OUTCOME BUDGET
OF THE
DEPARTMENT OF SPACE
GOVERNMENT OF INDIA
2013-2014

CONTENTS

EXECUTIVE SUMMARY

i. 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 natural 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.

ii. The Department of Space (DOS) and the 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.

iii. The overall thrust of the Space programme envisaged during 12th plan period will be sustained and strengthened in the already established space based services in the areas of Earth Observation, Satellite Communication, Disaster Management Support and Societal applications such as Tele-medicine, Tele-education and Village Resource Centres and to undertake advanced space missions including Mars Orbiter Mission, Aditya-1 and Chandrayaan-2. The details of the programmes envisaged during the 12th Plan period are dealt in para 4 of Chapter 1.

iv. The Budget proposals for the Department of Space for 2013-2014 have been formulated under the framework of Decade Profile 2010-2020 and the Twelfth Five Year Plan (2012-2017). The BE 2013-2014 for Department of Space stands at ₹ **6792.04 Crores** comprising of ₹ **5615.04 Crores** 'Plan' outlay and ₹**1177.00 Crores** 'Non-plan' outlay. The outlay has been arrived at taking into account the Programmatic targets set for 2013-2014.

v. The Department has prepared **"Outcome Budget 2013-2014"** as per the extant guidelines issued by the Ministry of Finance, Department of Expenditure. The Table 2.1 annexed to Chapter II gives the Outcome Budget for 2013-2014 in the prescribed format.

vi. 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.

vii. The major programmatic targets for 2013-2014 are the following:-

- Launch & operationalisation of state-of-the art Meteorological satellite, INSAT-3D. This will provide continuity of meteorological services of aging Kalpana-1 satellite;

- Launch of GSAT-7 which is a user funded communication satellite. GSAT-7 was initially planned for launch on-board GSLV. Due to the schedule criticality of GSAT-7 satellite, provision is made for the launch of GSAT-7 satellite through procured launch services;

- Launch of communication satellite GSAT-14 onboard GSLV-D5. The spacecraft will have 6 Ku-band and 6 Ext-C band transponders;

- Launch and operationalisation of IRNSS-1 - first of the seven satellites planned for IRNSS programme on-board PSLV-C21;

- Progress in other ongoing projects viz., GSLV Mk III, Semi cryogenic engine development, INSAT-3 & 4 satellites, Chandrayaan-2, Aditya-1 and ASTROSAT, GISAT and Small satellites for Atmospheric studies;

viii. The Department has five Grant-in-aid Institutions under its fold viz., Physical Research Laboratory, National Atmospheric Research Laboratory, Semi-conductor 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.

ix. 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.

x. 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 & FA of the Department takes a rigorous review of the expenditure/commitment status on a monthly basis to ensure that the financial and programmatic targets are realized. With this, the Department has been able to meet most of the programmatic and financial targets.

xi. 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.

INTRODUCTION

1.1 The Indian Space Programme had a modest beginning with the launch of the first sounding rockets in November 1963 from the Thumba Equatorial Rocket Launching Station (TERLS), an obscure fishing village near Thiruvananthapuram for the investigation of ionosphere using sounding rockets. Further, the Indian Space Programme was institutionalized in November 1969 with the formation of Indian Space Research Organisation (ISRO). 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). ISRO was also brought under the newly formed DOS in September 1972. Since then, over the last five decades, 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 including climate variability and change. 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 has been to establish and operationalise space services in a self reliant manner in the thrust areas of Satellite Communication and Satellite based information for management of national services and Satellite Meterological applications. The indigenous development of Satellites, launch vehicles and associated ground segment for providing these services, is integral to these objectives. With the establishment of the two major operational space systems – the Indian National Satellite (INSAT) for telecommunication, television broadcasting and meteorological services and management and the Indian Remote Sensing Satellite (IRS) for resource monitoring and management. With the establishment of these two major operational space systems, the Indian Space Programme has been providing operational services to the user community in the country. Two operational launch vehicles, Polar Satellite Launch Vehicle (PSLV) and Geo-synchronous Satellite Launch Vehicle (GSLV) provide self reliance in launching IRS and 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 September 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). 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 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 mechanism and launch vehicle design; composite materials 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 (SPL) at VSSC carries out research in atmospheric and related space sciences. Apart from this, the Construction & Maintenance Division (CMD) carries out 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). An Ammonium Perchlorate Experimental Plant (APEP) has been set up by VSSC 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.

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, Air Breathing Propulsion, Geo-Synchronous Satellite Launch Vehicle (GSLV) MK-III Development and development of critical technologies for Human Space Flight.

B. Liquid Propulsion Systems Centre (LPSC)

The Liquid Propulsion System Centre (LPSC) with its facilities located at Thiruvananthapuram (Valiamala), Mahendagiri and Bangalore is the lead Centre in the development of liquid and cryogenic propulsion stages for launch vehicles and satellites. In LPSC, Valiamala, Thiruvananthapuram management of system projects, design activities in the area of storable, cryogenic and semi cryogenic liquid propulsion systems, electric propulsion systems, flow control components and modules and spacecraft thrusters are carried out. In LPSC, Mahendragiri, assembly and testing of storable and cryogenic liquid rocket engines and stages, spacecraft thrusters testing in sea level and high altitude conditions, storage of liquid and cryogenic propellants and production of liquid hydrogen etc., are carried out. In LPSC, Bangalore, spacecraft propulsion systems design, realization and integration, monopropellant thruster and component design, spacecraft propellant tank design and realization, managing production of propellant tank and structures for launch vehicles development and production of transducers are carried out.

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 six major areas: Mechanical Systems Areas, Digital & Communications Area, Integration & checkout area, Power Systems & Avionics Production area, Control & Mission Area and Reliability & Components Area. 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 is responsible for design, development and production of electro-optic sensors like earth sensors, star sensors, sun sensors, magnetic sensors, temperature sensors and optical gyros for spacecraft use. LEOS is also responsible for the fabrication of various types of optics for satellite cameras & radiometers and development of indigenous detectors for spacecraft. LEOS is also involved in the development of miniature sensors Micro Electro Mechanical Sensors (MEMS) devices, development of Charge Coupled Devices (CCD), Time Delay Integration (TDI) devices with external participation.

F. Space Applications Centre (SAC)

The Space Applications Centre (SAC) at Ahmedabad is responsible for the development, realization and qualification of communication, navigation, earth observation & meteorological payloads and related data processing and ground systems. The Centre carries out development of ground systems and application activities in the areas of communications, broadcasting, earth observations for remote sensing of natural resources, weather and environmental studies, disaster monitoring/mitigation, etc. SAC plays an important role in harnessing space technology for a wide variety of applications for societal benefits. The activities of SAC 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.

G. Development and Educational Communication Unit (DECU)

The Development and Educational Communication Unit (DECU) at Ahmedabad is involved in the conceptualisation, definition, planning, implementation and socio-economic evaluation of innovative developmental communications in space applications. The major current activities of DECU include: Training and Development Communication Channel (TDCC), Village Resource Centres (VRC), Tele-Health (TH), Tele-Education (TE) mission and new satellite communication development and applications.

H. National Remote Sensing Centre (NRSC)

National Remote Sensing Centre (NRSC) located at Hyderabad is responsible for satellite data acquisition, processing and dissemination of aerials and remote sensing data. 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.

I. Indian Institute of Remote Sensing (IIRS)

Indian Institute of Remote Sensing (IIRS), Dehra Dun is a premier training and educational institute set up for developing trained professional in the field of Remote Sensing, Geoinformatics and GPS Technology for Natural Resources, Environmental and Disaster Management.

The main area of the function of the Institute is capacity building through technology transfer among user community, education at post-graduate level in the application of Remote Sensing and Geoinformatics for Natural Resources Management and promote research in Remote Sensing and Geoinformatics. The Institute provides value-added services in the field of natural resources management, remote sensing, GIS and GPS technology. Earlier, IIRS, Dehradun, was functioning under NRSC. With effect from April 30, 2011, IIRS has been re-organised as a separate Unit of ISRO.

J. 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 for 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 & computers & 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 Byalalu near Bangalore for India's mission to moon, Chandrayaan-1, has been recently established by ISTRAC.

K. Master Control Facility (MCF)

The Master Control Facility (MCF) located 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 out the life of the satellites. The operations involve continuous tracking, telemetry and commanding, special operations like eclipse management, station-keeping maneuvers and recovery in case of contingencies. MCF interacts with the user agencies for effective utilisation of the satellite payloads and to minimize the service disturbances during special operations.

L. ISRO Inertial Systems Unit (IISU)

The ISRO Inertial Systems Unit (IISU) situated at Vattiyoorkavu, Thiruvananthapuram carries out research and development in inertial sensors, inertial systems, navigational software, actuators

& mechanisms and to realize the flight units of these system for the launch vehicle & satellite programmes and allied satellite elements. IISU is organised into research and development divisions in the areas of launch vehicle inertial systems, spacecraft inertial systems, inertial system production and reliability & quality assurance. It has facilities for precision fabrication, assembly, clean room and integration & 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 management/utilisation of natural resources using remote sensing data in conjunction with conventional techniques.

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 funded by DOS through grant-in-aid. It is a premier institute engaged in basic research in experimental & theoretical physics and earth sciences. PRL is also responsible for the administration of the Udaipur Solar Observatory. Research activities in the area of infrared astronomy, solar and plasma astrophysics, solar and galactic astronomy, geo-cosmo physics, planetary atmosphere, solar-terrestrial physics, laboratory astrophysics, theoretical physics and archaeology & hydrology are carried out at PRL. PRL is also involved in conducting extensive academic programmes for Doctoral and Post Doctoral research and also has an Associateship programme for University Teachers.

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. The main objectives of NARL are (i) Basic research in atmospheric science (ii) Indigenous technology development for probing the atmosphere and (iii) Application of Weather and Climate research for short and long term weather prediction. NARL has a variety of state-of-the art equipments such as the Mesosphere-Stratosphere-Troposphere (MST) Radar, different types of LIDARs, regular GPS sonde balloon launches, automatic weather station etc. NARL is available for national and international scientists to conduct research in atmospheric & space sciences and related disciplines.

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

The North-Eastern Space Applications Centre (NE-SAC) located at Shillong set up as an autonomous society jointly with the North- Eastern Council, is supporting the North-Eastern Region by providing information on natural resources utilisation & monitoring, infrastructure developmental planning & interactive training using space technology inputs of remote sensing & satellite communication. 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 SCL is engaged in the design, development and manufacture of Very Large Scale Integrated Circuits (VLSIs) and development of systems for telecommunication & space sectors Board Level Products. The 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.

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 primary objective of creating world class Institution in the area of advanced Space Science and Technology education and generating high quality human resources to meet the quality human resource requirements of DOS/ISRO. The Institute has undergraduate, postgraduate and doctoral programmes in the area of space science technology and applications. 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. It started functioning from its own new campus at Valiamala from August 15, 2010. The annual intake of the Institute is about 150-200 students. The first batch of fresh graduates from the Institute has been inducted to various DOS/ISRO Centres/Units in August 2011.

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, the Department has evolved the following programmes:-

(a) Launch Vehicle programme having indigenous capability for launching spacecrafts;

(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 Twenty second 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. However, there were failures of 2 Geo-synchronous Satellite Launch Vehicle (GSLV) flights viz. GSLV-D3 with Indigenous Cryogenic Stage during April, 2010 and GSLV-F06 with Russian Cryogenic Stage during December, 2010.

3.3 The Indian Remote Sensing satellite system is one of the largest constellations of remote sensing satellites in operation in the world today. With currently twelve operational satellites in orbit – TES, RESOURCESAT-1, CARTOSAT-1, CARTOSAT-2, CARTOSAT-2A, CARTOSAT-2B, IMS-1, RISAT-1, RISAT-2, OCEANSAT-2, RESOURCESAT-2 and MEGHA-TROPIQUES in IRS series of satellites which provide data in a variety of spatial, spectral and temporal resolutions. 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. SARAL (Satellite with Agros and Altika) is an Indo-French joint mission for oceanographic application, has been successfully launched from SDSC-SHAR on February 25, 2013 onboard PSLV-C20.

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. Indian National Satellite (INSAT) system is a joint venture of the Department of Space, Department of Telecommunications, India Meteorological Department, All India Radio and Doordarshan. Established in 1983, INSAT is the largest domestic communication satellite systems in the Asia Pacific Region with eleven satellites in operation – INSAT-2E, INSAT-3A, INSAT-3C, INSAT-3E, KALPANA-1, INSAT-4A, INSAT-4B, INSAT-4CR, GSAT-8, GSAT-10 and GSAT-12. Among these satellites, INAT-3A and KALPANA-1 with imaging payloads are providing frequent observations on meteorological parameters over Indian regions. The overall coordination and management of INSAT system rests with the INSAT Coordination Committee (ICC).

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 Chandrayan-1 have sent useful scientific data about Moon. The data collected from various payloads of Chandrayaan-1 were analysed by world wide scientists. Development of a multi-wave length astronomy satellite ASTROSAT and India's second mission to moon, Chandrayaan-2 have also been taken up. An Orbiter Mission to Mars, Mars Orbiter Mission, is planned to be launched during October, 2013. 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 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 Twelfth Five Year Plan 2012-2017

4.1 During the 12th Plan, the thrust of the space programme will be on augmentation INSAT/GSAT capacity to meet demand for transponders, establishment of the Indian Regional Navigational Satellite System over Indian region, continuation of established services with improved capabilities with thematic series of Indian EO satellites, expansion of satellite based applications including societal applications, strengthening of Polar satellite Launch Vehicle (PSLV) and Geo-synchronous Launch Vehicle (GSLV) as the workhorse vehicle, Realisation of developmental flights of next generation launch vehicle (GSLV MK III) capable of launching 4T class INSAT satellites; pursuance of semi-cryo engine development, undertaking space science and planetary exploration; strengthening space-based Disaster Management Support and developing critical technologies for the human spaceflight programme.

4.2 In the area of **Satellite Communications,** it has been planned to augment the INSAT capacity to bridge the gap between the demand and supply of the transponders for meeting all the requirements of the country and also to maintain sufficient spares capacity to meet contingencies. Development of state-of-the-art technologies and latest applications areas shall also be pursued.

4.3 The demand to be met for Transponders by end of 12th Five Year Plan is estimated to be ~ 398. In order to meet the emerging demand for operational transponder, 14 communication satellites are planned to be realised during the 12th Plan period for (a) increasing the transponder capacity (b) introducing new generation broadband VSAT systems (c) introduction of Ka band systems (d) building high power S-band satellite mobile communications and (e) introduction of new generation geo-imaging satellite.

4.4 In terms of spacecraft platforms, it is planned adopt I-2K, I-3K and I-4K buses for the communication

satellites. I-3K and I-4K buses are planned to be launched using procured foreign launcher. It is also planned to initiate development of High throughput I-6K – 12KW bus in higher frequency bands like Ka/Ku and the technologies associated with it.

4.5 Maintaining and securing sufficient orbit-spectrum resources for country's Satcom activities will be a thrust area of 12th Plan. It has been planned to pursue rigorously to secure spectrum for 100 additional Ku-band transponders and around 50 C-band/Ext C-band transponders in newer orbital locations.

4.6 **Satellite based Navigation** service is an emerging satellite based system with commercial and applications. Establishment of an independent Indian Regional Navigation Satellite System (IRNSS) over Indian region with a constellation of 7 satellites was planned to be realised during the 11th Plan. Considerable progress has been achieved in realizing the various subsystems of these satellites and the constellation shall be completed during the 12th Plan. Implementation of the final operational phase for satellite based augmentation system (SBAS) GAGAN (GPS Aided Geo Augmented Navigation) over the Indian Airspace is also an important targets for 12th Plan. Formulation of Indian Satellite Navigation Policy to facilitate growth of Satellite based navigation application will also be pursued. Work towards augmentation of IRNSS system with 4 additional satellites shall also be initiated during the 12th Plan

4.7 The thrust areas of **Earth Observation and Atmospheric Sciences Programme** for the 12th Plan will be in continuation of established services with improved capabilities with three thematic series of Indian EO satellites i.e. Natural resources, Cartography and Ocean & Atmosphere, including all-weather capability; development of newer state-of-the-art capabilities to meet specific user requirements; augmentation of ground segments for effective utilization of the various sensors; and special emphasis application missions in the areas of agriculture, environment, large scale mapping, infrastructure planning, oceanography, climate and atmospheric studies. To achieve the above, 8 Earth Observation missions are planned during the 12th Five Year Plan period. With the realization of these missions, there would be significant improvements in the areas of short term weather and ocean state forecasting, natural resources management, high resolution cartography, large scale mapping, space based Essential Climate Variables (ECVs) with enhanced spatial, spectral, radiometric and temporal resolution.

4.8 The **Disaster Management Support (DMS) Programme** of ISRO is intended to provide near real time information support and services from imaging and communication satellites towards efficient management of disasters in the country. Major programmatic targets of DMS programme during 12th Five Year Plan period will be Operationalization of National Database for Emergency Management (NDEM), Continuation of impact mapping and monitoring of natural disasters with improved turnaround time and with newer capabilities, acquisition of close contour data through ALTM, extension of the communication network to the District Emergency Operation centres, geo-location based services such as Search & Rescue and distress alerts, operational dissemination of the information and products directly to the affected areas, Operational utilization of early warning systems and extension of the Hydro-meteorological network.

4.9 The main focus of the **Space Transportation Systems** during 12th plan period will be towards achieving self-sufficiency in launching our satellites, developing launch vehicles for enhanced payload capability, adopting appropriate outsourcing strategies for assuring productionisation of launch vehicles, enhancement of infrastructure for launch vehicles and developing advanced technologies for the future. Towards this, enhancement of level of production of PSLV Vehicle systems with vigorous industry participation, completion of qualification of indigenous Cryogenic Upper Stage (CUS), proving GSLV with indigenous cryogenic stage, as a reliable workhorse launch vehicle, Completion of development and qualification of C25 Engine & Stage, completion of one development flight of GSLV Mk III with 4.0 T GTO capability, progress on the development of Semi cryogenic engine with the establishment of test facilities, augmentation spaceport infrastructure to meet the launch vehicle requirements shall be pursued. During the 12th Plan period, 17 PSLV missions, 6 GSLV MK-II missions and 2 GSLV MK-III missions (including one experimental mission) are planned to be accomplished.

4.10 **Space Sciences & Planetary Exploration** missions contribute significantly towards understanding the mysteries of the universe, our existence and provide an opportunity towards development of cutting edge technologies. Through space science investigations, we seek to understand the processes governing solar radiation, evolution of planetary system, formation of galaxies, evolution of stellar systems and the universe. Missions initiated during the 11th Plan such as Chandrayaan-2, Astrosat-1 and Aditya-1 will be realised in 12th plan. Undertaking India's First Mission to Mars, Mars Orbiter Mission will be an important milestone during the 12th Plan. In addition, an X-Ray polarimeter (POLIX) to study the x-ray polarization from bright x-ray emitting objects shall also be pursued.

4.11 Technological advancement, which is essential to maintain competitive relevance, will be an important thrust area for future space endeavors. The current level of technologies have to be upgraded to a higher magnitude and novel concepts have to be developed in order to achieve a much better and reliable space system. New technologies acquired will be the driving force for futuristic space missions. Towards this the following technological development activities are planned during the 12th plan period.

4.12 In the area of Launch Vehicle technology development, critical technology initiatives such as composite segmented booster case for large solid motors, elastic memory composites and Carbon-carbon technology demonstrators including optimization studies of carbon-carbon processing through CVI furnace, Robotics for planetary missions, Nano materials and composite, lunar soft lander etc., shall be pursued. Similarly, in the area of Satellite Technology development of Green House Gases and Trace gases sensors using hyperfine and ultrafine spectrometers, Field based multi-frequency microwave Ground Penetrating Radar, Reflective Optics with large diameter mirrors, Advance SiC Mirror technology for 2 to 2.5 M Optics, CFRP and composite based telescope/ antenna structures, higher capacity Lithium ion batteries, Electric propulsion along with chemical propulsion, miniaturization – MMICs, ASICs, FPGAs, HMCs, BGAs based systems, I-6K Unified bus with modular design, multi EV panels and scalable structure (Bus module & payload module), Inter-satellite communication links, Multi-channel Waveguide Rotary Joint, Development of Portable Ku-band Tele-medicine Terminal, Satcom based Automatic Identification System (AIS), development of Indigenous Space qualified atomic clocks & On-board time synchronization technology shall be initiated.

4.13 In order to demonstrate emerging new technology developments, a series of experimental satellites have been planned. One of the major missions being the technology demonstration related to Docking and Rendezvous. These satellites will be flown on the PSLV missions as auxiliary or co-passenger satellites.

4.14 In addition, policy initiatives such as New Satcom Policy, Space Legislation, Space Navigation policy etc., shall be put in place to facilitate the growth and development of Space Science and Technology in the country.

4.15 Few specialized technical facilities for supporting the development, fabrication, integration and testing of the satellite systems and launch vehicles systems as well as launch and mission management have been planned during the 12th Plan period. The critical facilities considered amongst others during the 12th plan include establishment of Third Launch Pad at Sriharikota to support the increased launch frequency of PSLV, GSLV, Multiple Object Tracking Radar for tracking the space debris to safeguard our space assets, Second Vehicle Assembly Building to improve the launch turn around, Second Cryogenic Main Engine and Stage Test facility at LMF, Mahendragiri, solar cell production facility to minimizing the dependency for solar cell from foreign sources and setting up of Space Technology Parks at different locations to facilitate industry participation in Indian Space Programme.

4.16 Overall, 58 missions are planned for realisation during 12th Plan period which includes 33 Satellite missions and 25 Launch Vehicle missions.

4.17 The Plan Outlay for the missions planned for the 12th Plan period as well as the advance investments required for the missions planned for the early phase of 12th Plan, has been indicated to be ₹ 39,750.00 Cr. The non-plan budgetary support during 12th Plan is expected to be ₹ 7,500 crores approx.

4.18 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.

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OUTCOME BUDGET 2013-14

1.1 The Budget proposals for the Department of Space have been formulated under the framework of Decade Profile 2010-2020 and the missions planned for Twelfth Five Year plan (2012-2017). The BE 2013-14 for Department of Space stands at ₹**6792.04** crore comprising of ₹**5615.04** crore 'Plan' outlay and ₹**1177.00** crore 'Non-plan' outlay. The outlay has been arrived at taking into account the Programmatic targets set for 2013-2014.

1.2 The Department has prepared **"Outcome Budget 2013-14"** based on the guidelines contained on the subject in the Department of Expenditure, Ministry of Finance Office Memorandum No. 10(3)/E. Cord/2012 dated January 01, 2013. The Table 2.1 annexed to this Chapter, gives the Outcome Budget for 2013-2014.

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.r.

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.

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Department of Space

TABLE-2.1

OUTCOME BUDGET 2013-2014

(₹ in Crores)

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
	LAUNCH VEHICLE TECHNOLOGY									
1	Geo-synchronous Satellite Launch Vehicle (GSLV).	Develop a launch vehicle to launch 2Ton class INSAT satellite into Geosynchronous Transfer Orbit (GTO) through three developmental flights.		---	---	---	Realisation and integration of stages of GSLV-D5 flight. Launch of GSAT-D5 for in-flight validation of indigenous cyro stage. Realization of subsystems for GSLV D6 mission.	Self-reliance in launching 2T class of communication satellites.	Launch of GSLV-D5 with indegenous Cryo stages planned in June 2013.	GSLV D1 and D2 have been successfully launched during 2001 and 2003. GSLV-D3 was launched in 2010 but was unsuccessful. Funding required for GSLV D5 is being met from GSLV-Operational programme. Hence, no provision is shown in the current year.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
2	Cyrogenic Upper Stage Project (CUSP).	Development of a restartable cryogenic engine & stage for GSLV to replace the Russian supplied Cryogenic stage of GSLV.	335.89	---	0.10	---	Delivery and integration of the Indigenous cryo stage with the launch vehicle. Cryogenic stage flight performance test on board GSLV-D5.	Achieve self reliance in launching 2T class INSAT type of satellites.	Launch of GSLV-D5 with indegenous Cryo stages planned in June 2013.	Indigenous cryostage has been tested on ground for the flight duration. The flight stage was flown in GSLV-D3 flight but was unsuccessful.
3	GSLV Operational.	To fabricate 16 operational GSLV launch vehicles (GSLV F1 - 16) and take advance procurement actions for additional vehicles and launch communication satellites.	3550.96	---	215.91	---	Realisation of subsystems for solid and liquid stages of GSLV-F08 mission.	Augmenting INSAT system with additional transponders to meet the communication requirements.	GSLV-F08 mission planned during 2014-2015.	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
4	GSLV Mk III Development.	To develop a Geosynchronous satellite launch vehicle capable of launching 4Ton class INSAT type of satellites to GTO.	2498.00	---	139.53	---	Readiness of S200 & L110 flight stages Readiness of passive C25 stage for flight testing. Completion of qualification tests and Mission simulation tests Launch campaign & launch of GSLV Mk III Experimental flight. C25 Engine tests, C25 development stage realization & S200 ST03 static test.	Partial Outcome: 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.	GSLV-Mk III Experimental flight targeted for 2013-14.	GSLV MK III will have the capability to launch 4T class of communication satellite into Geosynchronous Transfer Orbit.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
5	PSLV-Continuation Project.	To fabricate Operational Polar Satellite Launch Vehicles (PSLVs) for launching Remote Sensing and Scientific satellites.	1518.00	---	350.00	---	Mission planning, final vehicle Assembly, Testing and Launch of C22, C23 with IRNSS-R1A and Mars Orbiter satellites on-board respectively.	Launching of India's first mission to Mars. Launch of first Navigational satellite IRNSS-R1A to build a constellation of satellites for Indian Regional Navigational Services.	Two operational flights of PSLV are planned during 2013-14.	PSLV had so far 22 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 1750 kg through continous improvements in the launch vehicle.
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	---	0.50	---	Final Assembly, Integration and testing of SRE-II.	Outcome: SRE-2 will demonstrate the critical technologies required for recoverable launch vehicles.	SRE-2 will be launched as a co-passenger in PSLV.	SRE-1 was successfully launched on 10th Jaunary 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.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
7	Vikram Sarabhai Space Centre (VSSC).	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	263.49	469.38	---	Realisation of subsystems for three PSLV missions (PSLV C22, C23 and C25), two GSLV missions (GSLV-D5 and D6) and the first experimental flight of GSLV MKIII mission (LVM3-X mission Re-usable Launch Vehicle (RLV HEX-01) targeted for launch in September 2013 First scramjet flight testing with two active scramjet engine modules and fuel feed system in ATV-D02. Establishment of technical facilities such as Altitude nozzle testing lab, Advanced Thermo Vacuum facility, 9 Mev LINAC for high energy radiography, Optical Structure facility, Facility augmentation at HAL-ASD for Light alloy structures fabrication, sea surveillance RADAR, Magnesium Chloride recycling facility at KMML, Sodium Chlorate facility at TCC, CVI furnace, etc.	Technology development initiatives and hardware development and realisation lead to state-of-art launch vehicles for Indian Space Programme.	Continuing efforts in technology and hardware development to remain state of the art in launch vehicle and satellite technology for Indian space programme.	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)		6	7	8
8	ISRO Inertial Systems Unit. (IISU).	Research, Development and realisation of inertial sensors and systems for launch vehicles and allied satellite elements.	NA	---	69.01	---	Delivery of flight and flight standby systems of RESINS and GAINS for five PSLVs and two GSLV missions. AINS 200 ILG realization for GSLV Mk III Experimental mission. Realization of inertial systems for 8 satellite missions. Procurement of major equipment such as Single axis Rate Table with Thermal Chamber, Laser Lithographic System, High accuracy co-ordinate measuring machine, Precision CNC Turning Centre, CNC Optical Grinding machine.	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. Inertial 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.	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
9	Liquid Propulsion Systems Unit (LPSC).	Development of earth storable liquid propulsion and cryogenic propulsion technology/ systems for launch vehicles and satellites.	NA	103.97	335.12	---	Delivery of integrated propulsion system for satellite missions. CE20 Thrust Chamber hot tests in TCT facility, Integration and testing of Cryo Engine. C25 passive stage flight test in LVM3-X flight. Flight test of L110 stage in LVM 3 X flight. Hardware realisation and delivery of PS2, PS4 stages and control power plants for PSLV. Realisation of GS2 stages, L40 stages and CUS for GSLV. Delivery of SITVC & RCS systems for RLV HEX mission.	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.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
10	Manned Mission Initiative/Human Space Flight Program.	Development of critical technologies for human spaceflight like Crew Module (CM) system, Environmental Control and Life Support System (ECLSS), Flight suit (FS) and Crew Escape System (CES).	145.00 (Pre-project phase).	---	27.00	---	Realisation of Crew Module for LVM3-X Mission. Demonstration of Pad abort test. Commisioning of Environmental Simulation Chamber. Realisation of Engineering model of subsystems of ECLSS and its testing in ESC.. Functional testing of flight suit in ESC. Realisation of 2.5 ton CM structural model for simulating the complete parachute deployment sequence through air drop test.	The final outcome, in terms of availability of technologies for manned mission would take about 3-4 years.	Crew escape system demonstration through pad abort test is targetted in 2013-14.	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	**Outlay 2013-14**			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
11	Semi-cryogenic Engine / Stage Deveopment.	Developing a higher thrust semi-cryogenic core stage for the unified modular launch vehicle.	1798.00	---	180.00	---	Engine sub systems realization. Development of advanced materials. Installation of facilities at LMF. Development of Engine systems.	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 cost effective and eco-friendly technology which is expected to ensure low cost access to space.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
12	Indian Institute of Space Science and Technology.	To develop high quality manpower required for Space Science, technology and applications programmes.	NA	12.00	138.50	---	Completion of admissions for the academic year 2013-14. Conduct of the courses for the academic year 2013-14.	The second batch of students have been inducted to ISRO Centres/units during August 2012. 3nd batch of graduates expected to be inducted during August 2012.	Completion of admissions for new Academic year by July 2013.	IIST has started the courses from the Academic year 2007-08. The annual intake of the institute is 156 studnets for three courses in Avionics, Aerospace engg and applied science. The IIST campus is now located in Valiamala.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
	SATELLITE TECHNOLOGY									
13	Oceansat-3	Development and Launch of Oceansat-3 satellite for Oceanographic applications. This will be a continuation mission to Oceansat-1 and Oceansat-2.	Yet to be approved.	--	5.00	--	Project Report Preparation.	Partial Outcome: Review of Project Report.	Review of Project Report is expected to be completed during 2013-14.	Oceansat-3 will provide continuity of data for already established services in the area of Oceanographic applications.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
14	Indian Regional Navigational Satellite System.	To develop a constellation of Indian Regional navigational satellite system (IRNSS) for providing positioning services.	1420.00	---	135.00	---	Launch of IRNSS-R1A Satellite - the first satellite in IRNSS series. Integration of IRNSS-R1B & R1C. Establishment of Ground elements. Operationalisation of GPS Aided GEO Augmented System (GAGAN).	Partial Outcome: 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 2013.	Satellite Navigation is strategically an important area of Space technology applications.
15	GSAT-11: Advanced Communication Satellite.	Development and launch of a 4T class communication satellite with advanced communication payloads.	500.00	---	203.00	---	Development of structural and subsystem qualification models of the spacecraft and payload subsystems.	Partial Outcome: Finalisation of payloads for the satellite.	Government have approved the project in August 2009.	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
16	SARAL	Development and launch of a 400-450 kg class satellite for ARGOS and ALTIKA.	73.75	---	10.00	---	Post-launch operations and Operationalisation of SARAL.	Final Outcome: Launch and operationalisation of SARAL.	Approval for SARAL project was obtained in Feb 2009. The SARAL satellite mission is to be launched during 2012-13 into a sunsynchronous, 6 am- 6 pm orbit at an altitude of around 800 km.	SARAL - Satellite with Argos and Altika - is a joint mission with the French Space Agency CNES.
17	GEO-Imaging Satellite (GISAT).	To Develop a geosynchronous satellite capable of imaging in visible and thermal band with 50m resolution for continuous observation of Indian Sub-continent for quick monitoring of disasters, natual calamities and episodic events.	392.00	--	80.00	--	Development of Payload and sub-systems.	Partial Outcome: Development of Payload and other subsystems of GISAT is expected during 2013-14.	GISAT was approved in 2009.	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
18	Resourcesat-2A	Develop and Launch Resoucesat-2A satellite to provide continuity of data in the area of Natural Resources Management.	200.00	---	28.00	---	Preliminary Design Review(PDR). Initiation of procurement action for long lead items.	Partial Outcome: Preliminary Design Review.	PDR of Resourcesat-2A is planned during 2013-14.	Resoucesat-2A is a follow-on mission to Resourcesat-2 satellite which was launched on 2011.
19	Cartosat-3	Develop and Launch an advanced remote sensing satellite with enhanced resolution of 0.25m for cartographic applications and high resolution mapping.	Yet to be approved	---	10.00	---	Preparation of Project Report and its submission for Approval.		The approval of Cartosat-3 is expected during 2013-14.	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
20	Scattsat	Develop and Launch a Remote Sensing Satellite with pencil beam Ku-band scatterometer and milimeter wave sounder.	Yet to be approved.	---	5.00	---	Finalisation of project report for Scattsat and processing the same for approval of the Government.	Partial Outcome: Approval of Project Report for Scattsat.	Government approval for Scattsat expected during 2013-14.	Scattsat will provide data for measurement of wind vector and vertical temperature profile of atmosphere useful for atmospheric & Oceanographic studies.
21	RISAT-1A	Develop and Launch a Microwave Remote Sensing Satellite with C-band Synthetic Aperture Radar for Flood Management and Agricultural Applications.	Yet to be approved.	---	1.00	---	Finalisation of project report for RISAT-1A and processing the same for approval of the Government.	Partial Outcome: Approval of Project Report for RISAT-1A.	Government approval for RISAT-1A is expected during 2013-14.	RISAT-1A is a follow-on mission to RISAT-1 with C-band multi-polarised Synthetic Aperture Radar having capability of imaging under all weather conditions.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	**Outlay 2013-14**			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
22	Earth Observation - New Missions (RISAT-3 and Future EO missions).	To undertake New Earth Observation Missions with enhanced imaging capability.	(Project not yet approved).	---	0.01	---	Finalisation of project report for RISAT-3 and processing the same for approval of the Government.	Partial Outcome: Approval of Project Report for RISAT-3.	Government approval for RISAT-3 is expected during 2013-14.	RISAT-3 is a microwave remote sensing satellite for disaster management and agriculture applications.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
23	ISRO Satellite Centre.	Developing Satellite Technology and implementation of satellite systems for scientific, technological and application missions.	NA	114.67	242.13	---	Technology Development initiatives - Robotic arms for Lunar Lander, Docking mechanism for small spacecrafts, Digital telemetry transmitter, Deep Space X and Ka-band telemetry and ranging transmitter, Ultra wide band antenna, S-band high power SSPA, Thermoelectric generators etc. Assembly, integration and testing of Satellites for launch. (IRNSS-R1A, GSAT-14, INSAT-3D and GSAT-7) The structure delivery and fabrication activities for GSAT-9, GSAT-11, GSAT-15, Mars Orbiter Mission, IRNSS-2&3.	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 ISRO Satellite Centre (ISAC) is the lead centre for Satellite Technology. A new facility, ISRO Satellite Integration and Test Establishment (ISITE) including a Comprehensive Assembly, Test and Thermo-Vaccum Chamber (CATVAC) has been set up recently.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
24	Laboratory for Electro-optics Systems. (LEOS).	Research and Development in the field of electro-optics systems required for satellites.	NA	---	38.60	---	Satellite integration level testing of sensors for GSAT-14, IRNSS-R1A, ASTROSAT, GSAT-7 and INSAT-3D. . Development of Sensors and Optics for GSAT-11, Cartosat-3, Chandrayaan-2 and MARS Orbiter Mission. Development of Laser Induced Breakdown Spectroscopy (LIBS) payload and Camera for LAND ROVER. Development of Silicon Carbide (SiC) optics technology, Navigational cameras for Lunar Rover, and space grade color camera for SRE-2.	Realisation of tested and qualified electro-optical sensors such as earth sensor, sun sensor, star sensor, magnetometer and sensor electronics for satellites. Electro-optic sensors are intermediate products used in satellites.	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.	LEOS have developed unique technological capability in the field of optics fabrication and Micro Electro-Mechanical Systems (MEMS) for space applications.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
25	Semi-conductors Laboratory (SCL).	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	44.70	60.94	---	Process Qualification and Operationalisation of 8" FAB line. Completion of process integration lots and fabrication & testing of SRAM devices. Fabrication, packaging and characterisation of High range pressure sensors. Development of proto-type devices for devices such as Low Voltage Differential Signalling Transmitter, Low Voltage Differential Signal Receiver, CCD Signal Processor, Timing Sequencer, On-Board Controller, Protocol controller ASIC etc.	Realisation of micro electronic devices such as ASICs, MEMS based devices, CCDs, memories, etc, for strategic applications. The output of this unit is an intermediate product used as components / devices in satellites and launch vehicles.	Technology/ process / device development, improvement and scaling up is a continuous process to remain state-of-art in the ares of micro-electronics technology and to achieve maximum self-reliance in this strategic area.	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 orgnisations such as DRDO, DAE and ISRO.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
26	Satish Dhawan Space Centre - SHAR. (SDSC-SHAR).	To build, maintain and operate state-of-art launch infrastructure for assembly and launching of rockets, solid propellant preparation and auxiliary support facilities.	NA	162.17	295.66	---	Preparation of Launch vehicle segments, Integration, propellant servicing, and launch of PSLV flights. Preparation of L40 strap-ons, GS2 and cryo stages. launch support to GSLV launches. Production of S200 segments for static test and experimental flight of GSLV MK III. Configuration finalisation, PDR, CDR and completion of procurement planning for Multi Object Tracking Radar. Configuration finalisation of second Vehicle Assembly Building.	Realisation of tested and qualified solid motors for PSLV and GSLV. Solid propellant motors and Launch complex facilities are intermediate stages for launching of rockets.	Launch support for PSLV C22, C23, C24 and C25, GSLV D5 & GSLV-Mk III experimental flights are planned to be completed in 2013-14.	A State-of-art new Mission Control Centre and Launch Control Centre have been established at Sriharikota to enable launch of future advanced launch vehicles as well as to provide redundancy for the existing MCC.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
27	ISRO Telemetry, Tracking and Command Network. (ISTRAC).	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	61.72	67.54	---	On-orbit operation and maintenance of all Indian Remote Sensing satellites. Launch and downrange tracking support for PSLV C22, to C25 and GSLV D5 missions. LEOP support for IRNSS, MARS Orbiter Mission and GSAT-14. Operationalisation of of IRNSS Ground Segment. Installation and Commissioning of C-band DWR at TERLS, Thiruvananthapuram. Delivery of X-Band DWR to NARL, Gadanki.	Enabling operational services of remote sensing and scientific satellites.	On-orbit operation and maintenance of satellites is a continuous round-the-clock process.	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). ISTRAC has established a Special Deep Space Network at Bylalu near Bangalore for Chandrayaan-1 with a 18 m dia and 32 m dia Antenna realised through Indian Industries.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
	SPACE APPLICATIONS									
28	Space Applications Centre (SAC).	Design and development of payloads for communication, meteorological and remote sensing satellites and conduct space applications research and development.	NA	143.51	192.57	---	Delivery of payloads for INSAT-3DR, GSAT-15, GSAT-16 and IRNSS-R1C. Development of payloads for Chandrayaan-2, GISAT, Resourcesat-2A. Completion of technology development for Milimeter Wave Humidity Sounder, Ground Penetration Radar (GPR) and Ground Based C-Band Scatterometer.	The payloads are intermediate products required for building satellites. Technology development initiatives and experiments lead to realisation of state-of-art payloads.	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.	

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
29	Development and Educational Communication Unit (DECU).	Conceptualisation, definition, planning, implementation and socio-economic evaluation of the developmental applications of space technology.	NA	14.61	32.14	---	Replacement of Damaged Hub and Teaching End of Mizoram Tele-Education network. Up-gradation of ROT to Interactive Terminals (100 ROTs of Odisha & 100 in Karnataka) using hybrid Technology Up-gradation of the Telemedicine nodes in two states to integrate them with the existing Tele-education hubs installed in various states for an integrated approach. Re-activation of VRC nodes. Addition of 100 new VRC nodes.	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.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
30	National Natural Resources Management System (NNRMS).	Developing National Natural Resources Management Applications using Remote sensing data and supporting region-specific remote sensing applications.	NA	---	31.50	---	Completion of natural resources mapping at 1:10000 scale for entire country under Space-based Information Support for Decentralised Planning (SIS-DP) Completion of 9th cycle of Land Use / Land Cover Mapping at 1:250K scale. Initiation of 10th cycle. Updation of NRDB Repository with the datasets from the ongoing projects.	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 Scineces, Ministry of Rural Development, Ministry of Environment and Forests, Ministry of S & T and State development agencies for various natural resource management applications.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
31	Earth Observation Application Mission.	To evolve newer applications / R&D programmes, guiding remote sensing application programme with the user agencies.	NA	---	4.37	---	Earth Observation application projects - Fire risk alarm system, international crop assessment, Narcotic Crop Assessment Project, 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.,		Application of Earth Observation data for developmental activities is a continuous process.	

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
32	North Eastern Space Applications Centre (NE-SAC).	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	2.20	5.80	---	Preparation of forest working plans and schemes for entire North Eastern Region Soil and land capability mapping of all agricultural districts of North Eastern Region Preparation of Space Based Information System on North Eastern Region (SBIK-NER) Water balance analysis of Umiam reservoir in Meghalaya Setting up of one Electronics research lab equipped with some specific hardware and software for research/ design works pertaining to SATCOM Electronics.	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.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
33	National Remote Sensing Centre (NRSC).	Acquisition, processing, distribution of data from Indian Remote Sensing Satellites and research, development and executing remote sensing application projects in collaboration with users.	NA	89.39	109.61	---	Integration of Data Reception from all ongoing IRS missions into IMGEOS. NRSC shall continue to support all services and development works for various natural disasters. Augmentation of Facilities with new aerial Large Format Digital Camera, distributed architecture set-up for Bhuvan services, Virtualization system for IMGEOS.	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 Scineces, Ministry of Rural Development, Ministry of Environment and Forests, Ministry of Science and Technology and State development agencies for various natural resource management applications.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
34	Indian Institute of Remote Sensing (IIRS).	To Develop trained professional in the field of Remote Sensing, Geoinformatics and GPS Technology for Natural Resources, Environmental and Disaster Management.	NA	5.77	24.58	--	Conduct various courses for the Academic year 2013. Initiation of inter-disciplinary long-term Research Programme in North Western Himalaya on "Monitoring & Assessment of Ecosystem Processes" Introduction of Customized courses for capacity building of State/ Central Govt. officials engaged in various national developmental programmes.	Capacity Building in the Area of Remote Sensing, Geoinformatics and GPS Technologies.	Completion of Courses as per Academic Calendar 2013.	Since April 30,2011, IIRS has been functioning as a Unit of ISRO.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
35	Disaster Management Support.	Providing space technology inputs and services on a reliable and timely manner for the disaster management system in the country.	NA	---	30.42	---	Information support for Periodical monitoring of Floods, Landslides, Drought, Forest fires and Cyclones. Processing of ALTM data of Godavari basin Phase-II (3500 sq. km) and Mahanadi basin Phase –II in Orissa (9500 sq. km) will be completed and delivered to user. Completion of installation of 500 numbers of DTH based Digital Disaster Warning System. Establishment of North Eastern Regional Node for Disaster Risk Reduction (NER-DRR) Continuation of support for global disaster management efforts through International Charter, Sentinel Asia etc.	Strengthening of Disaster Management System in the country.		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.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
	SPACE SCIENCES									
36	ASTROSAT	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	---	5.00	---	Assembly and Integration of payloads to the main structure. Environmental tests and readiness for launch.	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 2014 onboard PSLV.	ASTROSAT is a unique observatory satellite simultaneously covering a range of high energy radiation hitherto not covered from any other global observatory missions.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
37	Indian Lunar Mission Chandrayaan-1& 2.	The baseline mission objective of Chandrayaan-2 is to soft land at a suitable site on the lunar surface and to carry out in-situ chemical analysis.	811.00	---	78.00	---	Chandrayaan-2: Design and development of payload elements. Completion of mainframe system PDR. Fabrication of structures. Fabrication of spacecraft subsystems - BMU, Power, RF systems.	Final outcome is the enhanced understanding of the Moon and its environment from the analysis of the scientific data received from Chandrayaan satellite.	Chandrayaan-2 is slated for launch in 2014-15.	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 satisfactorily provided a new insight on the Moon's origin and evolution.

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1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
38	ADITYA-1	To launch a spacecraft, which will be the first Indian Space based solar coronagraph, which will be available for solar coronal observation to all the Indian researchers in the field of Solar Astronomy.	127.75	--	20.00	--	Development of Solar Coronagraph. Procurement of long lead / critical materials.	Final outcome is to achieve a fundamental understanding of the physical processes that heat the solar corona, accelerate the solar wind and produce Coronal Mass Ejections (CMEs).	The project is approved in 2009-10 with a total cost of Rs 127.75 Crores.	
39	Mars Orbiter Mission	Design, Develop and Launch a Spacecraft to reach and orbit around Mars to study Martian surface features and atmosphere.	450.00	--	167.50	--	Assembly, Integration and Testing of Mars Orbiter. Launch of Mars Orbiter.	Intermediate Outcome: Launch of Mars Orbiter.	Mars Orbiter is scheduled for launch during 2013-14.	Mars Orbiter Mission will be India's first mission to Mars Planet undertaken by ISRO.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
40	Physical Research Laboratory (PRL).	Carryout basic research in the areas of astronomy and astrophysics, solar physics, planetary science, interplanetary science, earth's magnetosphere, phere,atmosphere, earth's surface and interior, theoretical physics, quantum optics / lasers C99.	NA	39.83	101.63	---	Development of space qualified model of the 2 payloads for Chandrayaan-2 mission and the proposed payload for the Mars mission. Design and development of sub-systems for the proposed X-ray polarimeter mission.	Partial Outcome: Capability to develop complex payloads and analysis of data for space science and planetary exploration. PRL is primarily an R & D institution and the outcome is in the form of expanding our knowledge in the areas of Astronomy and Astrophysics, Solar physics, Planetary science, Earth Science, Atmospheric science and related fields.	Space Science Research is a continuous process.	

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1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
41	Sensor Payload development / Planetary Science Programme.	Design and Development of Engineering model of sensors/scientific instruments for space and planetary science programme.	NA	---	3.53					
42	National Atmospheric Research Laboratory (NARL).	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	3.80	16.77	---	Developemnt of portable Mesosphere Lower Thermosphere Photometer (P-MLTP) with temporal resolution of 20 seconds. Development of ground-based lightning sensors using VHF interferometry/ magnetic direction finding combined with optical sensing to locate the source direction of the lightning events.	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.

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1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
43	Atmospheric Science Programme.	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	---	21.80	---	Establishment of instrumentation over oceans. Collaborative programme on Cloud-Precipitation systems. Installation of nearly 200 nos of AWS. Meso-net data utilization for crucial ongoing projects of ISRO and other agencies. Initiation of a national project on ""Assimilation of soil moisture and other land surface parameters"" Development of space borne cloud radar.	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 substanitally enhance the data inputs for weather modelling.

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1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
44	RESPOND	To strengthen the academia interaction through collaberative research, educational and scientific activities.	NA	---	22.80	---	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-base and human resources in academic institutions in the area of space research.	The Research is a continous 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.

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1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
45	ISRO Geosphere Biosphere Programme (ISRO GBP)	To investigate the processes between Geosphere-Biosphere-Atmosphere and their interactions, radiative forcing, regional climate,micro gravity and and space science promotion / research.	NA	---	26.73	---	Initiatives on National Action Plan for Climate Change. Studies on atmospheric trace gases, transport and modeling. Impacts of Land Use/Land Cover and run off change with particular reference to forest cover, shifting cultivation areas and habitation pattern on the climate of Barak basin in north eastern India 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.	

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1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
46	Other Schemes		NA	3.00	14.10	---				
47	Small Satellites for Atmospheric Studies and Astronomy.	To design and develop small satellites for study of Earth's near space environment, study of aerosol and gases, inner magnetosphere and Solar Physics.	9.85	---	5.00	---	Realisation of subsystems and payload of the spacecraft.	Partial Outcome: Realisation of subsystems of the spacecraft.	Spacecraft realisation in 2014.	Nano satellite for Aerosol monitoring.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
	DIRECTION, ADMINISTRATION AND OTHER PROGRAMMES.									
48	Development of Space Materials and Components.	Indigenous development of high reliability electronic components including micro-electronics devices, space grade materials.	NA	---	17.51	---	Development of Traveling 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.	Import substitution of critical space grade materials and components.	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.

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1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
49	Advance Ordering.	Stockpiling of critical components, materials and sub-assemblies for satellites and launch vehicles.	NA	---	10.00	---	Procurement of long lead components, materials, sub-assemblies.	Partial Outcome: Procurement planning of components and materials	Continuous process.	
50	Others (includes mainly ISRO Head quarters, Civil Engineering Division Head quarters, DOS secretariat and Central Management Expenses).	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	79.23	27.64	---	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.	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
	INSAT OPERATIONAL									
51	Master Control Facility	To carryout continuous Monitoring & Control of Geo-Stationary Satellites of India – during initial orbit raising and regular On-orbit phases of various Satellite Missions	NA	35.94	37.97	---	On orbit operations and maintenance of INSATs, GSATs and METSATs. Establishment of Satellite Control Centre for IRNSS Missions Delivery of main Hardware for Optical Telescope Project at Ponmudi & Mt. Abu. Launch and Early Orbit phase operations support for INSAT-3D, GSAT-7, GSAT-14 and IRNSS-1 Missions.	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.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
52	INSAT-3 satellites (including launch services).	Development and launch of third generation INSAT-3 satellites (INSAT-3A to 3E) to augment the capacity of INSAT system.	2979.63	---	25.30	---	Assembly, tegration,Testing and launch of INSAT-3D Spacecraft.	Final outcome: Availability of meteorological data from the satellite after the launch and operationalisation of INSAT-3D.	Launch and operationalisation of INSAT-3D is targeted during 2013-14.	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.
53	INSAT-4 Satellites (including launch services).	Development and launch of fourth generation INSAT-4 satellites to augment the INSAT system capacity. (Currently, INSAT-4A to 4G and GSAT-9, GSAT-10 & GSAT-12, GSAT-14 and GSAT-6A have been approved).	3642.70	---	97.00	---	Assembly, Integration and Testing of GSAT-14 satellites and its readiness for launch. Payload and mainframe subsystem realisation of GSAT-9, GSAT-6 satellites.	Launch of GSAT-14 to augment the transponder capacity with 6 Ku Band and 6 extended C Band transponders.	GSAT-14 satellite is targeted for launch in 2013-14 by using GSLV-D5.	INSAT system currently has 196 Transponders, which is used for Telecommunications, Broadcasting, Business Communications, Rural Area communications, Emergecny communication and developmental communications.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
54	Service Charges for Leasing of INSAT/GSAT Transponders.	To facilitate augmentation of transponder capacity of INSAT/ GSAT system.	NA	--	200.00	--				
55	INSAT-3D Launch Services.	To Launch INSAT-3D Spacecraft by using procured launch services.	477.00	--	270.00	--	Securing launch slot with a service provider.	Launch of INSAT-3D satellite using procured launch Services.	Launch of INSAT-3D is scheduled during 2013-14.	
56	GSAT-15 Satellite.	To develop a communication satellite with 24 Ku-band transponders and a GAGAN payload.	Yet to be approved	---	100.00	---	Approval of the project. Preliminary Design Reviews.	Partial Outcome: Approval of GSAT-15 project.	Approval of GSAT-15 is expected during 2013-14.	GSAT-15 will further augment GSAT/INSAT system with 24 Ku-band transponders.
57	GSAT-15 Satellite - Launch Services.	To secure Launch Slot for GSAT-15 satellite through procured launch services	Yet to be approved	---	300.00	---	Signing of Launch Services Contract with a Service Provider.	To secure a launch slot for launching GSAT-15.	Signing of Launch Services Contract is targetted during 2013-14.	
58	GSAT-16 Satellite.	To develop a communication satellite with 24 C-band, 12 Upper Ext-C band and 12 Ku-band transponders.	Yet to be approved	---	95.00	---	Approval of the project. Preliminary Design Reviews.	Partial Outcome: Approval of GSAT-16 project.	Approval of GSAT-16 is expected during 2013-14.	GSAT-16 will further augment GSAT/INSAT system with 24 C-band, 12 Upper Ext-C band and 12 Ku-band transponders.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2013-14			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
59	GSAT-16 Satellite - Launch Services.	To secure Launch Slot for GSAT-16 satellite through procured launch services.	Yet to be approved	---	305.00	---	Signing of Launch Services Contract with a Service Provider.	To secure a launch slot for launching GSAT-16.	Signing of Launch Services Contract is targetted during 2013-14.	
60	GSAT-17 Satellite and follow-on missions.	To develop follow-on communication satellites in order to Augment INSAT/GSAT Transponders.	Yet to be approved	---	90.00	---	Preparation of Project Reports for GSAT-17 & 18 Satellites.	Partial Outcome: Approval of GSAT-17 & 18 projects.	Approval of GSAT-17 & 18 satellites is expected during 2013-14.	
61	GSAT-17 Satellite and follow-on missions - Launch Services.	To secure Launch Slots for Future Communication satellites through procured launch services.	Yet to be approved	---	10.00	---	RFP for Launch services Contract.	To secure a launch slot for launching GSAT-17 & 18 satellites.	Signing of Launch Services Contract is targetted during 2014-15.	
62	GSAT-7 Launch Services.	To Launch GSAT-7 Spacecraft by using procured launch services.	479.00	--	14.00	--	Securing launch slot with a service provider.	Launch of INSAT-3D satellite using procured launch Services.	GSAT-7 is expected to be launched during 2013-14.	
	Total		**21517.58**	**1177.00**	**5615.00**					

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 and most of relevant societal applications. Some of the recent applications of space technology such as Tele-medicine and Tele-education have had a far reaching impact on national development. These efforts together with condusive policies and reform measures adopted by the Department have yielded rich results.

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 farmed 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 about 300 technologies to Industries for commercialization. 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, interactive vocational training towards alternate livelihood etc. ISRO primarily acts as technology and bandwidth provides, Tele-medicine 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 473 VRCs have been set up in Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Meghalaya, Nagaland, Orissa, Rajasthan, Sikkim, Tamil Nadu/Pudhucherry, Uttar Pradesh, Uttarakhand, West Bengal, A&N Islands. 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.

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

ONGOING PROJECTS/PROGRAMMES

1. GSLV-Operational Project

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
3550.96	1919.34	208.96	250.00	214.91

1.1 In order to meet the launch requirement of 2 tonne class of operational INSAT/GSAT satellites, the GSLV-Operational Project has been conceived. Currently, the approved scope of the Project include realization of 16 launch vehicles (F01-F16).

1.2 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 the strap-on stages. However, GSLV-F04 carrying INSAT-4CR was successfully launched on September 2, 2007. The GSLV F-06 mission carrying GSAT-5P launched on December 25, 2010 was unsuccessful due to untimely and inadvertent snapping of a group of 10 connectors located at the bottom portion of the Russian Cryogenic Stage.

1.3 GSLV F06 FAC and GSLV D3 FAC final reports have been submitted. All the recommendations from GSLV F06 FAC and GSLV D3 FAC were incorporated and implemented for GSLV D5 mission. Modifications in Fuel Booster Turbo Pump (FBTP) and Oxidizer Booster Turbo Pump (OBTP) were carried out along with improvements in CUS stage elements. The CUS lower shroud was redesigned and strengthened. Wire tunnel configuration was modified by extending its length. The lanyard connector mounting bracket was relocated from the lower shroud to truss member. GSLV D5 mission strategy has been reviewed and approved by MRR-01. It is planned to conduct high altitude testing (HAT) on indigenous Cryo stage for which the existing TCT facility of GSLV MkIII at LMF is augmented.

1.4 GSLV D5 aerodynamic characterization was revisited for which 830 wind tunnel blow downs were carried out at NAL & GK. CFD simulations were carried out in-house for incremental effects on protrusion, overall aerodynamic load distribution and Cp distribution on protrusions. The total run-time for all the CFD simulations was 4176 hours.

1.5 Considering the successive failures of GSLV D3 and GSLV F06 mission, it has been decided to establish the robustness of GSLV vehicle by having the next two subsequent missions as developmental flights. GSLV D5 with 3.4m PLF and indigenous cryo stage will be flown during 2013-14 and GSLV D6 with 4m PLF and indigenous cryo stage will be flown during 2014-15.

2. GSLV-Operational Project

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
2498.00	2304.44	72.09	72.10	139.53

2.1 GSLV Mk III Project is responsible to develop a cost effective heavy lift Launch Vehicle (LVM3) capable of launching 4 ton class of communication satellites into Geo-synchronous Transfer Orbit (GTO). The major propulsion modules in LVM3 include two S200 solid strap-on stages, L110 core liquid stage & C25 cryogenic upper stage. The facilities required for hardware realisation, assembly & testing have been established at different work centres. Both S200 & L110 stages have been qualified through static hot tests. Critical Design Reviews (CDR) of both S200 and L110 have been completed. Sub-systems for S200 & L110 flight stages have been realized.

2.2 Full vehicle integration mock up was carried out at SDSC-SHAR to validate the facility & vehicle interfaces. The propellant mock up of L110 stage was carried out at launch pad to validate the servicing interfaces & procedures. Ground Resonance Test of LVM3 in Core alone configuration has also been completed. Structural qualification tests, Acoustic & Vibration tests of sub-assemblies & separation system functional tests are progressing well. C25 integrated engine test is planned during 2013-2014.

2.3 The first experimental flight (LVM3-X) with passive C25 stage is planned in the first quarter of 2013-2014.

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

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
2863.52	2183.24	380.00	170.00	350.00

3.1 The Polar Satellite Launch Vehicles (PSLV) are capable of placing 1750 kg class IRS satellites in Sun Synchronous Orbit, 1 tonne class in Geo-Synchronous Transfer Orbit (GTO) and 3000 kg class satellites in Low Earth Orbit.

3.2 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-1) 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 pre-determined 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 were 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. PSLV-C12 successfully launched RISAT-2 along with ANUSAT satellites on April 20, 2009. PSLV-C14 carrying Oceansat-2 along with six other nano satellites placing it in circular SSPO orbit was successfully launched on September 23, 2009. On July 12, 2010, the PSLV-C 15 in addition to Cartosat-2B carried four auxiliary satellites, namely STUDSAT built jointly by students from a Consortium of seven engineering colleges from Karnataka and Andhra Pradesh, two nano satellites i.e., NLS 6.1, NLS 6.2 from University of Toronto, Canada and ALSAT-2A, a micro satellite from Algerian Space Agency.

3.3 PSLV-C16 launched on April 20, 2011 carried Resourcesat-2 and 2 auxiliary satellites namely Youthsat (Indian Mini Satellite -2) and XSAR (developed by the Nanyang Technological University, Singapore). PSLV-C17 was carrying an exclusive communication satellite GSAT-12, launched successfully on July 15, 2011. PSLV-C18 launched on 12th October, 2011, carried Megha-Tropiques satellite which is an INDO-FRENCH collaborative programme. The co-passengers are SRMSAT (SRM University), JUGNU (IIT Kanpur) and VESSELSAT-1 (LUX Space, Luxembourg).

3.4 PSLV-C19 successfully launched RISAT-1, India's first indigenous Radar Imaging Satellite on 26 April, 2012 and the PSLV-C21/SPOT-6 mission on 9 September, 2012 which was a dedicated commercial mission with two foreign spacecrafts, viz., SPOT-6 (France) and PROITERES (Japan) on-board. SPOT-6 (712 kg) was the heaviest commercial satellite launched by PSLV so far. On 25th February, 2013 PSLV-C20 successfully launched SARAL, which is a joint project of DOS/ISRO and French National Space Agency. Satellite (Satellite with ARGOS and ALTIKA) is designed to monitor the sea water level. PSLV-C20 also carried 6 satellites viz., Sapphire, NEOSAT, 3 Nos of NLS-8 series and STRaND.

3.5 Future launches of PSLV planned for the next year are given below:

- PSLV-C22 carrying India's first Regional Navigation satellite, IRNSS-1A in the first quarter of 2013-2014;
- PSLV-C25 with India's first MARS Orbiter Mission in September/October, 2013;

3.6 With 23 Consecutive successful launches so far, PSLV has repeatedly proved itself as a reliable, versatile and cost-effective launch vehicle of ISRO.

4. Cryogenic Upper Stage (CUS) Project

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
335.89	335.88	0.10	0.10	0.10

4.1 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.

4.2 The CUS-3 stage was flight tested in GSLV-D3 mission on 15th April, 2010 which was unsuccessful. A comprehensive technical assessment of CUS-3 flight stage by National Panel of Eminent Experts was carried out and recommendations were implemented. Accordingly, the margins on fuel booster turbo pump speed were demonstrated in ground test. Ground preparation of the stage was satisfactory and achieved the required lift off conditions. On board chilling of feed lines, maintenance of the propellant tank pressures during flight etc., were successfully demonstrated and required conditions for the engine ignition were achieved.

4.3 The expected performance of the stage was not achieved due to the anomaly in the Fuel Booster Turbo-Pump (FBTP). Subsequently, Fuel Booster Turbo Pump (FBTP) failure simulation tests were conducted at SET facility considering various suspected failure scenarios in GSLV D3 mission. Later, based on FAC & Expert Committee recommendations, FBTP was modified with increased seal clearances & qualification tests were carried out. Also, engine level tests were also conducted using A4 Main Engine, wherein modified OBTP was flight acceptance tested & performance of modified FBTP was assessed.

4.4 The Flight Main engine (A7) was realized & two cold start tests were conducted to finalize the parameters for flight acceptance hot test. Flight acceptance testing of steering engines (SE18 & SE 22) was successfully conducted at SET-HAT, LMF. Fuel & Oxidizer booster turbo pumps were realized and flight acceptance tested. Indigenous LOX & LH2 level sensors were realized &flight acceptance tested. Stage structures viz. modified Lower Stub Adaptor (LSA), Lower Truss (LT) and Inter Tank Truss (ITT) were realized & delivered for flight stage integration.

5. Indian Remote Sensing Satellites (IRS) Projects

(₹ in crores)

	Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
Oceansat-2&3	129.15	126.18	50.00	0.00	5.00
Resourcesat -2&3	138.79	137.83	10.50	0.80	0.00
Resourcesat-2A	200.00	0.00	0.00	0.00	28.00

5.1 Oceansat-2 envisaged as in-orbit replacement to Oceansat-1 carries Ocean Color Monitor and a Ku-band pencil beam Scatterometer. In addition, it carries a Radio Occultation Sounder for Atmospheric Studies (ROSA), developed by the Italian Space Agency (ASI). Oceansat-2 is used for identification of Potential Fishing Zones, sea-state forecasting, coastal zone studies and provide inputs for weather

forecasting and climatic studies. The spacecraft was launched successfully onboard PSLV-C14 on 23rd September 2009. The payloads have been commissioned and the performance of the spacecraft is normal. Oceansat-3, planned to be realized during the 12th Plan, will be a follow-on Satellite for Oceansat-2 to provide continuity of data on Ocean and Coastal resources.

5.2 Taking into account the increased use of space imageries for different applications and continued Earth Observation services required from the IRS satellites, Resourcesat-2 was conceived as a continuity mission with enhanced capabilities, which will be mainly for crop applications, vegetation dynamics and natural resources census applications. Resourcesat-2 was successfully launched onboard PSLV C-16 on April 20, 2011.

5.3 Resourcesat-2A has been approved with an estimated cost of ₹200.00 Cr. Resourcesat-2A is conceived as a follow-on mission to provide continuity of services with enhanced capabilities, which will be mainly for crop applications, vegetation dynamics and natural resources census applications.

6. Radar Imaging Satellite Project (RISAT)

(₹ in crores)

	Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
RISAT-1	378.49	379.95	0.25	0.90	0.00
RISAT-1A	Yet to be approved	0.00	0.00	0.00	1.00

6.1 Radar Imaging Satellite (RISAT) is a microwave remote sensing mission with Synthetic Aperture Radar (SAR) as a payload operating in C band. The Satellite is designed for an operational life of 5 years. The total mass of the satellite works out to the 1780 kg. The Satellite was successfully launched by PSLV-C19 on 26th April, 2012.

6.2 RISAT-1A is conceived as a follow-on mission to RISAT-1 satellite. RISAT-1A will have a Synthetic Aperture Radar operating in C-band capable of imaging in day-night all-weather conditions.

7. Indian Lunar Mission – Chandrayaan-2

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
425.00	96.43	82.50	56.01	78.00

7.1 The baseline mission objective of Chandrayaan-2 is to soft land at a suitable site on the lunar surface and carry out in-situ chemical analysis. Chandrayaan-2 is envisaged as a two module configuration comprising of Orbiter Craft module and Lander Craft module. Both the modules interfaces mechanically by a inter module adapter. Chandrayaan-2 is planned to be launched onboard GSLV MK II with a lift off mass of 2560 kgs and will carry two rovers each weighing 50 kgs. One Rover is developed by Russian Space Agency and the other at ISRO Satellite Centre.

7.2 Preliminary studies for the landing site selection have been done and a possible list of payloads has been prepared. Design & configuration finalization is in progress. An integrated review of Chandrayaan-2, to assess the programmatic re-alignment, has been conducted at ISRO Head Quarters. The review recommended that India could realize the Lander module in a time frame of next few years. Consequent to the review, Advisory Committee on Space Science (ADCOS) has finalized the payloads to be accommodated on the Lander module. Mission configuration details are near finalization. Another review has been conducted to finalize the specification of the payloads for Lander and Rover modules. The project report is under finalization for obtaining necessary approvals.

8. Astrosat 1&2

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
177.85	166.68	6.00	2.55	5.00

8.1 The Astrosat project is aimed at design, development, fabrication and launch of an astronomical observatory for study of cosmic sources. Astrosat has been configured to carry onboard five payloads, to meet the mission goals. The spacecraft will carry four instruments sensitive in the X-ray band and one instrument with two telescopes covering the UV and Visible bands. The spacecraft weighs around 1500 kg in low-earth orbit of 650 Km altitude, low inclination circular orbit. The life of the satellite has been configured for a minimum period of 5 years.

8.2 Towards realization of the UVIT (Ultra Violet Imaging Telescope) payload, flight Model doors have been assembled to flight telescope and door deployment tests have been completed. The LAX-PC (Large Area Xenon-filled Proportional Counters) payload, is going through the calibration tests at Tata Institute of Fundamental Research. Critical design Review of the Payload system has been conducted.

9. INSAT-3 Satellites (including Launch Services)

(₹ in crores)

INSAT-3 Satellites & Launch Services	Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
	3119.63	3014.20	300.75	242.86	295.30

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 a state-of-art meteorological satellite with 6 channel Imager and 19 channel Sounder payload. The spacecraft is built around 1-2 K platform with lift-off mass of 2050 Kg with a designed mission life of 7 years. The spacecraft will be located at 82^0E longitude in geostationary orbit. The

spacecraft has many new elements like the star sensor micro stepping Solar Array Drive (SADA) and the Bus Management Unit (BMU). INSAT-3D spacecraft is under advanced stages of realization and spacecraft level tests are in progress. The spacecraft is planned to be launched onboard a procured launcher ie M/s. Arianspace, France during the first quarter of 2013-2014.

10. INSAT-4 Satellites (including Launch Services)

(₹ in crores)

	Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
INSAT-4	3597.70	2955.35	471.90	180.42	97.00
Leasing of Transponders	-	-	170.00	40.00	200.00

10.1 The fourth generation INSAT-4/GSAT Satellite series has been planned to meet the capacity and service requirements in the areas of Satellite Telecommunication Broadcasting, DTH, Emergency Communications & Mobile Multimedia Services. The sanctioned cost of the first two satellites in the INSAT-4 series, INSAT-4A & 4B, approved in March 2004 is ₹453.00 crores for spacecraft development and ₹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. The first satellite in the fourth generation INSAT-4 series, INSAT-4A has been successfully launched on December 22, 2005 from Kourou, French Guyana, which carried 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 to INSAT-4A. The replacement satellite INSAT-4CR (cost ₹43.20 crores) was realised on fast track mode and launched successfully on September 2, 2007 onboard GSLV-F04.

10.2 The sanctioned cost of INSAT-4C satellite, planned for launch onboard GSLV is ₹95.75 crores to carry 12 Ku band transponders. INSAT-4D/GSAT-5 was configured to carry 24 C-band transponders & the total sanctioned cost was ₹123.75 crores. The satellite was launched on 25th December 2010. However, GSAT-5P could not be placed in orbit due to the failure of GSLV F-06 mission.

10.3 The sanctioned cost of INSAT-4E/GSAT-6, the multi-media satellite is ₹269.00 crores. Primary goal of GSAT-6 is to cater to the consumer requirements of providing entertainment and information services to vehicles through Digital Multimedia consoles and to the Multimedia mobile phones. The spacecraft carries a 5 spot BSS and 5 spot MSS. The spacecraft is configured based on 1-2K bus system with a lift off mass of 2200kg to be stationed at 830 with a mission life of 12 years. The spacecraft is primarily configured with CxS and SxC transponders. The mainframe structure has been delivered. Payload and Flight subsystems are ready for Assembly and Integration.

10.4 GSAT-8/INSAT-4G Communication Satellite is a state-of-art Satellite, which has 24 Ku band transponders and a two channel GPS Aided Geo Augmented Navigation (GAGAN) payload for (a) augmenting the INSAT System Capacity in Ku-band (b) providing a second Geostationary augmentation payload for the operational phase of GAGAN and (c) providing continued and uninterrupted service. The sanctioned cost of GSAT-8/INSAT-4G Communication Satellite is ₹610.00 crores. The satellite was successfully launched on 21st May 2011, from Kourou, French Guyana onboard Airane-5-VA-2012.

10.5 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. The spacecraft employs the standard I-2K structure with the power handling capability of around 2.8KW with a lift-off mass of 2330 kg. The sanctioned cost of GSAT-9 is ₹140.00 crores. Procurement activities for long lead items for GSAT-9 have been initiated and subsystem fabrication and testing is in progress.

10.6 The sanctioned cost of GSAT-10 is ₹735.00 crores. The spacecraft carries 12 Ku-Band, 12 C-Band and 12 Extended C-band transponders. The spacecraft employs the standard 1-3 K structure with the power handling capability of around 6 KW with a lift-off mass of 3400 kgs. GSAT-10 Communication satellite has been successfully launched on September 30, 2012 onboard ARIANE-5 launch vehicle from the Kourou launch base in French Guyana. The in-orbit testing has been successfully completed and leasing of transponders to users is underway.

10.7 GSAT-12, the communication satellite built by ISRO, weighs about 1410 kg at lift-off. GSAT-12 is configured to carry 12 Extended C-band transponders to meet the country's growing demand for transponders in a short turn-around-time. The 12 Extended C-band transponders of GSAT-12, will augment the capacity in the INSAT system for various societal applications like Tele-education, Tele-medicine and Village Resource Centres (VRC). The sanctioned cost of GSAT-12 is ₹80.00 crores. GSAT-12 was launched successfully on 15th July 2011, onboard PSLV C-17.

11. Space Capsule Recovery Experiments (SRE-I & II)

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
88.20	85.08	2.20	1.00	0.50

11.1 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-I) was successfully launched onboard PSLV-C7 on January 10, 2007 and successfully recovered from the Bay of Bengal after re-entry from orbit on January 22, 2007. SRE-I 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-I is a major landmark achievement of Indian Space Programme and it has laid a strong technological foundation for future re-usable launch vehicle systems.

11.2 SRE-II is a follow-on mission to SRE-I to further validate the re-entry technologies. The Aero thermo structure with silica tile thermal protection system has been realised. Propulsion system integration has been completed. Solar panels are ready after acceptance tests. Payloads qualification models are realized and tests are in progress. Parachutes and floats are ready after acceptance tests. Mission management unit (MMU) hardware is ready and on-board software in loop (OILS) tests for de-boost phase is completed.

12. Navigational Satellite System

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
1420.00	743.67	170.00	134.15	135.00

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

12.2 The Indian Regional Navigation Satellite System (IRNSS) is an independent regional navigation satellite system. It is designed to provide position accuracy better than 10m over India and the region extending about 1500 kms around India. IRNSS system mainly consists of three components viz: Space Segment, Ground Segment and User Segment. IRNSS constellation consists of seven satellites. Four spare satellites are also planned to be realized. IRNSS provides two basic services such as Standard Positioning Service (SPS) for common civilian users and Restricted Service (RS) for special authorized users.

12.3 The configuration of the satellite has been finalized and the Satellite constellation of 11 satellites for IRNSS applications is being studied. IRNSS spacecraft bus is being realised around I1K bus specifically configured for navigation application. The IRNSS satellites are being configured for PSLV Launch with a lift-off mass of 1370 kg. The Navigation Payload is being developed to generate low IRNSS signals namely Standard Positioning Service and Restricted Service for the users.

12.4 The launch campaign schedule, status of hardware and mission criticalities have been thoroughly reviewed in a special review at Vikram Sarabhai Space Centre. Assembly of all solid stages have been completed. The launch of IRNSS-R1A is scheduled during 2013-2014.

13. Semi Cryogenic Engine Development

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
1798.00	69.97	150.00	84.96	180.00

13.1 The objective of the Semi Cryogenic Engine Development is to power the future heavy lift Unified Launch Vehicles (ULV) and Reusable Launch Vehicle (RLV) of India. This semi cryogenic engine, which uses a combination of cryogenic as well as earth storable propellants, developing a thrust of 2000 kN, is planned as the booster engine for the Common Liquid Core of ULV. This engine uses Liquid Oxygen and Kerosene as propellants. The engine is planned to be developed and qualified over a span of 6 years. In this, the first four years is planned for subsystem development and the remaining two years will be used for development and qualification of the engine. The facilities needed for testing also has to be made ready in 4 years.

13.2 The Preliminary Design Review (PDR) for Semi-cryogenic engine development has been completed. Preparation of fabrication drawings of subsystems have been completed. A MOU has been signed

with NFTDC for the realisation of copper alloy for Thrust chamber. Single element Pre-Burner (PB) injector realised and injector spray charaterisation using PIV was carried out. Test facility for single element pre-burner commissioned at PRG facility, VSSC. Semi Cryo Test facility design by M/s Rolta has been completed.

13.3 Design of Semi Cryo Engine including heat exchanger and ejector is competed. Fabrication drawings and documents are generated based on the PDR and joint reviews. Configuration design of subscale engine is completed. Preliminary Design Review (PDR) of Hydraulic Actuation System (HAS) and Hydraulic Power System (HPS) for Engine Gimbal control is completed and Technical specifications are finalized.

13.4 Single Element Pre-Burner injector element has been hot tested successfully. Ignition of LOX/ Isrosene propellant with hypergolic slug igniter and flame holding, demonstration of safe handling of pyrophoric fluid TEA, validation of start sequence, characterization of injector elements and qualification of Hayness-214 material are the major achievements of the tests.

13.5 Design of single element thrust chamber is completed and fabrication drawings are generated. Single element thrust chamber injector elements are realized and cold flow tests were carried out. Special pre burner which will provide hot gases for testing the single element thrust chamber has been realized.

14. Megha Trophiques

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
81.60	81.13	0.40	0.23	0.00

Megha-Tropiques is an ISRO-CNES of France joint mission and is intended for studying water cycle and energy exchanges in the tropics using a satellite platform. The mission envisages development of a satellite using ISRO's bus and mission specific payloads, which will be jointly developed by ISRO and CNES. The data to be received at the ISTRAC Ground Station, Bangalore, will be shared between the two agencies. The satellite was launched on-board PSLV C-18 on 12th October 2011.

15. SARAL

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
73.75	35.53	15.00	19.00	10.00

15.1 The objectives of the Satellite with Argos and Altika (SARAL) Mission are (i) to design and develop satellite bus in the weight range of 400 kg including payloads up to 200 kg mass and (ii) to establish required ground infrastructure for receiving and processing of the ALTIKA payload data within India for ocean related applications. SARAL is a co-operative mission between DOS/ISRO and CNES, France with payloads from CNES and the spacecraft bus from DOS/ISRO. Two payloads namely

Altika and ARGOS are planned in this mission. Altika is a Ka band altimeter for ocean applications and ARGOS is a data collection platform for collecting variety of data from ocean buoys to animal behaviour. SARAL is part of international continuing missions using these payloads.

15.2 The spacecraft was successfully launched by PSLV-C20 on February 25, 2013 which carried another 6 Satellites Sapphire, NESaT, 3 nos of NCS-8 series and STRaND.

16. GSAT-11 (Advanced Communication Satellite)

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
500.00	78.94	250.00	119.50	203.00

The Advanced Communication Satellite is intended to be developed as an advanced multi beam communication satellite, employing a new 1-4K Bus proposed to carry 32Ka x Ku band - Forward Link Transponders and 8 Ku x Ka band Return Link Transponders. The spacecraft has a lift off mass of 4500 Kg and the power handling capability of around 10KW. Spacecraft level PDR completed. System level interface are finalized. Layout design is initiated and activities for development of structural and subsystem qualification models are taken up. The spacecraft is scheduled for launch onboard procured launcher in 2014-2015.

17. ADITYA

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
127.75	8.58	20.00	3.40	20.00

The ADITYA-1 Project will be the first Indian Space based solar coronagraph, which will be available for solar coronal observation to all the Indian researchers in the field of Solar Astronomy. The major scientific objective of the ADITYA-1 is to achieve a fundamental understanding of the physical processes that heat the solar corona (base to the extended), accelerate the solar wind and produce Coronal Mass Ejections (CMEs). The proposed scientific goals are to detect and understand (i) the existence of waves in the solar corona and the nature of waves (ii) the role of waves in heating the solar coronal plasma (iii) formation of coronal loops (iv) magnetic nature of coronal loops (v) the pre-eruption dynamics of CMEs and (vi) CME's role in driving the space weather. It is planned to be launched by PSLV launch vehicle into 800 km polar orbit (dawn to dusk orbit). It will carry an internally occulted solar coronagraph of a mass of 130 kgs. Preliminary Design of optics and detector systems have been completed.

18. Geo-Imaging Satellite (GISAT)

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
392.00	9.90	50.00	23.50	80.00

Geo-Imaging Satellite (GISAT) is conceived as a multi-spectral multi-resolution advanced remote sensing satellite capable of imaging from geo-stationary orbit. Geo Imaging provides continuous observation of Indian sub-continent in visible bands during the day and in Thermal and Infra Red Bands during day and night. The data will be extremely useful in quick monitoring of disasters, natural hazards, calamities and observing episodic events.

19. Mars Orbiter Space Mission

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
450.00	0.00	125.00	125.00	167.50

19.1 Mars Orbiter Mission being our first mission to a distant planet is primarily driven by the technological objectives and supplemented by the scientific objectives. The objectives of the mission are (i) design and development of a Mars orbiter with a capability to perform earth orbital maneuvers, Martian Transfer Trajectory and most importantly the Mars orbit insertion/capture after nearly 300 days of travel, (ii) Mission design, planning, management and operations of the Mars Deep Space Mission. (iii) Communication between earth station and orbiter at a distance of nearly 400 Million km. Mars Orbiter Mission is scheduled for launch during the earliest minimum energy launch opportunity that exists in November 2013 using Polar Satellite launch vehicle (PSLV-XL).

19.2 Preliminary Design Reviews of all the spacecraft system and payloads have been completed. The structure has been delivered and the propulsion system integration is in the final stage. All the spacecraft systems and payloads are in the advanced stage of fabrication.

DEPARTMENT OF SPACE/ISRO CENTRES/UNITS

20. Vikram Sarabhai Space Centre (VSSC)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
784.36	652.62	732.87

20.1 VSSC, located around picturesque Veli Hills near Thiruvananthapuram, is the lead Centre responsible for the design and development of launch vehicle technologies, sounding rockets and associated technologies for the Indian Space Programme. 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 and Testing, Propellants, Polymers, Chemicals, Materials, Propulsion, Space Ordinance and System

Reliability. Activities like Programme Planning & Evaluation, Construction & Maintenance, Safety, Personnel and General Administration support the centre's core functions. The mandate for VSSC is:

- Research and Development for ongoing and future space transportation systems of ISRO.
- Multiple missions as per ISRO's launch manifest.
- Ensuring Low cost access to Space.

20.2 **Major Achievements during 2012-2013**

- Successful launch of two major missions, viz., PSLV-C19 placing RISAT-1, India's first indigenous radar imaging satellites and PSLV-C21 with two foreign spacecraft SPOT-6 and PORITERES which was a dedicated commercial mission;
- Successful launch of PSLV-C20 mission with SARAL on February 25, 2013;
- All the recommendations from GSLV F06 FAC and GSLV D3 FAC are being incorporated and implemented for GSLV D5 mission;
- Conducted the Lower shroud qualification test, Acoustic test on wire tunnel, Steering Engine Actuator test, Flight acceptance test of CUS main engine and CUS Steering engines, FBTP and OBTP;
- The High Altitude Test (HAT) facility for validation of modifications in CUS stage elements by vacuum ignition trials is being done in a fast track mode; The Vehicle integration trial is carried out at SDSC-SHAR and full vehicle build up and preparations at launch complex has been rehearsed for GSLV MKIII;
- In the case of RLV-TD, Wind Tunnel test of 1:1 model of FADS, Balloon Test of qualification model of Radar Altimeter, Iron Bird Simulation test of Control actuators and Control electronics, Vibration test of avionics bay module in flight configuration and dynamic characterization testing of Avionic bay – Engineering model sub assembly were completed;
- Realization of carbon-carbon cap and shell hardware for SRE with revised process is in progress;
- Carried out functional qualification testing of the air intake cowl opening mechanism of scramjet engine with flight load simulation and develop a high frequency data acquisition unit for scramjet flight testing for the Air Breathing Propulsion Project;
- Successfully tested RH200 IIST Flight (VYOM), the first sounding rocket designed and developed by students of IIST;
- Nine RH200 flights with chaff payload were successfully conducted for MET studies;
- Completed Mission design and sequencing for Launch Pad Abort, Full scale Crew Module water Impact tests, Parachute ejection and deployment tests, and Environmental Simulation Chamber fabrication for the HSP Project;
- The major facilities established are Angular Motion Simulator, Propulsion Research Laboratory, 250KN Shaker, Vacuum Heat Treatment and Brazing furnace, and Ceramic Matrix Composite Processing facility and FEP coating facility.

20.3 **Major Activities Planned during 2013-2014**

- Three PSLV missions are targeted for next year viz., PSLV-C22/IRNSS-1A, PSLV-C23/Astrosat and PSLV-C25 with India's first MARS Orbiter;
- Two GSLV missions are also planned during the coming year viz., GSLV-D5/GSAT 14 Mission and GSLV-D6 / GSAT-6 Mission;
- The first experimental flight with passive cryo stage (LVM3-X Mission) is targeted in the first half of 2013;
- RLV-HEX 01 mission is targeted for launch by September 2013 and ATV-EX, the reconfigured version of ATV D01 is planned for launch from SDSC SHAR during January 2013;
- Engineering model realizations of robotic micro manipulator for LUNAR exploration is also targeted for the year;
- Major facilities like Advanced Thermo vacuum facility, Establishment of altitude nozzle testing laboratory, 9Mev LINAC for high energy radiography, Optical Structure facility, Facility augmentation at HAL-ASD for Light Alloy Structures fabrication, Magnesium Chloride recycling facility at KMML, sea surveillance radar, CVI furnace, Sodium Chlorate facility at TCC, etc are proposed to be completed.

21. ISRO Inertial Systems Unit (IISU)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
62.67	56.26	69.01

21.1 The ISRO Inertial Systems Unit (IISU) situated at Thiruvananthapuram is responsible for research and development of Inertial Systems for both Launch Vehicles and Spacecraft programmes of ISRO. IISU also designs and develops Actuators and Mechanisms for Spacecraft and allied applications.

21.2 The Unit is organised into Research and Development divisions in the fields of Launch Vehicle inertial systems, Spacecraft inertial systems, advanced inertial system, Bearing and Space Tribology, Inertial system production and Reliability & Quality assurance. Many TDP & R&D activities are carried out in the fields of inertial sensors, systems and various spacecraft mechanisms, to reduce size, volume, power, weight, costs and also to increase accuracies, durability, life, redundancy and flexibility in operating environments. IISU is also equipped with facilities for precision fabrication, assembly & clean room, integration & testing of Inertial sensors, Systems and Actuators.

21.3 **Major Achievements during 2012-2013**

- Delivered launch vehicle Inertial Systems (RESINS, RPG and GAINS) for PSLV-C21 mission;
- Realization of flight and flight standby for RESINS MKIV, RGP and GAINS for GSLV D5, PSLV C20/SARAL, PSLC C22/IRNSS and LVM3X missions;
- Delivered Spacecraft Inertial Systems (IRU, Wheels and SADA) for GSAT-6, GSAT-15, ASTROSAT, GSAT-16, Mars Orbiter Mission, IRNSS-1A, 1B & 1C missions;

- Completed piggyback testing of Mini RESINS, RGPD, MEMS based RGP in PSLV C21 mission;
- Delivered and tested the AINS 200QM in LVM3 EB level;
- Qualification of RESINS MKIVA completed and QM delivered for LVM3 X mission;
- Realization of AINS 200 package for flight testing in PSLV C23 and that of Filter Wheel Mechanism & Bellow Pump Mechanism for ASTROSAT;
- Realization of Wheel Drive electronics with 1553 interface for INSAT-3D and future satellite programmes and 48 DTGs for various projects;
- Realization of engineering model of multi stack hybrid stepper motor, hybrid stepper motor for MGMS, BLDC Motor for FWM, High dynamic GPS receiver, high resolution high accuracy ADC-18 bit, digital CSA, microgravity measurement package and acceleration measurement package;
- Completed the following facility augmentation activities :
    - Installation and commissioning of Tribometer and Paralyne Coating facility;
    - Installation and commissioning of High Precision Jig Boring machine;
    - EMI test Facility;
    - Installation and commissioning of Wire Cut Electrical Discharge Machine at SMMF;
    - Civil works for Common Administrative Building.

21.4 **Major Programmes for 2013-2014**

- Realization of flight and standby systems of RESINS and GAINS for five PSLV and two GSLV missions and launch support and post flight analysis.
- Delivery of RGPD FM for LVM3
- Realization of AINS 200 ILG-FM for LVM3-X mission;
- Realization of Inertial Systems (IRU, Wheels, WDE & SADA) for CARTOSAT 2C, GSAT-9, GSAT-17, IRNSS-1D, IRNSS-1E, RESOURCESAT-2A, Chandrayaan-2 and INSAT 3DR;
- Realization of EM of Dual Gimbal DTG, Optical encoder, Rotary transducer, High performance navigation processor, Gryo compassing for ship borne tracking terminal and Redundant TMR MEMS Rate Gyro package;
- Realization of Flight & FS reaction Wheels for ASTOSAT & IRNSS series projects;
- Miniaturization of Wheel Drive Electronics using power HMC & TCS HMC;
- Realization of FPGA based unified SADA Electronics for IRS & INSAT;
- Realization of I-6K SADA Mechanism for GSAT-11;
- In-house realization of low cost 12-channel high dynamic GNSS receiver;
- Development of 24-channels Virtex based GPS receiver;
- Development Completion of Tuning Fork rate gyro;
- Design and process technology development for Tunneling accelerometer (MEMS accelerometer);
- Design and development of small Tri-axial head for micro acceleration measurement;

- Production of RGPD for Launch Vehicles;
- Procurement of major equipments for ISRO Space Tribology Lab (ISTL)-Sputtering Unit, Tribometer and Ion plating system;
- The following major facility augmentation activities are planned during the year :-
    - Single Axis Rate Table with Thermal Chamber;
    - Laser Lithographic system;
    - High accuracy co-ordinate Measuring Machine;
    - Precision CNC Turning Centre;
    - Ultrasonic High Speed Machining Centre;
    - CNC Optical Grinding machine;
    - Vibration/Shock Response System;
    - Precision AMS;

22. Liquid Propulsion Systems Centre (LPSC)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
436.35	344.39	439.09

21.2 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.

22.2 **Major Achievements during 2012-2013**

- Realization of Mo Successfully conducted flight acceptance hot test of A7 main engine. Flight assembly of main engine (A7) & steering engines (SE 18 & SE22), integration of engines to stage and functional welding of FBU (D10) with LH2 propellant tank have been completed. Realized indigenous LH2 Propellant Acquisition System (PAS) flight hardware, Acceptance tested and integrated to LH2 propellant tank. High Altitude Test (HAT) Facility-TCT modification for CUS HAT Test is in the advanced stage of completion. Planned to complete qualification of PAS, CUS A4 Engine HAT Testing, Integration and delivery of CUS 05 flight stage for GSLV D5 mission and realization of engine & stage subsystems for CUS 06 flight stage for GSLV D6 mission;

- All engine systems were realized for the integration of engine for development test for C-25 Project. C25 Stage assembled at SDSC-SHAR for Ground Resonance Test (GRT). Stage configuration and fluid circuits & measurement plans are finalized. Fluid mock up stage assembly

was decontaminated, revalidated and delivered for GRT. L110 Critical Review Design (CDR) has been conducted. Stage fluid schematic is finalized and drawings are released with Electro Mechanical Actuators. L110 flight stage pre-assembly operations are in progress. Integration & delivery of passive C25 stage for LVM3-X flight and LOX tank structural test completion is planned during the year;

- Completed design of Hydraulic Actuation System for engine gimbal control and successfully completed design of six engine software for modeling the physical processes in the design of Semi Cryo engine with source codes;

- PS2, PS4 stages and Control Power Plants (CPP) performed satisfactorily during the successful missions of PSLV-C19 & C21. Post flight analysis (PFA) were also carried out;

- Preflight preparations on all L40 stages have commenced at SDSC-SHAR for the GSLV D5 mission;

- Bi-propellant propulsion system was delivered for GSAT-10 and orbit raising maneuvers were successfully completed. Integrated propulsion system is made ready for GSAT-7 & GSAT-14 Spacecrafts. RISAT-1 satellite propulsion systems performed satisfactorily. Propulsion systems for SARAL spacecraft have been realized. AOCS (22N) thrusters were delivered for IRNSS-1 mission;

- As part of MARS mission simulation, LAM injector test at sea level after 45 days of propellant wetting have been completed at TERLS facility. HAT test at LMF is in progress;

- LAM Mk II version development tested and delivered for GSAT-7 & 14 missions. Sea level qualification hot test of high performance PS4 engine was successfully carried out. Experimental studies to optimize the Cryogenic turbo pump parameters were completed and a design database was established. A new thrust measurement system is developed to measure the actual thrust in pulse duty cycle of AOCS engine;

- Piezo electrically actuated normally closed micro valve is developed for EPS. Qualification of MEMS 3 in 1 transducer for RLV-TD has been completed;

- Thrust Chamber Test Facility (TCT) HAT facility modification for CUS engine test is in advanced stage of completion. Scramjet propulsion Test facility augmentation for semi cryo single element test is in the advanced stage of completion;

- L 40 Stages integrated at L40 integration facility at M/s HAL and delivered for GSLV mission;

- Indigenous copper alloy developed for cryo engine thrust chamber. Indigenous castings developed for CUS thrust frame. Indigenous machined die forgings developed for cryo engine turbo pump. Indigenous Forgings developed for Vikas engine equilibrium regulator & valve;

- Completion of Indigenous 18mN Stationary Plasma Thruster (SPT) development testing and

qualification for flight, development of Carbon-carbon nozzle extension for CE20 engine application, development of C-SiC composite thrust chamber for satellite thrusters, development of igniter for Air breathing engine and combustion studies on single element using a windowed combustion chamber are also planned during the year;

22.3 Major Activities Planned during 2013-2014

- Planned to complete integration and delivery of CUS 06 flight stage for GSLV D6 mission, realization and acceptance testing of subsystems for CUS 07 stage for GSLV mission;

- Planned to complete CE20 Thrust chamber testing at TCT facility, Integrated Turbo pump/Gas Generator bootstrap mode test Phase II, Integrated engine realization and development tests at MET & TCT-HAT facility, stage integration for ground development test and stage ground development Test at MET facility;

- Realization of hardware for first and second developmental flights (D1 & D2) and assembly of flight stage for developmental flight-D1;

- Realization of single element water cooled thrust chamber & subscale thrust chamber, hot tests on single element thrust chamber, hot test of sub scale thrust chamber, realization of engine subsystem parts and completion of indigenous development and launch campaign activities for Semi-Cryogenic Engine Development Project;

- Realization and delivery of PS2, PS4 stages and control Power Plants (CPP) for PSLV continuation programme and launch campaign activities;

- Realization and delivery of GS2 stage and L40 stages (through industry) for GSLV continuation programme and launch campaign activities;

- Planned to deliver integrated propulsion systems for GEOSAT and IRS missions;

- Planned to integrate, test & deliver SITVC & RCS flight package for the first HEX mission;

- Development of hydrostatic lift-off seals for cryo turbo-pump, development of cryo bearings, demonstration of nano heat technology for semi-cryo application, dual bell nozzle design validation through hot tests, development of Automatic test System (ATS) for abort validation, digital pressure sensor development, MEMS based temperature sensor development, development of sensor networking, development of satellite thrusters with green propellants and development of advanced coolant channel technology for liquid engines;

- Commissioning of Scram jet Propulsion Test facility (SPTF), MET Augmentation for C25 stage test, Cryo subsystem Facility commissioning, High power SPT test facility establishment and TCT augmentation for semi cryo subscale engine test;

- Production of transducers;

- Continuation of production of cryogenic propellants through ILHP and supply for engine tests & launch;

- Production of earth storable propellants to be continued through industry to meet the LV and Satellite programme;

- Planned to install machines at industries to meet the enhanced production requirement of earth storable and cryogenic engines;

- Integrated production of components and modules at industry.

23. ISRO Satellite Centre (ISAC)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
471.06	321.43	356.80

23.1 The ISRO Satellite Centre (ISAC) at Bangalore is the lead Centre for Satellite Technology. ISAC is Carrying out conceptualization, design, fabrication, testing and integration and in-orbit commissioning of satellite systems through time bound projects. ISAC is functionally organised in six major areas: Mechanical Systems Area, Digital & Communication Area, Integration & Checkout Area, Power Systems & Avionics Production Area, Controls & Missions Area and Reliability & Components Area. Electronic and Mechanical fabrication facilities, Environmental test facilities support the centre in fabrication and testing activities. Programme Planning and Evaluation Group is responsible for all planning and acts as the central coordinating agency and technical secretariat of Director of the Centre. Space Astronomy Group has been involved in optical, X-ray and Gamma ray astronomy research with strong emphasis on instrumentation. Computer and Information Group is responsible for establishment and management of centralised IT infrastructure in ISAC. Avionics Production Division is the nodal agency for production of standardized electronic packages. Three Programme Management Offices coordinate the implementation of the INSAT, IRS & Small satellites and Navigation Programmes. CMD is responsible for planning, execution and maintenance of all civil works related to centre.

23.2 ISRO Satellite Integration and Test Establishment (ISITE) functioning under ISAC is equipped with state-of-the-art clean room facilities for spacecraft integration and test facilities including 6.5M Thermo-Vacuum Chamber, 29T vibration facility and Compact Antenna Test Facility under one roof. Assembly Integration and Testing of all communication & Navigation Spacecraft is carried out at ISITE. A dedicated facility for productionisation of standardized sub-systems has been established at ISITE.

23.3 **Major Achievements during 2012-2013**

- Completed integration and Testing of GSAT-10 Spacecraft, which was launched successfully onboard Ariane-5 on 29th September, 2012;
- Realization of GSAT-7 & INSAT-3D spacecraft is under advanced stage and spacecraft level tests are in progress;
- Subsystem fabrication of GSAT-14 is in advanced stage and the major bus systems are delivered to the clean room. Integration activities are in progress and the satellite is expected to be ready for launch during 2012-13;

- Completed Preliminary Design Review (PDR) of GSAT-11 spacecraft and development of qualification models are in progress, while the PDR of GISAT is planned during the year;
- Completion of PDR for Mars Orbiter Mission. Structure, RCS systems & power packages have been delivered to the clean room and integration activity has commenced;
- Sub-system fabrication activities for Resourcesat-2A project have been initiated;
- SARAL spacecraft which was delivered to SDSC-SHAR in January, 2013 was successfully launched on February 25, 2013;
- Delivered mainframe structure for ASTROSAT to clean room and sub systems are being delivered;
- Completed sub-system level PDRs for Chandrayaan-2 and the rover proto model is under realization. Six wheel rover configuration is being worked out. The Indigenous lander development proposal is finalized;
- Major sub systems of IRNSS-1A have been delivered to AIT and the integration activities are in progress.;
- Taken up Technology development programmes for future missions like Chandrayaan-2, Cartosat-3, Human Space Programme, GISAT etc., to meet technology requirements;
- Commissioned 10 ton vibration facility at ISAC for spacecraft and sub-system level tests. Anechoic chamber is being established in ISITE for spacecraft level EMI/EMC tests and shall be commissioned during the year;

23.4 **Major Programmes for 2013-2014**

- Planned to complete assembly integration & testing of IRNSS-R1B/R1C, GSAT-6, FSAT-7, GSAT-15, Mars Orbiter Mission and Astrosat.;
- Planned to complete sub-system fabrication for GSAT-9, GSAT-11, GSAT-16, Resourcesat-2A, Chandrayaan-2 and IRNSS spacecraft;
- Design finalization of Lunar Lander for Chandrayaan-2 and realization of proto model for Rover;
- Validation of Navigational Payload, Spacecraft, Ground segment, Navigation software for IRNSS;
- Delivery of indigenous and procured IRIMS reference receivers;
- Realization of technologies for future spacecraft viz., Cartosat-3, I-4K/I-6K bus development, Interplanetary missions and HSP;
- Establishment of Space Science Instrumentation Facility and Space Park at ISITE;
- Initiation of construction work of High Density Interconnect facility, Assembly Integration & test Facility (AITF-II) at ISITE;

24. Laboratory for Electro-Optics Systems (LEOS)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
54.78	35.12	38.60

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

24.2 **Major Achievements during 2012-2013**

- Integration of sensors and Optics for RISAT-1, GSAT-10, SARAL, INSAT-3D, GSAT-7 and GSAT-14 with satellite and tested. Also provided pre-launch and post-launch support to RISAT-1 and GSAT-10 Satellites;
- Test and evaluation of sensors for Astrosat, SRE-2, Resourcesat-2A, GSAT-6, GSAT-11, Chandrayaan-2 and IRNSS-1 are under progress;
- Fabrication and testing of sensors and electronics for GSAT-15, Cartosat-2C, Cartosat-3 and Mars Orbiter Mission spacecrafts have been initiated;
- Single axis FOG is delivered to GSAT-14 and currently under satellite tests;
- APS based star sensor under advanced stage of development;
- MEMS based inclinometer for Chandrayaan-2 Rover is under fabrication;
- Flight unit off Indigenous thermistor bolometer is under qualification;
- Development model of Lyman Alpha Photometer (LAP) fabricated. Laser source delivered to SAC and 100mJ Laser source design finalized;
- Two sets of telescope optics for 'Imager and Sounder payloads' of INSAT-3DR delivered to SAC. Telescope optics for Cartosat-2C and Cartosat-2D are under testing. Primary mirror & secondary mirror of High Resolution Optics (HRC) for Cartosat-3 under testing;

24.3 **Major Programmes planned for 2013-2014**

- Planned to complete Satellite integration level testing of sensors and launch of Astrosat, GSAT-14, GSAT-7, INSAT-3D, Cartosat-2C, IRNSS-1 & SRE-2;
- Planned to develop Sensors and Optics for GSAT-11, Cartosat-3, Chandrayaan-2 and MARS Orbiter Mission;
- Planned to develop Laser Induced Breakdown Spectroscope (LIBS) payload and Camera for Land Rover;
- Planned to develop Lyman Alpha Photometer (LAP) for Mars Orbiter Mission;
- Planned to develop Indigenous Laser Source for LIDAR and Laser Induced Breakdown Spectroscope (LIBS) for lunar & interplanetary missions, Silicon Carbide (SiC) optics

technology, Navigation Cameras for Lunar Rover (Chandrayaan-2) and Space Grade color Camera and image storage unit for SRE-2;;

- Planned to develop Raman Spectroscope for optical material analysis and development of solar coronagraph optics for ADITYA-1;
- Planned to establish new Facilities such as Magneto-Rheological Finishing (MRF) facility, Ultra-Precision CNC Centering and turning Machine, Lens Centering and Edging Machine and 6-axis Robot polishing machine to facilitate the development of new sensors and optics.

25. Satish Dhawan Space Centre (SDSC-SHAR)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
437.84	353.86	457.83

25.1 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 & Cryogenic propellants storage and servicing facilities, tracking and telecommand stations, real-time data processing and range & flight safety.

25.2 **Major Activities Completed and Planned during 2012-2013**

- Completed the preparation and integration of Launch vehicles and servicing & launch of PSLV C19 & PSLV C21 missions;
- Successful launch of SARAL Satellite on board PSLV-C20;
- Second launch pad is being prepared for GSLV D5 vehicle integration and launch;
- New MCC/LCC is made operational with PSLV C19 mission;
- Completed augmentation works at Second Launch pad for servicing of LVM3 vehicle and vehicle integration trails for the full scale engineering version of the LVM3 vehicle and mock up on L110 stage;
- Acoustic Suppression system realization works with LVM3 missions from the Second Launch pad are in the final stage of commissioning;
- Planned to commission additional 300 Gallon Vertical Mixer during 2012-13;
- Realization of full scale version of the Multi Object Tracking Radar (MOTR);
- Realization of additional facilities like Second Vehicle Assembly Building (SVAB);

25.3 **Major Activities Planned during 2013-2014**

- To meet the increased launch frequency requirements, augmentation of facilities like Solid Motor production, Stage preparation facilities, Integration facilities, Satellite preparation facilities, Propellant Servicing systems, Range operations systems etc., for simultaneous preparation and launch of two launch vehicles at any given point of time, which will enable the Centre to meet the increased launch frequency requirements up to 8 launches per year;

- Commencement of works related to Second Vehicle Assembly Building (SVAB), Second Casting Facility & Curing Facility and Second Propellant Machining Facility;
- Commissioning of L40 Storage facility, PSO/PSOM XL Preparation facility, Bulk Storages for MMH & MON3 Propellants and 4.5T Vertical Mixer;
- Production of solid motors for PSLV/GSLV Mk2 & LVM3;
- To complete static testing of S200 Motor-ST03;
- To complete stage preparation, Integration and launch of PSLV/GSLV Mk2 & LVM3 vehicles as per launch manifest.

26. ISRO Telemetry, Tracking and Command Network (ISTRAC)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
126.02	104.02	129.26

26.1 ISRO Telemetry, Tracking and Command and (ISTRAC) is entrusted with the primary responsibility to provide spacecraft TTC and mission control services to major launch vehicle and Spacecraft missions of ISRO. Major objectives that go with the above key responsibility are carrying out mission operations for all operational remote sensing and scientific satellites, providing TTC services from launch vehicle lift-off till injection of satellite into orbit and to estimate its preliminary orbit in space and hardware and software developmental activities that enhance the capabilities of ISTRAC for providing flawless TTC and Space Operations services.

26.2 In order to realize these objectives, ISTRAC has established a network of ground stations at Bangalore, Lucknow, Mauritius, Sriharikota, Port Blair, Thiruvananthapuram, Brunei and Biak-1 & 2 (Indonesia) and the Deep Space Network Stations at Byalalu near Bangalore. The Mission Operations Complex located at Bangalore carries out round-the-clock mission operations for all remote sensing and science satellites. All network stations of ISTRAC are connected to the Mission Operations Complex (MOX) through dedicated high performance satellite/terrestrial communication links. Alternate Spacecraft Control Centres (ASCCs) established at Lucknow and ISDN provide the capability to switchover spacecraft operations from one location to another, in case of disaster scenarios affecting operations from MOX.

26.3 ISTRAC has also been mandated to provide space operations support for Deep Missions of ISRO, undertake development of radar systems for launch vehicle tracking and metrological applications, to provide Search & Rescue and Disaster Management Services and maintenance of hub station for 'spacenet' services. Establishment, operation and maintenance of ground segment for the Indian Regional navigational satellite System consisting of IRNSS Navigational Control Centre connected to IRNSS CDMA Ranging/IRNSS Range Integrity Monitoring Stations through dedicated IRNSS Data Communication Network is yet another major responsibility vested in ISTRAC.

26.4 **Major Achievements during 2012-2013**

- Provided pre-launch simulation, launch and early operations phase support for PSLV-C19/ RISAT-1 and PSLV-C21/SPOT-6 satellites;

- Provided Launch and Early Orbit Phase (LEOP) support for GSAT-10. The network is being readied for PSLV-C20/SARAL and GSLV-D05/GSAT-14 support;
- Provided round-the-clock support and payload programming provided for IRS P6, TES, Cartosat-1, Hamsat, Cartosat-2, Cartosat-2A, IMS-1, Risat-2, Oceansat-2, Cartosat-2B, Resourcesat-2, Youthsat-01, Megha-Tropiques, Risat-1 and SARAL;
- Transportable Terminal (TT) set up in Rodrigues Island and vital satellite communication links between TT and Mauritius Terminal provided for TTC support for RISAT-1 mission;
- Replaced 8m antennas with 11 m antenna at Port Blair and Thiruvananthapuram as part of the modernization plan;
- Established second Indian Uplink Station (INLUS-2) in Bangalore under GPS Aided Geo Augmented Navigation-Flight Operations Phase;
- Commissioned IRNSS Navigation Control Centre, four CDMA Stations, IRNSS Network Timing and six IRMS as per IRNSS Ground Segment realization plan;
- Mission Operations Complex-1 and 2 connected through Digital Video for interoperability;

26.5 **Major Programmes for 2013-2014**

- Planned to provide LEOP Support for GSLV-D05/GSAT-14, PSLV-C22/IRNSS-1, PSLV-C23/ ASTROSAT, PSLV-C24/IRNSS-2, PSLV-C25/Mars Orbiter Mission and other missions on the anvil;
- Continuation of round-the-clock support and payload programming for IRS satellites viz., IRS-P6, TES, CARTOSAT-1, HAMSAT, CARTOSAT-2, Cartosat-2A, IMS-1, RISAT-2, Oceansat-2, Cartosat-2B, Resourcesat-2, Youthsat-01, Megha-Tropiques, RISAT-1 and SARAL;
- IRNSS Ground Segment is expected to enter operational phase immediately after the launch;
- Commencement of civil works and procurement action for the establishment of second IRNSS Control Centre (INC-2) at Lucknow;
- Planned to realize hardware required for Mars Orbiter Mission support. Finalization of agreements with external space agencies for TTC and navigation support for Mars Orbiter Mission;
- Upgradation of DSN-32 and realization of Transportable Terminals have been taken up on priority as part of the preparations for supporting Mars Orbiter Mission;
- Establishment of C Band DWR at TERLS;
- Continuation of quality improvement efforts through ISO-9001: 2008 quality management system;
- Operation and maintenance of TTC network stations at Bangalore, Sriharikota, Lucknow, Thiruvananthapuram, Port Blair, Brunei, Biak and Mauritius;

27. Space Applications Centre (SAC)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
306.55	304.57	336.08

27.1 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 & 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, Delhi Earth Station, portable and mobile Earth Stations, Laboratories for remote sensing & communication activities, fabrication and environmental test facilities for development & 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, monitoring/mitigation etc. SAC has also been involving industry and practicing outsourcing & indigenous development of technology and vendors.

27.2 **Major Achievements during 2012-2013**

- The Mahalanobis National Crop Forecast Centre (NCFC) was set up under the DAC, MOA on April 23, 2012 in the Pusa campus, New Delhi. FASALSoft, developed at SAC for data analysis of both SAR and optical remote sensing, was installed and technical support was provided for setting up of laboratory and relevant training was provided to the team of the Centre;
- Planned to complete spacecraft level Integration and for GSAT-7, INSAT-3D and GSAT-14 payloads;
- Planned to complete payload level integration & testing of GSAT-9 & IRNSS-1B payloads;
- Completed PDR for Mars Orbiter Mission, GISAT, GSAT-15 & GSAT-16;
- Planned to realize payloads for Mars Orbiter Mission and delivery of the same during the year;
- Planned to complete RISAT-1 SAR calibration exercise during the year;
- Scheduled to complete development work on ETM Rubidium Atomic clock, Optical terminal for 1 Gps Link, SAC-Bopal Free Space Optical link, System engineering for advanced communication payloads and Enhancement of Four channel SPS receiver to seven channel receiver for IRNSS during the current year;
- Initiated Cartosat-1 global DEM project;
- Planned to conclude projects on utilization of Oceansat-2 data and Phase-II of Meteorology and Oceanography;
- Upgradation of ATF facility to 20 GHz and commissioning of Tapered Anechoic Chamber antenna test by the third quarter of 2012;

- Expected to complete development activity for SAC-Bopal calibration site for high resolution Optical & NIR sensors for land applications by the end of the year;
- Planned to complete SATMET-8 PF Course for imparting training to Scientists and Engineers from the Asia Pacific region through the nine months PG Diploma programs of the CSSTEAP by April 2013;

27.3 **Major programmes for 2013-2014**

- Delivery of INSAT-3DR, GSAT-15, GSAT-16 and IRNSS-1C payloads;
- Sub System level development is planned to be completed for GSAT-17, GSAT-18, GSAT-11 and GSAT-7A communication payloads;
- Development work on payloads for Chandrayaan-2, GISAT, Resourcesat-2A and Cartosat-2C/D is expected to reach an advanced stage;
- DHA is expected to be completed by the middle of 2013 for Aditya-1 mission;
- Work is initiated for Scatterometer Repeat (Scatsat-1/Oceansat-3) and RISAT-R1A SAR repeat missions;
- Planned to complete Technology Development works on Mm wave Humidity Sounder, Ground penetration Radar (GPR) and Ground Based C-Band Scatterometer;
- Development of IRNSS user Receivers;
- Augmentation of MSS Type-D hub and various other ground systems developed for GSAT-6 Applications;
- Planned to complete development of software to reach an advanced stage for HYSI payload for GISAT, Mars Mission payload, Cartosat-2C/2D and Chandrayaan-2;
- Planned to conclude the projects on utilization of RISAT-1 data by the end of 2013-14;
- Conceptualization of science and applications projects for utilization of data from Lunar and Mars surfaces;
- Planned to complete infrastructure/facilities like IRNSS Signal monitoring Facility, GSAT-11 ground segment, Integration and test facility for communication payloads at Bopal campus, Image Visualization (3D/Virtually Reality cave) and a Video wall are planned to added;
- Proposed to commence SATCOM-9 Course of CSSTEAP in August 2013 which will end in April 2014;

28. Development and Educational Communication Unit (DECU)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
51.12	15.06	46.75

28.1 The Development and Educational Communication Unit (DECU) at Ahmedabad is involved in the conceptualisation, definition, planning, implementation and socio-economic evaluation of developmental space applications. The major current activities of DECU include EDUSAT projects, their implementation action & utilisation, Training and Development Communication Channel (TDCC), Village Resource Centre (VRC), Gramsat Programme (GP), Tele-Health (TH), Tele-Education (TE) mission and new satellite communication development and applications.

28.2 **Major Achievements during 2012-2013**

- Completed addition of 2 Edusat Networks in Sikkim and YASHADA Maharashtra and migration of 6 Networks (620 Terminals) including 3 Networks of MP, GNDU, AEES, RCI. Installation & commissioning in remaining sites (Assam - 17, Bihar - 15) are planned to be completed. Migration in 5 networks namely Pondicherry, WBTU, NCSM, IDSP & INDO-US are also planned;
- Users made responsible for proper utilization & getting AMC on their own in 20 networks and conducted North-East Tele-education Users' Meet – 2012;
- Proposed to set up Technical Support & Training Centre (TSTC) in Uttarakhand and Jammu & Kashmir;
- Planned to upgrade ROT to Interactive in Rajastan and West Bengal Tele-education Network;
- Planned to establish Monitoring Facility at DECU, migration of 165 Nodes from GSAT-3 to GSAT-12, up-gradation of Telemedicine nodes of Chhattisgarh, SAC, and Shankar Netralaya mobile van (Kolkata) was completed on the Telemedicine network;
- Planned to upgrade network to incorporate Continued Medical Education (CME);
- Completed 70 Programmes – 11 programmes (Tele-Education) and 59 programmes (Satcom applications which include 4 live transmissions) and around 202 Programmes DVDs handed over to various States/Users;
- Uploaded 40 Videos on ISRO Educational Portal and 50 more videos planned to be uploaded on ISRO Educational Portal Monitoring & observation of Edusat Networks at DECU;
- Several DECU generated video programmes were telecasted over various channels of Doordarshan (DD National, DD News, DD Bharti, DD India and Loksabha TV) ;
- Completed status and Feedback study of Chhattisgarh Edusat Networks;
- Completed a case study on Rajiv Gandhi Project for Edusat supported Elementary Education (RGPEEE) Network and an Educational Needs Assessment Study of Arunachal Pradesh Edusat Network;
- Operationalisation of the new Renderfarm System with autoloader;
- Digitised 250 video programmes and planned to digitize 500 more;
- Planned to augment of Video Editing Facility by addition of high-end Non-Linear Editing System and integration with Central Storage System & Digital Assets Management system;
- Planned for Motion Capture System (MoCap) for realistic 3D Character Animations for ISRO, Education & Development programmes;
- Provided Technical Support/Consultancy to SAC (Virtual Reality), IIRS Dehradun, SDSC-SHAR, DST-Rajasthan, ANSSIRD-Karnataka, Information Dept. & BISAG-Gujarat, RCVP Academy-MP, VTU Mysore and IIST.

28.3 **Major Activities Planned during 2013-2014**

- Planned to upgrade ROT to Interactive 100 ROTs of Odisha & 100 in Karnataka Tele-education networks using hybrid Technology;
- Planned to conduct Tele-education Users' Meet – 2013 at Jammu & Kashmir;

- Planned to establish new Telemedicine nodes and mobile vans as per the requirement from the users and ISRO policy;
- Planned to upgrade Telemedicine nodes to integrate them with the existing Tele-education hubs installed in various states for an integrated approach and planned to be implemented in two states;
- Continue the augmentation of the Telemedicine network to incorporate CME and continued support to Rajasthan Telemedicine network;
- Planned to migrate Telemedicine nodes from INSAT-3A to GSAT-12;
- Planned to assess the performance/utilisation of the Telemedicine nodes, shifting of non-performing nodes and accommodate new users;
- Planned to conduct an All India Telemedicine Users' Meet – 2013;
- Planned to conduct a feedback and utilization study will be conducted on YCMOU and RCI Edusat Network to understand operational status, utilization level and opinion of concerned officials;
- Planned to monitor and observe National and Regional Edusat networks for regular feedback.
- Planned to digitize 1000 programmes digitization under Video Programmes Archival;
- Planned to set-up HD Production for meeting the HD quality requirements of ISRO, international conventions and TV Channels Telecast;
- With the launch of GSAT-12, it is planned to re-activate all the existing VRCs and addition of 100 new VRC nodes including Expert Centres and Hospitals;
- Planned to upgrade the Natural Resource databases and for selected areas, databases on detailed scale will be generated;
- Planned to inaugurate VRC networks, shifting and reinstallation of VSATs and other equipments in selected areas.

29. National Remote Sensing Centre (NRSC)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
273.52	214.87	199.00

29.1 NRSC is one of the Centres of Indian Space Research Organisation, striving to realize the Indian space vision, as a key player in Earth Observation and Disaster Management Support Programmes. NRSC is responsible for acquisition, processing and dissemination of aerials and satellite remote sensing data and is continuously exploring the practical uses of remote sensing technology for multilevel (global to local) applications. It also has a focused programme of creating training manpower through capacity building in remote sensing. IIRS which was a constituent of NRSC became a separate Unit of ISRO in April 2011. RRSC (East) was shifted from Kharagpur to Kolkata in May 2011. RRSC (North) was merged with IIRS in October 2011. Present infrastructure of NRSC is spread over six campuses – Balanagar (Hyderabad), Bengaluru, Nagpur, Jodhpur and Kolkata.

29.2 **Major Achievements during 2012-2013**

- The RISAT-1 satellite (launched on April 26, 2012) data was successfully received and processed at the IMGEOS facility. As part of Antarctica Ground station for Earth Observation Satellites (AGEOS) activities, necessary infrastructure like Data reception and communication systems, computer hardware / software (developed in-house) etc are readied and shipped. They shall be commissioned by March, 2013;
- Significant developments under BHUVAN include: populating high-resolution data and addition of Wastelands (1:50,000 scale) Urban Land Use (1:10,000 scale) thematic data for user downloads. As part of satellite data dissemination services, the geophysical products (VI & NDVI) are added to the existing set of categories, and Ocenasat-2 products are being made available to the global user community within 150 minutes of pass acquisition. NRSC has so far distributed 11915 products to users, besides facilitating the download of another 116746 products through web (Apr-Sep'12). To meet increasing demand for high resolution satellite data, Cartosat-1 data is being acquired in wide mono mode. Conducted Satellite data User Interaction Workshop was held at NRSC during February, 2012;
- Under DSC, 10497 fires were reported during the active fire season (Apr – Jun 2012). Major floods were reported in 4 states (Assam, Bihar, UP and AP). From the kharif 2012, NRSC has transferred the agricultural drought project to Mahalanobis National Crop Forecast Centre (MNCFC), Ministry of Agriculture (GOI), and is offering technical support. NRSC has responded to six emergency requests under Sentinel Asia. Landslide inventory and damage assessment of Uttarkashi landslide and Okhimath (Uttarakhand) landslide were carried out;
- Major ongoing User funded Projects include: groundwater prospects and quality mapping work is in progress under Phase-IV of RGNDWM. Thematic Mapping under NUIS will be completed for 152 towns by Dec 2012. Under India-WRIS project taken up for CWC, content generation, databases (spatial & non-spatial) organization and development of version 2.0 of the portal are in progress. 27 / 50 irrigation project sites work was completed and is in progress for the remaining 23 Projects sites under AIBP Phase-II and the project will be completed by December 2012. Glacial lakes & water bodies, inventoried in 2010-2011 were monitored (greater than 50 Ha.) during the period. Under Oceanography and Atmospheric studies, works are in progress to generate a semi-operational pressure field product, cyclone studies, Oceanic Heat Content retrieval using satellite and in-situ observations etc;
- A new entity Environmental and Climate Sciences Area (ECSA) is carved out of remote sensing applications to facilitate focused research on ocean and atmospheric systems. Flux tower in Sunderbans (West Bengal) was operationalised for wetland ecosystem as part of NCP. This will be helpful for measuring fluxes (CO2, H2O, Methane and Energy) and computation NPP on monthly/annual basis. Collection of soil samples across the country completed. Analysis for organic carbon and total soil carbon estimations are in progress;
- Under Aerial Services and Digital Mapping activities, both aircrafts were flown for about 65 hours for aerial photography tasks. LiDAR data of Godavari and Mahanadi river basins (10,300 km2) under DMSP were acquired;
- NRSC has imparted training (1 to 12 weeks) on Remote sensing and GIS to 166 officers

by organising one regular and four customised training courses besides conducting two programmes exclusively for ISRO/DOS employees;

- Major infrastructure augmentations in progress include: overhauling the aircraft engines and retrofit of avionics (one aircraft) and procuring a new aerial LiDAR sensor, Instrumentation system for Ocean-CO2 measurements, upgradation of Library facility.

29.2 **Major Programmes for 2013-2014**

- Planned to integrate data reception from all ongoing IRS missions into IMGEOS. Data reception from SARAL mission will be operationalized;
- Planned to commission Antarctica Ground station and commence data reception operations, and acquire all IRS Satellites data from AGEOS and integrate into the IMGEOS Facility through Communication Satellite Link;
- Planned to make improvements to BHUVAN portal like Indigenous 3D visualization, Distributed System architecture, content enhancement (both image & thematic), complex online geo-processing and more user centric applications are planned;
- Planned to continue to support all services and development works for various natural disasters. All NNRMS, ISRO-GBP, EOA, TDP and Utilisation Programmes shall be sustained like SIS-DP, NR Census etc. All ongoing User funded National Missions and Projects like RGNDWM (Phase – IV), India WRIS, seasonal snow melt run-off and ocean and atmospheric studies will be continued and research initiatives under various programmes shall be pursued;
- Major infrastructure augmentations include procuring new aerial Large Format Digital Camera, upgradation of security infrastructure, modernization of computer infrastructure of RCs, operationalise the new NDEM facility with required software and hardware, distributed architecture set-up for Bhuvan services, Virtualization system for IMGEOS.

30. Indian Institute of Remote Sensing (IIRS)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
32.48	24.03	30.35

30.1 The Indian Institute of Remote Sensing (IIRS) located at Dehradun is responsible for capacity building in the field of Remote Sensing and GIS applications. It has grown manifold and has established itself as an institute of repute both nationally and internationally. Realizing the potential of Earth Observation System and ISRO's forthcoming initiatives in the areas of natural Resource Survey, Earth & Atmospheric Sciences and Oceanography, IIRS has been reorganized as a separate entity of ISRO w.e.f. April 30, 2011. IIRS will continue its training, education and research programmes with enhanced focus on Microwave Remote Sensing, Hyper-spectral Remote Sensing and Climate studies.

30.2 **Major Achievements during 2012-2013**

- Conducted various scheduled courses (i.e. Certificate/ Diploma/ M.Tech./M.Sc/ITEC/NNRMS.) as per Academic Calendar 2012-13, along with customized user specific on demand courses;

- Introduced two additional M.Tech., specialization in the areas of Geoinformatics and Satellite Image Processing and Photogrammetry;
- Organisation of New short course on small satellite mission;
- Technology Development Programmes and EOAM Programmes are under progress;
- Procurement of Spectro-Radiometer for establishment of Hyper-spectral Lab, Large Aperture Scientillimeter, Direct Shear Testing equipment for soil;
- Hosting of Biodiversity Information System website within the framework of ISRO Geo Portal; upgradation of IIRS Network System and upgradation of Flood Modelling Software, Strengthening of mathematical modeling and polarimetric SAR processing;
- Replacement & Augmentation of PC's in various Labs of IIRS and CSSTEAP DX Type AC Plant with room AC unit, and Strengthening of Compound Wall/Security Track with lighting;
- Procurement of Server for Digital Work Flow System (DWFS) and Technical furniture in IIRS Labs, furnishing of IIRS Hostels, Augmentation of energy efficient lighting, ACS & Video Surveillance, Solar Water Heating in Godavari Hostel;

30.3 **Major Achievements during 2012-2013**

- Continue to conduct various scheduled courses (i.e. Certificate/ Diploma/M.Tech./M.Sc./ITEC programs) as per Academic Calendar 2013-14 and Tailor made user defined courses;
- Planned to customize courses for capacity building of State/ Central Govt. Departments Officials implementing various national level developmental programs / schemes;
- Planned to conduct summer training for students of various Universities;
- Strengthening of IIRS training activities with close interaction with the State Department and National Institutions;
- Support to CSSTEAP for conducting RS & GIS course and other short programs;
- Plan to continue TDP in emerging areas of Remote Sensing, spatial modeling and instrumentation and collaborative R & D activities with NRSC, SAC, ISAC, PRL;
- Collaborative research with major National Institutes i.e., WIHG, SASE, NIH, GB Pant Institute, Y.S. Parmar University and EOAM / Research programme on Mountain Ecosystem in Western Himalayas;
- Procurement of Spectro-radiometer with accessories for Hyperspectral lab (2,400nm to 16,000 nm), Full Bistatic Ground Penetrating Radar (GPR), Terrestrial Laser Scanner (TLS), Portable Laser Scanner, Spectro sensor for continuous NDVI & PRI measurement, Wet Sieving Apparatus, Soil Permeability Meter, Direct Shear testing equipment, Microtop II Sunphotometer;
- Augmentation of Central Data Center Networking & Server Upgrades and Main Server;
- Upgradation of MAT Lab software, Flood Modeling Software, SARSCAPE Software, TNT MIPS v2012 software, PCI Geometica software, River Tools software licenses, City Engine software.

31. Master Control Facility (MCF)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
70.52	48.91	73.91

31.1 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 centre 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.

31.2 **Major Programmes for 2013-2014**

- INSAT-2E decommissioned on 23rd April 2012, after 13 years of useful service;
- Completed replacement of SCES # 3 Servo system;
- Completed transition of Mission Computer system from Unix hardware to Linux;
- Completed replacement of A/c plant at SCES # 1;
- Provided LEOP operations of GSAT-10 mission;
- Augmentation of Automated Test Equipment (ATE) Set-up for In-Orbit Tests (1st Phase) at SCES # 4;
- Commissioned SCES # 2 at MCF-Bhopal;
- Installed & Commissioned UPS Battery Bank at SCES # 5.

31.3 **Major Activities Planned during 2013-2014**

- To provide LEOP Operations for INSAT-3D, GSAT-7 and IRNSS-1 Missions;
- To complete augmentation of Automated Test Equipment (ATE) Set-up for In-Orbit Tests (2nd phase) at SCES # 4;
- Planned to establish C & Ku band Earth Station with a 11m FMA Terminal for GEOSAT programme.

32. National Natural Resources Management System (NNRMS)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
53.74	22.50	31.50

32.1 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. Nine Standing Committees are (i) Agriculture & Soils

(ii) Bio-resources (iii) Geology & Minerals (iv) Water resources (v) Rural Development (vi) Urban Development (vii) Cartography (viii) Ocean & Meteorology and (ix) Training & Technology. 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.

32.2 Considering the changing technological and applications dimensions in the country and elsewhere, the NNRMS currently focuses on (i) user funded projects meeting the objectives/goals of the user Departments/Agencies both at the national and regional/local scale; (ii) proactive applications projects of relevance at the national and regional/local scale and (iii) organising the spatial databases for supporting, planning, implementation and monitoring of a variety of developmental programs.

32.3 **Major Activities during 2012-2013**

- Space based Information System for De-Centralised Planning (SIS-DP) project aims to develop ICT enabled geospatial platform using space based EO systems and engage local bodies for planning and execution of area based developmental activities in a de-centralised, speedy and transparent manner. Under this project, natural resources mapping at 1:10,000 scale for the entire country and the prioritized component for five States are under progress. Efforts are underway for capacity building as well as dissemination of information/data to 6500 panchayats through BHUVAN portal of ISRO;
- Taken up creation of a systematic spatial database for different themes under Natural Resources Census project. The 8th cycle of Land use/Land Cover mapping at 1:250,000 scale will be completed and the activities with respect to 9th cycle will be initiated. Subsequent to the successful completion of the 1st cycle of Land use/Land Cover Mapping at 1:50K, the 2nd cycle of land use/land cover has been taken up towards generation of seamless spatial database as well as land use/land cover charges with respect to 1st cycle database. Geomorphological and lineament mapping will be completed for 3000 sheets out of 4500 sheets of the entire country. Forest cover change alert system using IRS multi sensor data project has been taken up to develop semi automated forest cover change detection methodology using multi temporal data. A pilot study taken up for parts of Maharashtra is under progress;
- Under the Natural Resources Database project, the repository will be populated with additional geospatial database including the ongoing projects like natural Resources Census, Rajiv Gandhi National Drinking Water Mission etc. The redesigning of NNRMS Home page will be initiated with new elements including a separate page for sharing of activities among Standing Committees of NNRMS;
- Extended technical and financial support to various agencies/institutes for conducting multi-tier/multi-theme training courses. Efforts of satellite based distance learning programme in Remote Sensing and Geographic Information System as well as Hyperspectral Remote Sensing is being continued to cover more number of Universities/academic Institutes;
- Technical support is provided to State Remote Sensing Applications Centres for executing projects of relevance to development of the States

32.4 **Major Programmes for 2013-2014**

- Under SIS-DP project, preparation of natural resources mapping at 1:10K for entire country will be completed and will be systematically organized for dissemination. In addition, cadastral overlay for 5 priority states will be completed. Dissemination of information/data will be done for 18000 more panchayats;
- Under NRC, project the 9th cycle of LU/LC cover mapping at 1:250K will be carried out and mapping activity for the 10th cycle will be initiated. The efforts of satellite data preparation and land use/land cover mapping under 2nd cycle of LU/LC mapping at 1:50K, will be carried out for major parts of the country. The geomorphological and lineament mapping for the country will be completed and the data/information will be disseminated through BHUVAN portal. A pilot study taken up for parts of Maharashtra will be completed and the national Workshop for Sub Annual Forest Monitoring System will be organized;
- NRDB Repository would be updated with the datasets from the ongoing projects. Efforts towards development of 3D wb tools for visualization of spatial datasets as well as demonstration of on-line geo-processing through NNRMS portal will be carried out;
- To take up GCPL Phase-III activities to augment the GCPL Phase I and II database with improved accuracies;
- Considering the technological development and requirement a few new projects will be taken up in different application areas;
- Planned to continue efforts for providing technical support to State Remote Sensing Applications Centres as well as human resources development in the area of RS & GIS;
- Planned to continue user sponsored projects in different application areas at the behest of respective user Ministry/Department.

33. Disaster Management Support (DMS)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
30.38	12.00	30.42

33.1 The Disaster Management Support (DMS) Programme of ISRO provides near real time support and services from aero-space systems, both imaging and communication, towards efficient management of disasters in the country. The DMS programme addresses the natural disaster such as flood, cyclone, drought, forest fire, landslide and Earthquake. The major components of the DMS programme include creation of digital database for facilitating hazard zonation, damage assessment, monitoring of major natural disasters using satellites and aerial data, development of appropriate techniques and tools for decision support establishing satellite based reliable communication network, deployment of emergency communication equipment and R&D towards early warning of disasters.

33.2 **Major activities and achievements during 2012-2013**

- Mapped and monitored major flood in Assam, Bihar, Uttar Pradesh and Andhra Pradesh and around 114 flood maps were generated and disseminated. Flood hazard atlas was prepared for Bihar and Orissa and draft atlas was sent for ground verification and feedback;

- Extended the Flood Early Warning System to 14 districts of Assam. A prototype flood forecasting system has been established at Godavari basin and installed at CWC, Hyderabad for operational prediction of floods;
- Transferred the detailed methodology, execution plans and databases of NADAMS project to Mahalanobis Crop Forecast Centre (MNCFC). The monthly drought reports have been prepared and disseminated by MNCFC to the Ministry of Agriculture, Government of India, and the respective state departments of Agriculture and Relief;
- Tracked all the cyclones originating in the Indian ocean region. A web server called SCORPIO has been established for real time monitoring and prediction of cyclones;
- Near real time active forest fire alerts are being generated twice a day during the fire season and disseminated to the concerned and the information is being uploaded to the INFRRAS and Bhuvan websites;
- Carried out Satellite based landslide inventory for Amarnath route and parts of vulnerable areas in Uttarakhand State;
- Delivered high resolution database and close contour maps using Aerial Laser Terrain Mapper (ALTM) of Brahmaputra basin in Assam to DMSP database;
- Completed high resolution data acquisition for Godavari basin Phase-II and part of Mahanadi basin in Orissa using LFDC sensor;
- Completed operationalisation of MSS-Type-D hub in Delhi Earth Station on 24x7 basis which is manned by CRPF. Out of the 50 Type-D terminals, 27 are being used by CRPF;
- Established the National Database for Emergency Management (NDEM) Phase 1 infrastructure and a meeting of the Officers from the Nodal Ministries were held. The mobile based applications developed for NDEM has been demonstrated to states and NDMA officials. A live demo of NDEM prototype was carried out at Assam;
- Re-established DMS VPN network using a transponder onboard GSAT-12;
- Supported International disaster management activities through International charter and Sentinel Asia projects;
- The DTH based Disaster Warning System has been developed and 59 systems have been dispatched for installation;
- Civil works for the installation of S band Doppler Weather Radar (DWR) at Cherapunji is in the final stages and installation and commissioning of the same is expected to be completed during the year. Civil works for the C-band DWR and TERLS, Thiruvananthapuram is progressing well and the installation of the equipment is targeted during the year;
- Planned to establish the minimum infrastructure for realization of North Eastern Regional Node for Disaster Risk Reduction (NER-DRR).

33.3 **Major activities planned during 2013-2014**

- Carried out Near Real Time Flood Mapping and Monitoring for all the major floods in the country. Flood hazard atlas for Orissa and West Bengal will be validated and released. Studies on Flood hazard and risk assessment with LIDAR DTMs in collaboration with academic institutions and Flood Inundation Simulation Modeling will be carried out;

- Continuation of support to MNCFC for operational drought assessment in the existing states and expansion of NADMS high resolution coverage to new states;
- Field level instrumentation and experimental analysis of different bio-physical parameters such as soil moisture, canopy temperature etc are planned for improving drought detection;
- Data acquisition of 14500 sq. km in Assam using ALTM-DC. Processing of ALTM data of Godavari basin Phase-II will be completed and delivered to user. Ground leveling of Brahmaputra basin Phase-II in Assam will be taken up;
- Planned to establish and operationalize NDEM Phase-2 systems at Shadnagar. The NDEM manpower will be positions and the facility at Shadnagar will be operationalized;
- Initiation of establishment of Mirror server for NDEM at MHA. Pursuing with MHA for extension of the VPN network to district Emergency operation centres of the 241 multi hazard prone districts of the country;
- Completion of installation of 500 numbers of DTH based Digital Disaster warning systems;
- Operationalisation of the Cherrapunji DWR and TERLS C band DWR;
- Sites for the other Radars will be identified and civil, electrical and A/c works will be initiated;
- Planned to establish the NER-DRR with full functionality.

34. ISRO Geosphere Biosphere Programme (ISRO GBP)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
27.69	22.50	26.73

34.1 The ISRO GBP focuses its research efforts on understanding the natural rhythms and patterns of the Earth system's self regulation, the extent to which anthropogenic forcing interacts with the natural variability of Earth system in producing climate change, the types, scales and rates of change and the thresholds of changes that threaten sustainable development. The research is done through multi-institutional participation and co-ordinated effort. The programme generates the scientific knowledge for decision making and inputs to international protocols and conventions.

34.2 **Major Activities during 2012-13**

- Produced several scientific publications in peer-reviewed journals of international repute;
- Primary data from nationwide large network of observation sites established under I-GBP has provided a better understanding of India's regional climate and atmospheric composition. These data helps us to counter the baseless allegations like "brown cloud", black carbon, etc.
- Under the project on aerosol Radiative Forcing over India (ARFI) the network of observatories is expanded to more than 41 locations and it has immensely contributed to scientific capacity building. Special aerosol problems have been undertaken, balloon-borne measurements of black carbon (BC) profiles have been made. Spatial distribution map of black carbon mass concentration over Indian region has been prepared. The first observational evidence of elevated atmospheric warning and its northward gradient in height and amplitude led to the formulation of the new experiment "Regional Aerosol Warming Experiment (RAWEX)" which has now become an international project (RAWEX-GVAX). Under the project NOBLE (Network

of Observatories for Boundary Layer Experiments), a network of 11 stations is established. Characterisation of sea breeze circulation over Thumba coast during winter monsoon has been completed. Based on Doppler SODAR echogram from Thumba, Port Blair and Shillong, atmospheric boundary layer (ABL) has been characterized;

- High-resolution monsoon reconstruction for the last 331 years, for the west coast of India is reconstructed. Years of extreme events (drought/flood) that occurred before instrumental period are identified in the reconstruction. In this reconstruction solar cycle (~21 year-magnetic cycle) is found which suggests significant association between sun and Indian monsoon;
- The project on Atmospheric Trace gases Chemistry, Transport and Modeling (AT-CTM) has made significant progress and the research publications appeared in peer reviewed national and international journals. Integration of surface observations with satellite-based data and modeling to understand the spatial and temporal distribution of trace gases across the country has been clearly demonstrated. The in-situ and transported sources of these gases have been identified. Quantification of the trace gases is in progress. They have proposed many innovative approaches to quantify and model their role in climate change;
- The project Atmospheric Dust Chemistry and Transport Modeling (ADC&TM) has also made significant progress. Atmospheric concentrations of particulate polycyclic aromatic hyudrocarbons (PAHs) and their isomer ratios have been studied for two distinct biomass burning emissions (post-harvest burning of paddy-residue n Oct-Nov and wheat-residue burning during April-May) in the Indo-Gangetic Plain (IGP). The large temporal variability in the concentrations of particulate species and OC/EC ratio (range : 1.9-25.7) is attributed to differences in the two biomass burning emissions and their relative source strength. Impact of continental outflow from south and Southeast Asia during winter months on the dispersal of pollutants over Tropical Bay of Bengal has been studied. To evaluate the importance of atmospheric deposition of Iron (Fe) on N and C fixation, marine nitrogen and carbon fixation from present day simulations of atmospheric deposition of nitrogen, phosphorus, and iron were carried out;
- Under the National Carbon Project (NCP), three flux towers at forest sites of 15-20 mt height at Barkot, Uttharanchal; Haldwani, Uttharanchal and Behule, M.P and one 3 meter tower at Agriculture site (Meerut) were established. Several fast and slow response sensors on flux towers and ground sensors o flux towers and ground sensors were established to measure surface carbon and water flux on diurnal basis. A multi-institutional national phytomass observation program consisting of 54 institutions and 74 Principal investigators was carried out. Pilot studies in 16 test-sites in different ecological regions in the country have been taken to test the methodology for biomass estimation and spectral modeling using optical and microwave data in forest ecosystems. Seasonal crop biomass and net primary productivity (NPP) estimation using remote sensing and modeling and crop NPP (above and below ground) from historical agricultural statistic data was also carried out. Simulated NPP reveals a strong seasonality and inter-annual variability across India and estimated NPP is about 1.68 Pg C. Out of this 56% and 24% were contributed by agriculture and forest area respectively and season wise contribution shows 70% during kharif (JUN-OCT) and 30% during rabi (NOV-MAY). Satellite-based Vegetation Photosynthesis Model (VPM) was implemented which used drivers like solar radiation, temperature, fPAR, Light Use Efficiency. The project emphasizes on the NPP in the dominant ecosystems. The project is developing a methodology of upscaling the in-situ observations to satellite sensor-based observations;

- Under another project, creation of land use land cover (LULC) database at decadal interval (1985, 1995 and 2005) for all the 14 major river basins (entire country) based on satellite image interpretation and legacy data has been completed. The project has developed indigenous software for analyzing the drivers of LULC change and modeling the future LULC scenarios. The indigenous model for prediction of LULC change was tested in the Yamuna river basin. Variable Infiltration capacity (VIC) model has been tried in Pennar basin and studied the impact of LULC change on hydrological regime for the future (year 2025). It was found that there was a 37% increase in run-off due to change in land use (increase in built up and decrease in forest area). These studies have lot of implications on our land use policy.

34.3 **Major Activities Planned during 2013-2014**

In addition to continuing the above mentioned ongoing projects, the following three new components will be taken up during 2013-14. They are:

i) Investigating and quantifying aspects of the marine carbon (C) and nitrogen (N) cycles using stable isotope techniques and assess their role in global climate change. This project will characterize the variability in N and C fixation rates with emphasis on specific experiments to study the recently discovered processes such as Anammox and direct N2 fixation by diazatrophs,

ii) Reconstruction of past monsoon from speleothems using oxygen isotopic measurements in speleothems,

iii) Study of Energy Balance of Rural India using geospatial Inputs at village level, quantification of Green House Gases emissions resulting from energy use in Rural India., development of an energy flow model and assessment of net energy balance of Rural India.

35. ISRO Sponsored Research Programme (RESPOND)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
21.80	21.20	22.80

35.1 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 relevant to the Space Programme. In addition, RESPOND also supports Advanced Technology Research in Space Technology Cells established at premiere Institutions like IIT's and IISc.

35.2 The main objective of this programme is to establish strong links with academic institutions in the country to carry out research and developmental projects which are of relevance to space and derive useful outputs of such R&D to support ISRO programmes. RESPOND programme aims to enhance academic base, generate human resources and infrastructure at the academic institutes to support the space programme. The major activity of RESPOND is to provide support to research projects in wide range of topics in space technology, space science and space applications to universities/ institutions. In addition conferences, workshops and publications, which are of relevance to space research, are also being supported.

35.3 During the year, 19 New Projects, 26 Ongoing Projects have been approved for supporting. Space Technology Cells established at IIT, Kharagpur & Bombay and ISRO Chair at University of Pune, and 30 conferences/symposia/ publication and other scientific promotional activities have also been approved for supporting and 30 RESPOND projects have been successfully completed.

36. Atmospheric Science Programme (ASP)

₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
18.70	7.92	21.80

36.1 Atmospheric Science Programme (ASP) has been formed to provide an impetus to studies and research in the critical areas of atmospheric of modeling and a mechanism for interactions with scientific department and academia for initiating/taking up suitable projects, leading to operational end user products in different domains. The primary goal of Atmospheric Science Programme will be to adopt a holistic approach towards generation, validation and assimilation of data (ground based, oceanic, atmospheric, satellite, radar data) and develop tailored models with advanced land-ocean-atmosphere process, moisture fluxes, could dynamics for operational applications of socio-economic relevance.

37. Earth Observation Applications Mission (EOAM)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
2.80	1.49	4.37

37.1 The thrust of EOAM is mainly (i) evolve newer applications. R&D Programmes based on technology trends – leading to operational applications programmes (ii) guiding remote sensing applications programme with the user community towards implementation of remote sensing based solution and (iii) steering commercial activities of remote sensing involving development of value added services. Under EOAM various R&D and technology development studies like horticultural inventory, fluvial geomorphological mapping, snow and glacier studies, precision farming, water use in agriculture, surface deformation/mapping using differential SAR interferometry, desertification monitoring and assessment, geophysical investigations, etc. Apart from the above, pre-investigation studies of Cartosat are also being carried out. Some of the new remote sensing applications studies planned/ taken up under EOAM include hot spot mapping and monitoring, coal pitheads, riverine wetlands, forest ecosystem, working plan for forest management, crop growth monitoring system, etc.

37.2 **Major Activities Planned during 2012-2013**

- Completed flood forecasting and development of spatial decision support system for flood damage mitigation;
- Completed multi remote sensing and geophysical data integration for understanding the surface and subsurface geological setup for mineral exploration;
- Planned to evaluate sensitivity of hyper spectral remote sensing satellite data based indices to in-situ measured biophysical characteristics of dry deciduous forests;
- Automatic extraction of Geomorphic features using satellite remote sensing;
- Study of meoscale process in the western Bay of Bengal;
- Modelling suspended sediment dynamics in Ganga river using Hyper-Spectral data;

- Target parameter retrieval and land cover mapping using synthetic aperture radar Polarimetry (PolSAR) technique;
- Application of hyper spectral RS data for mineralogical and/or lithological discrimination demand based irrigation planning of an irrigation command area using AWS and remote sensing data;
- Hyperspectral and Spectroradiometer Analysis for identification of Base Metal Deposits in parts of Central Rajasthan;
- Solar energy and Wind energy Potential mapping using Remote sensing and GIS;
- Development of mathematical Method for very high spatial resolution Satellite Image classification;
- Estimation of atmospheric parameters from multi/hyper spectral images : validation and operational applications (Atmospheric correction);
- Comparison of class separability between Fully Polarimetric/Dual/Single-Polarization SAR;
- Mapping the ecological condition of coral reefs of the world;
- Snow and Glacier Studies-Phase-II;
- Remote sensing based Hydro-Meteorological Assimilation in the Hydrological and weather Forecasting Models;
- Mapping, Modeling and Impact Assessment of land Subsidence in Northern India;
- Modeling temporal and spatial pattern of north western Himalayan cities;
- Rainfall retrieval using remotely sensed data and study of extreme rainfall events over NWH regions;
- GIS mapping of major vector borne diseases in NER.

37.3 **Major activities planned during 2013-2014**

- Planned to complete fire risk alarm system using integrated approach;
- Planned to experiment on international crop assessment using EO data;
- Planned to complete integrated Spatial Farming Systems Analysis techniques with RS and Ancillary data;
- Planned to estimate periodic water balance components and generation of geo-spatial hydrological products at uniform grid-wise at National scale;
- Planned to complete early warning system for flood disaster mitigation – using space inputs through hydrological modeling approach;
- Planned to complete crop identification and its growth assessment using hyperspectral satellite data;
- Planned to complete satellite based thermal data utilization for crop condition assessment;
- Planned to develop Satellite Radar Altimeter Waveform re-tracking algorithms for accurate height over land and inland water bodies;
- Planned to complete Geo Dynamics of Indian sub-continent using GPS and Gagan data;
- Planned to complete operational methodology for horticultural crop inventory;
- Planned to take up Narcotic Crop Assessment Project (NCAP);
- Planned to estimate above ground biomass using SAR data in tropical and subtropical forests of North East India;
- Planned to analyse water balance of Umiam (Barapani) reservoir in Meghalaya;
- Planned to monitor rice and maize growth and yield under variant nitrogen in soil by remote sensing technique.

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FINANCIAL REVIEW

1. 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 evolved a mechanism of reviewing and monitoring the commitment and expenditure status of various programmes/projects approved in the annual budget periodically 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 by the Additional Secretary & FA of the Department of Space to ensure that the allocated funds are fully utilised. Accordingly, while formulating the Revised Estimates 2012-2013, 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 the Additional Secretary & FA of the Department takes a rigorous review of the expenditure/commitment status on a monthly basis 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 of 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., 2009-2010, 2010-2011 and 2011-2012 are given below:

Financial performance 2009-2010

(₹ in crores)

	Non-Plan	Plan	Total
Budget Estimates 2009-2010	859.00	4100.04	4959.04
Revised Estimates 2009-2010	995.00	3172.04	4167.04
Actual Expenditure 2009-2010	994.20	3168.76	4162.96

4. The Revised Estimates 2009-2010 was reduced to ₹**4167.04** crores in compliance with the reduced ceilings fixed by the Ministry of Finance. The actual expenditure during the year was ₹**4162.96** crores which is about ***99.90%*** budget utilization with respect to RE.

Financial performance 2009-2010

(₹ in crores)

	Non-Plan	Plan	Total
Budget Estimates 2010-2011	778.00	5000.04	5778.04
Revised Estimates 2010-2011	880.00	4000.04	4880.04
Actual Expenditure 2010-2011	878.83	3603.40	4482.23

5. The Revised Estimates 2010-2011 was reduced to ₹**4880.04** crores in compliance with the reduced ceilings fixed by the Ministry of Finance. The actual expenditure during the year was ₹**4482.23** crores which is about ***91.85%*** budget utilization with respect to RE.

Financial performance 2011-2012

(₹ in crores)

	Non-Plan	Plan	Total
Budget Estimates 2011-2012	926.00	5700.04	6626.04
Revised Estimates 2011-2012	1000.00	3432.04	4432.04
Actual Expenditure 2011-2012	999.18	2785.08	3784.27

6. The Revised Estimates 2011-2012 was reduced to ₹**4432.04** crores in compliance with the reduced ceilings fixed by the Ministry of Finance. The actual expenditure during the year was ₹**3784.27** crores which is about ***85.38%*** budget utilization with respect to RE.

7. The scheme-wise/project-wise details of BE, RE and Actuals for 2011-2012, BE & RE for 2012-2013 and BE for 2013-2014 are given in Table 5.1 enclosed.

8. The year-wise break-up of the 274 Utilization Certificates Outstanding as on 31.01.2013 is indicated below:

Sl.No	Year of Sanction of Grant	Due		Utilization Certificates received		Outstanding	
		No.	Amount	No.	Amount	No.	Amount
1.	1976-77	39	11.03	38	10.98	1	0.05
2.	1977-78	68	36.96	68	36.96	0	0.00
3.	1978-79	72	32.33	72	32.33	0	0.00
4.	1979-80	105	60.35	104	60.30	1	0.05
5.	1980-81	95	45.36	94	44.98	1	0.38
6.	1981-82	109	56.16	108	56.13	1	0.03
7.	1982-83	98	67.72	93	67.03	5	0.69
8.	1983-84	99	67.80	98	67.78	1	0.02
9.	1984-85	120	53.20	117	52.23	3	0.97
10.	1985-86	93	50.69	92	50.64	1	0.05
11.	1986-87	82	43.94	77	42.64	5	1.30
12.	1987-88	96	58.82	94	53.94	2	4.88
13.	1988-89	67	53.08	67	53.08	0	0.00

Sl.No	Year of Sanction of Grant	Due		Utilization Certificates received		Outstanding	
		No.	Amount	No.	Amount	No.	Amount
14.	1990-91	60	93.34	60	93.34	0	0.00
15.	1991-92	49	153.19	48	153.04	1	0.15
16.	1992-93	50	109.64	50	109.64	0	0.00
17.	1993-94	63	128.89	62	127.61	1	1.28
18.	1994-95	72	249.65	72	249.65	0	0.00
19.	1995-96	84	338.19	84	338.19	0	0.00
20.	1996-97	105	391.38	105	391.38	0	0.00
21.	1997-98	115	645.51	115	654.51	0	0.00
22.	1998-99	143	652.96	142	652.76	1	0.20
23.	1999-00	188	779.58	186	778.28	2	1.30
24.	2000-01	185	2574.58	181	2519.71	4	54.87
25.	2001-02	178	1495.87	171	1366.96	7	128.91
26.	2002-03	196	1370.66	185	1207.91	11	162.75
27.	2003-04	240	1422.17	225	1219.22	15	202.95
28.	2004-05	240	1706.06	228	1487.44	12	218.62
29.	2005-06	248	1346.99	222	1229.10	26	117.89
30.	2006-07	243	1601.34	227	1575.46	16	25.88
31.	2007-08	226	1311.49	213	1271.20	13	40.29
32.	2008-09	248	2044.61	226	1871.97	22	172.64
33.	2009-10	275	2190.87	220	1988.52	55	202.35
34.	2010-11	233	1619.85	168	1210.49	65	409.36
	TOTAL	**4672**	**22960.09**	**4398**	**21212.16**	**274**	**1747.93**

8.1 Continuous follow-up action is being taken with the grantee institutions for submission of Fund Utilization Certificates duly supported by statement of audited accounts in respect of the above 274 cases.

8.2 In addition to the above, the Department has also evolved effective mechanisms to monitor the physical progress of the sponsored research projects. The duration of such research projects is generally 3 to 5 years. Periodical reviews, both physical and financial, are carried out every year by an expert committee to assess the research progress and recommend the grants to be released to such projects for the following year. The mechanism ensures that the funds released to the projects are utilized for the intended purposes.

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Department of Space

TABLE-5.1

Financial Review: Overall Trends in Expenditure 2010-2014

(₹ in Crores)

Sl. No.	Programmes/Projects/Centres/Units	Budget 2011-2012	Revised 2011-2012	Actuals 2011-2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
A	**SPACE TECHNOLOGY**						
I	**Launch Vehicle Technology**						
1	Cryogenic Upper Stage Project	0.10	0.10	0.00	0.10	0.10	0.10
2	PSLV-Continuation Project	250.00	265.00	299.74	380.00	170.00	350.00
3	GSLV Mk-III Development	125.64	110.07	110.05	72.09	72.10	139.53
4	Space Capsule Recovery Experiment - I & II	4.40	2.20	1.73	2.20	1.00	0.50
5	GSLV – Operational Project (including Mk-III Operational)	292.46	200.00	222.81	258.96	250.00	215.91
6	Vikram Sarabhai Space Centre	686.03	623.05	598.98	784.36	652.62	732.87
7	ISRO Inertial Systems Unit	39.74	36.88	43.91	62.67	56.26	69.01
8	Liquid Propulsion Systems Centre	314.33	299.19	303.72	436.35	344.39	439.09
9	Manned Mission Initiatives/Human Space Flight Programme	98.81	13.17	11.18	60.46	14.00	27.00
10	Indian Institute of Space Science & Technology	100.00	10.00	0.00	100.00	50.00	150.50
11	Semi Cryogenic Engine Development	150.00	50.00	28.29	150.00	84.96	180.00
	Sub-Total	**2061.51**	**1609.66**	**1620.41**	**2307.19**	**1695.43**	**2304.51**
II	**Satellite Technology**						
12	Oceansat-2 & 3	50.00	1.00	0.00	50.00	0.00	0.00
13	Resourcesat-2 & 3	32.66	14.00	13.70	10.50	0.80	0.00
14	G.SAT-4/GSAT-4R/GSAT-11 EM	50.00	0.00	0.00	0.00	0.00	0.00

Sl. No.	Programmes/Projects/Centres/Units	Budget 2011-2012	Revised 2011-2012	Actuals 2011-2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
15	**RISAT-1**	0.95	0.95	2.84	0.25	0.90	0.00
16	Advanced Communication Satellite (GSAT 11 including Launch Services)	410.00	52.50	44.41	250.00	119.50	203.00
17	Navigational Satellite System (including IRNSS)	218.30	144.50	120.22	170.00	134.15	135.00
18	ISRO Satellite Centre	320.69	321.55	308.68	471.06	321.43	356.80
19	Laboratory for Electro-Optics System	42.85	32.10	33.13	54.78	35.12	38.60
20	Semi-conductor Laboratory	80.00	76.58	49.78	75.47	75.47	105.64
21	Earth Observation-New Missions (Cartosat-3, Tes Hyperspectral, GISAT	200.00	12.00	9.90	50.00	2.20	0.01
	DMSAR-1, ENVISAT, SCATSAT, RISAT-3 & Future EO Missions)						
22	SARAL	22.50	20.55	21.49	15.00	19.00	10.00
23	Geo-Imaging Satellite (GISAT)	0.00	0.00	0.00	50.00	23.50	80.00
24	Resourcesat-2A	0.00	0.00	0.00	0.00	0.00	28.00
25	Cartosat-3	0.00	0.00	0.00	0.00	0.00	10.00
26	**Scattsat**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**5.00**
27	**RISAT-1A**	0.00	0.00	0.00	0.00	0.00	1.00
28	Oceansat-3	0.00	0.00	0.00	0.00	0.00	5.00
	Sub- Total	1427.95	675.73	604.15	1197.06	732.07	978.05
29	Satish Dhawan Space Centre - SHAR	434.77	326.38	321.03	437.84	353.86	457.83
30	ISRO Telemetry, Tracking and Command Network	93.36	132.85	121.15	126.02	104.02	129.26
	Sub- Total	**528.13**	**459.23**	**442.18**	**563.86**	**457.88**	**587.09**
	TOTAL : A - SPACE TECHNOLOGY	**4017.59**	**2744.62**	**2666.74**	**4068.11**	**2885.38**	**3869.65**

Sl. No.	Programmes/Projects/Centres/Units	Budget 2011-2012	Revised 2011-2012	Actuals 2011-2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
B	**SPACE APPLICATIONS**	0.95	0.95	2.84	0.25	0.90	0.00
1	Space Applications Centre	420.75	307.60	283.37	306.55	304.57	336.08
2	Development & Educational Communication Unit	84.36	21.55	17.79	51.12	15.06	46.75
3	Earth Observation Applications Mission	2.53	1.79	1.40	2.80	1.49	4.37
4	National Natural Resources Management System	74.82	36.14	23.60	53.74	22.50	31.50
5	North Eastern Space Applications Centre	8.00	8.00	0.00	8.00	8.00	8.00
6	Disaster Management Support	34.57	18.87	12.77	30.38	12.00	30.42
7	National Remote Sensing Centre	223.80	200.27	190.97	273.52	214.87	199.00
8	Indian Institute of Remote Sensing (IIRS)	0.00	0.00	0.00	32.48	24.03	30.35
	TOTAL : B - SPACE APPLICATIONS	**848.83**	**594.22**	**529.90**	**758.59**	**602.52**	**686.47**
C	**SPACE SCIENCES**						
1	Physical Research Laboratory	80.70	75.53	64.45	111.90	65.48	141.46
2	ISRO Geosphere-Biosphere Programme	24.74	21.10	16.44	27.69	22.50	26.73
3	Sensor Payload Development/Planetary Science Programme	30.00	1.95	1.51	20.00	1.50	3.53
4	Megha-tropiques Project	2.00	5.35	5.34	0.40	0.23	0.00
5	ADITYA	40.00	18.50	2.49	20.00	3.40	20.00
6	Indian Lunar Mission-Chandrayaan-1&2	80.00	70.00	57.34	82.50	56.01	78.00
7	Astrosat-1 & 2	10.00	7.00	6.49	6.00	2.55	5.00
8	National Atmospheric Research Laboratory (NARL)	19.34	15.83	13.43	17.20	14.03	20.57
9	National Institute of Climate Change and Environment Studies (NICES)	0.10	0.10	0.00	1.00	0.00	0.00
10	Sponsored Research (RESPOND)	15.00	16.10	14.40	21.80	21.20	22.80

Sl. No.	Programmes/Projects/Centres/Units	Budget 2011-2012	Revised 2011-2012	Actuals 2011-2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
11	Atmospheric Science Programme	25.20	15.87	4.85	18.70	7.92	21.80
12	Small Satellites for Atmospheric Studies & Astronomy	5.00	5.55	4.37	2.46	2.00	5.00
13	Other Schemes	19.04	10.80	9.18	17.10	8.31	8.90
14	Mars Orbiter Mission	0.00	10.00	0.00	125.00	125.00	167.50
	TOTAL : C - SPACE SCIENCES	**351.12**	**273.68**	**200.29**	**471.75**	**330.13**	**521.29**
D	DIRECTION & ADMINISTRATION/OTHER PROGRAMMES						
1	Department of Space Secretariat	9.20	8.61	8.86	9.12	10.10	10.48
2	Indian Space Research Organisation (ISRO) Headquarters	58.86	59.35	60.45	66.38	65.44	68.75
3	International Co-operation	2.95	2.80	2.70	2.80	2.70	3.80
4	Other Programmes (Spl Indigenisation/ advance ordering, etc.)	251.56	29.55	16.55	117.42	23.06	51.39
	TOTAL D: DIRECTION, ADMINISTRATION & OTHER PROGRAMMES	**322.57**	**100.31**	**88.56**	**195.72**	**101.30**	**134.42**
E	INSAT OPERATIONAL						
1	INSAT-3 Satellites	52.40	30.10	29.98	36.50	21.86	25.30
2	INSAT-3 Launch Services	75.00	170.00	0.00	0.00	0.00	0.00
3	INSAT-4 Satellites (including leasing of Transponders)	857.10	294.25	229.59	560.90	173.42	297.00
4	INSAT-4 Launch Services	56.00	0.35	2.26	81.00	47.00	0.00
5	GSAT-7 Satellites (Launch Services)	0.00	180.90	0.00	207.70	448.51	14.00
6	Master Control Facility	45.43	43.61	43.47	70.52	48.91	73.91
7	INSAT-3D Launch Services	0.00	0.00	0.00	264.25	221.00	270.00
8	GSAT-15 Satellite	0.00	0.00	0.00	0.00	0.00	100.00
9	GSAT-15 Satellites-Launch Services	0.00	0.00	0.00	0.00	0.00	300.00

Sl. No.	Programmes/Projects/Centres/Units	Budget 2011-2012	Revised 2011-2012	Actuals 2011-2012	Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
10	GSAT-16 Satellites	0.00	0.00	0.00	0.00	0.00	95.00
11	GSAT-16 Satellites-Launch Services	0.00	0.00	0.00	0.00	0.00	305.00
12	GSAT-17 & Follow on Missions	0.00	0.00	0.00	0.00	0.00	90.00
13	GSAT-17 & Follow on Missions-Launch Services	0.00	0.00	0.00	0.00	0.00	10.00
	TOTAL : E - INSAT OPERATIONAL	**1085.93**	**719.21**	**305.30**	**1220.87**	**960.70**	**1580.21**
	GRAND TOTAL : GROSS	**6626.04**	**4432.04**	**3790.79**	**6715.04**	**4880.03**	**6792.04**
	Deduct Recoveries	0..04	0.04	6.52	0.04	0.03	0.04
	TOTAL : (NET)	**6626.00**	**4432.00**	**3784.27**	**6715.00**	**4880.00**	**6792.00**

AUTONOMOUS BODIES OF DOS/ISRO

1. Physical Research Laboratory (PRL)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
111.90	65.48	141.46

1.1 The Physical Research Laboratory (PRL) at Ahmedabad is an autonomous Institution supported mainly by the Department of Space. It is a premier Institute engaged in basic research in the fields of Astronomy, Planetary, Space, Atmospheric & Earth Sciences and Theoretical Physics. Academic programmes of PRL also include Doctoral & post-Doctoral research, summer programmes for science & engineering graduate students, Associateship programme for University teachers and outreach activities for high school students and general public.

1.2 **Major Achievements during 2012-2013**

- Routine observation with Optical Echelle Spectrograph for detection of exo-planets by radial velocity technique started in early 2012;
- Detection of water in lunar rock samples using Nano-SIMS;
- Analysis of Chandrayaan-1 data provided information on radiation environment in the earth-moon space and in lunar neighbourhood;
- Black carbon aerosol mass concentration over the Bay of Bengal have increased during the last decade and is highest in winter season, reflecting emission from bio-gas/bio-fuel burning in winter;
- Studies of isotopic composition of Neodymium (Nd) in Bay of Bengal shows significant contribution from the sediments delivered by the Ganga-Brahmaputa (G-B) river system and highlight the significance of G-B river system in dissolved Nd budget of the global ocean.;
- Claim for an elementary particle (neutrino) moving faster than light, made by a European experimental group, was pointed out to be erroneous;
- Installation of multi-application Solar Telescope at Udaipur lake site nearing completion;
- Planned to complete Engineering models of the two payloads from PRL, selected for the Chandrayaan-2 mission;
- Planned to complete laboratory demonstration of the high resolution X-ray spectrometer proposed for the X-ray polarimeter mission;

1.3 **Major Programmes for 2013-2014**

- Detection of specific earth-like exo-planets based on detailed observation of probable candidates using Echelle Spectrograph from Mt. Abu Observatory;
- Planned to develop space qualified model of the 2 payloads for Chandrayaan-2 mission and the proposed payload for the Mars mission;

- Planned to design and develop of sub-systems for the proposed X-ray polarimeter mission.
- Planned to study global climate change, anthropogenic versus natural effects with reference to Indian and Asian regions;
- Planned to initiate further studies of time scale of processes and sources of extinct nuclides present in the early solar system using Nano-SIMS, NG-MS and MC-ICPMS;
- Planned to study water present in lunar samples and studies of martian meteorites;
- Planned to study Molecular Physics, Optical Vortices and parametric oscillators;
- Planned to establish new facilities proposed under 12th Five Year Plan : Proton mass spectrometer;

2. National Atmospheric Research Laboratory (NARL)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
17.20	14.03	20.57

2.1 The National Atmospheric Research Laboratory (NARL) at Gadanki near Tirupati in Andhra Pradesh, is an autonomous Institution fully funded by the Department of Space, Government of India. The main activities of NARL are (i) carrying out fundamental research related to Earth's atmosphere using a variety of state-of-the-art equipments such as the Mesosphere-Stratosphere-Troposphere (MST) Radar, lidars, wind profilers, GPS balloon sonde, automatic weather station etc., (ii) research and development of advanced technology for atmospheric studies and transfer of the same to Indian industries and (iii) Modeling and prediction of weather and climate. NARL encourages national and international Institutes and Universities to make use of its facilities for front ranking research in atmospheric science.

2.2 **Major Achievements during 2012-2013**

- An intensive campaign has been conducted with the collocated MST radar, GPS balloon sonde etc., in order to validate the Lower Atmospheric Wind Profiler (LAWP) measured wind data. The data shows good agreement between the LAWP measured winds and that obtained from other techniques;
- Completed pilot study for the establishment of active phased array radar. The pilot project, with 133-element quasi-circular array, is implemented and different technologies are tested for the performance, such as out-door installation of TR modules, beam steering, optical Ethernet, multi-channel direct digital processing, pulse-to-pulse beam switching, automatic phase calibration etc.,
- Initiated development of necessary subsystems for the 30 MHz coherent radar interferometer;
- Successfully tested and evaluated a 7.5 kW solid state prototype TR module with a 14 deg tilted Yagi antenna;
- Designed, developed and installed an Incoherent Doppler lidar to measure atmospheric winds in the height region of 10-50 km;

- Intercomparison of the lidar winds was performed with GPS Sonde balloon data and the results are found to be in good agreement;
- The dual polarization lidar technology developed at NARL has been put in the ISRO/Antrix portal for transfer of technology to suitable industries;
- An ultrasonic thermometer has been built based on the principle that speed of sound is related to the ambient temperature. Temperature measurements with this thermometer are compared with those by a radiosonde temperature sensor in the laboratory for performance evaluation;
- A surface flux tower has been installed at NARL for the land surface modeling experiments. In continuation, instruments for measuring soil moisture, soil temperature and soil heat flux were successfully deployed;
- NARL is identified as a super validation site for Megha-Tropiques (MT) satellite launched in October, 2011. To validate MT-derived rainfall, a dense rain gauge network around Gadanki has been set up. Data from the network will be used for validating the satellite derived rain parameters once the data is released to the data validation team at NARL. Also special observational campaigns are planned with MST radar and with other collocated instruments available at NARL to validate the MT data;
- Work towards realizing an X-Band polarimetric radar is progressing and the installation is expected to be completed by March 2013;

2.3 Major Programmes for 2013-2014

- Initiation of activities towards realizing a Differential Absorption Lidar (DIAL) for ozone profile measurement;
- A climate observatory namely ISRO's Climate Observatory Network (ICON) is established in the campus of NARL as part of the on-going long-term program to measure aerosol properties, trace-gases concentration and atmospheric radiation New instruments namely Methane analyzer, night-time cloud cover detector, and elemental and organic carbon ratio analyzer will be added to the existing system;
- Replacement of the KEL ionosonde with a state of the art digital ionosonde;
- Development of a Portable Mesosphere Lower Thermosphere Photometer (P-MLTP) which will provide 20 second resolution data compared to current resolution of about 3 minutes and full field of view of 3^{o} instead of existing 4^{o};
- In order to complement and supplement ground-based observations, NARL is working towards in-situ and remote atmospheric experiments using flight instruments. Work is in progress towards development of Ultrasonic Thermometer for balloon-borne application and an Optical Ozonesonde;
- Development of ground-based lightning sensors using VHF interferometry/ magnetic direction finding combined with optical sensing to locate the source direction of the lightning events;
- Upgradation of data processing techniques for the WP radars;
- Initiation of in-house development of FPGA/microcontroller based beam steering controller for Phased antenna array and Digital receiver;

- Proposed to establish graphics based data assimilation and visualization system to obtain a uniform three dimensional view of data sets as the data sets generated by various instruments are in different formats with different spatial and temporal resolutions;

3. North-Eastern Space Application Centre (NE-SAC)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
8.00	8.00	8.00

3.1 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 by providing information on natural resources utilisation & monitoring, infrastructure developmental planning & interactive training using space technology inputs of remote sensing & satellite communication. The Centre networks with the State Governments in the North- Eastern Region and the North-Eastern Council for generating solutions for the developmental activities of the Region.

3.2 **Major Achievements during 2012-2013**

- Completed project on Remote sensing and GIS inputs for forest working plan preparation in Mizoram;
- Completed mapping of potential areas for sericulture development under the CSB funded project on Applications of Remote Sensing and GIS in Sericulture Development in all the selected 106 districts covering 24 States. Sericulture Information Linkages and Knowledge System (SILKS) web portal is ready for hosting;
- Under North Eastern District Resources Plan (NEDRP) programme all the seven districts of Meghalaya has been covered in Phase-I and work for 25 selected districts from remaining NER states has been initiated;
- Space Based Information Kiosk on North Eastern Region (SBIK-NER) conceptualized by NESAC has formally inaugurated by Honourable Minister of DONER on 26th June, 2012 at Vigyan Bhawan, New Delhi;
- There is significant improvement in terms of accuracy of forecast of floods under FLEWS project during 2012 flood season, which is above 80% as per official feedback received from department of Revenue & Disaster Management, Government of Assam;
- Post flood status mapping of flood protection embankments from high resolution satellite data and flood inundation mapping leading to assessment of post flood damages using Radarsat-2 satellite data during 2012 flood season;
- Significant progress made in Soil Resource Mapping under NRC project and Soil and land capability mapping funded by NEC;
- A study in the catchments of the Ranganadi Hydro Electric Plant (RHEP) has been taken up using remote sensing to assess the status of soil erosion with reference to upcoming projects in the area and silt deposition in the reservoir;

- Initiated a remote sensing and GIS based landslide hazard zonation map and reservoir rim stability studies for Subansiri Lower Hydro-Electric project;
- EOAM funded projects on mapping of forest flora and identification of potential areas for medicinal & aromatic plants in East Khasi Hills district of Meghalaya, Integrated watershed development planning for Bagra Watershed of Meghalaya, Optimization and regulation of transportation infrastructure for disaster management support for Shillong city, GIS mapping of mosquito vector borne diseases in north east India and Development of effective classification schemes for hyper spectral satellite data with potential applications in NER has made significant progress during the current year;
- Significant progress made in the projects on study on bio-ecology of Tea Mosquito bug funded by Dept. of Biotechnology, Govt. of India;
- Expansion of Edusat network in Assam, Meghalaya and Arunachal Pradesh;
- Taken up research in meso scale and short range weather forecasting to improve accuracy of rainfall forecasts;
- Assimilation of scatterometer data from Oceansat-2 satellite and satellite radiance data from Meghatropiques into the model to improve the forecast accuracy further;

3.3 **Major Programmes for 2013-2014**

- Planned to prepare remote sensing and GIS inputs working plants and schemes for entire North Eastern Region;
- Planned to complete soil and land capability mapping of all agriculture districts of North Eastern Region;
- Planned to continue/initiate Space Based Information Support for Decentralized Planning (SIS-DP) for NER, NRC-Geomorphology and Lineament Mapping on 1:50,000 scale, NRC-Rajiv Gandhi National Drinking Water Mission (RGNDWM): Phase IV, North Eastern District Natural Resources Plan and Space Based Information System on North Eastern Region(SBIK-NER) during the year;
- Planned to conduct a study on impacts of land use/land cover change with particular reference to forest cover and habitation pattern on the climate of Barak basin in north eastern India;
- Planned to conduct to study on bio-ecology of Helopeltis theivora and development of a forecasting model and study on hyperspectral data analysis;
- Planned to initiate soil Health Card for a selected micro watershed of Ri-Bhoi District of Meghalaya;
- Planned to conduct a study on above ground biomass estimation using SAR data in tropical and subtropical forests of North East India and water balance analysis of Umiam reservoir in Meghalaya;
- Planned to conduct a study to understand the airborne hyperspectral remote sensing for potential applications in NER; to monitor the growth and yield of rice and maize under variant nitrogen in soil by remote sensing technique and on utilisation of SAR/RISAT data;
- Planned to expand activity of EDUSAT network in NER states by installing new SIT and

commissioning of remaining telemedicine centres under ISRO-NEC telemedicine project;

- Planned to expand VRC network in NER states and landslide warning instrumentation for NER states;
- Planned to better utilizate the studio for content generation programs for societal development, disaster management awareness, distance education etc.;
- Planned to complete installation and commissioning of the system for the IRNSS facility as per the project plan;
- Planned to complete installation and commissioning of the system for the GSAT-4 Application Project (GAP-4) as per the project plan and start activities related to the experiment;
- Planned to set up one Electronics research lab having computer facilities equipped with some specific hardware and software to start with some research/design works pertaining to SATCOM Electronics in some specific areas like Radio Communication/RF Systems/DSP (Digital Signal Processing)/MEMS etc.;
- Planned to deploy group based SMS alert system under FLEWS projects and of field data transmission (FIDATRA) system using mobile technology;
- Planned to conduct land aerosol campaign covering E-W and N-S of NER during different seasons and estimate radiative forcing;
- Planned to establish laboratory for Space weather and Ionospheric studies and planned to participate in CAWSES-India programme by setting up node under National Space Weather observational Network in India;
- Planned to complete high resolution weather forecasting for NER using both WRF and MM5 model. Experiment to be continued with different physical schemes to identify the one most suitable for NER;
- Planned to extend the agro meteorological advisory services to other regions of NER having VRC network;
- Planned to use Spectro-Radiometer for establishing signature library for hyper-spectral studies;
- Planned to establish High Power Computing System for numerical weather prediction and thunderstorm nowcasting for Mizoram state;
- Planned to extend the Flood Early Warning System (FLEWS) by integrating inputs from various stakeholders involved in flood management. Emphasis will be given to forecast the extent and level of inundation with larger lead time;
- Planned to operationalize of NER-DRR;
- Planned to extend agriculture drought assessment;
- Planned to enhance capacity building in DMS through EDUSAT network utilization;

4. Semi-conductor Laboratory (SCL)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
75.47	75.47	105.64

4.1 SCL is entrusted with the task of Research & Development in the field of Microelectronics. SCL is engaged in the design, development, manufacturing, packing and testing of CMOS, Imaging and MEMS devices, including development of Process Technology. It is also involved in Hi-Rel Board fabrication & component screening for ISRO, indigenization of Electronic Boards for Air Force and production of Dr. Pisharoty Radio Sonde Systems. While the Design, Assembly, Testing, Quality/ Reliability Assurance Facilities are already in place, the Manufacturing facility is being upgraded from 0.8μm CMOS 6" Wafer Fabrication to 0.18μm CMOS 8" Wafer Fabrication. The development and manufacture of ASICs for strategic sector is the major thrust area. The up-gradation of CMOS Fab and commensurate facilities & utilities is the major project being carried out at SCL.

4.2 **Major Achievements during 2012-2013**

- Completed hook-up of all the 68 equipment received from Tower Semiconductor Limited (TSL);
- Commenced unit process establishment in Diffusion, Lithography, Chemical & Mechanical Polishing, Thin Films and Dry Etch areas. Unit processes for other areas are planned to start soon with the acceptance of more process equipment & is proposed to be completed by March 2013;
- Completion of installation and qualification of high purity piping;
- Planned to establish a Quality System in 0.18μm CMOS Fab and installation & training on Semiconductor Reliability Test System;
- 6" Fab-line has been operationalized in September, 2012 and production runs are planned to be carried outduring the year;
- 948 Radio Sonde Boards have been delivered against the target of 2500 for the year;
- 138 No. of Firemod Kits and 14 Test Rigs have been supplied to Air Force and only 4 Kits are required to complete the order;
- 14K devices comprising nine types of devices for the year are to be supplied to Railways for use in 3 Phase Electric Locomotive;
- 38K active and passive components are to be screened during the year for various ISRO Centres. Out of these 2000 Nos. of ADS1218, 576 Nos. of MAX1452 and 8814 Nos. of passive components have been screened upto September, 2012;

4.3 **Major Programmes for 2013-2014**

- Planned to complete all short loop runs and integration run for process qualification by August, 2013. Periodic Equipment Qualification and Preventive maintenance will be taken up to maintain good health of the equipment. All raw materials & consumables procurement will be done based on the planned production requirements. One Mask Set will be prepared for the devices planned to be fabricated in 8" Fab;

- Planned to complete process integration and fabrication and testing of SRAM devices to complete the process qualification;
- Planned to fabricate, package and characterize high range pressure sensors (10-100 bar);
- Planned to conduct DRIE process optimization and various bonding trials;
- Planned the production run of pressure (0-1, 3 bar), trimmable temperature and humidity sensors;
- Planned development of prototypes of devices such as Low Voltage Differential Signaling Transmitter (LVDS TX), Low Voltage Differential Signaling Receiver (LVDS RX), CCD Signal Processor (CSP), Timing Sequencer, On-board Controller (OBC1.1), Protocol Controller ASIC (PCA), Smart Card Module, Video Processor Logic (VPL), 12bit Analog to Digital Converter IP (pipeline ADC), Sigma Delta Analog to Digital Converter (ADC);
- Planned to augment the fabrication/calibration facilities to maintain the production levels of Dr. Pisharoty Sonde Boards at 400 boards per month;
- Planned productionization of receiver Unit/Ground Station for Dr. Pisharoty Sonde System;
- Planned Firemod Kit and other Professional Board depending on the P.O from Air Force;
- About 16K Nos. of nine variants of devices are proposed to be supplied to railways for use in 3 Phase electric Locomotive;
- Planned to increase the screening capability & capacity with emphasis on active components with a view to exploit the Ultraflex ATE facility. The tentative target set for active devices is 18000 nos. and passive is 30000 nos;
- Planned to continue HiRel fabrication/assembly of on-board cards;

5. Indian Institute of Space Science & Technology (IIST)

(₹ in crores)

Budget 2012-2013	Revised 2012-2013	Budget 2013-2014
100.00	50.00	150.50

5.1 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 education and generating high quality human resources to meet the quality 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, in the infrastructure provided by the Vikram Sarabhai Space Centre in Thiruvananthapuram. IIST has started functioning from its own campus at Valiamala, w.e.f. August 15, 2010.

5.2 The annual intake of students to the Institute is about 150-200. Admission to the B.Tech programmes of the Institute for the academic year 2011-2012 has been done through an entrance examination directly conducted by the Institute, viz., ISAT-2011. Over 80,300 candidates appeared in the 22 cities, where the Admission Test was conducted. M.Tech students and a few PhD students were selected from ISRO Centres and Units through interviews, whereas the remaining PhD students were selected through entrance examination, followed by interview.

5.3 The Institute shifted to its new campus in Valiamala in August 2010. The campus construction activities, which commenced in December 2008 gained more momentum after the Institute was shifted to the new campus. Two academic blocks, 11 hostels and canteen were completed and the work of remaining academic blocks, Students Activity centre, Library and administrative block are in varying stages of completion. Govt. of Kerala has handed over nearly the entire stretch of land acquired for IIST, barring a few patches. The setting up of laboratories is in progress. A well-equipped library with subscriptions to several print & e-journals were also set up. Moreover, internet, medical, sports and canteen facilities have also been established in the new campus for the benefit of students, faculty and staff.

5.4 The Institute is in the process of creating adequate scientific and technical infrastructure for supporting academics and high quality research. A number of well qualified and experienced faculty members have joined the Institute from many reputed Institutions in the country and abroad. The recruitment process for faculty, technical staff and administrative staff is continuing. A number of administrative responsibilities have been outsourced for better efficiency.

5.5 **Major Achievements during 2012-2013**

- Planned to conduct convocation of the second batch of BTech students;
- The Institute has started an annual education outreach activity called IIST@Schools from 2010;
- Nine major national workshops were organized at the Institute by the various Departments in 2012. Three workshops are announced for the end of 2012;

5.6 **Major programmes for 2013-2014**

- IIST proposes to join the single entrance examination of HRD with 40% marks from Board examination and 60% marks from the entrance examination for the B.Tech courses. IIST proposes to select the candidates from the HRD examination;
- The Institute also has plans to offer post-graduate degree programmes in several niche areas;
- Planned to initiate Post-Doctoral Programme, initially in five years in order to take research activities to the next level

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