

OUTCOME BUDGET
OF THE
DEPARTMENT OF SPACE
GOVERNMENT OF INDIA
2008-2009

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CHAPTER-I

INTRODUCTION

1.1 India recognized the potential of space science and technology for the socio-economic development of the society soon after the launch of Sputnik by the erstwhile USSR in 1957. The Indian Space efforts started in the sixties with the establishment of Thumba Equatorial Rocket Launching Station (TERLS), an obscure fishing village near Thiruvananthapuram for the investigation of ionosphere using sounding rockets. Over the last four decades, India has come a long way in mastering the complex space technology and using it for various developmental activities in a self-reliant manner. The ever challenging task of space technology development and utilisation, has not only graduated from experimental and demonstration phases to an operation era, but also provided its potential to address the national needs. Notable progress has been made in the design, development and operation of space systems, as well as, using them for vital services like telecommunications, television broadcasting, meteorology, disaster management support and natural resources survey and management. The space programme has become largely self-reliant with capability to design and build satellites for providing space services and to launch them using indigenously designed and developed launch vehicles. The end-to-end capability in space for vital applications in communications, broadcasting, meteorology and natural resource information are of direct relevance for national development. The diverse roles of space technology & services in various fronts – social, economic, commercial

and strategic – have made the space systems an important component of our national infrastructure.

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

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

2.2 The primary objective of DOS is to promote the development and application of Space Science and Technology for socio-economic benefit of

the nation. The Indian Space Research Organisation (ISRO) is the research and development wing of the Department of Space and is responsible for executing the research and development programmes and schemes of the Department in accordance with the directives and policies laid down by the Space Commission and the DOS. The Space programme is executed through the ISRO Centre/Units and its Grant-in-aid Institutions i.e., the National Remote Sensing Agency (NRSA), 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-coordinated by national Committees, namely the INSAT Co-ordination Committee (ICC), the Planning Committee of National Natural Resources Management System (PC-NNRMS) and the Advisory Committee on Space Sciences (ADCOS). Five Regional Remote Sensing Service Centres (RRSSCs) undertake remote sensing application projects relevant to the concerned region. The ISRO Headquarters coordinates the overall programmes like launch vehicle, satellite communication, earth observation, space 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 and associated technologies. The Centre pursues research and development in the fields of aeronautics, avionics, composites, computer and information, control, guidance and simulation, launch vehicle design, mechanical engineering; mechanisms, vehicle integration and testing, propellants, polymers, chemicals and materials, propulsion, propellants and space ordinance, and systems reliability. Programme planning and evaluation, technology transfer and industrial coordination, human resources development, safety and personnel and general administration groups support the Centre. An Ammonium Perchlorate Experimental Plant (APEP) has been set up by VSSC at Aluva near Kochi. The Space Physics Laboratory at VSSC carries out research in atmospheric and related space sciences.

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

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

The Liquid Propulsion System Centre (LPSC) is the lead Centre in the development of liquid and cryogenic propulsion stages for launch vehicles and satellites. The activities are spread across Thiruvananthapuram, Mahendragiri and Bangalore. LPSC at Thiruvananthapuram carries out design and system engineering of earth storable and cryogenic engine and stages for launch vehicles and design and development of bipropellant thrusters and electric propulsion thrusters for spacecraft, control components and control

system. LPSC, Mahendragiri carries out assembly, integration and testing of earth storable and cryogenic engines and stages, high altitude testing of upper stage engine and spacecraft thrusters, as well as testing of subsystems. This centre also has facilities for storage of earth storable and cryogenic propellant including an Integrated Liquid Hydrogen Plant. LPSC at Bangalore carries out design, development and testing of propulsion system for spacecraft. It also carries out transducer design and development.

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

The Satish Dhawan Space Centre (SDSC-SHAR) is the main launch Centre of ISRO and has 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. The Centre has two launch pads from where the rocket launching operations on PSLV & GSLV are carried out.

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

The ISRO Satellite Centre (ISAC) at Bangalore is engaged in developing satellite technology and implementation of satellite systems for scientific, technological and application missions. ISAC is functionally organised into five major areas: mechanical systems area including structures, thermal systems and spacecraft mechanisms, digital and communications area comprising of digital systems and communication systems, integration and power area comprising spacecraft checkout, systems integration and power

systems, control and mission area consisting of control system mission development and computer and information and facilities. Reliability and components area comprising indigenisation and components and systems reliability and programme planning and evaluation group support the Centre. Four project management teams co-ordinate the implementation of projects. Space astronomy and instrumentation division is engaged in space science activities. A new facility, ISRO Satellite Integration and Test Establishment (ISITE) including a Comprehensive Assembly, Test and Thermo-vacuum Chamber (CATVAC) has been set up recently.

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

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

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

The Space Applications Centre (SAC) at Ahmedabad is engaged in the development of payloads for communication, meteorological and remote sensing satellites. SAC also carries out research and development on various space applications programme. The activities are grouped under microwave systems, satellite communication applications, sensor developments, image and information processing and remote sensing applications. Programme planning group, systems reliability group and library and documentation group support the Centre. SAC also operates Delhi Earth Station (DES) for satellite communication.

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

The Development and Educational Communication Unit (DECU) at Ahmedabad is involved in the conception, definition, planning, implementation and socio-economic evaluation of innovative developmental communications in space applications. The major activities of DECU at present include: EDUSAT pilot projects, implementation and utilisation; Training and Development Communication Channel (TDCC), Village Resource Centres (VRC), tele-medicine, science channel and new satellite communication development and applications.

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

The ISRO Telemetry, Tracking & Command Network (ISTRAC) at Bangalore provides mission support to low-earth orbit satellites as well as launch vehicle missions. ISTRAC has its headquarters and a multi-mission Spacecraft Control Centre at Bangalore. It has a network of ground stations at Bangalore, Lucknow, Sriharikota, Port Blair and Thiruvananthapuram in India besides stations at Mauritius, Bearslake (Russia), Brunei and Biak (Indonesia). ISTRAC activities are organised into network operations, network augmentation, mission operation and spacecraft health monitoring, communications and computers and control centre facilities and development projects. Programme planning and reliability groups support ISTRAC activities. ISTRAC also operates the Local User Terminal/Mission Control Centre (LUT/MCC) under the international programme for satellite aided search and rescue. An Indian Deep Space Tracking Network station at Bangalore for India's mission to moon, Chandrayaan-1, is being established by ISTRAC.

I. Master Control Facility (MCF)

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

J. ISRO Inertial Systems Unit (IISU)

The ISRO Inertial Systems Unit (IISU) at Thiruvananthapuram carries out research and development in inertial sensors and systems and allied satellite elements. IISU is organised into research and development in the areas of launch vehicle inertial systems, spacecraft inertial systems, inertial system production and reliability and quality assurance. It has facilities for precision fabrication, assembly, clean room and integration and testing.

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

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

A. **National Remote Sensing Agency (NRSA)**

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

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

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

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

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

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

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

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

The Semi-conductor Laboratory (SCL), Chandigarh, a public sector undertaking under the Department of Information Technology (DIT) came under the administrative control of Department of Space in March 2005. DOS has undertaken re-structuring of SCL into a research and development society. The society, named Semi-conductor Laboratory was registered in November, 2005. SCL is entrusted with design and development of Very Large Scale Integration (VLSI) devices and development of systems for telecommunication and space sectors. SCL has facilities for fabrication of micro-electronic devices in 0.8 micron range and Micro Electro Mechanical Systems (MEMS).

Actions to upgrade the facilities to fabricate advanced devices better than in 0.35 micron range have been initiated.

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

2.6 The Indian Institute of Space Science and Technology (IIST) is an autonomous body under DOS formed with the objective of creating quality human resources tuned to suit the state-of-art space programme. The Institute offers graduate, post-graduate and research programme in the area of space science technology and applications. The Institute has started functioning from the academic year 2007-2008 around the existing infrastructure of ISRO Centres in Thiruvananthapuram.

2.7 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.

2.8 **Antrix Corporation Limited (ACL)**

The Antrix Corporation Limited, Bangalore is the marketing agency under DOS with access to resources of DOS as well as Indian space industries. Antrix markets subsystems and components for satellites, undertakes contracts for building satellites to user specifications, provides

launch services and tracking facilities and organizes training of manpower and software development.

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

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

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

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

in 2004 and launch of GSLV-F04 carrying INSAT-4CR launched in 2007 was a major achievement in the Indian Space Programme.

3.3 The constellation of Indian Remote Sensing Satellites comprises of six satellites viz., IRS-1D, Oceansat-1, TES, Resourcesat-1, Cartosat-1 & Cartosat-2. They serve as main stay of the National Natural Resources Management System (NNRMS) besides providing data worldwide. Vital applications such as identifying zones which could yield ground water, suitable locations for recharging water, monitoring command areas, estimating crop areas and yields, assessing deforestation, mapping urban areas for planning purposes, delineating ocean areas with higher fish catch potential, monitoring of environment and scene specific spot imagery are being pursued actively by users with the space based data. The data from IRS Satellites is received worldwide through a network of International ground stations under commercial agreement with M/s. Antrix. The next satellite in IRS series, Oceansat-2, intended for Oceanographic studies is in advanced stages and is targeted for launch in 2008-2009 onboard India's PSLV. Development of a Radar Imaging Satellite (RISAT) with day and night all-weather imaging capability is also in progress.

3.4 INSAT contributes significantly to a variety of services in telecommunications and television broadcasting including meteorological observations, disaster communications, Tele-education and Tele-health services. In the field of Space communications and meteorology, the INSAT system, currently consisting of Eleven satellites, viz., INSAT-2E, 3B, 3A, 3C, 3E, 4A, 4B, 4CR, GSAT-2, EDUSAT and Kalpana-1 is one of the largest domestic communication satellite systems in the world, with a capacity of about 211 transponders in C, Ext-C, Ku and S bands. Latest Satellite in the series INSAT-4CR has been realised on fast track mode and was launched

successfully on 2nd September 2007 onboard GSLV-F04. Work on INSAT-4D, INSAT-4E, INSAT-4F (user funded) and INSAT-4G are in progress.

3.5 Front ranking scientific investigations are being carried out in the fields of astronomy, atmospheric sciences, planetary science and long term climatic research using satellites, balloons, sounding rockets & ground instruments. India's first mission to moon, Chandrayaan-1 has made significant progress towards realising the scientific instruments required for the mission. The mission includes the establishment of Deep Space Network which is in advanced stages and Chandrayaan-1 satellite is targeted for launch during Mid 2008 onboard the PSLV. Development of a multi-wave length astronomy satellite ASTROSAT has also been taken up. The Indian Space programme has enabled a significant role for national industries in realisation of space systems. A strong bond with academic institutions exists through extensive research partnership. Unique organisational systems have been evolved in the national space programme for fulfilling diverse functions like development, operations and applications of complex space systems. The space programme has enabled significant technology growth in multiple disciplines as spin-off benefits.

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

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

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

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

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

4.4 Building up large space systems like space stations, servicing and refueling of satellites in space and material processing are promising greater

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

4.5 The **Earth Observation (EO) Systems** during 11th plan is driven by two major considerations viz., ensuring continuity of EO data with improved quality duly addressing the current gap areas and the urge to maintain the global leadership in EO systems. The EO series of satellites, both in IRS and INSAT/METSAT series, addressed broadly the thematic applications in three streams viz., Resourcesat series, Cartosat series and Atmosphere series. An important specific target for 11th plan is to realize the Microwave remote sensing satellite RISAT which provides all-weather remote sensing capability critical for applications in Agriculture and Disaster Management. Strengthening ground segment to ensure and enhance effective utilization of the remote sensing data will be an important thrust area. Creation of Natural Resource Inventory and Data bases, Food security, Water security, Disaster Management support, Infrastructure development, Weather forecasting, Ocean State Forecasting, Environment protection, Climate variability and change are some of the thrust areas of EO systems applications identified for 11th plan.

4.6 The major emphasis in **Satellite Communications** during 11th plan will be towards meeting the growing demand for transponders, ensuring continuity of quality services, protection of space systems, efficient spectrum management and continuous improvement in technology. Based on the demand, the INSAT system capacity will be progressively augmented to about

500 transponders by the end of 11th plan period. Development of cost effective 4T-12KW bus with capacity of more than 50 transponders with flexibility to accommodate a wide range of payloads will also be undertaken. The thrust areas of applications include expansion and growth of tele-education, telemedicine and village resource centers, strategies for operationalisation and Institutionalisation with the involvement of Central Government Ministries/Departments, State Governments and NGOs, self-sustenance and large scale training.

4.7 **Satellite Navigation** is emerging as a vital area not only for civil aviation but in many other areas such as mobile telephones, surface transport, intelligent highway system, maritime transport, rail, oil and gas, precision agriculture, fisheries, survey and marine engineering, science, electricity networks and leisure. Besides completing the ground augmentation system GAGAN (GPS And GEO Augmented Navigation), a major target for 11th plan is to establish Indian Regional Navigational Satellite System with a constellation of 7 satellites. Co-operation and participation in global navigational systems will also be pursued.

4.8 The interest in **Space Science research** during 11th plan is focussed in four major areas viz., Planetary Exploration/Science, Astronomy and Astrophysics, Space Weather and Weather and Climate. The Space Science research in the country has gained impetus in the recent years with the undertaking of Planetary mission Chandrayaan-1, Multi-wavelength astronomy satellite ASTROSAT and climatic research satellite Megha-Tropiques and created special awareness and enthusiasm amongst the younger generation. A major target for 11th plan, therefore, is to complete these ongoing missions and plan for followon missions Chandrayaan-2 and Astrosat-2 for continued investigations. Besides this, a number of small satellite missions for studies in Solar Physics (Space borne Coronagraph “Aditya”),

Earth's Near Space Environment (Twin satellite missions SENSE-P and SENSE-E), investigations in inner magnetosphere (ITM) and studies in atmospheric aerosol and trace gases (I-STAG mission) have also been planned. Akin to this, a major challenge lies in creating the human resource base in the country for analysis of the enormous amount of scientific data that would be available from these missions. It is also planned during the 11th plan period to undertake technology development for newer missions such as Mars Orbitor, Asteroid Orbitor and Fly by Missions to Comets and Outer Solar System with a primary interest to understand the origin and evolution of solar system.

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

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

4.11 Human Resource Development, International co-operation, Industry and Academia interface, indigenous development of space materials and components and Space commerce will continue to be priority areas during 11th plan period. An important target during the 11th plan period will be to set up Indian Institute of Space Science and Technology (IIST) with a view to capture the talent at 'plus two' level in order to create quality human resources in the country for ISRO. The Institute has already started functioning from the academic year 2007-2008.

4.12 The budgetary resource for the missions planned during 11th plan period as well as the advance investments required for the missions planned for the beginning years of 12th plan period is fixed at Rs.33883 crores (at current prices). Out of this, the Plan outlay for 11th plan would be Rs.30883 crores while the non-plan budgetary support is expected to be Rs.3000 crores (approx).

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

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

5.1 The Department of Space is committed to:-

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

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

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

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

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

(b) Commercialisation Policy to extend the outreach of Indian Space assets, products and services to the global market through Antrix Corporation Dissemination of IRS data through International ground stations on commercial basis,

Leasing of INSAT transponders to private users, launching of foreign satellites by Indian Launch Vehicles (PSLV/GSLV), TTC support for foreign satellites, design and development of communication satellite for International customers.

(c) Remote Sensing Data Policy for acquisition and distribution of satellite remote sensing data from Indian and foreign satellites for civilian users in India.

(d) Satcom Policy to enable use of INSAT satellites by non-government sectors and to establish and operate private communication satellite.

(e) International Co-operation Policy for mutual benefit – bilateral and multilateral co-operative programmes, payloads of opportunity to be flown onboard Indian satellites and participation in international forums.

(f) Human Resource Development Policy oriented to retain the critical mass, training and development programmes, rewards and incentives, flexibility in career growth prospects, sabbatical opportunities and capacity creation in the academia through sponsored research.

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

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

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

CHAPTER II

OUTCOME BUDGET 2008-09

1.1 The Budget proposals for the Department of Space have been formulated under the frame work of Decade Profile 2010-20 and proposals for Eleventh Five Year plan (2007-12). The BE 2008-09 for Department of Space stands at Rs. 4074.00 crores comprising of Rs. 3600 crores Plan outlay and Rs. 474.00 crores Non-plan outlay. The outlay has been arrived at taking into account the Programmatic targets set for 2008-09.

1.2 The Department has prepared “**Outcome Budget 2008-09**” based on the guidelines contained on the subject in the Department of Expenditure, Ministry of Finance Office Memorandum No. 2(1)Pers/E-Coord/OB/2005 dated: 12th December 2006. The Table 2.1 annexed to this Chapter, gives the Outcome Budget for 2008-09.

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

2. Projects / Mission Mode Working

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

3. Intermediate Outputs :

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

nature, which will get integrated with the work of lead centre. This has been suitably reflected in the Outcome budget.

4. Partial Outcome :

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

5. Converting Outputs to Outcomes:

The Outcome of a programme is largely dependent on the Objectives of the Programme. The primary objective of Space Programme is to develop the Space Technology (comprising of development of Satellites,

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

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Department of Space

TABLE-2.1

OUTCOME BUDGET 2008-09

(Rs. in Crores)

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
	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 viz., GSLV D1, D2 and D3 flights	1405.19	---	1.00	---	Realisation of vehicle subsystems Assembly and integration of GSLV D3 launch vehicle on the launch pad to launch GSAT-4 satellite.	Total self-reliance in launching 2T class INSAT satellites.	Launch campaign for GSLV D3 is scheduled to start in Mid 2008.	GSLV D1 and D2 have been successfully launched during 2001 and 2003.
2	Cryogenic 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	---	Assembly, integration and testing of flight cryogenic stage. Delivery of flight model of cryogenic stage for use in GSLV.	Achieve self reliance in Cryogenic technology for launch vehicles	Cryo stage is planned to be transported to SDSC-SHAR for integration with the GSLV D3 during Mid 2008.	Full flight duration (720 s) test which is a critical test to qualify the indigenous cryogenic stage, has been successfully conducted on 15th November 2007 at LMF, Mahendragiri. Indigenous cryo engine has been successfully tested for cumulative test duration of more than 7000 secs.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
3	GSLV Operational	To fabricate Ten operational GSLV launch vehicles (GSLV F1 - 10) and take advance procurement actions for additional vehicles and launch communication satellites planned for 10th plan and beyond.	2270.00	---	255.00	---	Subsystem realisation, assembly and integration of GSLV F03 on launch pad. Hardware realisation for subsequent flights GSLV F05 & F06. Dev and qualification of Payload Assist Module (PAM) for Navigational Satellite Missions.	Augmenting the global navigational satellite services.	GSLV F03 flight is planned for third quarter of 2008-09.	GSLV has so far completed two operational flights successfully.(GSLV F01 and F04)

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
4	GSLV Mk III Development	To develop a Geosynchronous satellite launch vehicle capable of launching 4Ton class INSAT type of satellites to GTO.	2498.00	---	270.00	---	Commissioning of Solid Propellant Plant, Thrust Chamber Test Facility, Integration and Test Facilities. Completion of S 200 Static Tests, C25 Engine tests, L 110 Stage tests, realisation of propellant tanks for C 25 and L110 and readiness of avionics systems and SAS for ground tests.	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.	First developmental / test flight targeted for 2009.	
5	PSLV-C	To fabricate seven PSLV operational launch vehicles (PSLV C7 - C13) and take advance action for procurement of materials for two more flights PSLV C14 and C15 for launching Remote Sensing and Scientific satellites of 10th plan and beyond.	1345.52	---	180.00	---	Subsystems: Realisation of PS 01, PS0 motors, PS3 motor, PS4 stage, PS02 stage, avionics systems, control systems, stage auxiliary systems and interstage strcutres for PSLV C12 - C18. Qualification of High performance PS2 propellant tank and PS4 high performance Engine for High performance PSLV. Missions: Vehicle assembly, integration, testing and launch of PSLV C9, 11 & 12	Launching of Chandrayaan-1, Cartosat-2A, Oceansat-2, Third World Satellite and other customer satellites.	Three flights of PSLV are planned during 2008-09.	PSLV had so far 11 successive successful flights and has emerged as a versatile, reliable and cost-effective launch vehicle. Its launch capability has been progressively enhanced from 850 kgs to 1500 kg through continous improvements in the launch vehicle.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
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	---	10.00	---	Realisation of subsystems for followon mission SRE-2	Partial Outcome: Realisation of subsystems required for SRE-2.	SRE-2 launch is planned during 2009.	SRE-1 was successfully launched on 10th January 2007 onboard PSLV C7 and recovered on 22nd January 2007. This unique mission has demonstrated the capability to recover a satellite from orbit at a predetermined location and the associated technologies.
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 subsystems and provide infrastructure support for development and fabrication / testing of Indian launch vehicles.	N.A	128.41	303.87	---	Airbreathing Propulsion: Scramjet combustor tests in flight configuration, Commissioning of MACH 6 high speed combustor test facility, RH 560 (M) DMRF-FTD 01 vehicle characterisation flight with dummy scramjet engines followed by 2 Scramjet characterisation flights with H2 fuel injection. Sounding rocket launchings for atmospheric studies.	Technology development initiatives and hardware development and realisation lead to state-of-art launch vehicles for Indian Space Programme.	RLV-TD and air breathing propulsion are targeted for completion during 2009-10.	As a part of Air Breathing Propulsion technology, Supersonic combustion has been successfully demonstrated through ground tests in Nov-Dec 2005, which is a major achievement in the area of launch vehicle technology development.

(Rs. in Crores)

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
	VSSC contd....						<p>Reusable Launch Vehicle - Technology Demonstrator: Fabrication and assembly of Engineering Model, Structural Model and Proto model air frame, interstage and base shroud with fin, total aerodynamic characterisation using CFD and Wind Tunnel, Realisation and testing of all flight hardware.</p> <p>Installation of 6MW Plasma wind tunnel facility, Realisation of 1m HWT and 1m Shock tunnel facility, Installation and commissioning of Indigenous 250kN Shaker and Angular Motion Simulator.</p> <p>Production of Ammonium Perchlorate for Solid Propulsion systems</p> <p>Technology development initiatives in the area of avionics, aeronautics, advanced materials, propulsion systems, mechanisms, control and guidance and manufacturing technology.</p> <p>Launch Vehicle Hardware development and realisation for PSLV, GSLV and GSLV MK III launch vehicles.</p>			

(Rs. in Crores)

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
8	ISRO Inertial Systems Unit. (IISU)	Research, Development and realisation of inertial sensors and systems for launch vehicles and allied satellite elements.	NA	---	23.16	---	<p>Realisation of flight and standby units of RESINS Mk IV for RLV-TD</p> <p>Realisation of qualification model of miniature RESINS Mk</p> <p>VRRealisation of MEMS gyro based RGP</p> <p>Realisation of AINS flight model for GSLV Mk III</p> <p>Realisation and delivery of inertial systems for Resourcesat-2, Cartosat-2B, Youthsat, GSAT-5, RISAT, ASTROSAT and IRNSS.</p> <p>Realisation of flight and flight standby units for PSLV and GSLV flights.</p> <p>Development of advanced inertial systems.</p>	<p>Realisation of tested and qualified inertial systems such as Inertial Navigation systems, Servo Accelerometers, Mission management unit, Momentum Wheels, Reaction Wheels, Solar Array Drive Assembly, Gyros, inertial reference units, scan mechanisms, etc., for Launch Vehicles and Satellites.</p> <p>Inertial systems are intermediate products / subsystems used in satellites and launch vehicles.</p>	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 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
9	Liquid Propulsion Systems Unit (LPSC)	Development of earth storable liquid propulsion and cryogenic propulsion technology/systems for launch vehicles and satellites.	NA	46.33	157.86	---	<p>Development, integration and testing of first CE20 engine.</p> <p>Completion of L 110 development stage with Al alloy propellant tanks.</p> <p>Augmentation of PTS for L 110 engine.</p> <p>Realisation of Electric propulsion system for GSAT-4.</p> <p>Realisation of Liquid and Cryogenic Stages for launch vehicles (PSLV C9-C14) and GSLV D3, GSLV F03 and F05.</p> <p>Realisation of spacecraft propulsion systems for satellites. (GSAT-4, INSAT-3D, INSAT-4D, ASTROSAT and RISAT)</p>	<p>Realisation of tested and qualified (a) liquid and cryogenic stages for PSLV and GSLV and (b) Reaction control systems for IRS and GEOSAT Satellites.</p> <p>Liquid and Cryogenic propulsion systems are intermediate products / subsystems used in satellites and launch vehicles.</p>	Technology development, improvement and scaling up is a continuous process to remain state-of-art in satellite and launch vehicle technology and to achieve maximum self-reliance in this strategic area.	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.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
10	Manned Mission Initiatives	Develop a fully autonomous manned space vehicle to carry crew to low earth orbit and safe return to earth.	95.00 (Pre-project phase)	---	125.00	---	Mission design and analysis. Initiate development of critical / new technologies for crew module, service module, launch escape system, etc., Initiate establishment of long term facilities.	The proposal is in initial stages and the pre-project activities proposed in 2008-09 are prelude to identify the detailed elements required for undertaking a manned mission. The final outcome, in terms of availability of technologies for manned mission would take about 8 - 10 years.	A detailed project report is expected to be formulated for approval of the Government during 2008-09.	
11	Semi-cryogenic Engine / Stage Deveopment	Developing a higher thrust semi-cryogenic core stage for the unified modular launch vehicle.	(Project not yet approved)	---	22.50	---	Finalisation of the project report. Initiation of the design and development efforts. .	The proposal is in initial stages. The final outcome, in terms of availability of higher thrust semi-cryogenic stage is expected after six years.	The approval of the project is targetted during the FY 2008-09	
12	Indian Institute of Space Science and Technology	To develop high quality manpower required for Space Science, technology and applications programmes.	NA	---	65.25	---	Conduct of the courses for the academic year 2008-09 Initiation of building the campus and other infrastructural facilities.	The institute is in initial stages. The final outcome, in terms of availability of manpower for ISRO is expected after four years.	Government have approved the proposal of setting up the Institute.	IIST has started the courses from the Academic year 2007-08 around the existing infrastrucutre of VSSC. About 140 studnets have been admitted to three courses in Avionics, Aerospace engg and applied science.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
	SATELLITE TECHNOLOGY									
13	Oceansat-2	Development and launch of Oceansat-2 satellite with Ocean Color Monitor and Scatterometer instruments for Oceanography and coastal studies and providing continuity of services for Oceansat-1.	129.15	---	10.00	---	Integration and testing of the spacecraft including Scatterometer and OCM payloads. Launch and operationalisation of the satellite onboard PSLV.	Intermediate Outcome: Availability of Oceansat-2 data for Ocean and Coastal studies and Potential Fishing Zone advisory services. The data on Oceansat-2 is used by Ministry of Earth Sciences, Universities, academic institutions and NGOs.	The launch and operationalisation of Oceansat-2 is planned in 2008-09	Oceansat-1, launched on May 26, 1999, is currently providing the data for Ocean and coastal studies. The Oceansat data is also used for generating bi-weekly advisories to fisherman community on the Potential Fishing Zones.
14	Resourcesat-2	Development and launch of Resourcesat-2 for natural resource management applications & provide continuity of data / services currently provided by Resourcesat-1.	138.79	---	35.00	---	Fabrication and testing of LISS-3, LISS-4 and AWIFS payload camera. Realisation of spacecraft subsystems including Structure, power, AOCS, Propulsion, TTC and Sensors. Initiation of spacecraft integration activities.	Partial Outcome: Realisation of payloads and spacecraft subsystems.	Resourcesat-2 is planned for launch in 2009 onboard India's PSLV.	Resourcesat-1 (IRS-P6), launched on October 17, 2003 is currently providing the remote sensing data for various natural resource management applications. IRS data is also received world-wide through a network of international ground stations.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
15	Radar Imaging Satellite	Development and launch of Radar Imaging Satellite with active microwave sensors providing all-weather remote sensing capability for critical applications in Agriculture and Disaster Management.	378.49	---	25.00	---	Fabrication, assembly, testing of Synthetic Aperture Radar payload and delivery of the same for integration with the spacecraft. Realisation of spacecraft mainframe systems. Spacecraft assembly and integration activities.	The project is currently in intermediate stage. The final outcome of 'Indigenous capability to develop and realise complex microwave payloads for Remote Sensing and Disaster Management Applications' is associated with the launching of RISAT satellite.	Launch and operationalisation of RISAT is targeted for 2009 onboard PSLV.	The Transmit-Receive Module, one of the critical elements of the Synthetic Aperture Radar payload, has been successfully developed and qualified in association with an Indian Industry.
16	GSAT-4	Development and launch of GSAT-4 for advanced communication applications in Ka band.	99.00	---	7.00	---	Fabrication, assembly and testing of Navigation payload and Ka band payloads. Realisation of spacecraft subsystems. Assembly and Integration of the satellite. Launch operations from Sriharikota.	GSAT-4 will demonstrate the advanced Ka band related communication technologies for wide band application services in the country. The satellite navigation payload along with the ground augmentation under "GPS Aided GEO augmented Navigation (GAGAN) - Satellite based Navigation system" will enhance the air navigation services in the country.	GSAT-4 is planned for launch onboard GSLV D3 in 2008-09.	Ka band communication payload, which is an advanced communication technology, is being developed for the first time in the country.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
17	Navigational Satellite System	To develop a constellation of Indian Regional navigational satellite system (IRNSS) for providing positioning services and explore possibility of participation in global system.	1420.00	---	270.00	---	Procurement of critical parts and components. Finalisation of the design and completion of design review. Initiate work on ground system augmentation for IRNSS	Partial Outcome: Design and configuration of the spacecraft and payloads.	IRNSS is a constellation of 7 satellites and the first satellite in the series is planned for launch in 2009-10.	Satellite Navigation is strategically an important area of Space technology applications and taking into account the international scenario and the national requirements, Indian participation in global navigational systems is also under consideration.
18	Advanced Communication Satellite.	Development and launch of a 4T class communication satellite with advanced communication payloads	(Project not yet approved)	---	22.50	---	Preparation of project report and obtaining approvals. Finalisation of the configuration of the payload and spacecraft	Partial Outcome: Finalisation of payloads for the satellite.	Advanced Commun. Satellite (ACS) is under preliminary stages and the project report is planned for approval of the Government in 2008-09. Launch of ACS is expected during 11th plan period.	

(Rs. in Crores)

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
19	Earth Observation - New Missions (GEO HR, SARAL, Carto-3, TES-HyS, DMSAR)	To undertake New Earth Observation Missions of 11th plan such as GEO-HR mission for enhanced repetivity, Saral small satellite mission for Ocean and atmospheric studies, TES with Hyperspectral sensors, Cartosat-3 and SAR for Disaster Management Support.	(Project not yet approved)	---	65.00	---	Detailed studies on payload options and configuration of the spacecraft and finalisation of project report for GEO-HR and Saral Missions.	Partial Outcome: Finalisation of the payloads and spacecraft configuration.	The approvals of the Government for GEO-HR and Saral are planned during 2008-09.	Apart of 11th plan initiative.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
20	ISRO Satellite Centre	Developing Satellite Technology and implementation of satellite systems for scientific, technological and application missions.	NA	51.36	164.49	---	<p>Technology Development initiatives - Large Unfurlable Antenna development, Cryogenic Heat pipes, High performance onboard computer, Development of GPS receiver, miniaturised BMU, miniaturisation of DC DC convertor, development of multi split spectro polarimeter, etc.,</p> <p>Assembly, integration and testing of Satellites for launch. (Oceansat-2, Cartosat-2B, INSAT-4D, TWSAT, Resourcesat-2 and RISAT)</p> <p>Initiation of Final Operations Phase of GPS Aided GEO augmented Navigation (GAGAN) - Satellite based Navigation system.</p> <p>Subsystem development of Youthsat satellite.</p> <p>Setting up advanced electronic packaging facilities.</p>	Technology development initiatives and spacecraft hardware development and realisation lead to state-of-art satellites for Indian Space Programme.	Technology development, improvement and scaling up is a continuous process to remain state-of-art in satellite technology and to achieve maximum self-reliance in this strategic area.	The Spacecraft assembly, integration and test infrastructure has been recently augmented with a Class 100,000 clean room, state-of-art checkout facilities and Compact Antenna Test Range.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
21	Laboratory for Electro-optics Sensors.	Research and Development in the field of electro-optics sensors required for satellites.	NA	---	37.14	---	Fabrication of optics systems for Ultraviolet imaging telescope for Astrosat Assembly and testing of sensors for INSAT-4D, INSAT-4E, RISAT, Resourcesat-2 and Youthsat. Lunar Laser Ranging Instrument integration and testing. Establishment of high precision optics facility. Technology development initiatives: Four axis fibre optics gyro, development of laser source, development of miniature camera, foam based SiC materials and ISL sensors.	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.
22	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	---	34.28	---	Establishment of component screening setup for space grade components. Fabrication of various Application Specific Integrated Circuits (ASICs), MEMS, System products, foundry and IT services against specific requirements. Development of TDI CCD imager for space applications. Development of Radhard technology /process.	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 area 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 organisations 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
	LAUNCH SUPPORT, TRACKING NETWORK & RANGE FACILITIES									
23	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	55.25	182.74	---	<p>Processing 650T of propellant and production of S 139 segment and HPS3 motors.</p> <p>Launch support for GSLV F03, GSLV D3, PSLV C9, C11 and C12.</p> <p>Realisation of Solid propellant and Vehicle assembly facilities for GSLV Mk III</p>	<p>Realisation of tested and qualified solid motors for PSLV and GSLV.</p> <p>Services of launch complex facilities such as rocket assembly structures, launch pad, mission control centres, liquid and cryogenic propellant handling facilities, tracking radars, etc., for PSLV C9, C11 and C12, GSLV F03 and D3 launches.</p> <p>Solid propellant motors and Launch complex facilities are intermediate stages for launching of rockets.</p>	Launch support for GSLV F03, GSLV D3, PSLV C9, C11 and C12 flights are planned to be completed in 2008-09	A State-of-art Second launch pad has been established at Sriharikota to enable launch of future advanced launch vehicles as well as to provide redundancy for the existing launch pad.

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				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
24	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	16.42	46.86	---	<p>In-orbit operation and maintenance of all IRS satellites.</p> <p>Mission support for PSLV C9, C11, C12, GSLV F03, D3 and the satellites.</p> <p>TTC and Mission support for Chandrayaan-1. Spacenet and Hub services for Telemedicine, VRCs and ISRONET.</p> <p>Commissioning of Astrosat TTC and Data reception station.</p>	Enabling operational services of remote sensing and scientific satellites.	Onorbit operation and maintenance of satellites is a continuous round-the-clock process.	ISTRAC has recently commissioned 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									
25	Space Applications Centre (SAC)	Design and development of payloads for communication, meteorological and remote sensing satellites and conduct space applications research and development.	NA	58.67	111.17	---	<p>Fabrication and testing of payload for Satellites (RISAT, Resourcesat-2, INSAT-3D, INSAT-4D, GSAT-4 & Yothsat)</p> <p>Development of Navigational payloads for IRNSS.</p> <p>Development of terminals for utilisation of GSAT-4 and GSAT-7.</p> <p>Technology Development initiatives in critical areas of Microwave Remote sensing.</p>	<p>The payloads are the intermediate products / steps for satellites.</p> <p>Technology development initiatives and the propagation experiments lead to realisation of state-of-art payloads.</p> <p>The data from Met data centre is used by India Meteorological Department for Weather forecasting.</p>	Technology development, improvement and scaling up is a continuous process to remain state-of-art in payload sensors, communication transponders and space applications technology and to achieve maximum self-reliance in this strategic area.	
26	Development and Educational Communication Unit (DECU)	Conceptualisation, definition, planning, implementation and socio-economic evaluation of the developmental applications of space technology.	NA	4.60	53.81	---	<p>Implementation of EDUSAT network in the States of UP, Sikkim, HP, Manipur and Assam.</p> <p>To impart operational training to the users of EDUSAT network</p> <p>Expansion of Telemedicine and VRC networks.</p> <p>Utilisation of Training and Development communication channels</p>	The Tele-education, Tele-medicine and VRCs provide satellite connectivity for various development programmes implemented by State / Central agencies and NGOs. The benefit of these programmes is augmentation of the Education and healthcare infrastructure in the country for National development.	The application of space technology for developmental communication and education is a continuous process.	The user ministries concerned for EDUSAT network, Tele-medicine network and VRCs are Ministry of HRD, Ministry of Health and Family Welfare and Rural Development respectively.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
27	National Natural Resource Management System (NNRMS)	Developing National Natural Resource Management Applications using Remote sensing data and supporting region-specific remote sensing applications.	NA	---	28.23	---	Classification and mapping for Land use / Land Cover at 1:50,000 scale Mapping of degraded land for 60% of the geographical area of the country.T	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.
	Earth Observation Application Mission			---	2.68	---	Thematic mapping at 1:10,000 scale and ariel photography for NUIS.			
	Regional Remote Sensing Service Centres (RRSSC)			---	11.10	---	Generation of one cycle of Digital Elevation Model using Cartosat. Earth Observation application projects - Biodiversity characterisation at Landscape level, Mapping of ecological conditions of coral reef, Dev. of Remote sensing based bioclimatic index, etc., Implementation of region / user specific projects in application of remote sensing for developmental planning. Software development in the new areas of image processing.			Imageries of IRS are used by Ministry of Urban Development, Ministry of Agriculture, Ministry of Water Resources, Ministry of Earth Sciences, Ministry of Rural Development, Ministry of Environment and Forests, Ministry of S & T and State development agencies for various natural resource management applications.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
28	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	0.65	4.35	---	Ground water prospect map preparation for Assam and land degradation mapping. Setting up of ground system facilities for the conduct of distance education, training and Tele-education programmes for North East. Expansion of Tele-medicine programme. Implementation of special projects on Disaster Management Support.	Space technology inputs related to natural resource management, developmental communications and disaster management support for developmental programmes of the NE States.	The application of space technology for development of North Eastern Region is a continuous process.	NESAC is setup as an autonomous society jointly with the North Eastern Council to provided space technology based solutions for NE region.
29	National Remote Sensing Agency (NRSA)	Acquisition, processing, distribution of data from Indian Remote Sensing Satellites and research, development and executing remote sensing application projects in collaboration with users.	NA	32.00	3.00	---	Readiness of data reception and processing facilities for TWSAT and RISAT. Realisation of INDIA VISION project. Preparation of Ground water prospect maps in 10 States under Phase III. Completion of NUIS project. Conducting Aerial surveys Training activities at IIRS, Dehradun.	Availability of processed IRS satellite data and value added products of remote sensing technology / methods for use by various Ministries in Government, private entrepreneurs and NGOs.	Reception, processing and distribution of IRS data is a continuing activity.	IRS data are used by Ministry of Urban Development, Ministry of Agriculture, Ministry of Water Resources, Ministry of Earth Sciences, Ministry of Rural Development, Ministry of Environment and Forests, Ministry of Science and Technology and State development agencies for various natural resource management applications.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
30	Disaster Management Support	Providing space technology inputs and services on a reliable and timely manner for the disaster management system in the country.	NA	---	65.00	---	<p>Continuous monitoring and Space technology support for Floods, Drought, forest fires, etc.,</p> <p>Setting up of dedicated Airborne aerial survey facility for DMS.</p> <p>Organisation of National Database for Emergency Management in a phased manner.</p> <p>ALTM surveys in flood prone river basins for flood hazard zonation.</p> <p>Early warning system for cyclone.</p>	Strengthening of Disaster Management System in the country.	Setting up of dedicated Airborne aerial survey facility for DMS is planned by 2009.	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.
	SPACE SCIENCES									
31	Megha-Tropiques	Design and development of a satellite jointly with France to conduct ocean-atmosphere research particularly over tropical regions.	81.60	.	20.00	---	<p>Fabrication and testing of payload instruments.</p> <p>Flight Model subsystem realisation.</p> <p>Initiation of Assembly, Integration and Test Activities.</p>	<p>Partial Outcome: Design and configuration of the payloads and spacecraft.</p> <p>The project is currently in intermediate stage. Final outcome, in terms of climatic research data, is expected after the launch and operationalisation of Megha-Tropiques satellite.</p>	Launch and Operationalisation of Megha-Tropiques is targeted for 2009-10.	Megha Tropiques will contribute significantly towards the understanding of Weather systems of tropical region.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
32	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	---	25.00	---	Realisation of payload instruments. Spacecraft structure fabrication and qualification. Mainframe subsystems fabrication. Initiation of Spacecraft assembly, integration and testing.	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 2009-10	ASTROSAT is a unique observatory satellite simultaneously covering a range of high energy radiation hitherto not covered from any other global observatory missions.
33	Indian Lunar Mission Chandrayaan-1	To launch a spacecraft to orbit moon and carryout high resolution imaging to study moon's topography and distribution of minerals and chemicals on its surface.	386.00	---	78.00	---	Assembly, Integration and Testing of the Satellite. Launching of Chandrayaan onboard PSLV. Reception and processing of scientific data from Chandrayaan	Final outcome is the enhanced understanding of the Moon and its environment from the analysis of the scientific data being received from Chandrayaan satellite	Chandrayaan-1 is slated for launch in Mid 2008.	Chandrayaan-1 is India's first Mission to Moon. International Scientific Community have shown keen interest in participation. Six payloads from USA and Europe have been included in Chandrayaan in addition to Indian Payloads.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
34	Physical Research Laboratory (PRL)	Carryout basic research in the areas of astronomy and astrophysics, solar physics, planetary science, interplanetary science, earth's magnetosphere, ionosphere, atmosphere, earth's surface and interior, theoretical physics, quantum optics / lasers	NA	15.72	35.72	---	Completion of design review of the Multi angle Solar Telescope (MAST) and delivery of the Telescope by Vendor. Realisation of a multi-purpose volume phase holographic grating spectrograph. Developent of dual beam hot system for space weather studies.	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.	The Research is a continuous process.	
	Sensor Payload development / Planetary Science Programme		NA	---	5.00	---	Development of scientific instruments for measurement of trace gases and air glow. Studies on cloud physics modelling and experiments. Isotopic studies on early solar system objects and differentiated meteorites. Data analysis of Chandrayaan-1. Laboratory studies on cometary dust and interstellar grains.			

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
35	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	0.96	10.35	---	Cloud Radar development to study the microphysics of different types of clouds. Augmentation of the existing boundary layer lidar system with the capability of polarization to obtain the altitude profiles of aerosol size / shape information in the boundary layer. Establishment of data centre related to Atmospheric science. Development of 30 MHz coherent radar interferometer for research on ionospheric irregularities.	NARL is basically a research institute and the outcome of the programme will lead to expanding our understanding of the complex processes of the lower and middle atmosphere.	The Research is a continuous process.	NARL, located at Gadanki, Near Tirupati, has established a major state-of-art experimental National MST Radar Facility for middle atmospheric research.
36	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	---	14.49	---	Implement Active Array MST Radar concept to activate the CRI antenna array. Improved modelling for regional weather prediction. Densification of observational networks with AWS systems.	The Outcome is Intermediate in nature. The development efforts in terms of observational tools and modelling is applied by the operational agencies towards improved capabilities for weather prediction and climate monitoring.	The Research and development in atmospheric science is a continuous process.	An indigenous low cost version of the Automatic Weather Station (AWS) has been successfully realised towards building a network of AWS in the country, which will substantially enhance the data inputs for weather modelling.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
37	RESPOND	To strengthen the academia interaction through collaborative research, educational and scientific activities.	NA	---	13.00	---	Supporting Research and Development projects at academic institutions, universities and Space technology cells at IITs / IISc in the area of Space science, technology and applications.	Development of knowledge-base and human resources in academic institutions in the area of space research.	The Research and Development Activities are continuous process.	Over 80 Universities / institutions from different parts of the country participate in the RESPOND programme. Every year, about 150 R & D projects are undertaken under this programme.
38	ISRO Geosphere Biosphere Programme (ISRO GBP) Other Schemes	To investigate the processes between Geosphere-Biosphere-Atmosphere and their interactions, radiative forcing, regional climate, micro gravity and and space science promotion / research	NA NA	---	19.00 19.38	---	Carryout studies on aerosol radiative forcing over India. Studies on atmospheric trace gases, transport and modelling. Studies on energy and mass exchange in vegetative systems. Atmospheric boundary layer characterization. Land use/Land cover impact of Human dimensions in Indian River Basins. Atmospheric boundary layer network and characterisation. Establishment of Digital Work flow systems in ISRO / DOS. 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.	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
39	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	(Project not yet approved)	---	10.00	---	Definition of the Mission and finalisation of the project report.	Partial Outcome: Finalisation of the configuration.	Approval for the project is envisaged during 2008-09	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
DIRECTION, ADMINISTRATION AND OTHER PROGRAMMES										
40	Special Indigenisation / Advance Ordering	Indigenous development of high reliability electronic components including micro-electronics devices, space grade materials and stock piling of critical components and subassemblies for satellites and launch vehicles.	NA	---	350.00	---	Undertaking upgradation of micro-electronics fabrication facilities at Semi Conductors Laboratory to better than 0.35 microns. Dev and productionisation of Li Ion cells Development of Travelling Wave Tubes, solar cell interconnects, connectors, crystal oscillators, Application Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs), sensor devices, polymers, chemicals and metallic materials.	Indigenous capability for micro-electronics fabrication (better than 0.35 microns). Indigenous realisation of ASICs, C band Traveling Wave Tubes, Solar Cell interconnectors, PCB connectors, metal film resistors, silicon carbide mirrors, lithium ion cells and various metallic, non-metallic and polymer materials. These components / materials are intermediate products used in fabrication of satellites and launch vehicles.	The indigenous development of space materials and components to maximise the self reliance is a continuous process.	More than 150 types of high reliability electronic components and space grade materials, developed and qualified under this programme, are being currently used in various satellite and launch vehicles of ISRO.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
41	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	49.84	14.20	---	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 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
INSAT OPERATIONAL										
42	Master Control Facility	Carrying out initial phase operations and regular on-orbit monitoring and control of all Geostationary satellites of ISRO namely INSATs, METSATs and GSATs.	NA	12.04	42.77	---	<p>Launch and Early Orbit Phase operations and onorbit positioning of INSAT-4D & GSAT-4 satellites.</p> <p>Onorbit operations and maintenance of INSATs, GSATs and METSATs.</p> <p>Establishment of Ku bnd FMA terminal.</p> <p>Establishment of Transmitter location system for Interference Analysis.</p> <p>Establishment of Optical Tracking System for GEO satellites.</p>	Providing operational services of Geostationary satellites for the users in the area of telecommunications, broadcasting and meteorological data.	Onorbit operation and maintenance of satellites is a continuous round-the-clock process.	MCF has set up an Earth Station in Bhopal, Madhya Pradesh to augment the tracking, telemetry and communication infrastructure for GSO satellites.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2008-09			Quantifiable deliverables / Physical Outputs	Projected Outcome	Processes / Timelines	Remarks / Risk Factors
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	4(ii)	4(iii)	5	6	7	8
43	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.	2887.63	---	10.00	---	Realisation of Imager and Sounder payloads for INSAT-3D. Fabrication and testing of INSAT-3D spacecraft subsystems. Progress in assembly and integration of INSAT-3D spacecraft. Environmental testing of the spacecraft.	Partial Outcome: Realisation of tested and qualified advanced meteorological payloads for INSAT-3D satellite. The project is in intermediate stage and the final outcome, in terms of availability of meteorological data from the satellite, will accrue after the launch and operationalisation of INSAT-3D.	Launch and operationalisation of INSAT-3D is targeted for 2009.	INSAT-3A, 3B, 3C & 3E satellites in INSAT-3 series have already been launched successfully and are being used operationally. Currently, INSAT-3A and Kalpana (METSAT-1) are providing the meteorological data to the users for weather forecasting.
44	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 have been approved).	2635.70	---	340.00	---	Payload and spacecraft subsystems realisation for INSAT-4D. Assembly, integration and testing of INSAT-4D satellite. Subsystem realisation of INSAT-4E, INSAT-4G and GSAT-9 satellites.	INSAT-4D will augment the capacity of INSAT system with additional transponders for various telecommunications and broadcasting services including DTH services	INSAT-4D satellite launch in 2009.	INSAT system currently has 211 Transponders, which is used for Telecommunications, Broadcasting, Business Communications, Rural Area communications, Emergency communication and developmental communications.
	TOTAL			474.00	3600.00					

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

2. Space Industry Partnership

2.1 Department of Space has nurtured a strong partnership with Indian Industries in realizing the objectives of the Space Programme. More than 500 small, medium and large scale Industries participate in the programme in the form of hardware development and supply, software and other services. Almost 60% of a launch vehicle cost flows to Indian Industries. In the recently developed applications, almost 100% of the ground segment equipments / services for Tele-education and Tele-medicine have been formed out to Indian Industries. The Industry Participation policy of the Department has adopted several aggressive measures to promote the participation of Industries in the Space Programme. The Department, so far has developed and transferred 285 technologies to Industries for commercialization and has provided 270 technical consultancies in various fields to facilitate the Indian Industries to acquire the required technical know-how in the areas related to Space. It is important to note that this partnership with Industries has enabled the Department to meet the growing challenges of

advanced technology, handling complex manufacturing jobs and increasing demand for space services without any significant increase in in-house manpower.

3. Improved Delivery Mechanisms

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

3.2 Village Resource Centres (VRC), a recent initiative of the Department, is intended to provide various space enabled services such as tele-medicine, tele-education (non-formal), Geo-spatial information on natural resources, environment and infrastructure along with other community-centric services in an integrated manner and is an important step towards taking the benefits of space technology to the grass-root levels. The VRC is a totally interactive Very Small Aperture Terminal (VSAT) based network using INSAT satellite and IRS satellites.

3.3 The first cluster of three VRCs established jointly by ISRO and the M S Swaminathan Research Foundation (MSSRF) in October 2004. This network consists of four nodes located at Thiruvaiyuru, Thankatchimadam, Sempatti and Chennai in Tamil Nadu. Since then, the VRC network has expanded significantly and today about 335 VRCs are set up in the country in 16 States. (As on January 2008) Plans are afoot to expand the network of VRCs in a progressive manner.

3.4 One of the significant developments in the recent past has been the partnership developed with NGOs in setting-up, maintenance and operational support for the VRCs, Tele-medicine and Tele-education services. The industries are providing ground infrastructure and other IT based systems. It has been planned to progress towards building a tripartite association between ISRO, NGOs and the Industry in an effort to deliver the Space Services to the rural community in a cost-effective and reliable manner.

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CHAPTER IV

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

ONGOING PROJECTS/PROGRAMMES

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

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2007	Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
1405.49	1389.37	9.00	8.00	1.00

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

test flight, GSLV-D3 carrying the indigenous cryogenic engine & stage with GSAT-4 satellite onboard is planned for 2008-2009.

2. **GSLV-Operational Project**

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2007	Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
2270.00	681.74	265.00	236.50	255.00

2.1 In order to meet the launch requirement of 2 tonne class of operational INSAT satellites during the Tenth Plan and beyond, the GSLV-Operational Project has been conceived. The Project envisages ten operational flights (F01-F10) and advance actions on long lead items for the subsequent flights.

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

3. **GSLV Mk-III Development**

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2007	Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
2498.00	1421.29	335.00	284.08	270.00

GSLV Mk-III is intended to develop a cost-effective launch vehicle capable of launching 4 tonne class of communication satellites in Geo-synchronous Transfer Orbit (GTO) and upto 10 tonne satellites in Low Earth Orbit. The Project envisages the development of a number of technologies which include, amongst others, 200 tonne solid stage booster (S-200), 25 tonne cryogenic stage (C-25) and L-110 tonne liquid stage engines as core boosters. Detailed system definition/specification documents for the flight have been generated based on the final vehicle configuration. Preliminary Design Reviews for all systems have been carried out. Considerable progress have been made in the overall stage development for L-110 system. Design Review has been completed for gas generator and turbo pump for the C-25 system. Avionics requirements and specifications, flight measurement and transducer requirements have been finalized. Activities related to civil/mechanical works and procurement of equipment for the technical facilities required for S-200/L-110/C-25 are nearing completion. With the present status of progress, the first development flight of GSLV Mk-III is expected in 2009-2010.

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

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2007	Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
1345.52	1051.55	160.00	160.00	180.00

4.1 The Polar Satellite Launch Vehicles are capable of placing 1600 kg class satellites in Sun Synchronous Polar Orbit, 1000 kg class satellites into Geo-synchronous Transfer Orbit and 2800 kg class satellites in Low Earth Orbit.

4.2 The first of the operational flight of PSLV-C series (PSLV-C1), carrying IRS-1D satellite was successfully launched from Sriharikota on September 29, 1997 and the second, PSLV-C2 on May 26, 1999. PSLV-C2 injected IRS-P4 (Oceansat) as well as two foreign satellites, KITSAT-3 of the Republic of Korea and TUBSAT of Germany heralding India's entry into commercial launch vehicle market. The third flight, PSLV-C3 was successfully launched on October 22, 2001, with the Technology Experiment Satellite (TES), PROBA of Belgium and BIRD of Germany. The fourth flight, PSLV-C4, was successfully launched on September 12, 2002, injecting the 1060 kg Kalpana-1 (METSAT-1) satellite in the Geo-synchronous Transfer Orbit (GTO). This was the first time that a PSLV has been used to put a satellite in GTO. The fifth in the series, the PSLV-C5 has been successfully launched on October 17, 2003 injecting the 1360 kg IRS-P6 (Resourcesat-1) satellite in Sun Synchronous Polar Orbit. The sixth in the series, the PSLV-C6 has also been launched on May 5, 2005 carrying IRS-P5 (Cartosat-1) as

the payload. On January 10, 2007, PSLV-C7 has placed four satellites i.e, Cartosat-2, Space Capsule Recovery Experiment (SRE-I), LAPAN-TUBSAT and PEHUENSAT-1 in the predetermined orbit successfully. PSLV-C8 carrying Italian astronomical Satellite, Agile and AAM of India as payloads was successfully launched on April 23, 2007.

4.3 In its recent flight launched on January 21, 2008, PSLV-C10 launched TECSAR Satellite built by IAI, Isreal. With the consecutive eleven successive launches, the PSLV has emerged as a reliable, cost-effective launch vehicle. The next two launches of PSLV are planned before Mid 2008 to launch an advanced cartography satellite and Chandrayaan-1.

5. Cryogenic Upper Stage (CUS) Project

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2007	Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
335.89	333.86	1.30	1.30	0.10

The objective of the Project is to develop and qualify an indigenous restartable cryogenic stage employing liquid oxygen as oxidizer and liquid hydrogen as fuel for the upper stage of GSLV. The cryogenic engine has been successfully developed and tested for its full flight duration. All sub-systems for CUS 4 engine have been realised and stage structural testing and Ground Resonance Test will be completed. The CUS 5 flight standby stage will also be realised. The cryogenic stage has been successfully tested for the full flight duration 720 secs on 15th November 2007 at Mahendragiri Test Facilities. The

first flight of the indigenous cryo stage is targeted for flight testing by GSLV during 2008-2009.

6. Indian Remote Sensing Satellites (IRS) Projects

(Rs. in crores)

	Sanctioned Cost	Expenditure to end of March 2007	Budget 2007- 2008	Revised 2007- 2008	Budget 2008-2009
Cartosat-2	216.73	216.57	0.15	0.15	0.00
Oceansat-2	129.15	78.43	30.00	30.00	10.00
Resourcesat-2	138.79	16.99	50.00	48.00	35.00

6.1 The **Cartosat-2** Project, approved in June 2000, is an advanced high resolution satellite to support large scale cartographic mapping and thematic applications with scene-specific high resolution imagery of better than 1 meter. It is designed to address cadastral level applications geo-referenced to satellite data. The satellite was launched successfully onboard PSLV-C7 on January 10, 2007 and satellite has sent good imagery data and is being used for mapping applications. The launch of Cartosat-2 has opened new vistas for detailed mapping of the country for various applications including urban/rural planning and Disaster Management Support.

6.2 The main objectives of **Oceansat-2** Project are to design, develop, launch and operate a 3-axis stabilized spacecraft carrying an Ocean Colour Monitor (OCM) and Ku-band Scatterometer for Ocean and Coastal studies and to provide continuity of operational data services currently provided by Oceansat-1. The Oceansat-2 is slated for launch during 2008-2009 onboard PSLV.

6.3 Taking into account the increased use of space imageries for different applications and continued Earth Observation services required from the IRS satellites, **Resourcesat-2** has been conceived as a continuity mission with enhanced capabilities which will be mainly for crop applications, vegetation dynamics and natural resources census applications.

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

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2007	Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
378.49	282.95	56.00	56.48	25.00

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

applications, either in a stand-alone mode or in complementary to electro-optical sensors.

7.2 The Preliminary Design Review of sub-systems is in progress. The design and developmental activity pertaining to Tile and Transit-Receive (TR) modules has been completed and large scale production of TR modules is in progress. Integrated testing at Tile level for development model is underway. The flight model activities are being initiated. The satellite is expected to be launched during 2009.

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

(Rs. in
crores)

Sanctioned Cost	Expenditure to end of March 2007	Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
386.00	201.93	96.00	131.17	78.00

8.1 The main objective of the Indian Lunar Mission – Chandrayaan-1, approved in September 2003 is for expanding the scientific knowledge about the Moon, upgrading the technological capability and providing challenging opportunity for planetary research for a large number of growing young people of the country benefiting the human society at large. Detailed configuration studies on the follow-on mission Chandayaan-2 have been completed and the project proposal is under process for approval of the Government.

8.2 The work on Chandrayaan-1 Mission is progressing. The establishment of a Deep Space Network (DSN) required for communication has been completed. Two Antennas, one of 18m dia and other of 32m dia have been commissioned. The development of the scientific instruments and the spacecraft is in progress. The Spacecraft structure has been fabricated and tested the integration of the propulsion system to the spacecraft is in progress. The Chandrayaan-1 is targeted for launch during Mid 2008 on-board the PSLV.

9. Astrosat

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2007	Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
177.85	76.24	40.00	44.00	25.00

The objective of the Astrosat project, sanctioned in August 2004, is to build and launch an astronomical observatory satellite for expanding the scientific knowledge about the evolution of stellar objects and gather valuable scientific data on high energy Astronomy and Astrophysics research. The satellite will enable study of stellar objects simultaneously covering a range of high-energy radiations [gamma rays, X-rays and far/near Ultra Violet (UV) rays] hitherto not possible from any other current or planned global astronomy mission upto 2010. The satellite is planned for launch in 2009 onboard PSLV. The work on payload instrument and spacecraft sub-systems of Astrosat is in progress

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

(Rs. in crores)

	Sanctioned Cost	Expenditure to end of March 2007	Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
INSAT-3 Satellites & Launch Services	2979.63	2892.61	42.10	50.10	10.00

The objectives of INSAT-3 Spacecraft Project are to (i) build five INSAT-3 satellites (INSAT-3A to 3E) keeping flexibility for mid-course corrections to accommodate emerging requirements, carry out mission planning, launch campaign and initial phase operations and (ii) establish required programme elements for carrying out the same. INSAT-3B was launched on March 22, 2000, INSAT-3C on January 24, 2002, INSAT-3A on April 10, 2003 and INSAT-3E on September 28, 2003. INSAT-3D, configured as an advanced meteorological satellite with new payloads such as Imager and Sounder is targeted for launch during 2008-2009. For INSAT-3D spacecraft payloads instruments have been developed & qualified. Structures and propulsion elements for INSAT-3D Spacecraft integration have been realized and fabrication and assembly of flight units of Imager and Sounder is being undertaken. INSAT-3D is targeted for launch during 2009.

11. INSAT-4 Satellites (including Launch Services)

(Rs. in crores)

	Sanctioned Cost	Expenditure end of March 2007	Budget 2007-2008	Revised 2007- 2008	Budget 2008-2009
INSAT-4	2635.70	1478.36	286.00	472.15	310.00
Leasing of Transponders	-	-	10.00	10.61	30.00

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

11.2 The sanctioned cost of INSAT-4C satellite, planned for launch onboard GSLV is Rs.95.75 crores and will carry 12 Ku band transponders. INSAT-4D/GSAT-5 is configured to carry 24 C-band transponders & the total sanctioned cost is Rs.123.75 crores. The sanctioned cost of INSAT-4E/GSAT-6, the multi-media satellite is Rs. 269.00 crores. GSAT-8/INSAT-4G Communication Satellite is a state-of-art Satellite, which will have 18 Ku band transponders for (a) augmenting the INSAT System Capacity in Ku-band

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

11.3 The first satellite in the fourth generation INSAT-4 series, INSAT-4A has been successfully launched on December 22, 2005 from Kourou. It carries 12C band and 12 Ku band high power transponders enabling DTH broadcasting. The INSAT-4B has been successfully launched on March 12, 2007. INSAT-4C satellite was launched onboard GSLV F02 on July 10, 2006, but the launch was unsuccessful due to malfunction of one of the Liquid Strapon stages. The replacement satellite INSAT-4CR (cost Rs.43.20 crores) has been realised on fast track mode and launched successfully on September 2, 2007 onboard GSLV-F04. Work on INSAT-4D, INSAT-4E, INSAT-4F (User funded) and INSAT-4G is in progress.

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

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2007	Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
76.20	58.57	9.45	4.45	10.00

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

13. **GSAT-4**

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2007	Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
99.00	87.31	8.00	4.50	7.00

GSAT-4 Satellite has been configured for conducting various experiments in the Ka band communications and early introduction of geo-based navigation system. The spacecraft configuration has been finalised. All developmental activities relating to Ka-band payload have been completed. New technologies introduced in spacecraft bus elements have been developed and qualified. The integration and testing are the main activities planned in the months ahead. The satellite is targeted for launch on board GSLV during 2008-09.

14. **Navigational Satellite System**

(Rs. in crores)

Sanctioned Cost	Expenditure to end of March 2007	Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
1420.00	0.10	101.00	94.00	270.00

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

14.2 The Indian Regional Navigation Satellite System (IRNSS) is planned to be a constellation of 7 satellites – 3 in GEO and 4 in GSO orbit. IRNSS when implemented is expected to provide position accuracies similar to GPS in a region centered around India with a coverage extending upto 1500 km from India. The IRNSS project has been approved in June 2006. The configuration of the Satellite has been finalised and procurement of components and materials has been initiated. The ground system augmentation has also been takenup.

DEPARTMENT OF SPACE/ISRO CENTRES/UNITS

15. Vikram Sarabhai Space Centre (VSSC)

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
352.20	330.12	432.28

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

(iii) Space Physics Laboratory (SPL), which carries out research in atmospheric and related space sciences.

Major Achievements during 2007-2008

15.2 A major achievement during the year 2007-2008 was successful mission of PSLV-C8 which was launched from Second Launch Pad (SLP) on April 23, 2007 carrying an Italian Satellite AGILE and Advanced Avionics Module (AAM) injecting satellites into precise orbits. The significance of PSLV C8 launch were that it was India's first full-fledged commercial launch, first launch of PSLV in core-alone configuration and first flight injecting a satellite into a circular orbit of very low inclination (2.5^0). Subassembly preparations are in progress at various work centres for PSLV C9/Cartosat-2A/TWSAT/NLS-4/Rubin-8 mission with nine satellites. Mission studies are in progress for PSLV-C9/Chandrayaan-1 mission. All structural hardware drawings updates of GSLV-MK III are released except for metallic Head Shield, Equipment Bay and Payload Adaptor. First set of light alloy structures and first set of S200 motor case segment hard wares have been realised and proof pressure tests have been conducted. Flex Nozzle development programme for S200 is under advanced stages with commencement of S200 flex nozzle integrated test. Stage integration has commenced for the L110 development stage. RH200 sounding rocket flights have been conducted under Middle Atmospheric Research Program (MIDAS) campaign and Rocket Monsoon Experiment from TERLS Range. Functional qualification test of Moon Impactor Probe (MIP) separation system with simulated Chandrayaan model has been successfully completed. 2 Nos. of PSO nozzle assemblies, 28 Nos. RH-200 nozzle assemblies were realised through industry. The first PSO-XI nozzle assembly for PSLV Chandrayaan flight has been delivered. Mechanical integration and Electrical Integration operation,

Checkout operations and Launch Pad activities successfully completed for PSLV-C9, C10 & GSLV-F04 adhesive, SILCEMR9 for RLV was commissioned. All the PS1 motor segments and HPS3 Motor have been realized for the PSLV-C10 flight.

Major Activities Planned during 2008-2009

40 launchings of RH200 (MET) in March 2008 and September 2008 from TERLS Range are planned. Four test flights with high spin rate are planned from SDSC-SHAR. Wind tunnel tests are planned to be carried out for Technology Demonstration Vehicle (TDV) with control surface deflection for Reusable Launch Vehicle (RLV) Project. It is planned to complete aerodynamics characterization using CFD methods and realisation of Navigation and Guidance Control (NGC), Software design development. Supply of composite products for PSLV and GSLV continuation including Nozzles, SP throats, CC vanes, Motor cases, Pressurant tanks, Igniter cases, Interstage Structures and Payload Fairing for GSLV. Realisation of Payload Fairing, Equipment Bay shroud and Payload Adaptor for GSLV MK-III are also planned. Generation of manufacturing drawings for light alloy structures for the various ongoing projects and realisation of GSLV structures for F03 & F05 and PSLV structures for C12 to C14 are planned. Development of materials for manned mission will be initiated. Production of solid propellant towards realizing PSO/XL segments, special purpose motors, S200 igniter, S200 JM, RH-125/200.560M are planned. Installation and commissioning of vertical mixer and augmentation of process facilities. Production of Ammonium perchlorate at 800TPA, and setting up of a pilot plant under TDP for continuous production of Ammonium Perchlorate has also been planned.

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

(Rs.in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
21.25	23.54	23.16

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

Major Achievements during 2007-2008

16.2 Following were the major achievements made during 2007-2008:-

- (i) Delivery of Inertial Systems for Launch Vehicles and Spacecraft projects GSLV F04/INSAT 4CR, PSLV-C10, PSLV-C9/CARTOSAT-2A, PSLV-C12/CHANDRAYAAN-1, W2M, TWSAT, OCEANSAT-2, INSAT-3D and Avanti Hylas viz, Redundant Strapdown inertial systems (RESINS), Rate Gyro Packages (RGP), Solar Array Drive

Assembly (SADA), Inertial Reference Unit (IRU), wheels, Scan Mirror Mechanisms (SMM);

- (ii) Qualification and delivery of IRU with CSA (Ceramic Servo Accelerometer), Dynamically Tuned Gyro (DTG) and Inertial Management Unit (IMU) with MDTG) for TWSAT;
- (iii) Unified Solar Array Drive Assembly Electronics for all future satellites;
- (iv) Qualification and completion of Scatterometer scan mechanism and control electronics for Oceansat-2;
- (v) Completion of Inertial Guidance Unit development for GSLV MK III;
- (vi) Realisation of bigger sized mechanism like sounder and imager SSM flight model;
- (vii) Establishment of wiring and testing of miniaturized electronics;
- (viii) Production rate of 4 nos. of CSA and 3 nos. Inertial Laser Gyro (ILG) each per month;

Major Programmes for 2008-2009

16.3 During 2008-2009 following activities were planned:-

- (i) Delivery of Inertial systems for PSLV/GSLV missions;
- (ii) Realisation of flight and flight standby units of Redundant Strapdown Inertial Systems (RESINS) MKIV for RLV TD mission;
- (iii) Realization of qualification model for miniature RESINS MK V;
- (iv) High performance navigation processor with GPS aiding;

- (v) Realization of inertial systems for RESOURCESAT-2, RISAT, CARTOSAT-2B, YOUTHSAT, GSAT-5, ASTROSAT, GSAT-6 AND IRNSS;
- (vi) Establishment of Space Tribology Lab and Training Center.

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

(Rs.in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
217.95	171.59	204.19

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

Major Achievements during 2007-2008

17.2 Towards qualification of indigenous Cryogenic Upper State, long duration stage hot test of CUS 2 stage for 492s and flight duration of 720s was conducted. Engine and stage parameters during the test were found to match closely with prediction and the stage has been cleared for GSLV D3 mission. Towards realisation of CUS 3 stage flight stage, LH2 tank insulation has been completed. LOX tank internal integration & Proof Pressure Test (PPT) completed and insulation is in advanced stage of completion. Engine thrust chamber integration with feed system is nearing completion.

17.3 L 110 development stage integration is in progress. Stage interface with Principal Test Stand (PTS) and fluid servicing interfaces have been finalized. Launch campaign activities have been carried out for PSLV-C9 and GSLV F04 mission. PS2, PS4 and Control Power Plants (CPP) realisation is in progress for PSLV C9 mission. AOCS thrusters and Liquid Apogee Motor (LAM) engine delivered for W2M spacecraft, AOCS thrusters 22N (1no.) and 10N (7 nos.) have been delivered for GSAT4 and AOCS 22N thrusters (8 nos.) have been delivered for Chandrayaan mission.

17.4 L 110 & C25 assembly integration facility commissioning has been completed. Subscale engine test facility has been commissioned for CE 20 turbo pump tests. For thrust chamber test facility gas storage erection has been completed. Installation of solutionising furnace (for MK III) is completed. Cathode test facility has been established at LPSC, Bangalore. L40 stage integration is in progress. Realisation of engine and stage hardware is being continued. Liquid Propellants were supplied for launches and cryo engine/stage and earth storable test activities.

Major Programmes for 2008-2009

- Realisation and delivery of second flight stage with 15T loading for GSLV MK III mission;
- Realisation & testing of CE20 engine thrust chamber for the C25 project;
- CE 20 integrated engine realization & testing;
- Realisation of development stage with SS propellant tanks, hardware realization for qualification and flight stages;
- Realisation of L110 and C25 development stage propellant tanks (SS) and commencement of structure and stage test;
- Realisation of SS propellant tank for stage development tests;
- Completion of Integrated Propulsion system for delivery for satellite mission and launch campaign activities;
- To undertake detailed design and realization of Turbo pump elements including seals and bearings, testing of single element of pre burner at SET facility;
- Contract finalisation for Thrust Chamber Test (TCT) facility augmentation for semicryo subscale tests, coking studies, production of kerosene through pilot plant, testing of single element of thrust chamber etc;
- Main Engine Test (MET) augmentation for CE20 engine and C25 stage tests;
- Commissioning of CE20 HAT facility and Cryo Subsystem Test facility;
- Completion of augmentation of Principal Test Stand for L 110 stage testing;
- Augmentation of SPT test facility for 75mN thruster testing;

- Commissioning of Scramjet test facility, Cold flow test facility for semicryo injector testing.

17.5 Besides the above, L40 stage integration, realization of engine and stage hardware, integrated production of components and modules through industry, transducer production, and production of Propellants UH25, N2O4, MMH and LH2 & LOX etc, will be continued through Industry.

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

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
213.29	177.12	215.85

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

Major Achievements during 2007-2008

18.2 INSAT-4CR, replacement for INSAT-4C, subsystem realization and integration, spacecraft level testing were completed and successfully launched on board GSLV F04 on September 02, 2007. Cartosat-2A, identical to Cartosat-2, subsystem level integration activities are being pursued.

18.3 Substantial progress in subsystems realization of GSAT-4, Oceansat-2 and Chandrayaan-1 have been achieved. These spacecraft launches are slated during 2008. Similarly subsystems for the projects like RISAT, INSAT-3D and Cartosat-2B including two commercial projects (W2M and HYLAS) are under fabrication stages. Fabrication activities of subsystems for GSAT-5, ASTROSAT, Resourcesat-2, Megha-Tropiques and GSAT-6 have been taken up.

18.4 Indian Regional Navigational Satellite System (IRNSS) spacecraft configuration is finalized and subsystem fabrication is to be initiated by various groups. Productionisation of standardized subsystems like Telemetry, Telecommand power electronic packages, Bus Management Unit (BMU), solar panel, spacecraft battery, structure, heat pipes etc., have been realized.

18.5 High density fabrication facility, low temperature ceramic filters, high frequency and high power RF test Lab, low dose radiation source facility are some of the critical facilities for which procurement process has started. Thermovac, vibration and antenna characterization tests for INSAT-4B & 4CR satellites were successfully completed in the newly established ISITE facilities.

Major Programmes for 2008-2009

- Gearing up of activities for realisation and launch of Cartosat 2A, TWSAT, INSAT-3D, GSAT-5, GSAT-8, Cartosat-2B, RISAT;
- Realisation of subsystem for Hylas, Resourcesat-2, Astrosat, Meghatropiques, GSAT-6, GSAT-7 and IRNSS;
- Augmentation of BHEL Fabrication and Testing Facilities, Advance Electronic Packaging Facility, 10 TON Shaker System;
- Establishment of new High Power RF/Frequency Test Lab planned;

19. Laboratory for Electro-Optics Systems (LEOS)

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
21.21	15.76	37.14

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

Major Achievements during 2007-2008

19.2 All the sensors on-board INSAT-4CR performed satisfactorily. The first batch of export order of sun sensors to Germany was completed. Sensors for INSAT-3D, GSAT-4, CARTOSAT-2A were developed. Engineering model of Lunar Laser Ranging Instrument (LLRI) for Chandrayaan-1 and Ultra Violet Imaging Telescope (UVIT) optics for ASTROSAT were developed and tested. Test & evaluation of sensors for GSAT-5, W2M, RISAT, TWSAT, CARTOSAT-2B and CHANDRAYAAN-1 are under progress. Fabrication and testing of sensors and electronics for ASTROSAT, RESOURCESAT-2, OCEANSAT-2, HYLAS, GSAT-7, GSAT-8 and MEGHATROPIQUES have been initiated. All the sensors for CARTOSAT-2A with the satellite had been integrated and the integration testing are under progress. New clean room of '10000 class' grade was established for 'Thin film' activities. New Thermovac chamber was installed for sensor testing.

Major Programmes for 2008-2009

19.3 Development of Lunar Laser Ranging Instrument (LLRI), Satellite integration level testing of sensors and launch of CHANDRAYAAN-1, CARTOSAT-2B, GSAT-4, INSAT-3D, W2M & OCEANSAT-2 are planned during this period. Ultra Violet Imaging Telescope (UVIT) optics for ASTROSAT, miniature star tracker, MEMS based magnetic sensor, accelerometer & micro-bolometer will be developed. New facility for high precision optics will be established during 2008-2009.

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

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
198.94	213.38	237.99

20.1 Satish Dhawan Space Centre-SHAR (SDSC-SHAR) is the principal operational Centre for launching Sounding Rocket and Satellite Launch Vehicles. The activities at SDSC-SHAR are grouped under vehicle assembly & static test operations, range operations, liquid storage & service facilities and solid propellant booster plant. The main facilities in the Centre include those for production of solid propellant rocket boosters, ground and environmental qualification of rocket motors and their sub-systems, integration, check-out and launch of satellite launch vehicles, liquid propellants and cryogenic propellants storage and servicing facilities, tracking and telecommand stations, real-time data processing and range & flight safety.

Major Achievements during 2007-2008

20.2 The PSLV-C8 carrying AGILE satellite and Advanced Avionics Module was launched on April 23, 2007 from the Second Launch Pad. Production of two Nos. S139 Segments was completed for the PSLV-C9. Integration and launching of PSLV-C9 with Cartosat-2A & Canadian micro satellites are planned. Integration and launch of PSLV-C10/TECSAR has been completed. Stage servicing activities with Propellants & gases have been

completed for PSLV-C10 launch from First Launch Pad. Production of three Nos. S139 Segments are completed for GSLV-D3. Test and Evaluation of S200 motor static test stand systems are in progress. New propellant pumps have been commissioned at N204 Storages in First Launch Pad. Production of five Nos. S139 segments and one No. High Performance Motor (HPM) are planned for the PSLV-C11. Gas Service System at PS2/GS2 Tower have been commissioned. Commission of Propellant Bulk Storage and Gas cylinder Test facilities have been completed.

Major Programmes for 2008-2009

20.3 Assembly, Integration & Launch Campaign activities related to PSLV-C9/CATOSAT-2A Mission are in progress. Facilities like Solid Stage Assembly Building (SSAB), Satellite Preparation Facility-2 & C025 operation facility (TC-2) will be completed by December 2008.

20.4 Production of Solid segments for PSLV-C9, C11, GSLV-F04, GSLV-D3 were completed and segments production for GTSLV-F03 has commenced. To qualify the HTPB-IPDI propellant composition, 2.5T level trial casting was carried out and S139 segment level casting is planned. Production of 3 nos. of S200 motor segments is planned.

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

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
63.35	82.31	63.28

21.1 ISRO Telemetry, Tracking and Command Network (ISTRAC) provides mission support to low-earth orbit satellites as well as for launch vehicle missions. The other major responsibilities of the network are to carryout mission operations for all operational remote sensing and scientific satellites, to provide TTC services from ignition till satellite injection into orbit and to estimate the preliminary orbit in space in case of launch vehicle missions and to take up developmental activities for providing flawless TTC and mission operations services. ISTRAC has established a network of ground stations at Bangalore, Lucknow, Mauritius, Sriharikota, Port Blair and Thiruvananthapuram. The Spacecraft Control Centre (SCC) co-located with the Bangalore Ground Station, carries out round the clock operations. ISTRAC also operates the Local User Terminal/Mission Control Centre (LUT/MCC) under the international programme for Satellite-Aided Search and Rescue.

Major Achievements during 2007-2008

21.2 ISTRAC continued to provide (a) Spacecraft operation support and payload programming for IRS series of Satellites viz CARTOSAT-1, IRS P6, IRS P4, TES, IRS ID, IRS IC and HAMSAT, (b) Support for the successful launch and early Orbit Phase (LEOP) of PSLV-C 08/CARTOSAT-2/SRE-1/TUBSAT Missions and participation in re-entry phase operations for SRE-1 and early orbit phase support to GSLV-F04/INSAT-4CR mission and intensive ranging support for INSAT-4CR. Installation of 32 m antenna system for DSN-32 is in final stages. Major electronic systems have been realized. Civil Works for DSN32 antenna system are in advanced stages. The station is slated for commissioning in December 2007. DSN-18 Terminal, conceived as a redundant system for DSN32

has been installed and commissioned in July 2007. All activities related to ISTRAC Network Modernisation Programme Phase-II have been geared up and the TTC stations at SHAR-1 and SHAR-II have already been operationalised with the state-of-the-art systems incorporating monitoring and control features. Activities aimed at realization of IRS Data Reception Station in Mauritius under ISTRAC Network Modernisation programme Phase-II are in progress and the facility is expected to be operational in March 2008. Indian Space Science Data Centre (ISSDC) facilitating data processing, archival and dissemination of science payload data is being established at ISTRAC, Bangalore. CS-SCC Complex along with S band TTC station has been installed and commissioned at Bangalore for providing mission operations support for Cartosat-2A/2B. As part of Disaster Management Plan for spacecraft operations, Alternate Spacecraft Control Centres at SHAR and Lucknow have been operationalised for IRS-ID normal phase operations of IRS-1C. Satcom hub support was provided for Spacenet and Telemedicine and VRC services on regular basis. A trailer mounted 4.5m (transportable) terminal is being inducted for quick deployment at any location for short periods. The station will be ready during 2007-2008. Local User Terminals and Indian Mission Control Centre (INMCC) have been upgraded as part of Satellite Aided Search and Rescue (SASR) programme. Indigenously developed 11-m INLUS-RF Station has been established, integrated with INMARSAT-4F1 and deployed for 'Signal in Space' transmission. Final system acceptance tests on GAGAN TDS has been completed and a system accuracy of 2m obtained within peripheral reference sites.

Major Programmes for 2008-2009

- To provide spacecraft control operations and payload operations for IRS series viz., CARTOSAT-1, IRS-P6, IRS-P4, IRS-ID, TES and IRS-IC and HAMSAT and CARTOSAT-2 and CARTOSAT-2A satellites planned to be launched in the year;
- To provide TTC Network organization and tracking support for PSLV-C9/CHANDRAYAAN-1 Mission;
- Installation and commissioning of ASTROSAT TTC and data reception station;
- Spacenet services and Hub services for telemedicine & VRC and to provide LEOP and normal phase operations support for CHANDRAYAAN-1;
- To provide LEOP and normal phase operations support to OCEANSAT-2;
- Realisation of Science Data acquisition system for Astrosat & Meghatropiques;
- Establishment and Operationalisation of ISSDC facilities;
- Continued support to Disaster Management Charter;
- On-orbit operation and maintenance of Indian Remote Sensing Satellites;
- Establishment of ASTROSAT TTC and data reception station at IDSN Site.

22. Space Applications Centre (SAC)

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
149.14	126.77	169.84

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

Major Achievements during 2007-2008

22.2 Communication Payload for INSAT 4CR was realised and integrated with the spacecraft and successfully launched by the GSLV-F04. All the FM units of the Ka band payload for the GSAT-4 have been integrated on the satellite panel. The 20/30 GHz Beacon sources have been developed in house. The Regenerative payload has made good progress.

22.3 Indian Regional Navigational Satellite System (IRNSS) payload configuration, data structure and signal format have been analysed. Functional requirements of various sub-systems such as code-generator, encryption and error correction code and modulator, etc. were defined. A new type of modulation scheme, Binary Offset Carrier (BOC) modulation were developed. Design & development of five types of MMICs had been completed for each in C and Ku

bands received sub systems. GSAT 5 is expected to carry Travelling Wave Tube Amplifier (TWTA) with indigenously developed Electrical Power Conditioner (EPC) and Microwave Integrated Circuit (MIC) base Phase locked coaxial resonator oscillators. Several Antenna systems & feeds for all the payloads were developed & delivered.

22.4 Test and Evaluation of all electronics subsystems and fabrication of detector head assembly for the OCM (Ocean Color Monitor) payload of OCEANSAT-2 satellite have been completed. Work on the INSAT-3D meteorological payloads is in advanced stage. Preliminary thermovac tests was carried out on the integrated Engineering Thermal Model (ETM) Sounder payload. Integration of all subsystems, except scan mechanism for the Imager ETM payload have been completed. The Flight Model structure of the Third World Satellite (TWSAT) has been realized and fabrication of FM sub systems is in progress. For the two payloads of the Chandrayaan-1 mission, viz. Terrain Mapping camera (TMC) and Hyperspectral Imager (HySI), design & development of the camera electronics subsystems including qualification tests on the development model have been completed. Design & development of miniaturized electronics for the RESOURCESAT-2 has been completed.

22.5 Transmit-Receive (TR) modules of RISAT payload have been characterized and data from these have been integrated in the TR control units. Design Verification Model (DVM) model of the RISAT tile was subjected to rigorous testing. Qualification Model tile was qualified and FM production of tiles initiated. The payload is expected to be realised by middle 2008. The development model of the Ku band Scatterometer for the OCEANSAT-2 has been integrated.

Major Programmes for 2008-2009

22.6 The work on GSAT-5 to GSAT-9 series of satellites is under various stages of planning, development and realization. Planning for the GSAT-10 series onwards are initiated. Several R&D activities have been undertaken in the field of communication payloads development, like Delay Tolerant Deep Space Communication protocol, Cyclone warning and data communication system for the India sea, high bit rate modems, etc. Development of terminals for utilization of GSAT-4 and other satellites like GSAT-7 (UHF) etc. has also been initiated.

22.7 Payload sensors development has been initiated for some of the payloads keeping the future applications and potentials in view. Critical technology development in the field of Microwave remote sensing for the future satellite payloads, viz. L band Synthetic Aperture radiometer, Millimeter Wave Sounders/Radiometers operating up to 283 GHz for Meteorological/climatic mission and L band borne Synthetic Aperture Radar (SAR) is expected to be taken up.

22.8 In the field of Remote Sensing Applications the thrust would be towards utilization of Indian satellite missions including INSAT-3D, Oceansat-2, Cartosat series, RISAT, Resourcesat-2, Meghatropiques, etc., advanced R&D on retrieval of geo-physical and bio-physical products, early warning for disaster forecasting, data validation, synergy of Earth observations & Satellite Communications applications and scientific studies for moon mission.

23. Development and Educational Communication Unit (DECU)

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
85.36	72.48	58.41

23.1 The Development and Educational Communication Unit (DECU) at Ahmedabad is involved in the conception, definition, planning, implementation and socio-economic evaluation of developmental space applications. The major current activities of DECU include Training and Development Communication Channel (TDCC), Gramsat Programme (GP), Tele-Health (TH), Tele-Education (TE) mission and new satellite communication applications.

Major Activities Completed and Planned during 2007-2008

23.2 Under the Edusat Implementation programme, 9 networks in national beam and 34 networks in the regional beams comprising of a total nos. of 2679 Satellite Interactive Terminals (SIT) + 27236 Receive Only Terminals (ROT) have been installed and commissioned. Work on the configuration and implementation of the EDUSAT network for Rehabilitation/Council of India (RCI) and Bhoj University of MP has been taken up. Network in the States of Rajasthan and Andaman & Nicobar have been integrated, thus catering multiple services using hybrid connectivity. Installation of all ROT in the State of West Bengal has been completed. Continued the regular TDCC activities and networks have been upgraded/converged to cater multiple services like Tele-education, Telemedicine & VRC's etc. Planned to complete next phase of expansion of Punjab network with 6 more nodes for Tele-Medicine/Continuing Medical Examination applications (under the Tele Health Mission/ Telemedicine). Setting

up of Telemedicine connectivity and Village Resource Centres has achieved good progress. About 250 Tele-medicine Hospitals and more than 300 VRCs have been set up so far (as on January 2008).

Major Programmes for 2008-2009

23.3 During the year 2008-2009, expansion and augmentation of existing EDUSAT Networks are planned. It is also planned to expand EDUSAT network for Blind People's Association. Implementation of the EDUSAT network for Rehabilitation Council of India (RCI) are planned to be completed. Implementation of EDUSAT networks for the States of UP, Sikkim, Himachal Pradesh, Manipur & Assam are planned. Operational training for new and upcoming networks in various states and expansion of existing EDUSAT Networks have also been planned. Expansion of Telemedicine & Village Resource Centre networks have been planned to cover more States.

24. Master Control Facility (MCF)

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
51.68	40.71	54.81

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

B) at Bhopal, Madhya Pradesh with essential facilities to manage the satellite operations has been commissioned.

Major Achievements during 2007-2008

24.2 In-Orbit Testing (IOT) of INSAT-4B was successfully completed and satellite declared operational. An MOU was signed between ANTRIX and IMD for establishment of Very High Resolution Radiometer (VHRR) Data Reception facility, which will be taken up by MCF. Definition of Ground system configuration for Indian Regional Navigational Satellite System (IRNSS) Satellite Control Facility has been completed. Systems configuration details for Ku band Full Motion Antenna (FMA) have been worked out.

24.3 Procurement action for major elements under ‘Augmentation of Limited Motion Antenna (LMA) terminals’ at Hassan and Bhopal under progress. Installation works on Ka-band Fixed Earth Station Terminal and Transportable terminal are under progress. Procurement action for establishment of Ku-band FMA has been initiated.

Major Programmes for 2008-2009

24.4 MCF will provide Launch & Early Orbit Phase (LEOP) operations support for GSAT-4 Mission. Augmentation of LMA terminals in MCF, Hassan and Bhopal have been planned. Under the Technology Development Programme, Ku-band FMA terminal are planned to be established at Hassan. Augmentation of computer systems and Communication Network elements for additional Spacecraft operations are planned. Replacement of CCTV system at MCF-Hassan and augmentation of CCTV system at new facilities of Bhopal campus have been planned. It has been planned to establish Optical Tracking system for GEO Satellites.

25. National Natural Resources Management System (NNRMS)

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
53.97	15.78	28.23

25.1 The National Natural Resources Management System (NNRMS) has the objective of ensuring optimal management/utilisation of natural resources by integrating information derived from remote sensing data with conventional techniques. The NNRMS umbrella includes a large cross-section of Government Departments/Agencies, which are responsible for resources management sectorally and other agencies associated in developmental activities. NNRMS activities are co-ordinated at the National level by the Planning Committee of

NNRMS (PC-NNRMS) which frames guidelines for implementation of the systems and oversees the progress of remote sensing applications for natural resources management in the country. NNRMS, thus, encompasses conceptualisation and implementation of space system with ground-based data reception, processing and interpretation systems, and integrating the satellite-based remotely-sensed data with conventional data for resource management applications in various thematic areas.

Major Activities Completed/Planned during 2007-2008

25.2 Under the Natural Resources Census (NRC) programme, the 3rd cycle of Land use/land cover mapping on 1:250,000 scale for khariff season has been completed for generating crop area statistics. Regional workshops were conducted at RRSSCs for Land use/land cover/land degradation mapping at 1:50,000 scale using LISS III data. Mapping of soils at 1:50,000 scale using IRS data has been approved and the work has been initiated. Large-scale base maps of 40 sites (5226 sq. km) at 1:10,000 scale have been organized in Geo-database. Pilot project for geo-morphological mapping in five broad geo-morphological provinces in the country has been completed. Natural Resources Data Base (NRDB) is being organized with large volume of database from Natural Resource Repository (NRR) projects and legacy projects. Phase III of Rajiv Gandhi National Drinking Water Mission has been taken up. Phase-III of National wasteland mapping and monitoring project has been completed. Human Resources Development for Remote Sensing and GIS is pursued through conduct of specialised training programmes/workshops by DOS/ISRO for users and the Academic Institutions.

Major activities planned during 2008-2009

25.3 Nation wide land use/land cover mapping at 1:250,000 scale has been extended for another two more cycles upto 2009. Under Natural Resources Repository (NRC), classification and mapping will be completed for land use/land cover mapping at 1:50,000 scale and 1st cycle report for entire country will be brought out. It has been planned to complete mapping of degraded land for 60% of the geographical area of the country. Mapping of soils at 1:50,000 scale for around 34% of the country area will be continued. Under NRDB, populating database of more projects and release of indigenous GIS package for operational use has been planned. Generation of one cycle of Digital Elevation Model (DEM) using Cartosat-1 is planned. Thematic mapping at 1:10,000 scale and aerial photography for National Urban Information System (NUIS) will be completed and Geo-referencing of Cadastral maps with satellite images will be completed for Karnataka.

26. Regional Remote Sensing Service Centres (RRSSCs)

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
13.70	9.07	11.10

26.1 The five Regional Remote Sensing Centres (RRSSCs) at Bangalore, Dehradun, Jodhpur, Kharagpur and Nagpur have been established under the aegis of National Natural Resources Management System (NNRMS) with the prime objective of providing remote sensing application services to the users in the respective regions for better planning and optimal utilization of natural resources and also bring about awareness amongst the users on the potential of remote

sensing and associated technologies. Over the years, RRSSCs have significantly contributed in this direction by executing various National level projects, User projects, Application Validation projects and Technology & Software Development projects apart from conducting regular training programmes for users in digital data analysis, GIS and applications.

26.2 **Major Achievements during 2007-2008**

- Completion of 10 region-specific user projects in various themes like agriculture, forestry, watershed development, geology, environment, infrastructure applications, etc;
- Co-ordination of the activities of establishing Village Resource Centre (VRCs) in the respective regions;
- Software development/deployment and natural resources database creation for VRCs;
- Completion of two cycle of land use/land cover mapping at 1:250,000 scale for one cycle of land use/land cover mapping on 1:50,000 scale for Western India and Qualify Certification (QC) for entire country under Natural Resources Census project;
- Implementation and commissioning of systems and available region specific database under NRDB project at RRSSCs towards establishing Natural resources repository;
- Completion of monitoring of waterlogged area and mapping of soil salinity in 1000 major and medium command areas in 11 states across the country under Phase I & II of the national level project for Central Water Commission;

- Completion of multi-tier database using satellite imagery for Bangalore Metropolitan Region towards town planning and road alignment as “ISRO-BMRDA Data Repository”;
- Creation of Digital database for 60 disaster prone districts in 6 States for Disaster Management Support;
- Development of Decision Support System with basic Image processing, display and software;
- Development of Software packages like PRIMEWIN: Indigenous image processing software package for processing remote sensing data on windows: GRAMINS: Unified software for VRCs in open source environment, integrating best of the modules available in various packages developed by RRSSCs; ONERS : beta version of Sapphire--C software for processing CARTOSAT stereo data;
- Organising 11 Short-term courses and 24 awareness programmes for scientists of user Departments and school/college teachers.

26.3 **Major Programmes for 2008-2009**

- Provide support and execute region-specific user projects involving different disciplines and to execute a few R&D studies using high resolution, hyper spectral and microwave satellite data and also continued to contribute towards development of local context based contents along with software package in local languages for the identified sites for the VRCs;
- Monitoring of salinity and waterlogged areas for the remaining major & medium command areas under Phase III;

- Database creation, quality standardization and software development; Large scale mapping,
- Cadastral Referenced Database: CartoDEM, Regional Repositories under NRR, Natural Resources Database (NRDB), National Database for Emergency Management (NDEM);
- To pursue research and developmental activities towards development of various actionable products and services, newer applications using emerging technologies;
- To develop software in the new areas of image processing and development of customized packages to meet the user needs;
- To continue training programme of users and College/University teachers.

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

(Rs. in crores)

Budget 2006-2007	Revised 2006-2007	Budget 2007-2008
70.00	37.77	65.00

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

Space-based information on the disasters, affected areas, their impact, etc., on a near-real time basis. The main components of the Disaster Management Support Programme include (i) Establishment of a Decision Support Centre, (ii) Air-borne Laser Terrain Mapper (ALTM) surveys & hazard zonation, (iii) Database creation & query shell development, (iv) Emergency communication support, (v) Airborne SAR development, (vi) R&D support for DMS, (vii) Decision support tools development, and (viii) International Charter Support. The Decision Support Centre, being established at the National Remote Sensing Agency, Hyderabad, will be suitably interfaced with other Government agencies such as IMD, CWC, GSI, NIC, etc., and will provide online services to the State and Central Government user agencies.

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

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
25.32	25.28	19.00

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

from balloon-borne experiments are also used for studying the climate change processes. The ISRO GBP covered projects relating to climate observations & modeling, atmospheric chemistry & aerosols and Biogas cycles & Global changes.

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

(Rs. in crores)

Budget 2007-2008	Revised 2007-200	Budget 2008-2009
13.00	12.00	13.00

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

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CHAPTER - V

FINANCIAL REVIEW

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

2. The Department has instituted a system of periodically monitoring the commitment and expenditure status of the various programmes/projects approved in the annual budgets and take appropriate action, for making financial management more effective. In order to have better expenditure management, the monthly cash flow is also monitored scheme-wise/project-wise to ensure that the allocated funds are utilised effectively. Accordingly, while formulating the Revised Estimates 2007-2008, a critical appraisal of the progress - both physical and financial - is carried out consistent with the programmatic requirements. Quarterly targets are fixed for each major project/scheme during the beginning of the year and Additional Secretary/IFA of the Department periodically takes a rigorous review of the expenditure/commitment status to ensure that the financial and programmatic targets are realized. The project management councils/project management boards of all the major projects constituted at the DOS/ISRO Centre level also review the progress in expenditure/commitment

and initiate necessary follow-up actions keeping in view the programmatic criticalities. Thus, periodical review of the physical and financial performance of all the projects/schemes is an integral part of the planning and implementation strategy in DOS/ISRO.

3. The Financial performance of the Department in terms of Budget Estimates, Revised Estimates and Actual expenditure for the last three years viz., 2004-2005, 2005-2006 and 2006-2007 are given below:

Financial performance 2004-2005

(Rs. in crores)

	Non-Plan	Plan	Total
Budget Estimates 2004-2005	331.31	2400.70	2732.01
Revised Estimates 2004-2005	340.02	2200.76	2540.78
Actual Expenditure 2004-2005	339.52	2194.82	2534.34

4. The Revised Estimates 2004-2005 was reduced to Rs. 2540.78 crores in compliance with the reduced ceilings fixed by the Ministry of Finance. The actual expenditure during the year was Rs. 2534.34 crores which is about **99.75%** budget utilisation with respect to RE.

Financial performance 2005-2006

(Rs. in crores)

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

5. The BE 2005-2006 included a provision of Rs. 300 crores earmarked by Planning Commission for Satellite Navigation (global participation). The details of global participation in Satellite Navigation and the associated financial implications could not be finalised during the year as it involved a series of detailed negotiations with international agencies such as European Union/European Space Agency. Considering this and also the ceiling fixed by Ministry of Finance, the Revised Estimates 2005-2006 was reduced to Rs.2675.52 crores. The actual expenditure during 2005-2006 was Rs.2667.59 crores. i.e., **99.70%** budget utilisation wrt RE.

Financial performance 2006-2007

(Rs. in crores)

	Non-Plan	Plan	Total
Budget Estimates 2006-2007	390.02	3220.40	3610.42
Revised Estimates 2006-2007	397.02	2600.27	2997.29
Actual Expenditure 2006-2007	394.49	2594.17	2988.66

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

7. The scheme-wise/project-wise details of BE, RE and Actuals for 2006-2007, BE and RE for 2007-2008 and BE for 2008-2009 are given in Table 5.1 enclosed.

Department of Space

Table 5.1

Financial Review: Overall Trends in Expenditure 2006-09

(Rs. in crores)

Sl. No.	Programmes/Projects/Centres/Units	Budget 2006-2007	Revised 2006-2007	Actuals 2006-2007	Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
A	SPACE TECHNOLOGY						
I	Launch Vehicle Technology						
1	Geo-synchronous Satellite Launch Vehicle (GSLV) Project	11.30	7.10	9.30	9.00	8.00	1.00
2	Cryogenic Upper Stage Project	2.00	1.95	1.32	1.30	1.30	0.10
3	PSLV-Continuation Project	100.00	100.00	109.98	160.00	160.00	180.00
4	GSLV Mk-III Development	417.44	325.00	264.99	335.00	284.08	270.00
5	Space Capsule Recovery Experiment - I & II	11.48	11.48	14.00	9.45	4.45	10.00
6	GSLV – Operational	200.60	208.00	237.70	265.00	236.50	255.00
7	Vikram Sarabhai Space Centre	329.77	282.73	274.32	352.20	330.12	432.28
8	ISRO Inertial Systems Unit	19.82	20.80	21.74	21.25	23.54	23.16
9	Liquid Propulsion Systems Centre	154.45	143.24	127.65	217.95	171.59	204.19
10	Manned Mission Initiatives/Human Space Flight	0.00	0.00	0.00	50.00	4.00	125.00
11	Indian Institute of Space Science & Technology	0.00	0.00	0.00	75.00	25.00	65.25
12	Semi Cryogenic/Stage Development	0.00	0.00	0.00	25.00	0.00	22.50
	Sub-Total	1246.86	1100.30	1061.00	1521.15	1248.58	1588.48

II	Satellite Technology						
13	Cartosat-2	1.49	1.38	1.37	0.15	0.15	0.00
14	Oceansat-2 & 3	54.12	54.12	53.44	30.00	30.00	10.00
15	Resourcesat-2 & 3	30.00	20.00	16.99	50.00	48.00	35.00
16	G.SAT-4	10.00	15.00	15.28	8.00	4.50	7.00
17	METSAT-2	5.00	0.00	0.00	0.00	0.00	0.00
18	RISAT-1	93.85	50.00	54.64	56.00	56.48	25.00
19	Advanced Communication Satellite	25.00	0.00	0.00	12.00	0.00	22.50
20	Navigational Satellite System (including IRNSS)	440.00	0.20	0.10	101.00	94.00	270.00
21	ISRO Satellite Centre	171.87	177.97	176.21	213.29	177.12	215.85
22	Laboratory for Electro-Optics System	12.34	22.49	21.07	21.21	15.76	37.14
23	Semi-conductor Laboratory	25.00	27.50	27.00	41.12	41.07	34.28
24	Earth Observation-New Missions (Saral, Geo-HR Imager, TES-Hyp, DMSAR & Carto-3)	0.00	0.00	0.00	30.00	0.00	65.00
	Sub- Total	868.67	368.66	366.10	562.77	467.08	721.77
25	Satish Dhawan Space Centre - SHAR	153.41	175.35	172.79	198.94	213.38	237.99
26	ISRO Telemetry, Tracking and Command Network	55.97	79.47	65.80	63.35	82.31	63.28
27	ISRO Radar Development Unit (ISRAD)	1.86	2.71	2.68	4.49	5.65	0.00
	Sub- Total	211.24	257.53	241.27	266.78	301.34	301.27
	TOTAL : A - SPACE TECHNOLOGY	2326.77	1726.49	1668.37	2350.70	2017.00	2611.52

B	SPACE APPLICATIONS						
1	Space Applications Centre	128.15	126.14	122.73	149.14	126.27	169.84
2	Development & Educational Communication Unit	161.97	119.50	78.99	85.36	72.48	58.41
3	Earth Observation Applications Mission	8.68	6.94	7.05	3.97	3.38	2.68
4	National Natural Resources Management System	54.00	52.12	35.30	53.97	15.78	28.23
5	Regional Remote Sensing Service Centres	8.28	8.87	8.17	13.70	9.07	11.10
6	National Remote Sensing Agency(including Aid Equipment)	20.02	20.02	20.00	30.02	30.02	35.02
7	North Eastern Space Applications Centre	3.00	3.00	3.00	5.00	5.00	5.00
8	Disaster Management Support	24.35	26.47	9.22	70.00	37.77	65.00
	TOTAL : B - SPACE APPLICATIONS	408.45	363.06	284.46	411.16	299.77	375.28
C	SPACE SCIENCES						
1	Physical Research Laboratory	39.10	41.10	41.10	46.52	49.87	51.44
2	ISRO Geosphere-Biosphere Programme	7.68	8.05	7.80	25.32	25.28	19.00
3	Sensor Payload Development/Planetary Science Programme	5.60	10.30	2.29	23.25	7.50	5.00
4	Megha-tropiques Project	28.50	15.00	14.48	20.00	15.00	20.00
5	Indian Lunar Mission-Chandrayaan-1&2	142.75	115.60	100.25	96.00	131.17	78.00
6	Astrosat	56.45	35.80	34.72	40.00	44.00	25.00
7	National Atmospheric Research Laboratory (NARL)	7.28	7.70	7.70	9.62	7.95	11.31
8	Sponsored Research (RESPOND)	15.00	14.00	12.49	13.00	12.00	13.00
9	Atmospheric Science Programme	0.00	0.00	0.00	18.63	17.15	14.49
10	Small Satellites for Atmospheric Studies & Astronomy	0.00	0.00	0.00	2.00	0.00	10.00
11	Other Schemes	17.78	18.72	7.53	16.51	11.68	21.13
	TOTAL : C - SPACE SCIENCES	320.14	266.27	228.36	310.85	321.60	268.37

D	DIRECTION & ADMINISTRATION/ OTHER PROGRAMMES						
1	Department of Space Secretariat	4.60	4.89	4.60	4.69	4.90	5.46
2	Indian Space Research Organisation (ISRO) Headquarters	18.36	22.17	23.79	22.10	25.25	24.70
3	Civil Engineering Division	17.06	17.72	16.77	17.76	19.60	19.68
4	International Co-operation	3.43	3.43	3.91	3.00	3.15	3.15
5	Other Programmes (Spl inidgenisation/advance ordering, etc.)	123.26	135.02	381.63	248.76	25.25	361.10
	TOTAL D: DIRECTION, ADMINISTRATION & OTHER PROGRAMMES	166.71	183.23	430.70	296.31	78.15	414.09
E	INSAT OPERATIONAL						
1	INSAT-3 Satellites	68.10	81.00	64.93	42.00	50.00	9.90
2	INSAT-3 Launch Services	1.00	0.10	1.91	0.10	0.10	0.10
3	INSAT-4 Satellites	218.75	182.30	222.67	296.00	207.76	280.00
4	INSAT-4 Launch Services	60.00	160.00	55.58	100.00	275.00	60.00
5	Master Control Facility	40.50	34.84	31.68	51.68	40.71	54.81
	TOTAL : E - INSAT OPERATIONAL	388.35	458.24	376.77	489.78	573.57	404.81
	GRAND TOTAL : GROSS	3610.42	2997.29	2988.66	3858.80	3290.09	4074.07
	Deduct Recoveries	0.42	0.29	0.00	0.20	0.09	0.07
	TOTAL : (NET)	3610.00	2997.00	2988.66	3858.60	3290.00	4074.00

CHAPTER – VI

AUTONOMOUS BODIES OF DOS/ISRO

1. National Remote Sensing Agency (NRSA)

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
30.02	30.02	35.02

1.1 The National Remote Sensing Agency (NRSA) is an autonomous organisation under the Department of Space. From a modest start with only aerial mapping activities, NRSA has steadily built up its resources and infrastructure, along with a collection of multi-disciplinary human resource. NRSA today is the nodal agency for operational remote sensing activities in the country. It is responsible for acquisition, processing, dissemination and archiving of satellite and aerial remote sensing data, training of user scientists in various applications/studies in several disciplines for resource mapping/disaster monitoring and essential research & development in all its areas of applications in the country. Key areas of focus are facilitating resources monitoring and management and disaster mitigation, while maintaining a strong R&D base for development of new technologies. NRSA also operates a fleet of instrumented aircraft and has a satellite receiving station at Shadnagar, near Hyderabad. It also has facilities for generation of data products for various applications from remotely sensed data.

Major Activities during 2007-2008

1.2 Besides continuing all on-going operations, Oceansat-2 data reception activity has been made ready during the year 2007-2008. The data reception facility was established at Algeria for Antrix Corporation Ltd (ACL). During the year, the Cartosat-2 data products were announced for the users. Work on Disaster back up facility was initiated and will be realized by 2008. Master plan for development of Earth Station addressing the needs of next two year was generated.

1.3 In the area of remote sensing applications, 3rd cycle of Nation wide Land Use/Land Cover (LULC) mapping (1:250,000 scale) was initiated. Nation wide LULC mapping, Nation wide wasteland monitoring (1:50,000 scale) Rajiv Gandhi National Drinking Water mission – Phase III covering 6 States (on 1:50,000) were initiated. Accelerated Irrigated Benefit Programme project was taken up for CWC, to assess irrigation potential of 53 irrigation projects covering 5.45 M ha spread over 18 States. Phase III of DBT – DOS project on Biodiversity characterization at landscape level was initiated covering Deccan peninsula, Gangetic plains, Northwest India and Himalayan cold desert spread over 15 lakhs sq.km. Large scale pilot project for 40 towns was completed covering 5254 km sq. Rajasthan Urban Information System pilot study for Jaipur was completed. Snow melt runoff forecasts in Sutlej basin (for BBMB) and Inventory of glacial lakes/water bodies in Sutlej basin (for SJVNL) were completed. Farm, livelihood and health advisory services were taken up. Indian Institute of Remote Sensing (IIRS) has planned to establish 6 VRCs in Uttaranchal and Himachal Pradesh. Advisory services were initiated in A.P and Orissa. Satellite based evaluation of 732 water bodies was initiated in six States.

1.4 In the area of Disaster Management support, all ongoing Decision Support Centre (DSC) activities has been continued. Decision Support System (DSS) for various events (floods, drought, cyclone etc.,) are planned to be completed. Agricultural drought assessment for Madhya Pradesh and Haryana States will be operational at sub district level. NRSA would organize National Data Base for Emergency Management (NDEM) as nodal agency. Satellite based Virtual Private Network will be established connecting DSC with national and state emergency and other knowledge centers. Major floods of 2007 in Assam, Bihar, Orissa, Uttar Pradesh, West Bengal, Andhra Pradesh and Gujarat States were monitored and mapped. About 60 maps were disseminated to the users. Flood monitoring information System was developed for Bihar. Web based forest monitoring system is made operational. NOAA based national Agricultural drought assessment was completed for 13 States during Kharif season on fortnightly basis. Preparatory work for implementing National Database for Emergency Management (NDEM) has been completed (identification of hazard layers, scale, content, database standards, security mechanism, physical infrastructure etc.)

1.5 In the area of Aerial Services and Digital Mapping, procurement of aircraft(s) for support to Disaster Services & other flying tasks and Large Format Digital Camera and processing system are planned. Aerial photography for 36 towns of Karnataka, Chattisgarh are planned. Acquisition of Laser Terrain Mapper DC data for 25,000 sq km of flood plains/coastline. LIDAR survey for Tsunami warning centre, National cadastral database generation etc are planned. Aerial photography for 134 towns under National Urban Information System (NUIS) project has been completed.

Major Programmes for 2008-2009

1.6 In the area of Satellite Data Services, all Earth station operations will be sustained. Augmentation for TWSAT and RISAT data reception will be completed. Continued support will be extended to Algeria & other International Ground Stations and IRS Ground Stations. The IMGEOS Process re-engineering chain will be implemented in a phased manner. The CARTODEM data will be disseminated with suitable access (addressing security aspects) mechanism. Level of data product dissemination will be sustained but will move towards 'service mode' of operations. Web based services will be provided for Oceansat-2 data. Network security auditing is planned. Master plan for development of Earth Station will be implemented in phased manner.

1.7 In the area of Remote Sensing Application Projects, third cycle of LU/LC mapping (1:250,00 scale) will be completed. The NR-Census lab will be established by 2008-2009. LU/LC and Land degradation mapping project (1:50,000 scale) will be completed. In addition to national level estimates of crop forecast (paddy/wheat/potato), district level estimates of major crops of 17 States are proposed. The present Accelerated Irrigation Benefit programme (AIBP) taken up for 53 study areas would be completed and could be extended to the remaining 90 AIBP projects. Web based information systems for Biodiversity and Indian bio resource information network (IBIN) will be made functional. Filaria monitoring and Visualization system (Health GIS) is expected to take shape. Control survey, triangulation and geo referencing of satellite data will be taken up for 40 towns for Large Scale mapping project. NRSA will be the regional node for NRDB covering Andhra Pradesh, Tamil Nadu, Pondicherry and Andaman & Nicobar Islands. Expansion of the VRC network and regular tele-

education and tele-medicine services are planned. Dissemination of Natural resource database with cadastral overlays to the village communities is also planned.

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

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
46.52	49.87	51.44

2.1 The Physical Research Laboratory (PRL) at Ahmedabad, an autonomous institution under the Department of Space is a premier research institution in the country carrying out basic research in several areas of experimental & theoretical physics and earth sciences. PRL is also entrusted with the management of the Udaipur Solar Observatory (USO) and Infrared Observatory at Mt.Abu. Research activities carried out at PRL are mainly in the area of infrared astronomy, solar 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.

Major Achievements during 2007-2008

2.2 Design and development of a multi-purpose echelle spectrograph covering the spectral range 370 to 690 nm is under progress, which will be used on 1.2 m telescope at Mt. Abu Observatory to study AGB stars, binary stars,

extra-solar planet detection. The Solar Vector Magnetograph has been installed at the Udaipur Solar Observatory and tested successfully. Doppler Ribbon associated with an intense solar flare has been detected. Coordinated campaigns using sodium airglow photometer in conjunction with the sodium lidar and Indian MST radar at Gadanki is planned to investigate the atmospheric gravity wave propagation in the mesosphere. Characterization of soil carbon reservoirs in India using ^{14}C and ^{13}C isotopes is continued. The clean (1000 class) Chemical Laboratory has been completed to carry out isotope chemistry of rocks and water. Reconstruction of the record of long term seismicity and crustal shortening rates through time in Himalayas is being done by estimation of river incision rates, dating of fault gouges and by kinematic analysis.

2.3 Studies of volatiles (N and noble gases) in planetesimals will be initiated. Development and testing of the qualification model of HEX payload incorporating sub-systems developed at PRL and at ISAC has been completed. Propagation phenomena inside large mode area (LMA) optical fibres will be of synchronization in ecological systems, modeled based on coupled dynamical elements, has led to significant advances for extinction of species.

Major Programmes for 2008-2009

2.4 A multi-purpose Volume Phase Holographic Gating Spectrograph covering the range 500 to 900 nm with a 4K x 4K CCD detector will be realized. Design and fabrication of laboratory models of proposed X-ray and IR payloads for small satellite missions will be initiated. Development of the solar adaptive optics system and laboratory tests will be completed. Design review of the MAST telescope will be completed and the delivery of the telescope is expected

by 2009. Chemical characterization of aerosol particles will be made using a time-of-flight mass spectrometry. Study of boundary layer and its changes on the levels of surface ozone and its precursors are planned to be studied using a lidar operating at 532 nm at Ahmedabad. Development of satellite payloads for measurement of trace gases and air glow will be initiated. Isotopic studies of early solar system objects and differentiated meteorites will be continued. Laboratory studies of cometary dust and interstellar grains using nano-SIMS has been initiated. Planned to conduct cloud physics modelling and experiments. Aerosol chemistry at micro-and nano-scale will be investigated. Time-resolved spectroscopy for luminescence studies will be initiated. Chandrayaan-1 data analysis from the HEX and other payload will be initiated. Development of new instruments for future planetary missions will be taken up. Dynamical properties of networks and ratchet effects in chaotic system and solution of different nonlinear equations will be pursued. Research in the field of physics of the bottom quark will be initiated.

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

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
9.62	7.95	11.31

3.1 The National Atmospheric Research Laboratory (NARL) at Gadanki, Tirupati in Andhra Pradesh, is an autonomous institution under the Department of Space. The state-of-the-art MST Radar Facility for enhancing the scientific

understanding of atmospheric, climatic and allied natural phenomena is available for national and international scientists from various institutions and universities advanced research in atmospheric and space sciences and related disciplines.

Major Activities during 2007-2008

3.2 NARL's science activities during the current year is broadly classified into three categories, viz., Electrodynamics and Ionospheric Studies, Investigation of Atmospheric Structure and Dynamics and Studies on Clouds and Convection Processes. Under the Electrodynamics and Ionospheric Studies an extensive experimental program has been initiated to investigate the origin of the daytime 150-km irregularities and study the low latitude electrodynamics. The experiments include using the MST radar to carry out a detailed investigation on the 150-km echoes over Gadanki. The results will provide important input to investigate the 150-km echoing riddle.

3.3 The major scientific objectives in the investigation of atmospheric structure and dynamics are to understand the long-term variability in middle atmospheric winds and temperature, characterization of gravity waves and investigation of its generating mechanisms, quantitative estimation of contribution of different scales of waves to the momentum budget of middle atmosphere and tropopause dynamics stratosphere-troposphere exchange. Study of the characteristics of tides in the mesosphere and lower thermosphere region (80-100 km) indicate presence of 15-20 days modulation of diurnal tide activity.

3.4 Balloon radiosonde launches are made from Gadanki to validate density, refractivity, water vapor and temperature profiles derived from satellite

borne GPS Radio Occultation studies. Temperature data from co-located Nd:YAG Rayleigh lidar is also used. A major validation project is also planned to validate similar data to be obtained from the Indian Remote Sensing Satellite, Oceansat-2 to be launched next year.

3.5 To study aerosols and their variability, a Boundary Layer Lidar (BLL) is developed in-house and has been in regular operation. A polarization lidar system is also operated during night-time to investigate the upper troposphere and lower stratosphere up to 30 km height. The data are used for studies on the optical and dynamical characteristics of boundary layer aerosol, free troposphere aerosol transport during non-cyclonic periods, scattering and optical characteristics of convectively and locally generated tropical cirrus and stratospheric aerosol vertical distribution. Data collected using the MST radar and Lower Atmospheric Wind Profiler during the southwest monsoon period have been used to study the variation of rain Drop Size Distribution (DSD) with height and also with the type of precipitating system.

Major Programmes for 2008-2009

3.6 Data Assimilation and Modeling activity will be initiated at NARL which will be equipped with data processing and analysis unit to help user scientists at large to carry out research work leading to modeling of the earth's atmosphere and its response to various external perturbations. The proposed activity will also help in 'Human Resource Development' by providing a better environment for young scientists to take up the modeling activities in the country. A Rayleigh Doppler lidar will be developed in house to study winds in the stratospheric region which is not possible using MST radar technique. Also,

realizing the importance of man made effect in altering the properties of clouds, a major developmental activity of building a Cloud radar is being initiated. The proposed cloud radar will operate at 35GHz frequency and will be developed and installed at NARL in collaboration with SAC, Ahmedabad and ISTRAC, Bangalore. In order to add the temperature measurement capability to MST radar, the Radio Acoustic Sounding System (RASS) is designed and being tested. New R&D activity is proposed to work on improving the horn design so that the transmitted acoustic wavefront is pre-modulated to mitigate the effects of distortion due to the background wind.

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

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
5.00	5.00	5.00

4.1 The North-Eastern Space Applications Centre (NE-SAC) 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 and monitoring, developmental planning and interactive training using space technology inputs of remote sensing and satellite communication. The Centre interacts with the State Governments in the North Eastern Region and the North Eastern Council for generating technology-based solutions for the developmental activities of the Region.

Major Achievements during 2007-2008

4.2 During the year, the Centre has completed mapping of areas affected by sand casting due to floods in Assam using multi-date satellite data. The Centre has created the database on Deepar Beel biodiversity under the guidance of SAC, Ahmedabad. Satellite-based estimation of rice acreage for the entire State of Meghalaya and multiple crops for selected districts in the State has been completed. Temporal satellite imageries have been used for identification of potential tiger habitat and corridor out side Dampa tiger reserve in Mizoram. Species composition of the generation and pug mark locations of tigers have been integrated with remotely sensed data as inputs for tiger home range analysis. A model for quantitative estimation of weekly rainfall in each of the districts of north eastern region has been developed using KALPANA-1 satellite thermal band data.

4.3 In the area of Satellite communication applications, the Centre has facilitated establishment of EDUSAT utilisation network of SITs and Hub in Tripura and Meghalaya States. Under the ISRO Cancer Net project, connectivity has been given to Government Cancer Hospital in Agartala, Tripura. A network of 10 Village Resources Centres (VRCs) in Assam has been established. Work has been progressed in providing telemedicine connectivity between 151 Army Base Hospitals at Guwahati with peripheral Military Hospitals in the NER. In Association with SAG-SITAA/SAC, a series of experiments have been initiated on Ka band propagation impairment at NE-SAC.

4.4 In the area of Space Science activities, the Centre has co-ordinated and installed of 61 out of 80 Automatic Weather Stations (AWS) in the NER.

Others are being installed in Nagaland and Manipur. NE-SAC is also participating in the Severe Thunderstorm Observation and Regional Modeling (STORM), a project co-ordinated by Department of Science & Technology. In the area of Disaster Management Support (DMS), the Centre has prepared technical inputs (urban sprawl, house density, open places and vulnerability proneness to floods and land slides) to the Working Group II (technical) constituted by Government of Meghalaya for the preparation of Shillong City Disaster Management Plan. Detailed mapping of erosion prone areas of four selected sectors along the banks of Brahmaputra river in Assam has been completed for the Water Resources Department of Assam.

Major Programmes for 2008-2009

4.5 Work on creation of a Land Use/Land Cover database at 1:50,000 scale for the entire North-Eastern Region will be completed. The updating of the Wasteland maps using satellite data is also to be taken up for Meghalaya, Manipur and Nagaland. The Centre will take up the preparation of ground water prospective zone map of Assam under Rajiv Gandhi National Drinking Water Mission (RGNDWM). Eight new projects have been taken up under EOAM in the areas of remote sensing applications such as medicinal plant inventory, application in data mining techniques, natural resource and infrastructure study for border trade, sampling techniques for forest stock in hill areas, forecasting of floods etc. Wetland mapping of 1:50,000 scale for Meghalaya and Nagaland under National Wetland Mapping Project will be taken up by the Centre.

4.6 As far as Satellite Communication applications area is concerned, the Edusat network installation will be completed in Nagaland, Mizoram and

Arunachal Pradesh and work will be initiated in Assam, Manipur and Sikkim. 12 Village Resource Centres (VRCs) in Tripura, 8 in Nagaland will be established and work will be initiated in other States in the NER. Installation of remaining 52 telemedicine Centres in NER States under ISRO-NEC project and 6 telemedicine Centres under Army Network (Phase-I) will be completed. Under Ka propagation impairment studies, necessary equipments will be installed at NE-SAC.

4.7 In the area of Space Science activities, one environmental Observatory for measuring trace gases and aerosols will be set up under IGBP. Two pilot studies will be taken up on thunderstorm formation using KALPANA-1 satellite data along with AWS data. A facility for providing Agromet services and disaster forecasting for NER region will be initiated using satellite, DWR and AWS data.

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

(Rs. in crores)

Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
42.12	41.07	34.28

5.1 SCL is engaged in the Design, Development and Manufacture of Very Large Scale Integrated Circuits (VLSIs) and Board Level Products. SCL has an Integrated Facility comprising class 10, 6" Wafer Fabrication Plant, Design Facility, Test & Assembly. Quality Assurance and Reliability and system

Level Assembly Facility. Development & Manufacture of ASICs for Strategic Sector is the major thrust.

Major Achievements during 2007-2008

5.2 In the VLSI Division, Development and Manufacture of ASIC's for the Strategic Sector is the major thrust. About 40,000 Multiplexed Analog Signal Processor (MANAS) chips were delivered to SINP, Kolkata for use in an international project at CERN, Geneva. Phase-I of a Read Out Integrated Circuit (8x8 ROIC array) for a Quantum Well Infrared Photo detector (QWIP) has been completed. Feasibility study for Phase-II (320 X 256 ROIC array) has been initiated. Development of a 12-bit ADC – Analog to Digital Converter is continuing and is currently under fabrication. Manufacturing of ASIC for Radio Sonde has been initiated. In the area of MEMS, production of pressure sensor for type inflator application continued, a prototype for Radio Sonde was supplied to Indian Meteorological Department for initial evaluation. The design services for AIC, USA were continued.

5.3 An expert committee has re-examined the need for better technology at SCL which could address the requirements of higher complexity ASICs of the Strategic Sector and it has been decided to seek proposals for upgradation to 0.35/0.25 micron or better technology capability. Two separate Requests for Proposals (RFPS) for 0.35 micron 6" wafer fab upgradation and 0.25 micron or better 8" wafer fab with refurbished equipment have been sought through Global Tender Notice. During the period, Systems Division continued the screening of ADS1218 devices for which test software and associated hardware including that for Burn-In were developed in-house in association with VSSC. SCL successfully

bid in the tender floated by BSNL for supply of STM-1 equipment based on local technology and have won the contract which is under execution. Production of 23K High-end 3 Phase Feature Meter was completed for supply to JVVNL.

5.4 Under the Systems Development activity, the development of ZK2 Amplifier, Circuit Card Element, Firemod etc have been completed. Based on progress made in the development of the products, MIL grade samples of all the cards have been submitted for further evaluation and development of outer-box.

5.5 SCL has entered into an MOU with BARC, Mumbai for development Capacitive Micro-machined Ultrasonic Transducer (CUMUT) which will be used for nondestructive material testing. Design of CUMUT has been finalised and fabrication will commence shortly.

5.6 Consequent to formation of Reliability & Quality Assurance Division, efforts are made to organise the R&QA and thereby its activities, set-up systems and procedures and thrust on all quality aspects including documentation. Reliability prediction, failure analysis and quality audit activities are also being initiated.

5.7 In the area of Information Technology Services (ITS), SCL has implemented Smart Card based Time & Attendance System for the employees which is planned to be integrated with Access Control shortly. The SCL has also executed a project of Smart Card based Access Control System for 52 District Offices of Food Corporation of India. On the Education and Training front, the SCL continued its VLSI Design Education and training (VEDANT) programme. Reputed companies like Cypress, ST Microelectronic and Conexant conducted

campus placements and a number of students have been placed in various reputed Companies.

Major Programmes for 2008-2009

5.8 SCL has been making different types of ASICs, FPGAs, CCDs, Pressure sensors and other components for ISRO. The focus in the coming years will be to undertake radiation hardened devices and about more than 60 types of ASICs have been identified for development by SCL for Space Programme. SCL has also planned to upgrade their fabrication facilities to 0.35 micron level or better.

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

(Rs. in crores)





















Budget 2007-2008	Revised 2007-2008	Budget 2008-2009
75.00	25.00	65.25

6.1 Indian Institute of Space Science and Technology is an autonomous body under DOS formed with the objective of creating quality human resources tuned to suit the state-of-art space programme. The Institute offers graduate, post-graduate and research programme in the area of space science technology and applications. The Institute has started functioning from the academic year 2007-2008 around the existing infrastructure of ISRO Centres in Thiruvananthapuram. The annual intake is about 150-200 students. A permanent infrastructure for the Institute is under planning.

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Mission Profile 2006 - 13

11th PLAN

MISSIONS	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
EARTH OBSERVATIONS	 CARTOSAT-2	Commercial Launches of AGILE and TECSAR	TWSAT CARTOSAT-2A CARTOSAT-2B OCEANSAT-2 	RESOURCESAT-2 MEGHA-TROPIQUES RISAT-1 INSAT-3D 	TES-HY3 ALTIKA-ARGOS GEO-HR	 RESOURCESAT-3 DMSAR-1 CARTOSAT 3	RISAT-3 OCEANSAT-3
SATELLITE COMMUNICATIONS & NAVIGATION	INSAT-4C INSAT-4B 	INSAT-4CR 	GSAT-4 GSAT-5 (GLONASS N1) 	GSAT-6 GSAT-8 GSAT-9 IRNSS-1 IRNSS-2 (GLONASS N2) 	ACTS-1(F) GSAT-7 GSAT-10 IRNSS-3 IRNSS-4 	GSAT-11 GSAT-12 GSAT-13 IRNSS-5 IRNSS-6 	ACTS-2 GSAT-14 GSAT-15 IRNSS-7
SPACE SCIENCE & ENVIRONMENT	SRE-1 		CHANDRAYAAN-1 	ASTROSAT SRE-2 	CHANDRAYAAN-2 I-STAG 	ADITYA-1 SENSE-P SENSE-E ITM-1	
LAUNCH VEHICLES	F2 C7 	PSLV-C8&10 GSLV-F4 	PSLV-C9, C11-13 GSLV-F3, F5, D3  DMRJ-FTO	PSLV-C14-19 GSLV-F6-F9  MK III	PSLV-C20-23 GSLV-F9-13  RLV-TO	PSLV-C24-28 GSLV-F14-16  RLV-TO	