc.,

2.3 Following are the major Centres/Units of DOS/ISRO responsible for carrying out research and development activities as well as for undertaking the various projects and programmes:-

A. **Vikram Sarabhai Space Centre (VSSC)**

The Vikram Sarabhai Space Centre (VSSC) at Thumba, near Thiruvananthapuram is the lead Centre for the development of satellite launch vehicles, sounding rockets and associated technologies. The Centre pursues research and development in the fields of aeronautics, avionics, composites, computer & information, control, guidance & simulation, launch vehicle design, mechanical engineering; mechanisms, vehicle integration & testing, propellants, polymers, chemicals & materials, propulsion, propellants & space ordinance and systems reliability. The Programme planning & evaluation, technology transfer & industrial co-ordination, human resources development, safety & personnel and general administration groups support the Centre. The Space Physics Laboratory at VSSC carries out research in atmospheric and related space sciences. Apart from this, the Construction & Maintenance Division (CMD) takes care of planning, execution and maintenance of all civil works related to the Centre.

VSSC has extension Centres at Valiamala, housing the major facilities of the Polar Satellite Launch Vehicle (PSLV) and the Geo-

Synchronous Satellite Launch Vehicle (GSLV) Projects and at Vattiyoorkavu for the development of reinforced plastics and composites (Reinforced Plastics Facility). VSSC also supports the (i) Thumba Equatorial Rocket Launching Station (TERLS), the International sounding rocket range, (ii) Rohini Sounding Rocket (RSR) Programme. An Ammonium Perchlorate Experimental Plant (APEP) has been set up by VSSC at Aluva near Kochi.

The major programmes at VSSC include: Polar Satellite Launch Vehicle (PSLV), Geosynchronous Satellite Launch Vehicle (GSLV), Rohini Sounding Rocket, Space-capsule Recovery Experiment, Reusable Launch Vehicles and Air Breathing Propulsion.

B. **Liquid Propulsion Systems Centre (LPSC)**

The Liquid Propulsion System Centre (LPSC) is the lead Centre in the development of liquid and cryogenic propulsion stages for launch vehicles and satellites. The activities are spread across Valiamala, Thiruvananthapuram, Mahendragiri and Bangalore. LPSC at Valiamala, Thiruvananthapuram carries out design and system engineering of earth storable and cryogenic engine and stages for launch vehicles and design and development of bipropellant thrusters and electric propulsion thrusters for spacecraft, control components and control system. LPSC, Mahendragiri carries out assembly, integration and testing of earth storable and cryogenic engines and stages, high altitude testing of upper stage engine and spacecraft thrusters, as well as testing of subsystems. This Centre also has facilities for storage of earth storable and cryogenic propellant including an Integrated

Liquid Hydrogen Plant. The Construction & Maintenance Division (CMD) of the Centre is responsible for planning, execution and maintenance of all civil works related to the Centre. LPSC at Bangalore carries out design, development and testing of propulsion system for spacecraft. It also carries out transducer design, development & production.

C. **Satish Dhawan Space Centre- SHAR (SDSC-SHAR)**

The Satish Dhawan Space Centre (SDSC-SHAR) is the principal operational Centre for launching Sounding Rockets and Satellite Launch Vehicles. This Centre has the facilities for solid propellant processing, static testing of solid motors, launch vehicle integration and launch operations, range operations comprising telemetry tracking and command network and mission control centre. Management service group, Advanced Engineering Group, reliability and Sriharikota Common Facilities support the Centre. Apart from this, the Construction & Maintenance Division (CMD) takes care of planning, execution and maintenance of all civil works of the Centre. The Centre has two launch pads from where the rocket launching operations on PSLV & GSLV are carried out.

D. **ISRO Satellite Centre (ISAC)**

The ISRO Satellite Centre (ISAC) at Bangalore is engaged in developing satellite technology and implementation of satellite systems for scientific, technological and application missions. ISAC is functionally organised into five major areas: Mechanical Systems Area including structures, thermal systems and spacecraft mechanisms, Digital and Communications

Area comprising of digital systems and communication systems, Integration and Power Area comprising spacecraft checkout, systems integration and power systems, Control and Mission Area consisting of control system mission development and computer and information and facilities and Reliability and Components Area comprising indigenisation and components and systems reliability and programme planning and evaluation group support the Centre. The Construction & Maintenance Division (CMD) of the Centre is responsible for planning, execution and maintenance of all civil works related to the Centre.

Four project management teams co-ordinate the implementation of projects. Space astronomy and instrumentation division is engaged in space science activities. A new facility, ISRO Satellite Integration and Test Establishment (ISITE) including a Comprehensive Assembly, Test and Thermo-vacuum Chamber (CATVAC) has been set up recently.

E. **Laboratory for Electro-Optics Systems (LEOS)**

The Laboratory for Electro-Optics Systems (LEOS) at Bangalore carries out research and development in the field of electro-optics sensors and cameras required for satellites and launch vehicles.

F. **Space Applications Centre (SAC)**

The Space Applications Centre (SAC) at Ahmedabad is engaged in the development of payloads for communication, meteorological and remote sensing satellites. SAC also carries out research and development on various space applications programme. The activities are grouped under microwave

systems, satellite communication applications, sensor developments, image and information processing and remote sensing applications. Programme planning group, systems reliability group and library and documentation group support the Centre. The Construction & Maintenance Division (CMD) takes care of planning, execution and maintenance of all civil works related to the Centre.

The facilities of this Centre include the Ahmedabad Earth Station, the Delhi Earth Station, portable & Mobile Earth Stations, Laboratories for remote sensing & communication activities, fabrication & environmental test facilities for development and qualification of space and ground hardware. The Centre is responsible for the development, realization and qualification of communication, navigation, earth observation and meteorological payloads & related data processing & ground systems in the areas of communication, broadcasting, earth observations for remote sensing of natural resources, weather and environmental studies, disaster.

G. **Development and Educational Communication Unit (DECU)**

The Development and Educational Communication Unit (DECU) at Ahmedabad is involved in the conception, definition, planning, implementation and socio-economic evaluation of innovative developmental communications in space applications. The major activities of DECU at present include: EDUSAT pilot projects, implementation and utilisation; Training and Development Communication Channel (TDCC), Village Resource Centres (VRC), GramSat Programme (GP), Tele-Health (TH), Tele-Education (TE) mission and new satellite communication application.

#### H. **National Remote Sensing Centre (NRSC)**

The National Remote Sensing Centre (NRSC) at Hyderabad is responsible for satellite data acquisition and processing, data dissemination, aerial remote sensing and decision support for disaster management. NRSC has set up data reception station at Shadnagar near Hyderabad for acquiring data from Indian remote sensing satellites as well as others. The Centre is also engaged in executing remote sensing application projects in collaboration with the users. Indian Institute of Remote Sensing at Dehradun, which conducts training courses in remote sensing for user agency personnel at different levels, functions under NRSC.

Considering the fact that the erstwhile NRSA is closely associated with various programmes of DOS/ISRO, in particular the Earth Observation Programme, Disaster Management Support and other programmes of national importance and to enable NRSA to carryout its responsibilities in a more effective manner, the Government has decided to convert it into a Govt. entity, to be called as National Remote Sensing Centre (NRSC), a Centre under DOS/ISRO w.e.f. 01.09.2008.

#### I. **ISRO Telemetry, Tracking & Command Network (ISTRAC)**

The ISRO Telemetry, Tracking & Command Network (ISTRAC) at Bangalore provides mission support to low-earth orbit satellites as well as launch vehicle missions. ISTRAC has its headquarters and a multi-mission Spacecraft Control Centre at Bangalore. It has a network of ground stations at Bangalore, Lucknow, Sriharikota, Port Blair and Thiruvananthapuram in India besides stations at Mauritius, Bearslake (Russia), Brunei and Biak (Indonesia).

ISTRAC activities are organised into network operations, network augmentation, mission operation and spacecraft health monitoring, communications and computers and control centre facilities and development projects. Programme planning and reliability groups support ISTRAC activities. ISTRAC also operates the Local User Terminal/Mission Control Centre (LUT/MCC) under the international programme for satellite aided search and rescue. An Indian Deep Space Tracking Network station at Bangalore for India's mission to moon, Chandrayaan-1, has been recently established by ISTRAC.

J. **Master Control Facility (MCF)**

The Master Control Facility (MCF) at Hassan in Karnataka and Bhopal in Madhya Pradesh monitors and controls all the geo-stationary satellites of ISRO. MCF carries out operations related to initial orbit raising of satellites, in-orbit payload testing and on-orbit operations through the life of these satellites. The operations involve continuous tracking, telemetry and commanding, special operations like eclipse management, station-keeping manoeuvres and recovery in case of contingencies. MCF interacts with the user agencies for effective utilisation of the satellite payloads and to minimise the service disturbances during special operations.

K. **ISRO Inertial Systems Unit (IISU)**

The ISRO Inertial Systems Unit (IISU) at Vattiyookavu, Thiruvananthapuram carries out research and development in inertial sensors and systems and allied satellite elements. IISU is organised into research and development in the areas of launch vehicle inertial systems, spacecraft inertial

systems, inertial system production and reliability and quality assurance. It has facilities for precision fabrication, assembly, clean room and integration and testing.

2.4 A National Natural Resources Management System (NNRMS) with the Department of Space (DOS) as the nodal agency has been established to ensure optimal utilisation of natural resources using remote sensing data in conjunction with conventional techniques. Under NNRMS, five Regional Remote Sensing Service Centres (RRSSCs) at Bangalore, Dehradun, Jodhpur, Kharapur and Nagpur have been set up for execution of remote sensing application programmes in the respective regions.

2.5 Following are the Grant-in-aid institutions of DOS: -

A. **Physical Research Laboratory (PRL)**

The Physical Research Laboratory (PRL) at Ahmedabad, is an autonomous institution supported mainly by DOS. It is a premier institute engaged in basic research in experimental and theoretical physics, astronomy and astrophysics, and earth, planetary and atmospheric sciences. The activities cover a wide spectrum of competitive research in all these areas. PRL is also involved in conducting extensive academic programmes for Doctoral and Post Doctoral research and also has an Associateship programme for university teachers. It is also entrusted with the management of the Udaipur Solar Observatory (USO).

B. **National Atmospheric Research Laboratory (NARL)**

The National Atmospheric Research Laboratory (NARL) at Gadanki near Tirupati is an autonomous research laboratory fully funded by DOS. It is a Centre for atmospheric research with facilities like mesosphere-stratosphere-troposphere radar, LIDAR, lower atmospheric wind profiler, disdrometer, optical rain gauge and automatic weather station along with associated facilities. NARL is available for national and international scientists to conduct atmospheric research.

C. **North-Eastern Space Applications Centre (NE-SAC)**

The North-Eastern Space Applications Centre (NE-SAC) located at Shillong, is a joint initiative of DOS and North-Eastern Council to provide support to the North-Eastern region in using space science and technology for development. The Centre has the mandate to develop high technology infrastructure support to enable NE states to adopt space technology inputs for their development. At present, NE-SAC is providing developmental support by undertaking specific projects, utilising space technology inputs in remote sensing, satellite communication and space science.

D. **Semi-conductor Laboratory (SCL)**

The administrative control of SCL had been transferred from Department of IT to Department of Space w.e.f. 1<sup>st</sup> March 2005. SCL is engaged in the design, development and manufacture of Very Large Scale Integrated Circuits (VLSIs) and Board Level Products. SCL has an Integrated Facility comprising class 10, 6” Wafer Fabrication Plant, Design Facility, Test

& Assembly. Quality Assurance and Reliability and system Level Assembly Facility. Development & Manufacture of ASICs for strategic sector is the major thrust.

E. **Indian Institute of Space Science & Technology (IIST)**

The Indian Institute of Space Science and Technology (IIST) is an autonomous body under DOS formed with the objective of creating quality human resources tuned to suit the state-of-art space programme. The Institute offers graduate, post-graduate and doctoral programmes in the area of Space Science and Technology. The Institute has started functioning from the academic year 2007-2008 around the existing infrastructure adjacent to VSSC, Thiruvananthapuram. A permanent infrastructure for the Institute is in progress near LPSC, Valiamala.

2.6 Apart from this, the RESPOND programme of ISRO supports sponsored research activity in Space Science, Space Applications and Space Technology in various national academic/research institutions and Space Technology Cells in premier technological institutes of the country through grants-in-aid. The RESPOND Programme is aimed at promoting space research activities and to develop a large research based trained manpower and infrastructure facilities for specific activities of interest to the space programme in the country.

## 2.7 **Antrix Corporation Limited (ACL)**

The Antrix Corporation Limited, Bangalore is the marketing agency under DOS with access to resources of DOS as well as Indian space industries. Antrix markets subsystems and components for satellites, undertakes contracts for building satellites to user specifications, provides launch services and tracking facilities and organizes training of manpower and software development.

## 3. **Major projects/programmes of Department of Space**

3.1 The Department of Space (DOS) has the primary objective of promoting development and application of Space Science and Technology to assist in all-round development of the nation. Towards this Department has evolved the following programmes:-

- (a) Launch Vehicle programme having indigenous capability for launching space-crafts;
- (b) INSAT Programme for telecommunications, broadcasting, meteorology, development of education etc;
- (c) Remote Sensing Programme for application of satellite imagery for various developmental purposes; and
- (d) Research and Development in Space Science, Technology for subserving the end of applying them for national development.

3.2 Over the years, India has established two operational Space Systems - the Indian National Satellite (INSAT) System providing services for telecommunications, TV broadcasting and meteorology including disaster warning support and the Indian Remote Sensing Satellite (IRS) System for natural resource monitoring and management. The Polar Satellite Launch Vehicle (PSLV) is well proven through Fourteen successive successful flights and has emerged as a reliable cost-effective launch vehicle. The successful launch of two developmental flights of Geosynchronous Satellite Launch Vehicle, GSLV-D1 & D2 in 2001 & 2003, followed by first operational flight in 2004 and launch of GSLV-F04 carrying INSAT-4CR launched in 2007 was a major achievement in the Indian Space Programme.

3.3 The constellation of Indian Remote Sensing Satellites comprises of seven satellites viz., IRS-1D, Oceansat-1, TES, Resourcesat-1, Cartosat-1, Cartosat-2 and IMS (TWSAT). They serve as main stay of the National Natural Resources Management System (NNRMS) besides providing data worldwide. Vital applications such as identifying zones which could yield ground water, suitable locations for recharging water, monitoring command areas, estimating crop areas and yields, assessing deforestation, mapping urban areas for planning purposes, delineating ocean areas with higher fish catch potential, monitoring of environment and scene specific spot imagery are being pursued actively by users with the space based data. The data from IRS Satellites is received worldwide through a network of International ground stations under commercial agreement with M/s. Antrix. The next satellite in IRS series, Oceansat-2, intended for Oceanographic studies is in advanced stages and is targeted for launch in 2009-2010 onboard India's PSLV. Development of a

Radar Imaging Satellite (RISAT-1) with day and night all-weather imaging capability is also in progress.

3.4 INSAT contributes significantly to a variety of services in telecommunications and television broadcasting including meteorological observations, disaster communications, Tele-education and Tele-health services. In the field of Space communications and meteorology, the INSAT system, currently consisting of Eleven satellites, viz., INSAT-2E, 3B, 3A, 3C, 3E, 4A, 4B, 4CR, GSAT-2, EDUSAT and Kalpana-1 is one of the largest domestic communication satellite systems in the world, with a capacity of about 200 transponders in C, Ext-C, Ku and S bands. Work on INSAT-4D, INSAT-4E, INSAT-4F (User funded) and INSAT-4G are in progress.

3.5 Front ranking scientific investigations are being carried out in the fields of astronomy, atmospheric sciences, planetary science and long term climatic research using satellites, balloons, sounding rockets & ground instruments. India's first mission to moon, Chandrayaan-1 was successfully launched on October 22, 2008 on-board the PSLV C-11. The payloads of Chandrayaan-1 have sent useful scientific data about Moon. Development of a multi-wave length astronomy satellite ASTROSAT has also been taken up. The Indian Space programme has enabled a significant role for national industries in realisation of space systems. A strong bond with academic institutions exists through extensive research partnership. Unique organisational systems have been evolved in the national space programme for fulfilling diverse functions like development, operations and applications of

complex space systems. The space programme has enabled significant technology growth in multiple disciplines as spin-off benefits.

3.6 Indian capabilities in space thus represent a wide spectrum of expertise ranging from the conceptual design to building and operating of a variety of space systems, which are matched only by a few nations in the world. In view of these multiple dimensions and capabilities, India is recognised as a leader in space applications that have a wide impact on society.

#### **4. Overview of Eleventh five year plan 2007-2012 proposals**

4.1 The eleventh five year plan 2007-2012 proposals of the Department have been formulated under the framework of a Decade Profile 2010-2020 after extensive interactions, detailed studies and consultations within the organisation as well as with user community. The programmes and the Mission Profile have been based on the national developmental needs in the social and economic sectors.

4.2 The overall thrust of the Space programme during 11<sup>th</sup> plan will be to sustain and strengthen the already established space based services towards socio-economic development of the country. The following are the brief summary of the plan programmes envisaged during the Eleventh Plan in the area of Launch Vehicle Development, Earth Observation Systems, Satellite Communications & Navigation (INSAT, GSAT & IRNSS), Space Science Programme, Atmospheric Science Programme and Disaster Management Support.

4.3 In the area of **Launch Vehicle Development**, the major target for 11<sup>th</sup> plan is to complete the development of GSLV Mk-III capable of launching 4T class INSAT satellite and operationalise the vehicle. PSLV and GSLV will continue to be workhorse vehicles for launching IRS and INSAT (2T class) satellites and their capabilities will be further improved. Technology development and demonstration missions on Reusable Launch Vehicle including space recovery technologies and air breathing propulsion are also planned.

4.4 Building up large space systems like space stations, servicing and refueling of satellites in space and material processing are promising greater economic benefit to the nation. These require a large scale involvement of human beings in space for building and maintaining space assets. Space has emerged as the next frontier of human endeavor and manned missions are the logical next step to space research. Therefore, it was considered necessary to initiate the **development of Manned Missions** during 11<sup>th</sup> plan period by development of critical technologies. The major objective of the Manned Mission programme is to develop a fully autonomous manned space vehicle to carry two crew to 400 km LEO and safe return to earth.

4.5 The **Earth Observation (EO) Systems** during 11<sup>th</sup> plan is driven by two major considerations viz., ensuring continuity of EO data with improved quality duly addressing the current gap areas and the urge to maintain the global leadership in EO systems. The EO series of satellites, both in IRS and INSAT/METSAT series, addressed broadly the thematic applications in three streams viz., Resourcesat series, Cartosat series and Atmosphere series. An important specific target for 11<sup>th</sup> plan is to realize the

Microwave remote sensing satellite RISAT-1 which provides all-weather remote sensing capability critical for applications in Agriculture and Disaster Management. Strengthening ground segment to ensure and enhance effective utilization of the remote sensing data will be an important thrust area. Creation of Natural Resource Inventory and Data bases, Food security, Water security, Disaster Management support, Infrastructure development, Weather forecasting, Ocean State Forecasting, Environment protection, Climate variability and change are some of the thrust areas of EO systems applications identified for 11<sup>th</sup> plan.

4.6 The major emphasis in **Satellite Communications** during 11<sup>th</sup> plan will be towards meeting the growing demand for transponders, ensuring continuity of quality services, protection of space systems, efficient spectrum management and continuous improvement in technology. Based on the demand, the INSAT system capacity will be progressively augmented to about 500 transponders by the end of 11<sup>th</sup> plan period. Development of cost effective 4T-12KW bus with capacity of more than 50 transponders with flexibility to accommodate a wide range of payloads will also be undertaken. The thrust areas of applications include expansion and growth of tele-education, tele-medicine and village resource centers, strategies for operationalisation and Institutionalisation with the involvement of Central Government Ministries/Departments, State Governments and NGOs, self-sustenance and large scale training.

4.7 **Satellite Navigation** is emerging as a vital area not only for civil aviation but in many other areas such as mobile telephones, surface transport, intelligent highway system, maritime transport, rail, oil and gas, precision

agriculture, fisheries, survey and marine engineering, science, electricity networks and leisure. Besides completing the ground augmentation system GAGAN (GPS And GEO Augmented Navigation), a major target for 11<sup>th</sup> plan is to establish Indian Regional Navigational Satellite System with a constellation of 7 satellites. Co-operation and participation in global navigational systems will also be pursued.

4.8           The interest in **Space Science research** during 11<sup>th</sup> plan is focussed in four major areas viz., Planetary Exploration/Science, Astronomy and Astrophysics, Space Weather and Weather and Climate. The Space Science research in the country has gained impetus in the recent years with the undertaking of Planetary mission Chandrayaan-1, Multi-wavelength astronomy satellite ASTROSAT and climatic research satellite Megha-Tropiques and created special awareness and enthusiasm amongst the younger generation. A major target for 11<sup>th</sup> plan, therefore, is to complete these ongoing missions and plan for followon missions Chandrayaan-2 and Astrosat-2 for continued investigations. Besides this, a number of small satellite missions for studies in Solar Physics (Space borne Coronagraph “Aditya”), Earth’s Near Space Environment (Twin satellite missions SENSE-P and SENSE-E), investigations in inner magnetosphere (ITM) and studies in atmospheric aerosol and trace gases (I-STAG mission) have also been planned. Akin to this, a major challenge lies in creating the human resource base in the country for analysis of the enormous amount of scientific data that would be available from these missions. It is also planned during the 11<sup>th</sup> plan period to undertake technology development for newer missions such as Mars Orbiter, Asteroid Orbiter and

Fly by Missions to Comets and Outer Solar System with a primary interest to understand the origin and evolution of solar system.

4.9 **Disaster Management Support**, is intended to provide timely and reliable space inputs and services to the DMS in the country and is a vital area of space applications during 11<sup>th</sup> plan period. The major initiatives planned during 11<sup>th</sup> plan period include realization of a National Data Base for Emergency Management, Impact mapping and monitoring support for Disaster events, Satellite based communication support for Disaster Management, strengthening of early warning systems and development of tools and techniques for decision support systems for Disaster Management.

4.10 Considering the need to provide an impetus on studies and research in the critical area of atmospheric research, an **Atmospheric Science Programme (ASP)** has been planned with special emphasis on the use of satellite and advanced observation tools, techniques of modeling and a mechanism for interactions with scientific departments and academic for initiating suitable projects, leading to operational end user products in different domains. The primary goals of the program will be to pursue high quality research and development work in Meteorology, Atmospheric processes, Atmospheric dynamics with emphasis on use of satellite inputs.

4.11 Human Resource Development, International co-operation, Industry and Academia interface, indigenous development of space materials and components and Space commerce will continue to be priority areas during 11<sup>th</sup> plan period. An important target during the 11<sup>th</sup> plan period will be to set up Indian Institute of Space Science and Technology (IIST) with a view to

capture the talent at 'plus two' level in order to create quality human resources in the country for ISRO. The Institute has already started functioning from the academic year 2007-2008 around the existing infrastructure adjacent to VSSC, Thiruvananthapuram. A permanent infrastructure for the Institute is in progress near LPSC, Valiamala.

4.12 The budgetary resource for the missions planned during 11<sup>th</sup> plan period as well as the advance investments required for the missions planned for the beginning years of 12<sup>th</sup> plan period is fixed at to Rs.34883 crores (at current prices). Out of this, the Plan outlay for 11<sup>th</sup> plan would be Rs.30883 crores while the non-plan budgetary support is expected to be Rs.4000 crores (approx).

4.13 The Indian Space Programme has paved the way for creating cost-effective space infrastructure for the country in a self-reliant manner and the economic and social benefits brought in by the application of space technology to the national development have been significant. The Space Programme is poised to play a pivotal role in the national development in the forthcoming decade.

## 5. **Mandate of the Department of Space**

5.1 The Department of Space is committed to :-

- (i) provide national space infrastructure for the telecommunication needs of the country, including the required transponders and associated ground systems;

- (ii) provide satellite data required for weather forecasting, monitoring etc;
- (iii) provide satellite imagery and specific products and services required for application of space technology for natural resource management/developmental purposes to the Central Government, State Governments, Quasi Governmental Organisations, NGOs and the private sector;
- (iv) Promote Research & Development in space sciences and technology;

## 6. **Policy framework of Department of Space**

6.1 The Indian Space Programme is directed towards development and utilization of space science and technology in a self-reliant manner for the social-economic development of the country. Taking cognizance of the global space competitiveness, the policy framework of the Space programme envisages:

**(a) Industry Participation Policy** to promote participation of Indian Industries in the national space endeavors – higher levels of aggregates in system/stage level supply from the industry, use of ISRO facilities by Industry, technology transfer to the industry and technical consultancy services of ISRO expertise.

- (b) Commercialisation Policy** to extend the outreach of Indian Space assets, products and services to the global market through Antrix Corporation Dissemination of IRS data through International ground stations on commercial basis, Leasing of INSAT transponders to private users, launching of foreign satellites by Indian Launch Vehicles (PSLV/GSLV), TTC support for foreign satellites, design and development of communication satellite for International customers.
- (c) Remote Sensing Data Policy** for acquisition and distribution of satellite remote sensing data from Indian and foreign satellites for civilian users in India.
- (d) Satcom Policy** to enable use of INSAT satellites by non-government sectors and to establish and operate private communication satellite.
- (e) International Co-operation Policy** for mutual benefit – bilateral and multilateral co-operative programmes, payloads of opportunity to be flown onboard Indian satellites and participation in international forums.
- (f) Human Resource Development Policy** oriented to retain the critical mass, training and development programmes, rewards and incentives, flexibility in career growth prospects, sabbatical opportunities and capacity creation in the academia through sponsored research.

**(g) Effective user participation** in the space systems planning and utilization – establishment of inter-departmental/inter-ministerial co-ordination mechanisms viz., INSAT Co-ordination Committee (ICC), Planning Committee of National Natural Resource Management System (PC-NNRMS) and Advisory Committee on Space Sciences (ADCOS).

**(h) Upgrading the technological capabilities** to realise state of art cost effective space systems viz., satellites, launch vehicles and associated ground systems for providing national space services.

The above policy framework has paved the way for creating cost effective space infrastructure for the country in a self reliant manner, its efficient utilisation for national development, enabled a significant role for Indian Industries and technology growth in multiple disciplines as spinoff benefits.

\* \* \* \* \*

## CHAPTER II

---

### OUTCOME BUDGET 2009-10

1.1 The Budget proposals for the Department of Space have been formulated under the frame work of Decade Profile 2010-20 and proposals for Eleventh Five Year plan (2007-12). The BE 2009-10 for Department of Space stands at Rs. 4959.00 crores comprising of Rs. 4100 crores Plan outlay and Rs. 859.00 crores Non-plan outlay. The outlay has been arrived at taking into account the Programmatic targets set for 2009-10.

1.2 The Department has prepared “**Outcome Budget 2009-10**” based on the guidelines contained on the subject in the Department of Expenditure, Ministry of Finance Office Memorandum No. 2(1)Pers/E-Coord/OB/2005 dated: 6<sup>th</sup> May 2009. The Table 2.1 annexed to this Chapter, gives the Outcome Budget for 2009-10.

1.3 Table 2.1 has been organised as per the Statement of Budget Estimates (SBE) submitted by the Department. However, the order in which various Schemes/Project appear has been slightly modified in Outcome budget (as compared to SBE) with a view to bring related projects together. For example, under Launch Vehicle Technology, GSLV operational project has been brought immediately after GSLV project in order to bring all GSLV related projects together.

## **2. Projects / Mission Mode Working**

The Department of Space is largely project and mission oriented. The Department undertakes specific projects and programmes (viz., development of Satellites, launch vehicles and applications) based on demand for space services and executes them in a time-bound manner. Once the objectives of the project are achieved, the project is closed and the resources are re-deployed for other ongoing projects. The Missions and Projects are executed by the Centres and Units of ISRO under matrix management structure to ensure optimum utilization of resources. The Centres and Units are fixed entities and are the custodians of resources in terms of technology, infrastructure and human resources required for execution of the project.

## **3. Intermediate Outputs :**

The implementation of projects on development of satellites, launch vehicles and the associated ground systems is a multi-disciplinary and multi-institutional endeavour. The ISRO Centres/Units are organised based on their areas of specialisation/expertise. For launch vehicle projects, Vikram Sarabhai Space Centre is the lead centre while for Satellite Projects, ISRO Satellite Centre is the lead centre. The lead centre of the project will have the primary responsibility for overall design, subsystem interface specifications, project management and co-ordination in addition to development of subsystems for which the lead centre has specialisation. The other Centres/Units of ISRO will have the responsibility to realise specific subsystems/sub assemblies for the project in the area of their expertise/specialisation. Therefore, the output of the ISRO Centres/Units (other than the lead centre), related to realisation of subsystems for satellites and Launch vehicles, are of intermediate products in nature, which will get integrated with the work of lead centre. This has been suitably reflected in the Outcome budget.

#### **4. Partial Outcome :**

The gestation period for Space projects i.e., Development of Satellites, Launch vehicles and associated ground segments is generally 3 to 5 years, while in some complex projects, it could extend up to 8 – 10 years also. In the course of the development, the project goes through various phases such as finalisation of configuration and detailed design, engineering & proto models development and qualification testing, fabrication of flight subsystem units and testing, assembly, integration and testing leading to launching of the satellite into orbit. The Output and Outcome of a satellite or launch vehicle project during a year is a result of accumulated expenditure on the projects during the previous years. Similarly, the outlay of a satellite or launch vehicle project during a year does not necessarily result in output or outcome in the same year. While the deliverables and physical outputs are targeted and specified for each year for every project based on the development/realisation plans, the final outcome will accrue only upon the launch and operationalisation of the satellite. The time frame for such final outcomes are also specified in the Outcome budget. Therefore, for the projects which are in initial or intermediate stage, the partial outcome can be viewed as almost same as the Physical Output. However, the time frame for the final outcome is also specified in the Outcome budget.

## **5. Converting Outputs to Outcomes:**

The Outcome of a programme is largely dependent on the Objectives of the Programme. The primary objective of Space Programme is to develop the Space Technology (comprising of development of Satellites, Launch Vehicles and associated Ground segments), establish operational space systems in a self-reliant manner and demonstrate through pilot projects the potential applications of Space systems for national development in the areas such as Natural Resource Management, tele-communications, TV broadcasting, developmental communications, rural communications, Tele-education, Tele-medicine and Disaster Management support. Therefore, the nature of Outcome of the Space Programmes will be in the form of (a) Indigenous capability to develop and realise complex space systems such as satellites and launch vehicles; (b) Creating infrastructure in Space by launching and operationalisation of satellites including Space operations, which are utilised by various user agencies for national development; (c) Capacity building in terms of critical technologies and ground technical infrastructure of relevance for future and (d) Benefits to the society arising from application of space technology/systems such as IRS satellites, INSAT satellites in various fronts. These have been appropriately reflected in the Outcome Budget against various programmes/ schemes.

\* \* \* \* \*

**Department of Space**  
**OUTCOME BUDGET 2009-10**

TABLE 2.1

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
<b>LAUNCH VEHICLE TECHNOLOGY</b>										
1	<b>Geo-synchronous Satellite Launch Vehicle (GSLV)</b>	Develop a launch vehicle to launch 2Ton class INSAT satellite into Geosynchronous Transfer Orbit (GTO) through three developmental flights viz., GSLV D1, D2 and D3 flights.	1405.19	---	---	---	Assembly and integration of GSLV D3 launch vehicle on second launch pad to launch GSAT-4 satellite.  Launching of GSLV D3 (with indigenous cryo stage) carrying GSAT-4 onboard.	Total self-reliance in launching 2T class INSAT satellites.	Initiation of Vehicle stacking activities on Second Launch Pad by 1st quarter.	GSLV D1 and D2 have been successfully launched during 2001 and 2003.  Funding required for GSLV D3 has been provided during the previous years. Hence, no provision is shown in the current year.
2	<b>Cryogenic Upper Stage Project (CUSP)</b>	Development of a restartable cryogenic engine & stage for GSLV. (to replace the Russian supplied Cryogenic stage of GSLV)	335.89	---	0.37	---	Realisation and testing of flight cryogenic stage.  Transportation of flight cryogenic stage to SHAR and preparing the stage for flight with GSLV D3.	Achieve self reliance in launching 2T class INSAT type of satellites.	Integration of the flight cryo stage with GSLV D3 is planned in second quarter of current year.	Full flight duration (720 s) test which is a critical test to qualify the indigenous cryogenic stage, has been successfully conducted on 15th November 2007 at LMF, Mahendragiri. Indigenous cryo engine has been successfully tested for cumulative test duration of more than 7000 secs.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
3	<b>GSLV Operational</b>	To fabricate 16 operational GSLV launch vehicles (GSLV F1 - 16) and take advance procurement actions for additional vehicles and launch communication satellites planned for 10th plan, 11th plan and beyond.	3550.96	---	275.00	---	Realisation of subsystems for GSLV F06 and F03 Realisation of PAM-G structure. Realisation of CUS 15 stage. Mission planning, Vehicle integration and launch of GSLV F05 Mission carrying GSAT-5 into orbit.	Augmenting INSAT system with additional transponders to meet the communication requirements.		GSLV has so far completed two operational flights successfully (GSLV F01 and F04)

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
4	<b>GSLV Mk III Development</b>	To develop a Geosynchronous satellite launch vehicle capable of launching 4Ton class INSAT type of satellites to GTO.	2498.00	---	217.00	---	Completion of static tests on S 200.Realisation of C20 engine and conduct of engine tests.Realisation of propellant tanks for C 25.L 110 stage development test and readiness of stage for propellant mockup. Completion of structural tests.Functional tests on separation systems.Main Engine Test Facility augmentation. Thrust Chamber Test Facility readiness.	<b>Partial Outcome:</b> Realisation of technical facilities and development hardware required for GSLV Mk III. The project is currently in intermediate stage. The final outcome of achieving self reliance in launching 4T class of INSAT satellites will accrue upon successful flight testing of GSLV Mk III vehicle.	First developmental / test flight targeted for 2010-11.	

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
5	PSLV-C	To fabricate 15 PSLV operational launch vehicles (PSLV C14 - C28) for launching Remote Sensing and Scientific satellites of 10th plan and beyond.	1518.00	---	220.00	---	<p>PS2, PS4 and Equipment Bay readiness for PSLV C14.</p> <p>Interstage structure (IS3/4) and Heat shield structure for C 15 and C 16.</p> <p>Realisation of CBS structure for C 15 and C 16.</p> <p>Realisation of PS2 propellant tank for C16</p> <p>Missions: Vehicle assembly, integration, testing and launch of PSLV C14, 15 &amp; 16</p>	<p>Launching of RISAT-2, ANUSAT, Oceansat-2 and Resourcesat-2 satellites to augment the remote sensing space segment infrastructure of the country.</p>	<p>Three flights of PSLV are planned during 2009-10.</p>	<p>PSLV had so far 14 successive successful flights and has emerged as a versatile, reliable and cost-effective launch vehicle. Its launch capability has been progressively enhanced from 850 kgs to 1500 kg through continuous improvements in the launch vehicle.</p>
6	Space Capsule Recovery Experiment (SRE-1& 2)	Develop a recovery capsule and demonstrate the technology for recovery and conduct micro-gravity experiments through two flights viz., SRE-1 & 2..	76.20	---	12.00	---	<p>Realisation of Flight Model payloads.</p> <p>Fabrication and testing of flight models of subsystems viz., Deceleration and Flotation system, Mission Management Unit, Propulsion system, Thermal protection system, Aero Thermal Structures and Spacecraft systems.</p> <p>Flight model integration and readiness for launch.</p>	<p><b>Outcome:</b> SRE-2 will demonstrate the critical technologies required for recoverable launch vehicles.</p>		<p>SRE-1 was successfully launched on 10th January 2007 onboard PSLV C7 and recovered on 22nd January 2007. This unique mission has demonstrated the capability to recover a satellite from orbit at a predetermined location and the associated technologies.</p>

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
7	<b>Vikram Sarabhai Space Centre (VSSC)</b>	To develop critical and advanced technologies related to satellite launch vehicles including Reusable Launch Vehicles (RLV), Sounding rockets and allied satellite subsystems and provide infrastructure support for development and fabrication / testing of Indian launch vehicles.	N.A	273.26	340.16	---	<p>First scramjet characterization flight.</p> <p>Commissioning of Hypersonic Wind Tunnel and shock tunnel Facility.</p> <p>Launching of RH560MkII, RH300MkII and RH200 flights for study of Total solar eclipse.</p> <p>Reusable Launch Vehicle technology demonstrator hardware realisation and testing.</p> <p>Production of Ammonium Perchlorate for Solid Propulsion systems</p> <p>Technology development initiatives in the area of avionics, aeronautics, advanced materials, propulsion systems, mechanisms, control and guidance and manufacturing technology.</p> <p>Launch Vehicle Hardware development and realisation for PSLV, GSLV and GSLV MK III launch vehicles.</p>	Technology development initiatives and hardware development and realisation lead to state-of-art launch vehicles for Indian Space Programme.	RLV-TD and air breathing propulsion are targeted for completion during 2010-11.	As a part of Air Breathing Propulsion technology, Supersonic combustion has been successfully demonstrated through ground tests in Nov-Dec 2005, which is a major achievement in the area of launch vehicle technology development.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
8	<b>ISRO Inertial Systems Unit. (IISU)</b>	Research, Development and realisation of inertial sensors and systems for launch vehicles and allied satellite elements.	NA	---	30.84	---	<p>Delivery of Inertial system RESINS Mk IV for four PSLV and GSLVs.</p> <p>Realisation of inertial systems for Resourcesat-2, GSAT-6, RISAT-1, IRNSS, Megha-Tropiques, Astrosat, SARAL, SRE-2 and GSAT-7.</p> <p>Realisation of MEMS based aided INS.</p> <p>Realisation of Flight and Flight spare Momentum Wheels for INSAT and GSAT projects.</p> <p>Realisation of Flight and Flight spare Reaction Wheels for Cartosat, Astrosat and IRNSS satellites.</p> <p>Delivery of AINS - 200 flight model for Mk III.</p> <p>Realisation of high dynamics GPS receiver. Realisation of IRU with small ILG for application in future spacecraft missions.</p>	<p>Realisation of tested and qualified inertial systems such as Inertial Navigation systems, Servo Accelerometers, Mission management unit, Momentum Wheels, Reaction Wheels, Solar Array Drive Assembly, Gyros, inertial reference units, scan mechanisms, etc., for Launch Vehicles and Satellites.</p> <p>Inertial systems are intermediate products / subsystems used in satellites and launch vehicles.</p>	<p>Technology development, improvement and scaling up is a continuous process to remain state-of-art in satellite and launch vehicle technology and to achieve maximum self-reliance in this strategic area.</p>	

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
9	<b>Liquid Propulsion Systems Unit (LPSC)</b>	Development of earth storable liquid propulsion and cryogenic propulsion technology/systems for launch vehicles and satellites.	NA	73.70	212.23	---	<p>Hardware realisation and delivery of PS2, PS4 stages and control power plants for PSLV.</p> <p>Realisation of GS2 stages and L40 stages for GSLV.</p> <p>Delivery of integrated propulsion system for satellite missions viz., GSAT-5, Astrosat-1, Resourcesat-2, GSAT-4, RISAT-1 and INSAT-3D.</p> <p>Realisation of C25 qualification stage with Al. alloy propellant tanks.</p> <p>Realisation of propulsion modules for Reusable Launch Vehicles.</p> <p>Realisation and qualification of 75mN thruster for SPT.</p> <p>Commissioning of second test stand for AOCS thrusters.</p>	Realisation of tested and qualified (a) liquid and cryogenic stages for PSLV and GSLV and (b) Reaction control systems for IRS and GEOSAT Satellites. Liquid and Cryogenic propulsion systems are intermediate products / subsystems used in satellites and launch vehicles.	Technology development, improvement and scaling up is a continuous process to remain state-of-art in satellite and launch vehicle technology and to achieve maximum self-reliance in this strategic area.	Liquid Propulsion Systems Centre is the lead centre for development of liquid and cryogenic propulsion systems and has established unique technical infrastructure (test and fabrication facilities) at Mahendragiri, Valiamala and Bangalore.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
10	<b>Human Space Flight Program</b>	Develop a fully autonomous manned space vehicle to carry crew to low earth orbit and safe return to earth.	95.00 (Pre-project phase)	---	230.00	---	<p>Aerodynamic characterisation, Mission sequence and trajectory design of Test Vehicle.</p> <p>Design and development of separation system for Crew escape system.</p> <p>Design, layout finalisation of Service Module and Requirement finalisation and system design of propulsion system.</p> <p>Preliminary design, test benches and simulation of environment control and life support system.</p> <p>Finalisation of internal architecture and ergonomic model of crew module.</p> <p>Initiate activities related to Human Rating of GSLV.</p> <p>Initiate work on establishment of facilities - third launch pad, orbital vehicle preparation facility and crew training facilities.</p>	The final outcome, in terms of availability of technologies for manned mission would take about 8 - 10 years.	The project proposal is currently under consideration of the Government for approval.	The total estimated cost of the project is Rs. 12,400 crores.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
11	<b>Semi-cryogenic Engine / Stage Deveopment</b>	Developing a higher thrust semi-cryogenic core stage for the unified modular launch vehicle.	1798.00	---	155.00	---	Design of Semicryogenic engine test facility and award of Engineering procurement and construction contract.  Development of Engine gimbal actuator system.  Subscale thrust chamber and pre-burner design.	The project is in initial stages. The final outcome, in terms of availability of higher thrust semi-cryogenic stage is expected after six years.	The project was approved in Jan 2009.	Semicryogenic engine is expected to bringdown the launch cost.
12	<b>Indian Institute of Space Science and Technology</b>	To develop high quality manpower required for Space Science, technology and applications programmes.	NA	---	175.00	---	Completion of admissions for the academic year 2009-10  Conduct of the courses for the academic year 2009-10  Progress in building and other infrastructural facilities in the new campus.	The institute is in initial stages. The final outcome, in terms of availability of manpower for ISRO is expected from 2011 onwards.	Government have approved the proposal of setting up the Institute.	IIST has started the courses from the Academic year 2007-08 around the existing infrastrucutre of VSSC. About 140 studnets have been admitted to three courses in Avionics, Aerospace engg and applied science.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
<b>SATELLITE TECHNOLOGY</b>										
13	<b>Oceansat-2</b>	Development and launch of Oceansat-2 satellite with Ocean Color Monitor and Scatterometer instruments for Oceanography and coastal studies and providing continuity of services for Oceansat-1.	129.15	---	6.00	---	<p>Completion of Reaction Control System Integration with the structure.</p> <p>Completion of payload integration.</p> <p>Assembled mode testing of the spacecraft.</p> <p>Completion of Environmental tests.</p> <p>Transportation for launch, pre launch activities, launch (onboard PSLV) and operationalisation of the satellite</p>	<p><b>Intermediate Outcome:</b> Availability of Oceansat-2 data for Ocean and Coastal studies and Potential Fishing Zone advisory services. The data from Oceansat-2 is used by Ministry of Earth Sciences, Universities, academic institutions and NGOs.</p>	The launch and operationalisation of Oceansat-2 is planned in Mid 2009-10	Oceansat-1, launched on May 26, 1999, is currently providing the data for Ocean and coastal studies. The Oceansat data is also used for generating bi-weekly advisories to fisherman community on the Potential Fishing Zones.
14	<b>Resourcesat-2</b>	Development and launch of Resourcesat-2 for natural resource management applications & provide continuity of data / services currently provided by Resourcesat-1.	138.79	---	35.00	---	<p>Realisation of LISS-3, LISS-4 and AWIFS payloads</p> <p>Flight model subsystem realisation - TC, TTC, AOCE, Inertial sensors, Solar panels.</p> <p>Harness fabrication, spacecraft integration and checkout.</p> <p>Environmental tests and readiness of the spacecraft for launch.</p>	<p><b>Partial Outcome:</b> Realisation of payloads and spacecraft systems.</p>	Resourcesat-2 is planned for launch in 2009-10 onboard India's PSLV.	Resourcesat-1 (IRS-P6), launched on October 17, 2003 is currently providing the remote sensing data for various natural resource management applications. IRS data is also received world-wide through a network of international ground stations.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
15	<b>Radar Imaging Satellite (RISAT-1)</b>	Development and launch of Radar Imaging Satellite with active microwave sensors providing all-weather remote sensing capability for critical applications in Agriculture and Disaster Management.	378.49	---	5.00	---	<p>Completion of detailed design review.</p> <p>Realisation of Synthetic Aperture Radar Payload.</p> <p>Integration of the payload with the spacecraft and functional tests.</p> <p>Preshipment review and Prelaunch activities.</p>	<p>The project is currently in intermediate stage. The final outcome of 'Indigenous capability to develop and realize complex microwave payloads for Remote Sensing and Disaster Management Applications' is associated with the launching of RISAT satellite.</p>	<p>Launch and operationalisation of RISAT is targeted for 2010-11 onboard PSLV.</p>	<p>The Transmit-Receive Module, one of the critical elements of the Synthetic Aperture Radar payload, has been successfully developed and qualified in association with an Indian Industry.</p>
16	<b>GSAT-4</b>	Development and launch of GSAT-4 for advanced communication applications in Ka band.	99.00	---	2.90	---	<p>Realisation of Bus Management Units for the spacecraft.</p> <p>Ka band payload fabrication, testing and delivery for spacecraft integration.</p> <p>Assembly and Integration of the spacecraft.</p> <p>Assembled mode Integrated spacecraft testing and Environmental testing.</p> <p>Preshipment review, transportation to SHAR and launching of the satellite onboard GSLV D3.</p>	<p>GSAT-4 will demonstrate the advanced Ka band related communication technologies for wide band application services in the country.</p> <p>The satellite navigation payload along with the ground augmentation under "GPS Aided GEO augmented Navigation (GAGAN) - Satellite based Navigation system" will enhance the air navigation services in the country.</p>	<p>GSAT-4 is planned for launch onboard GSLV D3 in 2009-10.</p>	<p>Ka band communication payload, which is an advanced communication technology, is being developed for the first time in the country.</p>

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
17	<b>Navigational Satellite System</b>	To develop a constellation of Indian Regional navigational satellite system (IRNSS) for providing positioning services and explore possibility of participation in global system.	1420.00	---	270.00	---	<p>Critical Design Review of Navigational payload and spacecraft bus elements.</p> <p>Realisation of Spacecraft and payload hardware.</p> <p>Integration of the first IRNSS satellite.</p> <p>Establishment of INC facilities, computers, softwares, etc.,</p> <p>Integration and testing of IRNWT elements.</p>	<b>Partial Outcome:</b> Realisation of first spacecraft and ground systems.	IRNSS is a constellation of 7 satellites and the first satellite in the series is planned for launch in 2010-11.	Satellite Navigation is strategically an important area of Space technology applications and taking into account the international scenario and the national requirements, Indian participation in global navigational systems is also under consideration.
18	<b>Advanced Communication Satellite.</b>	Development and launch of a 4T class communication satellite with advanced communication payloads	(Project not yet approved)	---	5.00	---	<p>Obtaining approval of the Government for the project.</p> <p>Finalisation of the configuration of the payload and spacecraft</p>	<b>Partial Outcome:</b> Finalisation of payloads for the satellite.	Approval for the project is expected by Mid 2009.	

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
19	<b>Earth Observation - New Missions (SARAL, Carto-3, TES-HyS, DMSAR)</b>	To undertake New Earth Observation Missions of 11th plan such as GEO-HR mission for enhanced repetivity, Saral small satellite mission for Ocean and atmospheric studies, TES with Hyperspectral sensors, Cartosat-3 and SAR for Disaster Management Support.	(Project not yet approved)	---	13.00	---	<p>Preliminary Design Review for subsystems and spacecraft for SARAL.</p> <p>Realisation of SARAL spacecraft subsystems.</p> <p>Integration of the Spacecraft bus elements of SARAL.</p> <p>Conduct of Critical Design Review of SARAL.</p> <p>Conduct detailed studies on Carto-3, TES-HyS and DMSAR missions.</p>	<b>Partial Outcome:</b> Finalisation of the payloads and spacecraft configuration.	Approval for SARAL project was obtained in Feb 2009. The total approved cost for SARAL is Rs. 73.75 crores	A part of 11th plan initiative.  SARAL - Satellite with Argos and Altika - is a joint mission with the French Space Agency CNES.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
20	ISRO Satellite Centre	Developing Satellite Technology and implementation of satellite systems for scientific, technological and application missions.	NA	111.80	193.07	---	<p><b>Technology Development initiatives</b> - Miniaturised BMU, Robotics, HV Solar Array, Characterisation of Li-Ion cells, Cryogenic Heat pipes, High performance onboard computer, development of multi split spectro polarimeter, etc.,</p> <p>Delivery of Oceansat-2 satellite after integration and testing for launch.</p> <p>Assembly, integration and testing of Satellites for launch. (GSAT-4, INSAT-4D/GSAT-5 and Resourcesat-2)</p> <p>Spacecraft Hardware realisation &amp; Integration of YOUTHSAT satellite.</p> <p>Augmentation of HILS facility and Vibration Test Facility.</p>	Technology development initiatives and spacecraft hardware development and realisation lead to state-of-art satellites for Indian Space Programme.	Technology development, improvement and scaling up is a continuous process to remain state-of-art in satellite technology and to achieve maximum self-reliance in this strategic area.	The Spacecraft assembly, integration and test infrastructure has been recently augmented with a Class 100,000 clean room, state-of-art checkout facilities and Compact Antenna Test Range.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
21	<b>Laboratory for Electro-optics Sensors.</b>	Research and Development in the field of electro-optics sensors required for satellites.	NA	---	44.59	---	<p>Realisation of star tracker for YOUTHSAT and APS star tracker for SARAL.</p> <p>Delivery of UVIT optics for Astrosat.</p> <p>Assembly and testing of sensors for INSAT-4D, INSAT-4E, RISAT-1, Resourcesat-2 and Youthsat.</p> <p>Establishing test set up for sub meter resolution optics.</p> <p><b>Technology development initiatives:</b> Optical intersatellite link sensor, development of laser source, Ultra light weight optical surface, Robotic sensor, etc.,</p>	<p>Realisation of tested and qualified electro-optical sensors such as earth sensor, sun sensor, star sensor, magnetometer and sensor electronics for satellites.</p> <p>Electro-optic sensors are intermediate products used in satellites.</p>	<p>Technology development, improvement and scaling up is a continuous process to remain state-of-art in Electro-optics sensors technology and to achieve maximum self-reliance in this strategic area.</p>	<p>LEOS have developed unique technological capability in the field of optics fabrication and Micro Electro-Mechanical Systems (MEMS) for space applications.</p>

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
22	<b>Semi-conductors Laboratory (SCL)</b>	Design, development and manufacture of Very Large Scale Integrated (VLSI) circuits and system / board level products and leading R & D effort in the area of microelectronics.	NA	---	45.00	---	<p>Augmentation of component screening setup for space grade components.</p> <p>Fabrication of various Application Specific Integrated Circuits (ASICs), MEMS, System products, foundry and IT services against specific requirements.</p> <p>Delivery of EM of 12K TDI CCD imager for space applications.</p> <p>Development of Radhard technology / process</p> <p>Production of Dr Pisharoty Radiosondes.</p> <p>Dev. of MEMS based Temp, pressure and humidity sensors.</p> <p>Dev. of X ray CCDs for spectroscopy.</p>	<p>Realisation of micro electronic devices such as ASICs, MEMS based devices, CCDs, memories, etc, for strategic applications.</p> <p>The output of this unit is an intermediate product used as components / devices in satellites and launch vehicles.</p>	<p>Technology/ process / device development, improvement and scaling up is a continuous process to remain state-of-art in the areas of micro-electronics technology and to achieve maximum self-reliance in this strategic area.</p>	<p>SCL has integrated capability comprising of design, wafer fabrication (up to 0.8 micron technology), testing, packaging, quality assurance and system /board level assembly of micro-electronics devices. It has developed VLSI products, sensing devices and MEMS for strategic organisations such as DRDO, DAE and ISRO.</p>

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
<b>LAUNCH SUPPORT, TRACKING NETWORK &amp; RANGE FACILITIES</b>										
23	<b>Satish Dhawan Space Centre - SHAR. (SDSC-SHAR)</b>	To build, maintain and operate state-of-art launch infrastructure for assembly and launching of rockets, solid propellant preparation and auxiliary support facilities.	NA	99.91	240.50	---	<p>Production of S 139 segments for PSLV and GSLV</p> <p>Production of S 200 segments for GSLV Mk III</p> <p>Launch support for GSLV F05, GSLV D3, PSLV C12, C14 and C15.</p> <p>Commissioning of Wind profiler facility and New MCC facility.</p> <p>Augmentation of LH2 storage facility for Second Launch Pad.</p> <p>Commissioning of fire fighting systems for new magazine building.</p>	<p>Realisation of tested and qualified solid motors for PSLV and GSLV.</p> <p>Solid propellant motors and Launch complex facilities are intermediate stages for launching of rockets.</p>	<p>Launch support for GSLV F05, GSLV D3, PSLV C12, C14 and C15 flights are planned to be completed in 2009-10</p>	<p>A State-of-art Second launch pad has been established at Sriharikota to enable launch of future advanced launch vehicles as well as to provide redundancy for the existing launch pad.</p>

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
24	<b>ISRO Telemetry, Tracking and Command Network. (ISTRAC)</b>	To provide mission support (Telemetry, tracking and command) for low earth orbit satellites as well as launch vehicle missions through a network of ground stations.	NA	31.31	69.71	---	<p>Completion of Phase II of ISTRAC network modernisation.</p> <p>Establishment of MEOLUT station.</p> <p>Operation and maintenance of all IRS satellites and Chandrayaan-1.</p> <p>Mission support for PSLV C14, C15, C16, GSLV F05, D3 and the satellites.</p> <p>Hub services for Telemedicine, VRCs and Spacenet.</p>	Enabling operational services of remote sensing and scientific satellites.	Onorbit operation and maintenance of satellites is a continuous round-the-clock process.	<p>ISTRAC is an operational centre responsible for onorbit maintenance and operations of all low earth orbit satellites (like IRS) and planetary missions (like Chandrayaan-1).</p> <p>ISTRAC has recently commissioned an Indian Deep Space Network Station at Bylalu near Bangalore for Chandrayaan-1 with a 18 m dia and 32 m dia Antenna realised through Indian Industries.</p>

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
<b>SPACE APPLICATIONS</b>										
25	<b>Space Applications Centre (SAC)</b>	Design and development of payloads for communication, meteorological and remote sensing satellites and conduct space applications research and development.	NA	119.37	134.73	---	<p>Testing and characterisation of development model of all subsystems of L band SAR and MM wave sounder / radiometer.</p> <p>Development and realisation of GSAT-4 Ka band ground terminals.</p> <p>Finalisation of configuration and design details of advanced communication payload elements.</p> <p>Calibration, Validation and Operational product generation of Oceansat-2 data products.</p> <p>Flight Model Payload realisation and delivery to spacecraft for integration for IRNSS, GSAT-8,9,12, Resourcesat-2, RISAT-1 and YOUTHSAT.</p> <p><b>Technology Development initiatives</b> - Intersatellite links, system studies on micro satellite communication system, development of UHF terminals, Ka band propagation studies, development of TWT &amp; EPCs, etc.,</p>	<p>The payloads are the intermediate products / steps for satellites.</p> <p>Technology development initiatives and experiments lead to realisation of state-of-art payloads.</p>	<p>Technology development, improvement and scaling up is a continuous process to remain state-of-art in payload sensors, communication transponders and space applications technology and to achieve maximum self-reliance in this strategic area.</p>	

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
26	<b>Development and Educational Communication Unit (DECU)</b>	Conceptualisation, definition, planning, implementation and socio-economic evaluation of the developmental applications of space technology.	NA	7.72	50.41	---	<p>Setting up of EDUSAT model studio.</p> <p>EDUSAT content generation for selected user states.</p> <p>Expansion of Tele-medicine, Tele-education (Bihar, Chattisgarh, NE states, J &amp; K, Gujarath) and VRC networks.</p> <p>Conduct of social impact evaluation and awareness programmes for Tele-education, VRCs and DMS.</p> <p>Utilisation of Training and Development communication channels.</p> <p>Upgradation of SITs (500 nos)</p>	The Tele-education, Tele-medicine and VRCs provide satellite connectivity for various development programmes implemented by State / Central agencies and NGOs. The benefit of these programmes is augmentation of the Education and healthcare infrastructure in the country for National development.	The application of space technology for developmental communication and education is a continuous process.	The user ministries concerned for EDUSAT network, Tele-medicine network and VRCs are Ministry of HRD, Ministry of Health and Family Welfare and Rural Development respectively.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
27	<b>National Natural Resource Management System (NNRMS)</b>  <b>Earth Observation Application Mission</b>	Developing National Natural Resource Management Applications using Remote sensing data and supporting region-specific remote sensing applications.	NA	---	20.00	---	Land Use / Land Cover Mapping and Land degradation mapping at 1:50,000 scale - first cycle report for the whole country and Organisation of a National Workshop.  LU/LC mapping at 1:250000 scale - consolidated change analysis and report.  Dissemination of NRDB data sets through NNRMS portal to all users.  Release of indigenous GIS package for operational use.  Generation of Cartodem for 60% of the geographical area of the country.	Image processing tools / software and updated information on Natural resources for use by the concerned Ministries in Government.	The application of space technology for natural resource management is a continuous process.	NNRMS is a national level apex body in the country guiding and co-ordinating the application of satellite based remote sensing for natural resource management applications in various thematic areas.  Imageries of IRS are used by Ministry of Urban Development, Ministry of Agriculture, Ministry of Water Resources, Ministry of Earth Sciences, Ministry of Rural Development, Ministry of Environment and Forests, Ministry of S & T and State development agencies for various natural resource management applications.
				---	4.40		Earth Observation application projects - Cropping system analysis, snow and glacier studies, FASAL software development, Biodiversity characterisation, study of meso scale processes in bay of bengal, application of Hyperspectral remote sensing data, etc.,			

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
	<b>Regional Remote Sensing Service Centres (RRSSC)</b>			---	21.89	---	Implementation of region / user specific projects in application of remote sensing for developmental planning.  Software development in the new areas of image processing.			
28	<b>North Eastern Space Applications Centre (NE-SAC)</b>	To promote application of space technology for the development of north-eastern region in the areas of natural resource management, developmental planning, disaster management support, interactive training, tele-education, tele-medicine and other space applications.	NA	1.10	5.90	---	Identification of potential areas for silkworm food plants in Central Silk Board selected areas of NE.  Development of information system for medicinal and aromatic plants in Arunachala Pradesh.  Remote Sensing and GIS based inputs for road alignment mapping in Disaster prone areas of NER.  Setting up of ground system facilities for the conduct of distance education, training and Tele-education programmes for North East.  Expansion of Tele-medicine, Tele-education, VRC and AWS programmes.  Implementation of special projects on Disaster Management Support.	Space technology inputs related to natural resource management, developmental communications and disaster management support for developmental programmes of the NE States.	The application of space technology for development of North Eastern Region is a continuous process.	NESAC is setup as an autonomous society jointly with the North Eastern Council to provided space technology based solutions for NE region.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
29	<b>National Remote Sensing Centre (NRSC)</b>	Acquisition, processing, distribution of data from Indian Remote Sensing Satellites and research, development and executing remote sensing application projects in collaboration with users.	NA	35.30	105.86	---	<p>Ground system readiness for data reception and processing for Oceansat-2 and RISAT.</p> <p>Web hosting of BHUVAN portal.</p> <p>Data reception, processing and dissemination of data from operational IRS satellites.</p> <p>Initiate the work on IMGEOS infrastructure.</p> <p>Conducting Aerial surveys based on user requests.</p> <p>Training activities at IIRS, Dehradun.</p> <p>Operationalisation of Large Format Digital Camera.</p>	Availability of processed IRS satellite data and value added products of remote sensing technology / methods for use by various Ministries in Government, private entrepreneurs and NGOs.	Reception, processing and distribution of IRS data is a continuing activity.	IRS data are used by Ministry of Urban Development, Ministry of Agriculture, Ministry of Water Resources, Ministry of Earth Sciences, Ministry of Rural Development, Ministry of Environment and Forests, Ministry of Science and Technology and State development agencies for various natural resource management applications.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
30	<b>Disaster Management Support</b>	Providing space technology inputs and services on a reliable and timely manner for the disaster management system in the country.	NA	---	40.00	---	<p>Periodical monitoring of Floods, Landslides, Drought, Forest fires and Cyclones.</p> <p>Conclusion of contract for dedicated aerial survey facility for DMS</p> <p>Establishment of VPN user terminals. (50 nos)</p> <p>Data collection and digital mapping of ALTM surveys (8000 sq kms)</p> <p>Issue of work order for NDEM data base and portal.</p> <p>Field deployment of 30 nos of INSAT type D terminals.</p> <p>Readiness of Doppler Weather Radar for North East.</p>	Strengthening of Disaster Management System in the country.	Setting up of dedicated Airborne ariel survey facility for DMS is planned by 2010-11.	The Virtual Private Network connects Ministry of Home Affairs with State Emergency Operations Centre for real time exchange of critical information and digital data for Disaster Management.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
<b>SPACE SCIENCES</b>										
31	<b>Megha-Tropiques</b>	Design and development of a satellite jointly with France to conduct ocean-atmosphere research particularly over tropical regions.	81.60	---	15.00	---	Integration of MADRAS payload units at SAC  Delivery and Integration of SAPHIR and SCARAB payloads.  Spacecraft integration including Power Electronics, RF and BMU.  Final Assembly, Integration and Testing of the spacecraft.	<b>Partial Outcome:</b> Realisation of payloads and spacecraft.  The project is currently in intermediate stage. Final outcome, in terms of climatic research data, is expected after the launch and operationalisation of Megha-Tropiques satellite.	Launch and Operationalisation of Megha-Tropiques is targeted for 2010-11.	Megha Tropiques will contribute significantly towards the understanding of Weather systems of tropical region.
32	<b>ASTROSAT</b>	Design and development of a satellite for Multi-wavelength studies of a variety of celestial sources and phenomena using X-ray / Gamma ray astronomy instruments and UV telescope.	177.85	---	20.00	---	Fabrication of Structures.  Fabrication, assembly, testing and delivery of payloads for Integration.  Realisation of spacecraft subsystems - DH, SSR, OBC, Power, etc.,  Integration of Reaction Control System with the spacecraft.  Integration of payload with the satellite.	The project is currently in intermediate stage. Final outcome, in terms of scientific results of the data from the satellite will start accruing after the launch of ASTROSAT satellite.	ASTROSAT satellite launch is planned for 2010-11	ASTROSAT is a unique observatory satellite simultaneously covering a range of high energy radiation hitherto not covered from any other global observatory missions.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
33	<b>Indian Lunar Mission Chandrayaan-1 &amp; 2</b>	To launch a spacecraft to orbit moon and carryout high resolution imaging to study moon's topography and distribution of minerals and chemicals on its surface.	811.00	---	90.00	---	<p><b>Chandrayaan-1:</b></p> <p>Analysis of the Science data received from the Satellite.</p> <p><b>Chandrayaan-2:</b></p> <p>Finalisation of configuration of payloads and payload interfaces</p> <p>Fabrication of structures.</p> <p>Preliminary Design review.</p> <p>Fabrication of spacecraft subsystems - BMU, Power, RF systems.</p> <p>Finalisation of Mission Concept.</p>	Final outcome is the enhanced understanding of the Moon and its environment from the analysis of the scientific data being received from Chandrayaan satellite.	Chandrayaan-2 is slated for launch in 2011-12	Chandrayaan-1 was successfully launched into earth orbit on October 22, 2008. Subsequently, it was placed in the intended lunar orbit and the Moon Impact Probe was released on to the surface of Moon on November 14, 2008. The scientific instruments onboard Chandrayaan-1 are satisfactorily providing a new insight on the Moon's origin and evolution.



(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
35	<b>National Atmospheric Research Laboratory (NARL)</b>	Carryout scientific research in Atmospheric Science and serve as a major national experimental facility for atmospheric research in the country including boundary layer, troposphere, middle atmosphere, thermosphere and ionosphere.	NA	2.30	13.13	---	Cloud Radar development to study the microphysics of different types of clouds. Modeling and data centre establishment related to Atmospheric science. Study of atmospheric forcing and responses. Studies on weather and climate prediction research. Development of X band polarimetric radar for studying tropical precipitating systems. Development of portable Raman Lidar for profiling atmospheric water vapor and temperature.	NARL is basically a research institute and the outcome of the programme will lead to expanding our understanding of the complex processes of the lower and middle atmosphere.	The Research is a continuous process.	NARL, located at Gadanki, Near Tirupati, has established a major state-of-art experimental National MST Radar Facility for middle atmospheric research.
36	<b>Atmospheric Science Programme</b>	Undertake studies and research on development of advanced observational tools, use of satellite data and techniques of modelling in atmospheric science leading to user products for adoption by operational agencies.	NA	---	20.96	---	Augmentation of observational network with AWS, Wind profilers, GPS Sonde, DWR and GPS Receivers. Production of Boundary Layer Lidar by Industry. (8 nos) Conduct of GPS based experiments for Meteorology and Space Sciences. Mesoscale modeling to improve local weather prediction over National Capital Region. Improved modeling for Regional Weather Prediction.	The Outcome is Intermediate in nature. The development efforts in terms of observational tools and modeling is applied by the operational agencies towards improved capabilities for weather prediction and climate monitoring.	The Research and development in atmospheric science is a continuous process.	An indigenous low cost version of the Automatic Weather Station (AWS) has been successfully realised towards building a network of AWS in the country, which will substantially enhance the data inputs for weather modelling.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
37	<b>RESPOND</b>	To strengthen the academia interaction through collaborative research, educational and scientific activities.	NA	---	13.00	---	Supporting Research and Development projects at academic institutions, universities and Space technology cells at IITs / IISc in the area of Space science, technology and applications.	Development of knowledge-based and human resources in academic institutions in the area of space research.	The Research and Development Activities are continuous process.	Over 80 Universities / institutions from different parts of the country participate in the RESPOND programme. Every year, about 150 R & D projects are undertaken under this programme.
38	<b>ISRO Geosphere Biosphere Programme (ISRO GBP)</b>  <b>Other Schemes</b>	To investigate the processes between Geosphere-Biosphere-Atmosphere and their interactions, radiative forcing, regional climate, micro gravity and space science promotion / research.	NA  NA	---	25.78	---	Initiatives on National Action Plan for Climate Change.  Carryout studies on aerosol radiative forcing over India.  Studies on atmospheric trace gases, transport and modeling.  LU/LC and impact of human dimensions in Indian River Basins.  Undertaking microgravity research and space science promotion activities.	Enhancing the understanding of the dynamics of global environment & its impact on regional climate.  Improved weather prediction over Sriharikota which is of paramount importance for rocket launches.	The Research and Development is a continuous process.	

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
39	<b>Small Satellites for Atmospheric Studies and Astronomy</b>	To design and develop small satellites for study of Earth's near space environment, study of aerosol and gases, inner magnetosphere and Solar Physics	(Project not yet approved)	---	2.00	---	Definition of the Mission and finalisation of the project report.	<b>Partial Outcome:</b> Finalisation of the configuration.	Approval for the project is envisaged during 2009-10	

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
<b>DIRECTION, ADMINISTRATION AND OTHER PROGRAMMES.</b>										
40	<b>Special Indigenisation / Advance Ordering</b>	Indigenous development of high reliability electronic components including micro-electronics devices, space grade materials and stock piling of critical components and subassemblies for satellites and launch vehicles.	NA	---	213.86	---	Undertaking upgradation of micro electronics fabrication facilities at Semi Conductors Laboratory to better than 0.18 microns.  Dev and productionisation of Li Ion cells  Development of Travelling Wave Tubes, solar cell interconnects, connectors, crystal oscillators, Application Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs), sensor devices, polymers, chemicals and metallic materials.	Indigenous capability for micro-electronics fabrication (better than 0.18 microns).  Indigenous realisation of ASICs, C band Traveling Wave Tubes, Solar Cell interconnectors, PCB connectors, metal film resistors, silicon carbide mirrors, lithium ion cells and various metallic, non-metallic and polymer materials.  These components / materials are intermediate products used in fabrication of satellites and launch vehicles.	The indigenous development of space materials and components to maximise the self reliance is a continuous process.	More than 150 types of high reliability electronic components and space grade materials, developed and qualified under this programme, are being currently used in various satellite and launch vehicles of ISRO.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
41	<b>Others (includes mainly ISRO Head quarters, Civil Engineering Division Head quarters, DOS secretariat and Central Management Expenses)</b>	To provide overall direction and co-ordination of space programmes in the areas of Satellite Communications, earth observations, launch vehicle development, space sciences, space industry development, international co-operation and human resource development.	NA	58.73	22.38	---	Corporate functions.  Imparting training to international students at UN Centre for Space Science and Technology Education for Asia and the Pacific.	Providing overall direction and co-ordination of the space programme including long term planning.	Continuous process	

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
	<b>INSAT OPERATIONAL</b>									
42	<b>Master Control Facility</b>	Carrying out initial phase operations and regular on-orbit monitoring and control of all Geostationary satellites of ISRO namely INSATs, METSATs and GSATs.	NA	18.92	45.64	---	<p>Onorbit operations and maintenance of INSATs, GSATs and METSATs.</p> <p>Operationalisation of Ka band fixed Earth Station.</p> <p>Commissioning of Ku band Full Motion Antenna.</p> <p>Initiation of work on setting up of Optical Tracking System for GEO satellites.</p> <p>Launch and Early Orbit phase operations support for GSAT-4 and GSAT-5 satellites.</p>	Providing operational services of Geostationary satellites for the users in the area of telecommunications, broadcasting and meteorological data.	Onorbit operation and maintenance of satellites is a continuous round-the-clock process.	MCF has set up an Earth Station in Bhopal, Madhya Pradesh to augment the tracking, telemetry and communication infrastructure for GSO satellites.

(Rs. in Crores)

Sl. No	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2009-10			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
43	<b>INSAT-3 satellites (including launch services)</b>	Development and launch of third generation INSAT-3 satellites (INSAT-3A to 3E) to augment the capacity of INSAT system.	2887.63	---	8.70	---	<b>INSAT-3D Spacecraft:</b> Realisation of scan mechanism for Sounder and Imager payloads. Hardware realisation of IRU, WDE and sensor packages. FM realisation of Sounder and Imager payloads. Conduct of Hardware In Loop Simulation tests on spacecraft. Integration of the spacecraft.	<b>Partial Outcome:</b> Realisation of tested and qualified advanced meteorological payloads for INSAT-3D satellite.  The project is in intermediate stage and the final outcome, in terms of availability of meteorological data from the satellite, will accrue after the launch and operationalisation of INSAT-3D.	Launch and operationalisation of INSAT-3D is targeted for 2010.	INSAT-3A, 3B, 3C & 3E satellites in INSAT-3 series have already been launched successfully and are being used operationally.  Currently, INSAT-3A and Kalpana (METSAT-1) are providing the meteorological data to the users for weather forecasting.
44	<b>INSAT-4 Satellites (including launch services)</b>	Development and launch of fourth generation INSAT-4 satellites to augment the INSAT system capacity. (Currently, INSAT-4A to 4G and GSAT-9 & GSAT-12 have been approved).	2715.70	---	373.00	---	Realisation of payloads for GSAT-5 and GSAT-6 satellites. Integration of payload elements to the spacecraft. Readiness of unfurlable antenna and structures for GSAT-6 Integration and testing of GSAT-5 spacecraft for launch onboard GSLV. Subsystem realisation of INSAT-4E, INSAT-4G, GSAT-9 & GSAT-12 satellites.	INSAT-4D/GSAT-5 will augment the capacity of INSAT system with additional transponders for various telecommunications and broadcasting services including DTH services.	INSAT-4D/GSAT-5 satellite is targeted for launch in 2009-10.	INSAT system currently has 200 Transponders, which is used for Telecommunications, Broadcasting, Business Communications, Rural Area communications, Emergency communication and developmental communications.
<b>TOTAL</b>				<b>859.00</b>	<b>4100.00</b>					

## **CHAPTER III**

---

### **REFORM MEASURES AND POLICY INITIATIVES**

India has an impressive array of achievements in the area of development of satellites, launch vehicles, associated ground segment together with relevant applications. Some of the recent applications of space technology such as Tele-medicine and Tele-education has had a far reaching impact on national development. These efforts together with conducive policies and reform measures adopted by the Department have yielded rich dividends.

#### **2. Space Industry Partnership**

2.1 The Department of Space has nurtured a strong partnership with Indian Industries in realizing the objectives of the Space Programme. More than 500 small, medium and large scale Industries participate in the programme in the form of hardware development and supply, software and other services. Almost 60% of a launch vehicle cost flows to Indian Industries. In the recently developed applications, almost 100% of the ground segment equipments/ services for Tele-education and Tele-medicine have been formed out to Indian Industries. The Industry participation policy of the Department has adopted several aggressive measures to promote the participation of Industries in the Space Programme. The Department, so far, has developed and transferred 289 technologies to Industries for commercialization and has provided 270 technical consultancies in various fields to facilitate the Indian Industries to

acquire the required technical know-how in the areas related to Space. It is important to note that this partnership with Industries has enabled the Department to meet the growing challenges of advanced technology, handling complex manufacturing jobs and increasing demand for space services without any significant increase in in-house manpower.

### 3. **Improved Delivery Mechanisms**

3.1 With a view to take the benefits of space technology to the common man, the Department has evolved innovative delivery mechanisms to enhance the effectiveness of space services. One of the important initiatives in this direction is the Village Resource Centres (VRC)

3.2 VRCs provide a variety of space based products and services, such as: tele-education; tele-medicine; information on natural resources; interactive advisories on agriculture, fisheries, land and water resources management; livestock management; etc; interactive vocational training towards alternate livelihood; etc. ISRO primarily provides satellite connectivity and bandwidth; telemedicine and tele-education facilities; and available/customized spatial information on natural resources, along with indigenously developed query system. The responsibilities of housing, managing and operating VRCs, with all relevant contents rest with the associating agencies.

3.3 So far more than 470 VRCs have been set up in Tamil Nadu, Kerala, Karnataka, Gujarat, Orissa, Maharashtra, Andhra Pradesh, Madhya Pradesh, Rajasthan, Uttar Pradesh, Jharkhand, Bihar, Delhi, Puducherry,

Assam, Uttarakhand, Nagaland, Sikkim, Himachal Pradesh, Meghalaya, A&N Islands and around 40 are being set up in various states. Around 45 NGOs/Trusts/ Institutes/Govt. Departments have associated with DOS/ISRO in VRC programme.

3.4 The feedback from the VRCs has been highly encouraging. Even though it is difficult to isolate the impact created by VRCs alone since it is not a stand-alone system, VRC has clearly demonstrated the catalytic effect to other on-going activities. The programmes conducted cover a wide gamut, including agriculture, adult and computer literacy, alternate livelihood related vocational training, marketing of agro-products, micro-finance/enterprises, live stock management, healthcare and disaster relief measures. So far more than 5000 programmes have been conducted and around 400,000 people have availed the services.

\* \* \* \* \*

## CHAPTER IV

---

### REVIEW OF PERFORMANCE OF THE MAJOR ONGOING PROJECTS/PROGRAMMES/CENTRES OF DOS/ISRO

#### ONGOING PROJECTS/PROGRAMMES

##### 1. **Geo-Synchronous Satellite Launch Vehicle (GSLV) Project**

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
1405.49	1405.87	1.00	0.00	0.00

The Geo-Synchronous Satellite Launch Vehicle (GSLV) Project envisages the development of a launch vehicle capable of launching 2 tonne class INSAT type of satellites into Geo-synchronous Transfer Orbit (GTO). The GSLV is configured by replacing the upper two stages of Polar Satellite Launch Vehicle (PSLV) by a single cryogenic stage and the six solid strap-on motors by four liquid strap-on motors derived from the PSLV second stage. The first developmental flight of GSLV viz., GSLV-D1 was launched successfully on April 18, 2001 and the GSAT-1 satellite was injected into orbit. The second developmental flight viz., GSLV-D2 was launched successfully on May 08, 2003 injecting GSAT-2 satellite into

orbit. The third test flight, GSLV-D3 carrying the indigenous cryogenic engine & stage with GSAT-4 satellite onboard is planned during 2009.

## 2. **GSLV-Operational Project**

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
3550.96	950.06	255.00	240.00	275.00

2.1 In order to meet the launch requirement of 2 tonne class of operational INSAT satellites during the Tenth Plan and beyond, the GSLV-Operational Project has been conceived. Currently, the approved scope of the Project include realization of 16 launch vehicles (F01-F16).

2.2 The first operational flight GSLV-F01 was successfully launched on September 20, 2004 with GSAT-3 (Edusat) onboard. The second operational flight GSLV-F02 launched on July 10, 2006 with INSAT-4C on board was unsuccessful due to malfunctioning of one of L40 strapons immediately after lift off. A national level Failure Analysis Committee (FAC) had reviewed the flight data and recommended certain additional tests/improved inspection process, which were carried out. The subsequent flight GSLV-F04 carrying INSAT-4CR was successfully launched on September 2, 2007. Preparation for the next flight is in progress.

### 3. **GSLV Mk-III Development**

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
2498.00	1671.29	270.00	240.19	217.00

GSLV Mk-III is intended to develop a cost effective launch vehicle capable of launching 4 tonne class of communication satellites in Geo-synchronous Transfer Orbit (GTO) and upto 10 tonne satellites in Low Earth Orbit. The Project envisages the development of a number of technologies which include, amongst others, 200 tonne solid stage booster (S-200), 25 tonne cryogenic stage (C-25) and L-110 tonne liquid stage engines as core boosters. Detailed system definition/specification documents for the flight have been generated based on the final vehicle configuration. A Solid Propellant Plant (SPP) for manufacturing S-200 solid boosters for GSLV-MK III was successfully commissioned. Casting and curing of one of the live S-200 segments was completed successfully achieving excellent propellant properties. The facilities have undergone rigorous test and evaluation at various levels and many trials were carried out using inert propellant to obtain safety clearance from the review committees. The new S-200 SPP is provided with automation and remote operation features to reduce manpower and improve safety. With the present status of progress, the first development flight of GSLV Mk-III is expected by 2010-2011.

**4. Polar Satellite Launch Vehicle - Continuation (PSLV-C)  
Project**

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
2863.52	1266.55	180.00	150.00	220.00

4.1 The Polar Satellite Launch Vehicles are capable of placing 1000-1200 kg class IRS satellites in Sun Synchronous Orbit, 1 tonne class METSAT satellites in Geo-Synchronous Transfer Orbit (GTO) and 2800 kg class satellites in Low Earth Orbit.

4.2 The first of the operational flight of PSLV-C series (PSLV-C1), carrying IRS-1D satellite was successfully launched from Sriharikota on September 29, 1997 and the second, PSLV-C2 on May 26, 1999. PSLV-C2 injected IRS-P4 (Oceansat) as well as two foreign satellites, KITSAT-3 of the Republic of Korea and TUBSAT of Germany heralding India's entry into commercial launch vehicle market. The third flight, PSLV-C3 was successfully launched on October 22, 2001, with the Technology Experiment Satellite (TES), PROBA of Belgium and BIRD of Germany. The fourth flight, PSLV-C4, was successfully launched on September 12, 2002, injecting the 1060 kg Kalpana-1 (METSAT-1) satellite in the Geo-synchronous Transfer Orbit (GTO). This was the first time that a PSLV has been used to put a satellite in GTO. The fifth in the series, the PSLV-C5 has been successfully launched on October 17, 2003 injecting the 1360 kg

IRS-P6 (Resourcesat-1) satellite in Sun Synchronous Polar Orbit. The sixth in the series, the PSLV-C6 was successfully launched on May 5, 2005 carrying IRS-P5 (Cartosat-1) as the payload. On January 10, 2007, PSLV-C7 has placed four satellites i.e., Cartosat-2, Space Capsule Recovery Experiment (SRE-I), LAPAN-TUBSAT and PEHUENSAT-1 in the predetermined orbit successfully. PSLV-C8 carrying Italian astronomical Satellite, Agile and AAM of India as payloads was successfully launched on April 23, 2007. PSLV-C9 carrying Cartosat-2A/IMS Mission and eight nano-satellites for International customers was successfully launched on April 28, 2008. On January 21, 2008, PSLV-C10 has successfully launched TESCAR Satellite built by IAI, Israel. PSLV-C11 in its fourteenth flight successfully launched Chandrayaan-1 Spacecraft carrying 11 scientific payloads on October 22, 2008.

4.3 In its recent flight launched on April 20, 2008, the PSLV-C12 successfully launched RISAT-2 and ANUSAT satellites. With the 14 consecutive successful launches so far, PSLV has repeatedly proved itself as a reliable, versatile and cost-effective launch vehicle of ISRO. The launch of PSLV-C14 carrying Oceansat-2 Satellite is scheduled to be launched during second quarter of 2009.

## 5. Cryogenic Upper Stage (CUS) Project

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
335.89	334.82	0.10	0.70	0.37

The objective of the Project is to develop and qualify an indigenous restartable cryogenic stage employing liquid oxygen as oxidizer and liquid hydrogen as fuel for the upper stage of GSLV. The cryogenic engine has been successfully developed and tested for its full flight duration. All sub-systems for CUS 4 engine have been realised and stage structural testing and Ground Resonance Test will be completed. The CUS 5 flight standby stage will also be realised. The first flight of the indigenous cryo stage is targeted for flight testing by GSLV during 2009-2010.

## 6. Indian Remote Sensing Satellites (IRS) Projects

(Rs. in crores)

	Sanctioned Cost	Expenditure to end of March 2008	Budget 2008- 2009	Revised 2008- 2009	Budget 2009- 2010
Oceansat-2	129.15	107.82	10.00	12.00	6.00
Resourcesat-2	138.79	62.32	35.00	25.00	35.00

6.1 Oceansat-2 has been conceived as a continuity mission with enhanced/capabilities, which will be mainly for ocean biology and sea state applications. The payloads viz., Scatterometer & Ocean color monitor have been realized. The sub-system of the spacecraft have been fabricated & tested. The integration of the spacecraft is in advanced stage. The launch of Oceansat-2 onboard PSLV-C14 is planned during the first quarter of 2009-2010.

6.2 Taking into account the increased use of space imageries for different applications and continued Earth Observation services required from the IRS satellites, Resourcesat-2 has been conceived as a continuity mission with enhanced capabilities, which will be mainly for crop applications, vegetation dynamics and natural resources census applications. During the year, the engineering model structure after refurbishment has been delivered for assembly integration and test. Flight model development have started. Resourcesat-2 is slated for launch during 2010.

## 7. **Radar Imaging Satellite-1 Project (RISAT-1)**

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
378.49	340.73	25.00	30.00	5.00

7.1 The Radar Imaging Satellite (RISAT-1) with active microwave sensors, mainly, synthetic aperture radar is intended to provide all-weather, day and night imaging capability providing vital inputs during Khariff season for various agricultural and disaster management applications. Besides, with the known sub-surface penetration and the relief measurements capabilities, the microwave imaging from RISAT-1 will aid many other resources management applications, either in a stand-alone mode or in complementary to electro-optical sensors.

7.2 The development of Synthetic Aperture Radar payload has been completed. The realization of spacecraft subsystems is in progress. RISAT-1 is expected to be ready for launch onboard PSLV during 2010-2011.

## 8. Indian Lunar Mission – Chandrayaan-1&2

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
386.00	307.19	78.00	88.00	90.00

8.1 The main objective of the Indian Lunar Mission – Chandrayaan-1 is high resolution remote sensing of the Moon in low energy and high energy x-ray regions, etc., for preparing 3-dimensional atlas of regions of scientific interest of the Moon and chemical mapping of the entire lunar surface for various elements. The Mission includes the establishment of a Deep Space Network. On October 22, 2008, India's PSLV-C11 flawlessly performed the crucial task of launching Chandrayaan-1 spacecraft into an Earth orbit, thus facilitating the odyssey of Chandrayaan-1 to moon. Chandrayaan-1 was subsequently put into an orbit around the moon, which is about 4 lakh kms from the earth, after achieving an impressive accuracy of a few kilometers in its complex journey. The momentous task of placing the Indian tricolour carried by Chandrayaan-1 spacecraft on the Moon was accomplished on November 14, 2008, as the country celebrated the birthday of Pandit Jawaharlal Nehru. When Moon Impact Probe onboard Chandrayaan-1, impacted on the lunar surface with an accuracy of 10 km, it heralded India's entry into the big league of space agencies who had successfully reached their probes to the lunar surface. The instruments on board Chandrayaan-1 are satisfactorily providing a new insight on the Moon's origin and evolution. The excellent quality of high

resolution data from all the instruments has led to identification of new lunar features and characteristics, excellent topography of lunar surface and crater basins, an insight into the shadowed areas in the lunar polar regions and intensity of energetic particles and radiation dose around the Moon. The follow-on mission Chandrayaan-2 has been recently approved by the Government. Chandrayaan-2 mission is targeted for launch on GSLV during 2011-2012 time frame.

## 9. **Astrosat**

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
177.85	119.86	25.00	21.00	20.00

ASTROSAT is a dedicated and state of the art Indian Multi-wavelength Astronomy satellite. The objective of the Astrosat project is to build and launch an astronomical observatory satellite for expanding the scientific knowledge about the evolution of stellar objects and gather valuable scientific data on high energy Astronomy and Astrophysics research. The satellite will enable study of stellar objects simultaneously covering a range of high-energy radiations [gamma rays, X-rays and far/near Ultra Violet (UV) rays] hitherto not possible from any other current or planned global astronomy mission upto 2010. Detailed design & engineering of the payload & spacecraft systems has been completed. The development & realization of payload instrumentation is in progress.

Procurement of critical long lead time components required for spacecraft & payload systems has been completed. The Satellite is planned on board PSLV during 2010-2011.

10. **INSAT-3 Satellites (including Launch Services)**

(Rs. in crores)

	Sanctioned Cost	Expenditure to end of March 2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
INSAT-3 Satellites & Launch Services	2979.63	2931.83	25.00	21.00	20.00

The objectives of INSAT-3 Spacecraft Project are to (i) build five INSAT-3 satellites (INSAT-3A to 3E) keeping flexibility for mid-course corrections to accommodate emerging requirements, carry out mission planning, launch campaign and initial phase operations and (ii) establish required programme elements for carrying out the same. INSAT-3B was launched on March 22, 2000, INSAT-3C on January 24, 2002, INSAT-3A on April 10, 2003 and INSAT-3E on September 28, 2003. INSAT-3D is configured as an advanced meteorological satellite with new payloads such as Imager and Sounder. For the INSAT-3D spacecraft, new payloads such as Imager and Sounder have been qualified. Structure and propulsion elements for INSAT-3D Spacecraft integration have been realized and fabrication and assembly of flight units of Imager and Sounder payloads is in progress. Sub-systems such as mirror, scan motor detector imager etc., are being realized. INSAT-3D is planned for launch onboard GSLV during 2010.

## 11 INSAT-4 Satellites (including Launch Services)

(Rs. in crores)

	Sanctioned Cost	Expenditure end of March 2008	Budget 2008- 2009	Revised 2008- 2009	Budget 2009- 2010
INSAT-4	2715.70	2027.81	310.00	159.69	371.00
Leasing of Transponders	-	-	30.00	2.00	2.00

11.1 The fourth generation INSAT-4 Satellite series has been planned to meet the capacity and service requirements projected for the Tenth and Eleventh Five Year Plan periods. The sanctioned cost of the first two satellites in the INSAT-4 series, INSAT-4A & 4B, approved in March 2004 is Rs.453.00 crores for spacecraft development and Rs.901.00 crores for Launch Services. The objective of INSAT-4A & 4B Project is to design and develop high power satellites with 12 C-band and 12 Ku-band transponders which will enhance the capacity of the INSAT system considerably.

11.2 The sanctioned cost of INSAT-4C satellite, planned for launch onboard GSLV is Rs.95.75 crores and will carry 12 Ku band transponders. INSAT-4D/GSAT-5 is configured to carry 24 C-band transponders & the total sanctioned cost is Rs.123.75 crores. The sanctioned cost of INSAT-4E/GSAT-6, the multi-media satellite is Rs.269.00 crores. GSAT-8/INSAT-4G Communication Satellite is a state-of-art Satellite, which will

have 18 Ku band transponders for (a) augmenting the INSAT System Capacity in Ku-band (b) providing a second Geostationary augmentation payload for the GPS and GEO Augmented Navigation operational phase and (c) providing continued and uninterrupted service. The sanctioned cost of G.SAT-8/INSAT-4G Communication Satellite is Rs.610.00 crores. GSAT-9 will augment INSAT capacity and act a stand-by for high-power Ku-band capacity to be provided by INSAT-4A/4B/4CR/4G spacecrafts for Direct-to-Home (DTH) and Very Small Aperture Terminal (VSAT) applications. GSAT-9 is identical to INSAT-4C with 12 high power Ku-band transponders providing India coverage. In addition, it will carry the third GPS Aided GEO Augmented Navigation (GAGAN) payload. The sanctioned cost of GSAT-9 is Rs.140.00 crores and that of GSAT-12 is Rs.80.00 crores.

11.3 The first satellite in the fourth generation INSAT-4 series, INSAT-4A has been successfully launched on December 22, 2005 from Kourou, French Guyana. It carries 12C band and 12 Ku band high power transponders enabling DTH broadcasting. The INSAT-4B has been successfully launched on March 12, 2007 and is identical INSAT-4A. The replacement satellite INSAT-4CR (cost Rs.43.20 crores) has been realised on fast track mode and launched successfully on September 2, 2007 onboard GSLV-F04. Work on INSAT-4D, INSAT-4E, INSAT-4F (user funded) and INSAT-4G is in Progress.

## 12. Space Capsule Recovery Experiment (SRE-1 & 2)

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
76.20	62.57	10.00	10.00	12.00

The main objective of the Space Capsule Recovery Experiment (SRE) is to develop and demonstrate capability to recover an orbiting capsule back to earth and to carryout micro-gravity experiments in orbit. The recoverable capsule (SRE-1) was successfully launched onboard PSLV-C7 on January 10, 2007 and successfully recovered from the Bay of Bengal after reentry from orbit on January 22, 2007. SRE-1 was a unique mission incorporating several Key technologies such as reusable thermal protection system, deceleration and flotation system, re-entry control and propulsion systems, space qualified parachute systems, locating aids, etc. The successful recovery of SRE-1 is a major landmark achievement of Indian Space Programme and it has laid a strong technological foundation for future reusable launch vehicle systems. The work on SRE-2 is in progress. The SRE-2 will be launched by PSLV-C16 during 2010-2011.

13. **GSAT-4**

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
99.00	91.81	7.00	4.30	2.90

GSAT-4 Satellite has been configured for conducting various experiments in the Ka band communications area and early introduction of geo-based navigation system. The spacecraft configuration has been finalised. All developmental activities relating to Ka-band payload have been completed. New technologies introduced in spacecraft bus elements have been developed and qualified. The integration and testing are the main activities planned in the months ahead. The GSAT-4 satellite is planned for launch on board GSLV during 2009-2010.

14. **Navigational Satellite System**

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
1420.00	90.53	270.00	200.00	270.00

14.1 The main objective of the Satellite Navigation program is to establish a regional Indian Satellite Navigation System & explore opportunities for participation in global systems.

14.2 The Indian Regional Navigation Satellite System (IRNSS) is planned to be a constellation of 7 satellites – 3 in GEO and 4 in GSO orbit. IRNSS when implemented is expected to provide position accuracies similar to GPS in a region centered around India with a coverage extending upto 1500 km from India. The IRNSS project has been approved in June 2006. The Spacecraft configuration has been finalized. All the satellites of the constellation are being configured identically.

14.3 The spacecraft is basically configured with I-1K Bus to be compatible for launch onboard PSLV. However, a study is carried out to see the feasibility of launching of 2 IRNSS spacecrafts by GSLV. After detailed analysis it is found that it is possible to launch two numbers of inclined orbit satellites in one flight of GSLV.

14.4 The Technology Demonstration System (TDS) phase of the Indian Satellite-Based Augmentation System GAGAN has been successfully completed. Eight Indian Reference Stations, one Master Control Centre (MCC) and one Indian Land Uplink Station have been commissioned.

**DEPARTMENT OF SPACE/ISRO CENTRES/UNITS**

**15. Vikram Sarabhai Space Centre (VSSC)**

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
432.28	494.69	613.42

15.1 VSSC, located around picturesque Veli Hills near Thiruvananthapuram, is the lead Centre for the development of satellite launch vehicles and sounding rockets. The Centre has developed expertise in aeronautics covering aerodynamics, flight mechanics, thermal analysis and structural engineering, mechanical engineering covering manufacturing technology, production and computer aided design, avionics covering control and guidance, TTC systems and on-board computers, propellants, polymers, chemicals, materials and metallurgy, propulsion and space ordnance, launch vehicle mechanisms and launch vehicle design, composite materials and systems reliability. VSSC has extension Centres at Valiamala housing the major facilities of the Polar Satellite Launch Vehicle (PSLV) and at Vattiyorkavu for the development of reinforced plastics and composites (the Reinforced Plastics Facility). An Ammonium Perchlorate Experimental Plant (APEP) is located at Aluva, near Kochi. VSSC also supports the (i) Thumba Equatorial Rocket Launching Station (TERLS), the international sounding rocket range, (ii) Rohini Sounding Rocket (RSR) Programme and (iii) Space Physics Laboratory (SPL), which carries out research in atmospheric and related space sciences.

## **Major Achievements during 2008-2009**

15.2 Major achievements during the year 2008-2009 was successful mission of PSLV-C9 which was launched on April 28, 2008 carrying Cartosat-2A/IMS-Mission and eight nano-satellites for International customers. Chandrayaan-1 spacecraft, India's first un-manned mission to the Moon was launched successfully onboard PSLV-C11 from SDSC-SHAR on October 22, 2008. All the systems for Moon Impact Probe were realized, which was successfully demonstrated recently in the successful mission of Chandrayaan-1. Besides this VSSC realized 4m dia CFRP payload shield for GSLV-D3 and also new generation avionics Packages comprising Advanced Mission Computer systems and Advanced Telemetry Systems realized for GSLV-D3.

## **Major Activities Planned during 2009-2010**

15.3 During 2009-2010 realisation of flight and standby units for PSLV/GSLV missions, GSLV-MKIII, RLV-TD HEX mission and also realization of ASIC and smart sensor systems for avionics are the major activities planned.

## 16. ISRO Inertial Systems Unit (IISU)

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
23.16	23.19	30.84

16.1 The ISRO Inertial Systems Unit (IISU) situated at Thiruvananthapuram is responsible for research and development in the area of inertial sensors, inertial systems, navigation software, actuators and mechanisms and to realise the flight units of these system for the launch vehicle and satellite programmes. The Unit is organised into research and development divisions in the fields of launch vehicle inertial systems, spacecraft inertial systems, inertial sensors evaluation & simulation, inertial system production and reliability & quality assurance. IISU is equipped with facilities for precision fabrication, assembly and clean room, integration and testing.

### Major Achievements during 2008-2009

16.2 Following were the major achievements made during 2008-09:-

- (i) The production of Inertial sensors required for Inertial Systems of ISRO's launch vehicle programmes have been streamlined and being produced at the rate of 40 Nos. each per year;
- (ii) Inertial Navigation system were realized and delivered for PSLV C9 & PSLV-C11 launches;

- (iii) Inertial systems namely Inertial Reference Unit (IRU), Reaction Momentum Wheels, Solar Array Drive Assembly (SADA) & Scan mechanism were delivered for CARTOSAT – 2A, IMS 1, W2M & CHANDRAYAN -1 mission;
- (iv) Realized Momentum Wheel Assembly with modified lubrication system for GSAT 4 & INSAT 3D projects;
- (v) Realization of flight and flight standby for the following missions:-
  - (a) Redundant Strap Down Inertial Navigation System (RESINS) MK-IV for PSLV C-14/RISAT-2;
  - (b) RESINS MK IV for PSLV C-15/RESOURCESAT-2, YOUTHSAT;
  - (c) RESINS MK IV for RLV-TD;
  - (d) Inertial Measurement Unit (IMU) for SRE2;
  - (e) GPS Aided Inertial Navigation system (GAINS) deliverable for PSLV C-12 mission;
- (vi) Realisation of Inertial systems for OCEANSAT-2, GSAT-4, AVANTI HYLAS, YOUTHSAT, INSAT-3D, GSAT-5 & GSAT-8;
- (vii) Realisation of Flight & Flight Spare Reaction Wheels for INSAT, GSAT Projects, Cartosat-2 B, Resourcesat-2 & IRNSS series of Projects;
- (viii) Delivery of Flight models of Scan Mechanism for INSAT-3D Imager payload and scan mechanism and filter wheel drive for INSAT-3D Sounder payloads;
- (ix) Realisation & Qualification of AINS-200 (Advanced Inertial Sensor), single cluster Redundant Inertial Navigation System with six ILG (Laser Gyro) – 200 and 6 CSAs in Hexad Triad configuration for GSLV F-05 mission and delivery of proto for GSLV Mk-III;

## Major Programmes for 2009-2010

16.3 During 2009-2010 following activities are planned:-

- (i) Delivery of Launch Vehicle Inertial systems (RESINS-MKIV) for four PSLV/GSLV missions;
- (ii) Realisation of Micro Electro Mechanical System (MEMS) sensor based Aided INS (MAINS);
- (iii) Realisation of inertial systems for RESOURCESAT-2, GSAT-6, RISAT-1, IRNSS, MEGHATROPIQUES, ASTROSAT, SARAL, SRE 2 & GSAT-7;
- (iv) Realisation of in-house high dynamics GPS receiver;
- (v) Realisation of Navigation system for Human Space Flight Programme;
- (vi) Realisation of Flight & Flight Spare Momentum Wheels for INSAT & GSAT projects;
- (vii) Realisation of setting up of Space Tribology and Training Centre;
- (viii) Realisation of Flight & Flight Spare Reaction Wheels for CARTOSAT 2C, ASTROSAT & IRNSS series projects;
- (ix) Delivery of AINS – 200 flight model for GSLV-Mk III;
- (x) Realization of ILG – Digital and CSA – Digital;
- (xi) Realization of AINS – 300 with ILG – Digital and CSA – Digital sensors;
- (xii) Realization of IRU with small ILG for possible application in spacecraft mission;

## 17. **Liquid Propulsion Systems Centre (LPSC)**

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
204.19	209.36	285.93

17.1 The Liquid Propulsion Systems Centre (LPSC), with its facilities located at Thiruvananthapuram (Valiamala), Mahendragiri and Bangalore is the lead Centre in the area of liquid propulsion encompassing earth storable and cryogenic propulsion systems for launch vehicle and spacecraft programmes. The launch vehicle engine and stage design activities are carried out at its facilities at Valiamala. Spacecraft propulsion systems engineering, mono-propellant thruster development and transducer production activities are carried out at its facilities at Bangalore. Earth storable and cryogenic engine and stage facilities, assembly and integration of engine and stages for launch vehicles, propellant storage and Liquid Hydrogen production facilities are located at Mahendragiri.

### **Major Achievements during 2008-2009**

17.2 Integrated fluid mock up trials (Combined Liquid Oxygen and Liquid Hydrogen) CUS 02 Stage with Pre launch Operation (PLO) was successfully conducted at Second Launch Pad (SLP) SDSC-SHAR. In the C25 Project, CE20 Gas Generator version hardware realized as part of subsystem development. C25 stage main Umbilical systems studies carried out and finalized CUS umbilical design with necessary modifications for

C25 stage. Design Review of 7 types of pyro valves has been completed. LH2 tank (AA Version) has been realized. L110 engine nozzle closure system and interstage (IS ½ L) functional integration and acoustic testing completed. Core Base Shroud (CBS) positioned at Integrated Structural Test Facility (INSTEAF) for load test. Water tank expulsion trials with SS water tank conducted. Structural load testing of Inter tank structure (ITS) completed. UH25 tank (AA Version) realized.

17.3 Launch campaign activities have been carried out for PSLV-C9 and C11 missions. PS2, PS4 stages and Central Power Plant (CPP) delivered for PSLV-C11 mission. L40 stages have been delivered and realization of GS2 for GSLVD-3 mission is in progress. Integrated propulsion system has been delivered for CARTOSAT-2A and Chandrayaan-1 missions and on orbit performance of the spacecraft propulsion system was satisfactory. Integrated propulsion system has been delivered for W2M spacecraft.

17.4 Under semicryo pre-project, project report has been prepared and submitted to space commission and clearance obtained. For Reusable Launch Vehicle Technology Demonstrator (RLVTD), Secondary Injection Thrust Vector Control (SITVC), design of 3 pintle electromechanical injection valve and qualification tests have been completed. SITVC package realized for the first static test of S9 booster. For RLVTD 200 N monopropellant Hydrazine thruster realization and continuous firing for 20s duration and pulse mode firing for 500 pulse of 100/100 ms Pulse have been completed.

17.5 Under Facility Augmentation, Main Engine Test (MET) augmentation for Cryo Stage Fluid Systems contract has been signed with M/s CRYOGEN MASH, Russia. High pressure cryogenic tanks (LH2 Tank - 9.6m<sup>3</sup>, 22 MPa & LOX Tank – 4.18m<sup>3</sup>, 22MPS) have been received from M/s R & DIME Russia. High pressure valves and compensators for Thrust Chamber Test facility have been received at site. Steering Engine Test (SET) Control Centre for CE 20 LH2 TP test commissioned.

17.6 L40 stage integrated at L40 integration facility at M/s HAL and delivered for GSLV-D3 mission. Propellant tanks production has been continued through industry for earth storable and cryogenic application. Production of VIKAS engines and cryo engines continued through industry. PS4 engines have been realized through work centre through contract with M/s ASACO for the fabrication of integrated PS4 engine. Production of 2000 transducers per year has been achieved. Cryo propellants LH2 and LOX produced at Integrated Liquid Hydrogen Plant (ILHP) and supplied for engine/stage tests and GSLV launch. Production of earth storable propellants at industry is continued to meet Launch Vehicle and satellite Programme. Second LH2 plant commissioned at M/s ASL.

### **Major Programmes for 2009-2010**

17.7 Following are the major programmes/activities planned during 2009-2010:-

- Realisation and testing of C25 stage with SS version propellant tanks;

- Realization of C25 qualification stage with AI Alloy propellant tanks and realisation of qualification stage with Aluminium Alloy propellant tank;
- Realisation and delivery of flight stage, under C25 and L110 Projects;
- Realisation and delivery of PS2, PS4 stages and Control Power Plants for PSLV Mission;
- Realization and delivery of GS2 stages and L40 stages for GSLV Mission;
- Integrated propulsion system delivery for satellite missions, initiation of launch campaign activities for launch vehicle and satellite Missions;
- Delivery of pressurization system for SRE;
- Planned to design semicryo subscale thrust chamber, PDR of 2000kN semicryo engine, design and preparation of fabrication drawings, engine actuator system development, Hypergolic slug igniter developments etc., under the semicryo Engine Development project;
- Planned to deliver flight package readiness for Hypersonic Experimental (HEX) mission for Reusable Launch Vehicle Technology Demonstrator (RLVTD), Secondary Injection Thrust Vector Control (SITVC) and RCS;
- Planned to realize and qualify of 75 mN SPT thruster realization of flight model for 75 mN SPT etc., are planned;
- Development of nano heat transfer technology for augmentation of heat transfer in thrust chamber;
- Planned to commission second test stand for AOCS thrusters testing at LPSC, Mahendragiri;
- Commissioning of Scramjet test facility for semicryo main injector element testing;
- TCT augmentation for semi-cryo subscale engine test;
- Planned to integrate production of components and modules at industry;
- Continuation of production of Vikas engine, Cryo engine, propellant tanks for Earth Storable & Cryo application;

- Continuation of production of Cryo propellants (LH2 & LOX) through LHP and supply for engine test and launch;
- Production of 2000 transducers per year;
- Installation of machines at industries to meet the enhanced production of cryogenic engines;

## 18. ISRO Satellite Centre (ISAC)

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
215.85	253.44	304.87

18.1 The ISRO Satellite Centre (ISAC) at Bangalore is the lead Centre for Satellite Technology. The research and development activities carried out in ISAC are grouped under digital systems and communications area, spacecraft integration & power systems area, mechanical systems area covering structures & thermal systems, spacecraft mechanisms, controls & mission area and reliability & components area. ISAC has fabrication and test facilities required for various spacecraft and the related technology development activities. The Technical Physics Division conducts research in space sciences.

### Major Achievements during 2008-2009

18.2 Cartosat-2A (identical to Cartosat-2) weighing 686 Kgs was launched successfully onboard PSLV-C09 along with Indian Mini Satellite - 1 (IMS-1) on April 28<sup>th</sup> 2008. Cartosat-2A is an advanced remote sensing

satellite carrying onboard a single panchromatic camera capable of providing scene specific spot imageries for cartographic and host of other civilian applications. IMS-1 is the first mini satellite in the micro bus series developed for remote sensing application weighing 83 Kg and carrying two payloads viz. multi spectral camera and hyper spectral payload.

18.3 CHANDRAYAAN-1 is India's first instrumented mission to moon. Entire integration of satellite and test activities have been completed and spacecraft was launched successfully onboard PSLV-C11 on October 22, 2008 from SDSC-SHAR. The spacecraft weighs 1380 kgs and carries onboard a total of 11 payloads which also includes opportunity payloads from other countries viz., USA, UK, Bulgaria and Japan.

18.4 W2M developed and built for EUTELSAT, jointly with EADS-Astrium under a contract through ANTRIX was launched successfully on December 21, 2008. EADS Astrium was the prime contractor in charge of overall programme management and built the communications payload. The communication satellite bus is developed by Antrix/ISRO on a proven I-3K bus and the integrated payload systems is provided by Astrium. During the year the assembly, integration and spacecraft level testing activities have been successfully completed, & the W2m spacecraft was launched into orbit.

18.5 Substantial progress in sub-system realization of GSAT-4 and Oceansat-2 has been achieved. The spacecraft level integration activities are in advanced stage. The spacecraft are slated for launch during the first half of 2009.

18.6 HYLAS – a commercial project for AVANTHI has also achieved significant progress during this financial year. Major reviews including the critical design reviews has been completed. Fabrication of subsystems for INSAT-3D, GSAT-5, GSAT-6, Resourcesat-2, SRE-2, RISAT-1 and Cartosat-2B are in progress.

18.7 Indian Regional Navigational Satellite System (IRNSS) configuration has been finalized and productionisation of standardized subsystems of Telemetry & Telecommand, Power Electronic Packages, Bus Management Unit (BMU), Solar panel, Battery, Structure, Heat pipes, deployment mechanisms etc., have been planned along with the support of external industries.

### **Major Programmes for 2009-2010**

18.8 It has been planned to realize sub-systems for Resourcesat-2, Meghatropiques, RISAT-1, Youthsat, SRE-2, INSAT-3D, GSAT-5, GSAT-8 and IRNSS-1 satellites. Completion of Integration and test activities for the above spacecrafts have also been planned. During the year 2009-2010, it is planned to fabricate subsystems for Astrosat, SARAL, GSAT-6, GSAT-7 and IRNSS spacecraft.

18.9 Finalisation of configuration for Chandrayaan-2, Cartosat-3, GSAT-9 and Advanced Communication Satellite and procurement and establishment of some of the major facilities like-HILS Facility, Anechoic chamber, Acoustic Test Facility, Physical Parameter Machine etc., have been planned during 2009-2010.

## 19. **Laboratory for Electro-Optics Systems (LEOS)**

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
37.14	31.63	44.59

19.1 The Laboratory for Electro-Optics Systems (LEOS) at Bangalore is responsible for development and production of electro-optics sensors and optics for spacecraft use. Sensor system includes earth sensors, star sensors, sun sensors, magnetic sensors, temperature sensors and optical gyros for satellites. LEOS is also responsible for the fabrication of various types of optics for satellite cameras and radiometers and development of indigenous detectors for spacecraft. LEOS is also involved in the development of miniature sensors Micro Electro Mechanical Sensor (MEM) devices, development of Charge Coupled Devices (CCD), Time Delay Integration (TDI) devices with external participation.

### **Major Achievements during 2008-2009**

19.2 All the sensors on-board CARTOSAT-2A and IMS-1 has performed satisfactorily. The last batch of export order of sun sensors to Germany has been completed. All sensors for W2M were integrated with satellite and tested. Test & evaluation of sensors for INSAT-3D, GSAT-4, GSAT-5, RISAT-1, CARTOSAT-2B, ASTROSAT, RESOURCESAT-2, OCEANSAT-2, HYLAS 7 YOUTHSAT are under progress. Fabrication and testing of sensors and electronics for GSAT-6,

SARAL and MEGHATROPIQUES have been initiated. Ultra Violet Imaging Telescope (UVIT) optics for ASTROSAT was developed and being tested. New Miniature Star Tracker is under fabrication. The new test facility, clean room of '10000 class' for UVIT optics was established during this period.

### **Major Programmes for 2009-2010**

19.3 Satellite integration level testing of sensors and launch of OCEANSAT-2, CARTOSAT-2B, YOUTHSAT, GSAT-4, INSAT-3D, SARAL & OCEANSAT-2 are planned during this period. Ultra Violet Imaging Telescope (UVIT) optics for ASTROSAT, APS based star sensor, APS sun sensor, accelerometer & micro-bolometer will be developed. Optical inter-satellite link sensor, indigenous LASER source and laser induced breakdown spectroscopy (LIBS) and silicon carbide (SiC) optics technology will be developed during this period.

### 20. **Satish Dhawan Space Centre (SDSC-SHAR)**

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
237.99	318.95	340.41

20.1 Satish Dhawan Space Centre-SHAR (SDSC-SHAR) is the principal operational Centre for launching Sounding Rockets and Satellite Launch Vehicles. The activities at SDSC-SHAR are grouped under vehicle

assembly & static test operations, range operations, liquid storage & service facilities and solid propellant booster plant. The main facilities in the Centre include those for production of solid propellant rocket boosters, ground and environmental qualification of rocket motors and their sub-systems, integration, check-out and launch of satellite launch vehicles, liquid propellants and cryogenic propellants storage and servicing facilities, tracking and telecommand stations, real-time data processing and range & flight safety.

### **Major Achievements during 2008-2009**

20.2           The Cartosat-2A/IMS and eight nano-satellites for International Customers was successfully launched on April 28, 2008. Chandrayaan-1 spacecraft, India's first unmanned mission to the moon was launched successfully from second launch pad onboard Polar Satellite Launch Vehicle (PSLV-C11) from the SDSC-SHAR on October 22, 2008. The spacecraft was put into a transfer orbit with a perigee (nearest point to Earth) of 255 km and an apogee (farthest point to Earth) of 22,860 km, inclined at an angle of 17.9 deg to the equator. During 2008-2009, production of four S139 segments completed and six S139 segment and two HPS3 motor have been planned. Preparation and Integration of CUS mock-up vehicle and conducting fluid mock-up at Second Launch Pad has been completed. Production of two Nos. S139 Segments for GSLV-D3 project has been completed and Dummy NEZ hardware & five HES hardware processed in HIL facility for GSLV MK-III. Casting facility readiness and two numbers of cell casting trials were completed GSLV Mk-III and static testing of S200 motor, PSOM-XL motor, RLV-TD motor planned.

## Major Programmes for 2009-2010

20.3 During 2009-2010, it is planned to produce 10 Nos of S139 segments & 2 nos. of HPS3 motor for PSLV Project and three S200 segments for test motor (02) for GSLV Mk-III Project. Vibration test for GSLV Mk-III sub-assemblies and Verification of Quality (VOQ) testing of flight hardware is also planned. First S200 static test and to carry out Mock-up trials at launch pad are also planned. It is also planned to commission MCP, MCC and S-band radar and cryo arm during 2009-2010.

### 21. ISRO Telemetry, Tracking and Command Network (ISTRAC)

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
63.28	85.94	101.02

21.1 ISRO Telemetry, Tracking and Command Network (ISTRAC) provides mission support to low-earth orbit satellites as well as for launch vehicle missions. The other major responsibilities of the network are to carryout mission operations for all operational remote sensing and scientific satellites, to provide TTC services from ignition till satellite injection into orbit and to estimate the preliminary orbit in space in case of launch vehicle missions and to take up developmental activities for providing flawless TTC and mission operations services. ISTRAC has established a network of

ground stations at Bangalore, Lucknow, Mauritius, Sriharikota, Port Blair and Thiruvananthapuram. The Spacecraft Control Centre (SCC) co-located with the Bangalore Ground Station, carries out round-the-clock operations. ISTRAC also operates the Local User Terminal/Mission Control Centre (LUT/MCC) under the International programme for Satellite-Aided Search and Rescue.

### **Major Achievements during 2008-2009**

21.2 During the year, Launch and Early Orbit Phase (LEOP) support for PSLV C-11/Chandrayaan-1 and PSLV-C9/Cartosat-2/IMS-1 Missions were provided. Installation, performance evaluation and commissioning of 32 m antenna system (DSN-32) for Chandrayaan-1 support has been completed. LEOP Network for Chandrayaan-1 consisting of APL, JPL-NASA, Brazilian Space and Hawaii station of Universal Space Networks (USN) has been established. Activities related to ISTRAC Network Modernisation Programme Ph-II have reached the final phase with the modernization of Port Blair and Brunei incorporating the state-of-the-art monitoring and control features. Activities aimed at realization of IRS Data Reception Station in Mauritius under ISTRAC Network Modernisation programme Phase-II are in progress and the facility is expected to be operational in March 2009. The Indian Space Science Data Centre (ISSDC) facilitating data processing, archival and dissemination of science payload data has been established at Indian Deep Space Network (IDSN), Bangalore. Technical evaluation of hardware and software elements for data acquisition, storage, archival and dissemination scheme has been completed. The Centre now receives the Chandrayaan-1 science payload data. The DS-SCC Complex along with S band TTC station has been installed and commissioned at Bhopal for providing mission operation

support for Cartosat-2A/2B. Satcom hub support was provided for Spacenet, Telemedicine and VRC services on regular basis. A trailer mounted 4.5 m (transportable) terminal has been inducted for quick deployment at any location for short periods. The performance of the station was successfully demonstrated during PSLV-C09 and PSLV-C10 flights. Local User Terminals (LUT) and Indian Mission Control Centre (INMCC) have been providing round-the-clock support as part of Satellite Aided Search and Rescue (SASR) programme. Indigenously developed 11-m INLUS-RF Station has been established, integrated with INMARSAT-4FI and deployed for 'Signal in Space' transmission. Final system acceptance tests on GAGAN TDS has been completed and a system accuracy of <2 m obtained within peripheral reference sites.

### **Major Programmes for 2009-2010**

21.3 The ISTRAC has successfully gone through the re-certification process for maintaining quality standard conforming to ISO 9001:2000 for a period of 3 years upto August 28, 2010.

21.4 Spacecraft operations and payload programming for Chandrayaan-1, IRS series of Satellites and also continuation of support to TTC and missions operations support to Chandrayaan-1 mission will be continued. TTC Network stations at Bangalore, Sriharikota, Lucknow, Thiruvananthapuram, Port Blair, Brunei, Biak and Mauritius will be maintained & operated to provide TTC support for spacecraft missions.

21.5 During 2009-2010, it has been planned to install and commission ASTROSAT TTC and data reception station. Commissioning and operationalisation of second Mission Operations Complex were also planning during 2009-2010. It has also been planned to realize the ground segment of IRNSS project consisting of TTC stations, Reference stations, MCC and Navigation Central Centre.

## 22. Space Applications Centre (SAC)

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
169.84	195.13	254.10

22.1 The main activities of the Space Applications Centre at Ahmedabad include research and development work in various areas of space applications which are primarily aimed at national development and development of payloads for remote sensing and communication satellites. The activities of the Centre are grouped under microwave systems, satellite communication applications, sensor developments, image and information processing and remote sensing applications. The Centre has facilities for mechanical and electronic systems fabrication. The facilities of this Centre include the Ahmedabad Earth Station, the Delhi Earth Station, portable and mobile Earth Stations, Laboratories for remote sensing and communication activities and fabrication and environmental test facilities for development and qualification of space and ground hardware. The Centre is responsible

for the development, realization and qualification of communication, navigation, earth observation and meteorological payloads & related data processing & ground systems in the areas of communication, broadcasting, earth observations for remote sensing of natural resources, weather and environmental studies, disaster.

### **Major Achievements during 2008-2009**

22.2 As a part of Earth Observations Satellite Payload development activities, a record number of eight Electro Optical Payloads have been delivered to the project out of which three have been launched and are providing excellent imageries from orbit. Cartosat-2A and Indian Mini Satellite (IMS) payloads including Hyperspectral Imager (HySI-T) and Multi-Spectral Camera (MX-T), delivered to the project, during previous years, were launched on board PSLV-C9 on April 28, 2008. The post flight activities shows that all the payload are working satisfactorily. Chandrayan-1 payloads including Hyperspectral Imager (HySI-I), Terrain Mapping Camera (TMC) and Cameras for Moon Impact Probe (MIP) have been delivered. INSAT-3D payloads including Imager and Sounder (ETM) have been delivered to Project.

22.3 GSAT-4 Ka Band and GAGAN (SATNAV) payloads were successfully integrated, characterized and delivered for integration with spacecraft. GSAT-5 Communication Payloads are in final phase of hardware realization. For GSAT-6, designs of most of the sub-systems have been completed and fabrication of FM units have started. The systems design for GSAT-7 is in progress. Nor.C and Ext.C MMIC Receivers and C-Band Linearisers for 60 W TWTAs have been developed and a number of

SAW filters have been designed and developed for SATNAV & GSAT-4 Payloads.

22.4 As a part of SATCOM applications, SAC established a Satellite Communication link between Maitri, Antarctica and MCF, Hassan, Development of several Ground Based Terminals to support GSAT-4, UHF terminals for GSAT-7 and IRNSS applications are in progress.

22.5 Ocean State Forecasts for Ocean Waves (global) and Ocean Circulations (Indian Ocean) in open oceans implemented at INCOIS for operational use. The major achievement was the finalization of projects, involving collaborating agencies from all-over India, for utilisation of data from India satellite missions including INSAT-3D, Oceansat-2, RISAT and Meghatropiques, etc.

### **Major Programmes for 2009-2010**

22.6 The system studies and analysis are being conducted as a part of Advanced Technology satellite mission and the concept of broadband payload architecture in INSAT/GSAT system.

22.7 The flight model activities for different constituent subsystems of DMSAR are nearing completion and are under different stages of fabrication and T&E. Development of new sensors like Hyperspectral imager for LEO: missions, Thermal Imager for sea surface temperature and High Resolution Camera have been initiated.

22.8 GSAT-5 Communication payloads are expected to be realized during 2009-2010. The detailed assessment of payload subsystems requirement for GSAT-8 through GSAT-13 communication payloads and requisite action for in-house/industry participation has been taken. Ground Based Terminals, required to support GSAT-4 applications, are expected to be ready and the experiments for demonstration of GSAT-4 applications will be launched shortly.

22.9 In the field of EO Applications, the thrust would be towards utilisation of data from India satellite missions including INSAT-3D, Oceansat-2, Cartosat series, RISAT, Resourcesat-2, Meghatropiques, etc. A Programme on Climate change Research in Terrestrial environment (PRACRITI) is initiated which included studies related to impact of climate change on Agriculture System, Himalayan Cryosphere, Terrestrial Hydrology over India and the Sensor System Studies for Monitoring of Green House Gases.

### 23. **Development and Educational Communication Unit (DECU)**

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
58.41	60.00	58.13

23.1 The Development and Educational Communication Unit (DECU) at Ahmedabad is involved in the conception, definition, planning,

implementation and socio-economic evaluation of developmental space applications. The major current activities of DECU include Training and Development Communication Channel (TDCC), Tele-Health (TH), Tele-Education (TE) mission and new satellite communication applications.

### **Major Activities Completed and Planned during 2008-2009**

23.2 Under the Edusat Networks programme, 64 networks in (11 national beam and 53 regional beams) comprising of a total nos. of 35000 Terminals have been installed and commissioned. Test & Evaluation of 15 Hubs were completed. 11 EDUSAT networks successfully inaugurated. Technical guidance, deployment, operationalisation & monitoring of Satellite Interactive Terminals (SITs) & Teaching-Ends for DEI, BITS (Pilani) & Hotel Management Networks in National Beam are planned.

23.3 Under the Tele-medicine programme, 377 hospitals wherein 319 Remote nodes are connected to 58 Speciality hospitals. The networks have been further expanded to cover the areas of Mobile Tele-health and Continuing Medical Education (CME). Based on the recommendations of the special preview/advisory committee and hard-spots experts committee, about 25 numbers of programme production is planned. To make efficient utilization of satellite bandwidth which is provided on 24x7 basis, an integrated network of Tele-education & Tele-medicine is being proposed using the same hub and the channel. To start with, one of the States will be taken-up for implementation of integrated Tele-medicine & Tele-education network on a pilot basis. Under the Village Resource Centre (VRC) Programme, it is planned to initiate VRC network utilization study at a

national level to understand the utilization and identify the challenges of the technology for further expansion of the VRC networks.

### **Major Programmes for 2009-2010**

23.4 It is planned to upgrade existing Satellite Interactive Terminals (SITs) and Receive Only Terminals (ROTs) of national Beam users to work with the new LMS. It is also planned to establish NIFT & NIBM Edusat networks and to initiate implementation of Networks in rest of the States. Establishment of DTH networks covering all primary schools of each states in a phased manner. It is planned to undertake study in rural Gujarat on assessment of societal needs and requirement of health sector and identification of needy areas for telemedicine networks are planned. Research on Needs and Areas of Development Programmes topics to be initiated.

#### **24. Master Control Facility (MCF)**

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
54.81	54.10	64.56

24.1 The Master Control Facility (MCF) located at Hassan in Karnataka is responsible for initial orbit raising, payload testing and in-orbit operation of all geostationary satellites. MCF has integrated facilities comprising satellite control earth stations with associated electronics. The Satellite Control Centre (SCC) is the nerve center for satellite control

operations. A back-up MCF (MCF-B) at Bhopal, Madhya Pradesh with essential facilities to manage the satellite operations has been commissioned.

### **Major Achievements during 2008-2009**

24.2 MCF has provided Telemetry Tracking and Command (TT&C) and Launch & Early Operational Phase (LEOP) services to INMRSAT-4F3 Mission on behalf of Antrix Corporation Ltd. It is planned to complete Launch & Early Operations Phase (LEOP) & Initial Orbit Testing (IOT) Operations for GSAT-4 Mission and commissioning of Ku-band Full Motion Antenna (FMA) terminal. Supported the LEOP Operations of W2M Satellite mission. Procurement action for major elements under Augmentation of Limited Motion Antenna (LMA) terminals at Hassan and Bhopal under progress.

### **Major Programmes for 2009-2010**

24.4 MCF planned to undertake LEOP and IOT operations for INSAT-3D Mission and completion of augmentation of LMA terminals in MCF-Hassan and MCF-Bhopal. Augmentation of computer systems and Communication Network elements for additional Spacecraft operations are planned. Replacement of DF#2 and 3 at power station # 1 at Hassan. Augmentation of SCC chain # 2 UPS at Hassan and CCTV system at new facilities of Bhopal campus. It is also planned to establish Optical Tracking system for GEO Satellites and commissioning of Transmitter location system for Interference Analysis GEO Satellite.

## 25. National Natural Resources Management System (NNRMS)

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
28.23	26.63	20.00

25.1 The National Natural Resources Management System (NNRMS) has the objective of ensuring optimal management/utilisation of natural resources by integrating information derived from remote sensing data with conventional techniques. The NNRMS umbrella includes a large cross-section of Government Departments/Agencies, which are responsible for resources management sectorally and other agencies associated in developmental activities. NNRMS activities are co-ordinated at the National level by the Planning Committee of NNRMS (PC-NNRMS) which frames guidelines for implementation of the systems and oversees the progress of remote sensing applications for natural resources management in the country. NNRMS, thus, encompasses conceptualisation and implementation of space system with ground-based data reception, processing and interpretation systems and integrating the satellite-based remotely-sensed data with conventional data for resource management applications in various thematic areas.

### **Major Activities Completed/Planned during 2008-2009**

- Successfully completed 4<sup>th</sup> cycle of Land use/land cover mapping on 1:250,000 scale using AWiFS data and the Kharif area assessment under the Natural Resources Census (NRC) programme;
- Developed Web enabled LULC information system in conjunction with ancillary information (named as 'Bhusampada') to facilitate value added data query, utilization and dissemination;
- Completed nationwide land use/land cover mapping under NRC at 1:50,000 scale using IRS data for about 70% of the geographical area of the country;
- Taken up the responsibility of converting the existing soil maps prepared under NRIS project into NNRMS geodatabase standards under the nationwide soil-mapping project;
- Natural Resources Data Base (NRDB) is being organised with large volume of databases from NRR projects and legacy projects;
- Development of Indigenous GIS package based on "Open Geo Data Model" and PostGre RDBMS to give the power to visualize Raster and Vector data geographically and perform various Image Processing and GIS operations has been completed;
- Planned to complete the digital elevation model using Cartosat-1 stereo data, under CartoDEM project, for the 60% of the geographical area of the country, where GCPs are already available;
- Continued to extend technical support to SRSACs towards furthering the remote sensing and GIS based activities in their respective States;
- Support to academic institutions extended for setting up/augmentation of remote sensing and GIS infrastructure facilities;

**Major activities planned during 2009-2010**

- To carry out 5<sup>th</sup> cycle (2008-09) of land use/land cover mapping on 1:250,000 scale using IRS AWiFS data and consolidated 5-year change analysis;
- To complete spatial database organization and generation of seamless database of the 1<sup>st</sup> cycle of land use/land cover mapping at 1:50,000 scale;
- To complete the Land degradation mapping at 1:50,000 scale using IRS data for the remaining areas of the country;
- To organise Seamless database for entire country and the national report will be brought out;
- To complete Geo-referencing of Cadastral maps with satellite images in digital domain for Karnataka;
- To continue Large-scale base mapping activities for remaining sites;
- To carry out populating database with more thematic layers under Natural Resources Data Base (NRDB) project;
- To complete Thematic mapping at 1:10,000 scale and aerial photography for National Urban Information System (NUIS);
- To complete and disseminate generation of one cycle of DEM using Cartosat-1 for the remaining 40% of the areas of the country and dissemination to the users;
- To pursue Human Resources Development training in the area of Remote Sensing and GIS;
- To take up new application projects on High resolution DEM from Cartosat series, Cadastral level resources mapping of the country, Rural infrastructure assessment etc, taking into account of newer EO Missions;

26. **Regional Remote Sensing Service Centres (RRSSCs)**

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
11.10	13.77	21.89

26.1 The five Regional Remote Sensing Centres (RRSSCs) at Bangalore, Dehradun, Jodhpur, Kharagpur and Nagpur have been established under the aegis of National Natural Resources Management System (NNRMS) with the prime objective of providing remote sensing application services to the users in the respective regions for better planning and optimal utilization of natural resources and also bring about awareness amongst the users on the potential of remote sensing and associated technologies. Over the years, RRSSCs have significantly contributed in this direction by executing various National level projects, User projects, Application Validation projects and Technology & Software Development projects apart from conducting regular training programmes for users in digital data analysis, GIS and applications.

### **Major Achievements during 2008-2009**

- Successfully completed 20 region-specific user projects in various themes like agriculture, geology, environment, biodiversity, health, urban development, infrastructure, disaster etc., and about 10 other projects are on the verge of completion;
- Successfully completed (i) 3<sup>rd</sup> cycle of land use/land cover mapping at 1:250,000 scale for western India (3 States) and at 1:50,000 scale for Rajasthan and Himachal Pradesh; (ii) Land degradation mapping at 1:50,000 scale in Chattisgarh, Rajasthan, Uttar Pradesh and West Bengal under Natural Resources Census project;
- Co-ordinated generation of cadastral referenced database in Orissa, Jharkand, Bihar, Uttar Pradesh, Tamil Nadu, Assam, Punjab and Kerala under Natural Resources Repository (NRR) Programme;
- Successfully completed updation of wasteland maps on 1:50,000 scale for Himachal Pradesh and Rajasthan;
- Co-ordinated the activities of establishing Village Resource Centres (VRCs) in the respective region (totally 264 VRCs are coordinated by RRSSCs) in addition to providing software support and database creation;
- Provided mitigation and rehabilitation inputs generated from satellite images for Kosi River flood to Secretary, Disaster Management, Govt. of Bihar as a proactive initiative. These includes inundation areas, suggested sites for tube well locations for drinking water, plans for restoration of infrastructure;

- Completion of sedimentation and storage loss assessment for 26 reservoirs across the country for Central Water Commission;
- Developed software packages (i) KCBIS: Karnataka Coastal Biodiversity Information System and (ii) PLIS: Land information system for Punjab. In addition, following packages were upgraded with more tools and user interface: GRAMINS;.PRIMEWIN; GeoBrowser; and CAPEWORKS for crop acreage estimation;
- Planned to complete major regional projects like (i) Community forest management plan for Andhra Pradesh (ii) Developmental planning and monitoring of selected districts in Maharashtra and Karnataka under PM's Distress Districts Development Programme (iii) Potential hydropower sites investigation in 9 valleys of Alaknanda and Bhagirathi rivers in Uttarakhand;
- Taken up major nation-wide projects on (i) Water resources information system for the entire Country for CWC; (ii) Tea Garden Inventory & Monitoring: 15000 small & major gardens for Tea Board; (iii) Monitoring and Evaluation of NWDPPRA-ICRISAT watersheds;
- Eight short-term courses were organized for about 210 scientists of user departments and school/college teachers; 19 awareness programmes were also organized for about 612 school/college students;
- Organised workshops on various themes for the benefit of user and academic community;

## Major Programmes for 2009-2010

- Continue to provide support and execute region-specific user projects in different application areas and pursuing a few R&D studies using high resolution, hyper spectral and microwave satellite data;
- Continue to contribute towards development of local context based local contents along with software package in local language for the identified sites and overall regional coordination as a lead center for Village Resource Centre (VRC);
- Continue to support in terms of database creation, quality standardization and software development for the following: (i) Wasteland mapping & updating; (ii) Land degradation mapping; (iii) Cadastral Referenced Database, (iv) Natural Resources Census (NRC); (v) Natural Resources Database (NRDB), (vi) National Database for Emergency Management (NDEM) CartoDEM and other national missions of DOS/ISRO;
- To take up major nation-wide projects on (i) Mining Information System for Ministry of Mines, Govt. of India; (ii) Comprehensive Road information system under Karnataka State highway improvement programme (Kship) for Karnataka State; (iii) National land Records Modernization Programme (NLRMP) for Department of Land records, Ministry of Rural Development;
- To work towards Operationalising Regional Repositories; Developing new techniques in quantitative, microwave and hyperspectral remote sensing; Enhanced focus on locale-specific societal projects; Providing “actionable” products & services;

- Continue to maintain close co-ordination with State RS Centres, Central & State line Departments; NGOs & Academia;
- To pursue towards strategic repositioning of 3 RRSSCs: Kharagpur to Kolkata; Dehradun to Delhi and Bangalore to ISITE Campus and to initiate construction activity at Kolkata and Bangalore;
- To develop Software in the new areas of image processing and development of customized packages to meet the user needs;
- To continue efforts in capacity building and training programmes for users and college/university teachers;

## 27. **Disaster Management Support (DMS)**

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
65.00	29.32	40.00

27.1 The Indian landmass is prone to several natural disasters such as flood, cyclone, landslide, earthquake, etc. With the vast experience gained through operational use of space data, the concept of a space-based observation and communication system for disaster management support is being evolved in the country. Based on the experience gained through several studies using Space data, DOS/ISRO has initiated a programme for Disaster Management Support (DMS). The major goal of the Programme is to provide decision support through Space-based information on the disasters, affected areas, their impact, etc., on a near-real time basis. The main components of

the Disaster Management Support Programme include (i) Establishment of a Decision Support Centre; (ii) Air-borne Laser Terrain Mapper (ALTM) surveys & hazard zonation; (iii) Database creation & query shell development; (iv) Emergency communication support; (v) Airborne SAR development; (vi) R&D support for DMS; (vii) Decision support tools development and (viii) International Charter Support.

### **Major activities planned during 2008-2009**

27.2 The DMS-Decision Support Centre (DDSC) at NRSC, Hyderabad has continued monitoring of flood inundation and impact assessment in different parts of the country. The flood waves that affected parts of Assam, Bihar, Orissa, Uttar Pradesh and West Bengal have been monitored and the maps provided to concerned State and Central agencies. The flood Disaster in Bihar due to the breach in the course of Kosi River was continuously monitored and maps have been provided to the concerned state and Central agencies. The NARGIS Cyclone - which finally crossed Myanmar coast on May 1, 2008 and the SIDR Cycle-crossed Bangladesh coast on November 15, 2007 were tracked all through using primarily KALPANA-1 data. Under 1<sup>st</sup> Phase of the DMS Virtual Private Network, 30 nodes (out of 37) have been set up. INSAT based Distress Alert Transmitter (DAT) developed by SAC has been manufactured through industry. Industry delivered initial batch of 100 numbers (out of planned 1000 numbers), out of which 85 numbers of transmitters were distributed to fishermen through the Coast Guard authorities. Under the International Charter, IRS data were provided on the global disaster events and ISRO has joined the Phase-II of the Sentinel Asia (SA) initiative for supporting disaster management activities in the Asia-Pacific region.

### **Major activities planned during 2009-2010**

27.3 During the year 2009-2010, regular monitoring of disasters-including flood, agricultural drought assessment & monitoring in 14 States, landslides, forest fires, etc will be continued. Efforts would be placed to sustain and enhance the overall quality and turn-around time of space technology enabled products and services for disaster management in the country. The National Database for Emergency Management (NDEM) will be organised in phased manner and Early Warning Systems (EWS) for cyclone, flood, drought, landslide and forest fires will be developed. It is planned to conduct ALTM surveys in an area around 12,000 sq. kms in flood prone areas in Andhra Pradesh, West Bengal and Assam States. It is also planned and improve the Tools and techniques for decision support taking into account the operational requirements of National, State and District Emergency Operations Centres.

27.4 Planned to establish and operationalise INSAT Type-D hub and co-locate with VPN Hub at Delhi and to complete & expand the network to the district level in respect of DMS-VPN first phase (all the 37 nodes). It is also planned to operationalise and integrate the DTH based Digital Disaster Warning System (DDWS) with Doordarshan and IMD for disaster warning. Planned to initiate construction of permanent building for VPN Hub and NDEM mirror server at New Delhi in association with MHA and NDEM server building at Shadnagar, Hyderabad has also been planned.

27.5 During 2009-2010, it is planned to realize the Flight Model of Airborne Synthetic Aperture Radar (A-SAR) and to replace the Near Real Time Processor (NTP) by Real Time Processor (RTP). It is also planned to improve the processing capacity, data storage and network security for DSC and NDEM data servers and put in place necessary ground segment for the new Jet Aircraft, which is being procured.

28. **ISRO Geosphere Biosphere Programme (ISRO GBP)**

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
19.00	21.50	25.78

28.1 Global climate change is of great concern to the world scientific community, the UN bodies and many others. Realising the importance of scientific studies to arrive at specific mitigation strategies for Indian sub-continent, the ISRO Geosphere-Biosphere Programme was initiated in the early 90's. This Programme encompasses the study of land-air-ocean interaction, past climate, changes in atmospheric composition, aerosols, carbon cycle, bio-mass estimation, bio-diversity and other related areas of scientific investigation. The ISRO-GBP is aimed at using maximum data from ISRO's own satellites. Data from balloon-borne experiments are also used for studying the climate change processes. The ISRO GBP covered projects relating to climate observations & modeling, atmospheric chemistry & aerosols and Biogas cycles & Global changes.

29. **ISRO Sponsored Research Programme (RESPOND)**

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
13.00	12.65	13.00

29.1 The ISRO Sponsored Research Programme (RESPOND) supports research and developmental projects and other scientific activities at the academic institutions and R&D laboratories in the country in the areas of relevance to the Space Programme. RESPOND also supports Advanced Technology Research in Space Technology Cells established at premier Institutions like IITs and IISc. The major activities supported covers Research projects in wide range of topics in science, applications and technology areas and support to conferences, symposia and publications which are of relevance to space research. The prime objective of this programme is to strengthen the ISRO academic Institutions interaction for generation of a wider research infrastructural base and quality human resources for conducting space research in the country.

\* \* \* \* \*

## CHAPTER - V

---

### FINANCIAL REVIEW

The budget formulation process of the Department has been evolved over the years with emphasis on reviewing the resource requirements with reference to the criteria of Zero Base Budgeting approach. Multi-level budget reviews are carried out at the DOS/ISRO Centres/Units and Project Management Boards/Management Councils consistent with the programmatic and financial guidelines of the Department. The essentiality of each item, the schedule-budget linkages and cash flow requirements are critically analysed while formulating the budget.

2. The Department has instituted a system of periodical monitoring of commitment and expenditure status of various programmes/projects approved in the annual budget and take appropriate action, for making financial management more effective. In order to have better expenditure management, the monthly cash flow is also monitored scheme-wise/project-wise to ensure that the allocated funds are fully utilised. Accordingly, while formulating the Revised Estimates 2008-2009, a critical appraisal of the progress - both physical and financial is carried out consistent with the programmatic requirements. Quarterly targets are fixed for each major project/scheme during the beginning of the year and Additional Secretary & IFA of the Department periodically takes a rigorous review of the expenditure/commitment status to ensure that the financial and programmatic

targets are realized. The project management councils/project management boards of all the major projects constituted at the DOS/ISRO Centre level also review the progress of expenditure/commitment status and initiate necessary follow-up actions keeping in view the programmatic criticalities. Thus, periodical review of the physical and financial performance of all the projects/schemes is an integral part of the planning and implementation strategy in DOS/ISRO.

3. The Financial performance of the Department in terms of Budget Estimates, Revised Estimates and Actual expenditure for the last three years viz., 2005-2006, 2006-2007 and 2007-2008 are given below:

#### **Financial performance 2005-2006**

(Rs. in crores)

	<b>Non-Plan</b>	<b>Plan</b>	<b>Total</b>
Budget Estimates 2005-2006	348.02	2800.40	3148.42
Revised Estimates 2005-2006	375.02	2300.50	2675.52
Actual Expenditure 2005-2006	373.09	2294.50	2667.59

4. The BE 2005-2006 included a provision of Rs. 300 crores earmarked by Planning Commission for Satellite Navigation (global participation). The details of global participation in Satellite Navigation and

the associated financial implications could not be finalised during the year as it involved a series of detailed negotiations with international agencies such as European Union/European Space Agency. Considering this and also the ceiling fixed by Ministry of Finance, the Revised Estimates 2005-2006 was reduced to Rs.2675.52 crores. The actual expenditure during 2005-2006 was Rs.2667.59 crores. i.e., **99.70%** budget utilisation wrt RE.

### **Financial performance 2006-2007**

(Rs. in crores)

	<b>Non-Plan</b>	<b>Plan</b>	<b>Total</b>
Budget Estimates 2006-2007	390.02	3220.40	3610.42
Revised Estimates 2006-2007	397.02	2600.27	2997.29
Actual Expenditure 2006-2007	394.50	2594.16	2988.66

5. Noting that the proposal of participation in global Satellite Navigation Systems is yet to progress and also to comply with the expenditure ceilings fixed by Ministry of Finance, the Revised Estimates 2006-2007 was reduced to Rs.2997.29 crores. The actual expenditure was Rs.2988.66 crores, which represents about **99.71%** budget utilization wrt RE.

**Financial performance 2007-2008**

(Rs. in crores)

	<b>Non-Plan</b>	<b>Plan</b>	<b>Total</b>
Budget Estimates 2007-2008	438.62	3420.18	3858.80
Revised Estimates 2007-2008	459.02	2831.07	3290.09
Actual Expenditure 2007-2008	456.25	2821.75	3278.00

6. The Revised Estimates 2007-2008 was reduced to Rs.3290.09 crores in compliance with the reduced ceilings fixed by the Ministry of Finance. The actual expenditure during the year was Rs.3278.00 crores which is about **99.63%** budget utilization with respect to RE.

7. The scheme-wise/project-wise details of BE, RE and Actuals for 2007-2008, BE & RE for 2008-2009 and BE for 2009-2010 are given in Table 5.1 enclosed.

\* \* \* \* \*

## Department of Space

Table 5.1

### Financial Review: Overall Trends in Expenditure 2007-2010

(Rs. in crores)

Sl. No.	Programmes/Projects/Centres/Units	Budget 2007-2008	Revised 2007-2008	Actuals 2007-2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
<b>A</b>	<b>SPACE TECHNOLOGY</b>						
<b>I</b>	<b>Launch Vehicle Technology</b>						
1	Geo-synchronous Satellite Launch Vehicle (GSLV) Project	9.00	8.00	7.50	1.00	0.00	0.00
2	Cryogenic Upper Stage Project	1.30	1.30	0.96	0.10	0.70	0.37
3	PSLV-Continuation Project	160.00	160.00	215.00	180.00	150.00	220.00
4	GSLV Mk-III Development	335.00	284.08	249.98	270.00	240.19	217.00
5	Space Capsule Recovery Experiment - I & II	9.45	4.45	4.00	10.00	10.00	12.00
6	GSLV – Operational	265.00	236.50	268.32	255.00	240.00	275.00
7	Vikram Sarabhai Space Centre	352.20	330.12	304.13	432.28	494.69	613.42
8	ISRO Inertial Systems Unit	21.25	23.54	23.38	23.16	23.19	30.84
9	Liquid Propulsion Systems Centre	217.95	171.59	155.94	204.19	209.36	285.93
10	Manned Mission Initiatives/Human Space Flight	50.00	4.00	3.11	125.00	42.01	230.00
11	Indian Institute of Space Science & Technology	75.00	25.00	74.69	65.25	65.25	175.00
12	Semi Cryogenic Engine Development	25.00	0.00	0.00	22.50	4.09	155.00
	<b>Sub-Total</b>	<b>1521.15</b>	<b>1248.58</b>	<b>1307.01</b>	<b>1588.48</b>	<b>1479.48</b>	<b>2214.56</b>
<b>II</b>	<b>Satellite Technology</b>						
13	Cartosat-2	0.15	0.15	0.14	0.00	0.00	0.00
14	Oceansat-2 & 3	30.00	30.00	29.39	10.00	12.00	6.00
15	Resourcesat-2 & 3	50.00	48.00	45.33	35.00	25.00	35.00
16	G.SAT-4	8.00	4.50	4.50	7.00	4.30	2.90
17	RISAT-1	56.00	56.48	57.77	25.00	30.00	5.00

Sl. No.	Programmes/Projects/Centres/Units	Budget 2007-2008	Revised 2007-2008	Actuals 2007-2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
18	Advanced Communication Satellite	12.00	0.00	0.00	22.50	1.00	5.00
19	Navigational Satellite System (including IRNSS)	101.00	94.00	90.43	270.00	200.00	270.00
20	ISRO Satellite Centre	213.29	177.12	142.75	215.85	253.44	304.87
21	Laboratory for Electro-Optics System	21.21	15.76	14.66	37.14	31.63	44.59
22	Semi-conductor Laboratory	41.12	41.07	39.50	34.28	39.48	45.00
23	Earth Observation-New Missions (Saral, Geo-HR Imager, TES-Hyp, DMSAR & Cartosat-3)	30.00	0.00	0.00	65.00	2.70	13.00
	<b>Sub- Total</b>	<b>562.77</b>	<b>467.08</b>	<b>424.47</b>	<b>721.77</b>	<b>599.55</b>	<b>731.36</b>
24	Satish Dhawan Space Centre - SHAR	198.94	213.38	210.11	237.99	318.95	340.41
25	ISRO Telemetry, Tracking and Command Network	63.35	82.31	71.37	63.28	85.94	101.02
26	ISRO Radar Development Unit (ISRAD)	4.49	5.65	3.36	0.00	0.00	0.00
	<b>Sub- Total</b>	<b>266.78</b>	<b>301.34</b>	<b>284.84</b>	<b>301.27</b>	<b>404.89</b>	<b>441.43</b>
	<b>TOTAL : A - SPACE TECHNOLOGY</b>	<b>2350.70</b>	<b>2017.00</b>	<b>2016.32</b>	<b>2611.52</b>	<b>2483.92</b>	<b>3387.35</b>
	<b>B SPACE APPLICATIONS</b>						
1	Space Applications Centre	149.14	126.27	120.62	169.84	195.13	254.10
2	Development & Educational Communication Unit	85.36	72.48	76.10	58.41	60.00	58.13
3	Earth Observation Applications Mission	3.97	3.38	3.36	2.68	2.59	4.40
4	National Natural Resources Management System	53.97	15.78	6.79	28.23	26.63	20.00
5	Regional Remote Sensing Service Centres	13.70	9.07	57.22	11.10	13.77	21.89
6	National Remote Sensing Agency (including Aid Equipment)	30.02	30.02	30.00	35.00	0.00	0.00
7	North Eastern Space Applications Centre	5.00	5.00	5.00	5.00	5.00	7.00
8	Disaster Management Support	70.00	37.77	74.92	65.00	29.32	40.00
9	National Remote Sensing Centre	0.00	0.00	0.00	0.00	70.31	141.16
	<b>TOTAL : B - SPACE APPLICATIONS</b>	<b>411.16</b>	<b>299.77</b>	<b>374.01</b>	<b>375.26</b>	<b>402.75</b>	<b>546.68</b>

Sl. No.	Programmes/Projects/Centres/Units	Budget 2007-2008	Revised 2007-2008	Actuals 2007-2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
<b>C SPACE SCIENCES</b>							
1	Physical Research Laboratory	46.52	49.87	49.87	51.44	60.91	62.32
2	ISRO Geosphere-Biosphere Programme	25.32	25.28	20.24	19.00	21.50	25.78
3	Sensor Payload Development/Planetary Science Programme	23.25	7.50	3.57	5.00	4.50	5.00
4	Megha-tropiques Project	20.00	15.00	14.32	20.00	20.00	15.00
5	Indian Lunar Mission-Chandrayaan-1&2	96.00	131.17	105.26	78.00	88.00	90.00
6	Astrosat-1 & 2	40.00	44.00	43.62	25.00	21.00	20.00
7	National Atmospheric Research Laboratory (NARL)	9.62	7.95	7.95	11.31	12.78	15.43
8	Sponsored Research (RESPOND)	13.00	12.00	10.48	13.00	12.65	13.00
9	Atmospheric Science Programme	18.63	17.15	12.44	14.49	15.30	20.96
10	Small Satellites for Atmospheric Studies & Astronomy	2.00	0.00	0.00	10.00	0.00	2.00
11	Other Schemes	16.51	11.68	7.38	21.13	11.65	14.25
<b>TOTAL : C - SPACE SCIENCES</b>		<b>310.85</b>	<b>321.60</b>	<b>275.13</b>	<b>268.37</b>	<b>268.29</b>	<b>283.74</b>
<b>D DIRECTION &amp; ADMINISTRATION/ OTHER PROGRAMMES</b>							
1	Department of Space Secretariat	4.69	4.90	4.89	5.46	6.93	7.45
2	Indian Space Research Organisation (ISRO) Headquarters	22.10	25.25	25.55	24.70	36.89	51.28
3	Civil Engineering Division	17.76	19.60	18.66	19.68	24.20	0.00
4	International Co-operation	3.00	3.15	2.12	3.15	3.17	3.17
5	Other Programmes (Spl Indigenisation/advance ordering, etc.)	248.76	25.25	17.03	361.12	37.00	233.11
<b>TOTAL D: DIRECTION, ADMINISTRATION &amp; OTHER PROGRAMMES</b>		<b>296.31</b>	<b>78.15</b>	<b>68.25</b>	<b>414.11</b>	<b>108.19</b>	<b>295.01</b>

Sl. No.	Programmes/Projects/Centres/Units	Budget 2007-2008	Revised 2007-2008	Actuals 2007-2008	Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
<b>E</b>	<b>INSAT OPERATIONAL</b>						
1	INSAT-3 Satellites	42.00	50.00	39.22	9.90	20.00	8.60
2	INSAT-3 Launch Services	0.10	0.10	0.00	0.10	0.10	0.10
3	INSAT-4 Satellites	296.00	207.76	193.16	280.00	161.69	323.00
4	INSAT-4 Launch Services	100.00	275.00	274.25	60.00	0.00	50.00
5	Master Control Facility	51.68	40.71	37.66	54.81	54.10	64.56
<b>TOTAL : E - INSAT OPERATIONAL</b>		<b>489.78</b>	<b>573.57</b>	<b>544.29</b>	<b>404.81</b>	<b>235.89</b>	<b>446.26</b>
<b>GRAND TOTAL : GROSS</b>		<b>3858.80</b>	<b>3290.09</b>	<b>3278.00</b>	<b>4074.07</b>	<b>3499.04</b>	<b>4959.04</b>
<b>Deduct Recoveries</b>		0.20	0.09	0.00	0.07	0.04	0.04
<b>TOTAL : (NET)</b>		<b>3858.60</b>	<b>3290.00</b>	<b>3278.00</b>	<b>4074.00</b>	<b>3499.00</b>	<b>4959.00</b>

## CHAPTER – VI

---

### AUTONOMOUS BODIES OF DOS/ISRO

#### 1. National Remote Sensing Agency (NRSA)

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
35.00	0.00	0.00

1.1 The National Remote Sensing Agency (NRSA) was an autonomous organisation under the Department of Space, responsible for acquisition, processing, dissemination and archiving of satellite and aerial remote sensing data and training of user scientists in interpretation application of RS data.

1.2 Considering the fact that the NRSA is closely associated with the various programmes of DOS/ISRO, in particular the Earth Observation Programme, Disaster Management Support and other Programmes of national importance, NRSA has been converted into a Government entity, called National Remote Sensing Centre (NRSC), a Centre under the DOS/ISRO w.e.f. 01.09.2008. Hence, the budget provision in RE 2008-09 & BE 2009-10 under NRSA is shown as 'Nil'.

## 2. **Physical Research Laboratory (PRL)**

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
51.44	60.91	62.32

2.1 The Physical Research Laboratory (PRL) at Ahmedabad, an autonomous institution under the Department of Space is a premier research institution in the country engaged in basic research in experimental & theoretical physics, astronomy & astrophysics, earth and planetary & atmospheric sciences. It is also entrusted with the management of the Udaipur Solar Observatory (USO) and Infrared Observatory at Mt.Abu. Research activities carried out at PRL are mainly in the area of infrared astronomy, solar & plasma astrophysics, solar & galactic astronomy, geo-cosmo physics, planetary atmosphere, solar-terrestrial physics, laboratory astrophysics, theoretical physics and archaeology & hydrology. The PRL is also involved in conducting extensive academic programmes for Doctoral and Post Doctoral research and also has an Associateship programme for University teachers.

## Major Achievements during 2008-2009

2.2 Observations carried out by the Spitzer Space Telescope led to the first detection of alumina dust in stellar atmosphere around Nova-like object V4332 Sagittari. Detailed design review of the MAST (Multi-Application Solar Telescope) has been completed. HEX flight payload has undergone all the tests and successfully integrated to the Chandrayaan-1 Spacecraft, which was launched by PSLV-C11 on October 22, 2008. Fossil records in meteorites show that the now-extinct nuclides  $^{26}\text{Al}$  and  $^{60}\text{Fe}$ , present in early solar system, were co-injected into the proto-stellar cloud from a stellar source. Studies on the relevance of aerosol chemistry at sub-microscopic scale on atmospheric processes have been initiated. Installation of a new high resolution Secondary Ion Mass Spectrometer (Nano-SIMS) will be completed. The optics and the IKxIK IR Array of the new IR Imager/Spectrometer have been tested for their performance; integration is in progress. Instrumentation activities for design and development of several back-end and supporting instruments for the MAST are in progress. A rocket flight carrying multiple photometers was flown successfully from Thumba near Thiruvananthapuram to study air glow processes. A momentum spectrometer with multi-ion coincidence measurement capability has been developed to carry out studies on high energy ion collisions with molecules. Preliminary design for satellite payloads for measurement of trace gases is in progress. Charge Conjugation Parity (CP) violating effects arising from the tree level flavour changing decays of the bottom quark were investigated. Analytical studies suggest that signatures of new physics in the production of top quark can be detected through the study of the secondary leptons produced in the decay of top quark.

## **Major Programmes for 2009-2010**

2.3 Chandrayaan-1 science data from the Imaging Payloads as well as low-and high-energy X-ray payloads will be analyzed. It has been planned to initiate activities for design, development and demonstration of the use of potential nuclear techniques for possible payloads for future planetary missions. The fabrication of PARAS, the Echelle Spectrometer, for extrasolar planet search is expected to be completed and coupled to the 1.2m telescope at Mt.Abu in 2009-2010. The new IKxIK IR Array will be operational in both its imaging and spectrometer modes at the Mt.Abu Observatory. The Multi-Application Solar Telescope (MAST) is expected to be delivered in late 2009 and commissioning is expected to be completed by 2010. A major programme will be initiated to develop aircraft/balloon/satellite based sensors to study distributions of trace gases over the tropical region as well as to study thermospheric airglow emissions. Measurements and analysis aerosol chemical composition in the sub-micron and micron radius range will be initiated using a time of flight mass spectrometer. This study will provide the physical and chemical composition for each size of aerosol in the size range of 0.1 $\mu$ m and 3 $\mu$ m. Studies of interstellar dust present in primitive meteorites, using Nano-SIMS will be initiated. Intensive studies of ocean productivity, air, sea interaction, nano-scale aerosol chemistry will be taken up under ISRO Geosphere-Biosphere programme. Studies on signatures of physics beyond standard model, atomic parity violation, neutrinoless double beta decays and of classical and quantum-chaotic system will be pursued.

3.

### **National Atmospheric Research Laboratory (NARL)**

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
11.31	12.78	15.43

3.1 The National Atmospheric Research Laboratory (NARL) at Gadanki near Tirupati in Andhra Pradesh, is an autonomous institution under the Department of Space. The NARL has the facilities like Mesosphere-Stratosphere-Troposphere (MST) radar, LIDAR, lower atmospheric wind profiler disdrometer, optical rain gauge and automatic weather station. NARL is available for national and international scientists from various institutions and universities for carrying out advanced research in atmospheric and space sciences and related disciplines.

#### **Major Activities during 2008-2009**

3.2.1 The NARL has initiated several new activities during 2008-2009 in the Technology development arena for conversion of the existing MST Radar to a fully active aperture array. Under this project, the entire transmitter and received systems will be replaced using the solid-state transmit-receive (TR) modules. Technology demonstration has been completed successfully and the development work has been outsourced. NARL is also developing a 1.28GHz wind profiler for lower atmospheric

research applications with a Power-aperture product of about  $1.7 \times 10^4$  W- $m^2$ , which will have 256 rectangular patch antenna elements arranged in a 16 x 16 square matrix and each element is fed by a dedicated transmit-receive module (TRM).

3.3 To study the dynamics and electrodynamics of the mesosphere and lower thermosphere and E-regional ionosphere (60-110 km), an MF radar (2.5 MHz) system will be built indigenously and implemented with the state-of-the-art technology. It is planned initially to build the spaced antennae MF radar with 3 by 3 crossed center-fed half wave dipoles (total 18 antennae) occupying a land of 250m by 250m and install in the campus of Yogi Vemana University (YVU), Kadappa for which a Memorandum of Understanding (MoU) has been signed so as to initiate collaborative research works between NARL and YVU.

3.4 It is planned to demonstrate the technology of Rayleigh Doppler lidar indigenously. Accordingly, altitude region of 10-25 km will be probed first with a small aperture telescope, a stabilized laser and a single etalon with associated optics.

3.5 NARL is also coordinating in establishing an Indian Lidar Network for the three dimensional mapping of aerosol distribution, an important prerequisite for weather/climate change studies. Towards this, Technology Transfer of boundary layer lidar development is made with the private company, GOAL, Pudhucherry, which is now in the first phase of implementation.

## **Major Programmes for 2009-2010**

3.6 The forth coming satellites Oceansat-2 and the Megha Tropique will be carrying Radio Occultation Sounding Atmosphere (ROSA) payload of the Italian Space Agency and NARL has been identified as the nodal agency for the validation of the ROSA data as well as to facilitate data utilisation by the Indian Scientists.

3.7 It is planned to initiate a new program called Study of Atmospheric Forcing and Responses (SAFAR) with a main objective of studying radioactive, dynamical and electro-dynamical coupling processes in the equatorial atmosphere by conducting various complimentary observations simultaneously at NARL. The activity is divided mainly into four themes:- Theme 1 will cover convective activities in and around Gadanki and their role in Stratospheric Tropospheric Exchange (STE) processes. Aerosols, radiation and trace gases forcing of the atmosphere will be addressed in Theme 2. Theme 3 will focus on the impact of forcing on middle atmospheric dynamics and finally Theme 4 covers the upper mesosphere and lower thermospheric response to lower atmospheric forcing including space weather. A pilot campaign has already been completed during May-August 2008 to address some of the above issues. Presently SAFAR is a research program spearheaded by the scientists of NARL and proposed to conduct for three years (2008-2010). Participation from other national and international research groups will be encouraged in due course.

3.8 It is also planned to initiate new activities related to aerosols, radiation and trace gases since the DOS/ISRO is having elaborate space programme for remote sensing purpose which can potentially be used for radiation budget studies. A super site for validation of satellite derived radiation products and radioactive transfer code will be developed at NARL with all necessary and complimentary instruments. Weather and climate prediction research is another new activity getting initiated at NARL. This activity will have two main components viz., Operational and Research. The operational component will provide weather forecasts for specific activities such as rocket launch operations at SDSC-SHAR, while the research component is for the evaluation and improvement of the forecast skill over the Indian region. Towards this, a data center is also proposed to be established at NARL.

3.9 The other two major technology development envisaged during the period 2009-2010 is the development of X-band polarimetric radar for studying tropical precipitating systems, and a portable Raman Lidar for profiling atmospheric water vapor and temperature in the tropospheric region. The proposed lidar system will make use of 2W class 355 nm laser and a 350 mm aperture telescope as receiver.

#### 4. **North Eastern Space Application Centre (NE-SAC)**

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
5.00	5.00	7.00

4.1 The North-Eastern Space Applications Centre (NE-SAC) located at Shillong is an autonomous society set up jointly with the North-Eastern Council to support the North Eastern Region in using space science and technology for development. NE-SAC has the mandate to develop high technology infrastructure support to enable NE States to adopt space technology inputs for their development. At present, NE-SAC is providing developmental support by undertaking specific projects, utilising space technology inputs-remote sensing, satellite communication and space science.

#### **Major Achievements during 2008-2009**

4.2 The Centre has completed many remote sensing and GIS applications covering north eastern states. These projects have been carried out at specific request of users like State Forest Research Institute, Autonomous District Councils, State Directorate of Economics and Statistics, etc. One of the unique achievements during this year is development of a model for quantitative estimation of weekly rainfall using

KALPANA-1 satellite thermal band data. The Centre being the nodal agency for the Natural Resources Census (NRC) of entire NE region is collaborating with the respective State Remote Sensing Application Centres (SRSACs) in the region and completed the tasks assigned on time.

4.3 Under the Satellite Communication Activities, NE-SAC has commissioned the telemedicine nodes at 151 Army Base Hospital in Guwahati and military hospitals in Shillong, Agartala, Silchar and Lamakong. The Centre has facilitated establishment of EDUSAT utilization network of Satellite Interactive Terminals and Hub in Tripura and Meghalaya States. Connectivity has been given to Government Cancer Hospital in Agartala, Tripura. A network of 12 Village Resources Centres (VRCs) in Assam with expert nodes at Assam Agricultural University, Jorhat and ABITA's Gramin Krishi Unnayan Prakalpa at Guwahati has been established.

4.4 The Centre has coordinated establishment of 68 out of 80 planned Automatic Weather Stations (AWS) in the region and carried out many experiments related to rainfall characterization in the region. Study on characteristics of Aerosol Black Carbon at different parts of NER is in progress.

4.5 NE-SAC has given technical inputs (urban sprawl, house density, open places and vulnerability/proneness to floods and land slides) to the Working Group II (Technical) constituted by the Government of Meghalaya for the preparation of Shillong City Disaster Management Plan.

## **Major Programmes for 2009-2010**

4.6 NE-SAC plans to complete all major items under the Natural Resources Census projects in addition to applications of remote sensing and GIS in Sericulture development, funded by Central Silk Board. Eight projects taken up under EOAM in areas of remote sensing applications such as medicinal plant inventory, application in data mining techniques, natural resources and infrastructure study for border trade, sampling technique for forest stock in hilly areas, development of a pilot model forecasting of floods etc., will be continued during the period. Wetland mapping at 1:50,000 scale for Meghalaya, and Nagaland under National Wetland Mapping Project will be completed by NE-SAC.

4.7 EDUSAT network installation will be completed in Nagaland, Mizoram and Arunachal Pradesh and work will be initiated in Assam, Manipur and Sikkim. 12 VRCs in Tripura, 8 in Nagaland will be established and work will be initiated in other States in the NER. Installation of remaining 52 Telemedicine Centres in NER States under ISRO-NEC project and 11 Telemedicine Centres under Army Network will be completed.

4.8 One environmental Observatory for measuring trace gases and aerosols will be set up under IGBP. Two pilot studies will be taken up on thunder storm formation using KALPANA-1 satellite data along with Automatic Weather Station (AWS) data. A facility for providing Agromet services and disaster forecasting for NER region will be initiated using satellite, Doppler Weather Radar (DWR) and Automatic Weather Station (AWS) data under the space science programme.

## 5. **Semi-conductor Laboratory (SCL)**

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
34.28	39.48	45.00

5.1 The SCL is entrusted with the design, development and manufacture of Very Large Scale Integrated (VLSI) devices and development of systems for telecommunication and space sectors. SCL has an Integrated Facility comprising class 10, 6” Wafer Fabrication Plant, Design Facility, Test & Assembly, Quality Assurance & Reliability and System Level Assembly Facility. Development & manufacture of ASICs for Strategic Sector is the major thrust.

### **Major Achievements during 2008-2009**

5.2 The SCL has developed 3 devices viz, 4K CCD, DCL & Clock drivers successfully flown in Indian Mini Satellite IMS-1 launched on April 28, 2008. SCL is continuing its efforts in realizing & testing again similar devices for ISRO’s future mission with maximum yield. Realisation, testing & supply of 10,000 nos. ASICs for Indian Railways and further production of 200 nos. of FTI & Phase Shifters were planned. CMOS-MEMS Sensor, MEMS based Humidity, Temperature & Pressure Sensor optimization &

realization for IMD & ISRO programmes are being carried out. Rad-Hard technology-1, RF MEMS devices (viz. Capacitor, Inductor, Switch, Micro strip Antenna, Active components, filter, Oscillator) Proto testing & characterization shall be completed. Spin-offs from MEMS viz. Liquid Level Sensor, Pressure Sensor Array, Orifice Flow meter, Micro Heater, Micro shock tube, 1mN Thruster etc., shall be taken up as internal R&D. Use of these devices in ISRO Programmes shall be explored. Production of ultrasonic liquid level sensors for PSLV, GSLV and GSIV-MK-III shall be taken up. Upgradation of VLSI/MEMS characterization equipment shall be carried out. Production of 5000 nos. of Dr.Pisharoty Radio-Sonde system is planned.

### **Major Programmes for 2009-2010**

5.3 Realization, testing, characterization & supply of 15,000 nos. of Locomotive ASICs to Indian Railways & 3000 nos. of ASICs (CISP-128, FTI, TDI, DAC, Soft DAS, SRAM, PCA & Timing Sequencer) to various ISRO programmes. Proto fabrication, testing, packaging, screening & characterization of RFMEMS switch, filter Matrix, Phase Shifters, Ka, Ku band devices, CMOS-MEMS sensor, high pressure MEMS sensor, MEMS shock tube & 1mN Thrusters were planned to be completed. Complete characterization & optimization of 0.8  $\mu\text{m}$  HR poly in process, 1.2  $\mu\text{m}$  CCD process variation, X-ray CCD for astronomy, RAD-Hard Technology & 1kx1k FTI with dump-line features shall be completed. SCL has planned to productionise IMD-ASICs (1000 nos.) 5000 nos. of Dr.Pisharoty Radio Sonde systems and screening of 20000 components. Besides this, assembly of Hi-Rel boards are also planned.

5.4 Augmentation of VLSI/MEMS Fab. Facilities & Re-structuring for 0.18  $\mu$ m on 8" technology is in progress.

## 6. Indian Institute of Space Science & Technology (IIST)

(Rs. in crores)

Budget 2008-2009	Revised 2008-2009	Budget 2009-2010
65.25	65.25	175.00

6.1 The Indian Institute of Space Science and Technology (IIST), an autonomous body under DOS was established with the primary objective of creating world class Institution in the area of advanced Space Science and Technology responsible for generating high quality human resources to meet the sophisticated manpower requirements of DOS/ISRO. The Institute has undergraduate, postgraduate and doctoral programmes in the area of space science technology and applications. The Institute has started functioning from the academic year 2007-2008, around the existing infrastructure of ISRO Centres in Thiruvananthapuram. The annual intake of the Institute is about 150-200 students. A permanent infrastructure for the Institute is in progress near Liquid Propulsion Systems Centre (LPSC), Valiamala.

\* \* \* \* \*