

**INDIAN SPACE RESEARCH ORGANISATION
ISRO SATELLITE CENTRE, BENGALURU**

DIMENSIONS OF INDIAN SPACE PROGRAMME

Space Infrastructure

- Launch vehicles (PSLV, GSLV)
- Spacecrafts (LEO, GEO, Navigation & beyond) – INSAT, GSAT, IRS
- Sensors and Transponders

Ground Segment

- Data Acquisition, Processing, Calibration -Validation
- Fixed Satellite Services, Broadband Satellite Services, Mobile Satellite Services, Ground stations
- Deep Space Network , TTC Network

Applications

- Natural Resources Management
- Meteorology & Ocean Studies
- Satcom & Navigation
- Synergy: Earth Observation /Satcom/Navigation –Village Resource Centre

Capacity Building

- Formal education through Centre for Space Science & Technology Education in Asia & the Pacific , Indian Institute of Remote Sensing,...
- Indian Institute of Space Science & Technology

Institutionalization

- National Natural Resources Management System
- Involvement of stake-holders from the planning level
- Antrix

International Cooperation

- Bilateral and multilateral cooperation with various countries and international Organisations

- Tailored for national developmental needs with user participation - INSAT Coordination Committee/Planning Committee on National Natural Resources Management System / Advisory Committee for Space Sciences
- Realised **110** missions (41 Launch Vehicles & 69 Spacecraft)
- Launched **35** foreign spacecraft of 19 countries
- Human Resources: **16500**
- Strong Industry linkage; State-of-the-art Infrastructure; large user base
- International Cooperation and Commerce
- Self reliance in space transportation & spacecraft building/operations and leadership in Applications

INDIA'S NATIONAL SPACE SYSTEMS

Launch vehicles (PSLV, GSLV)



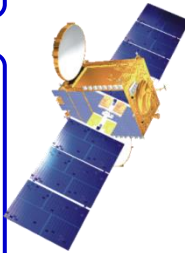
Earth Observation & Societal Applications



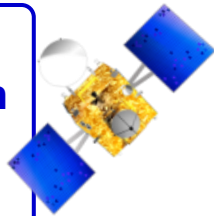
Indian Remote Sensing (IRS) Satellites



Indian Communication & Meteorological Satellites



Indian Navigation Satellites



Space Science & Planetary Exploration Satellites



Five Decades of Indian Space Programme

Applications driven, self-reliant programme
Focus on supporting national development goals

November 21, 1963

41 Launch Vehicle Missions
35 Satellites from other countries
69 + 2 Spacecraft Missions

INSAT-3E
28.09.03

KALPANA-I
12.09.02

ARYABHATA
19.04.75

IRS-1C
28.12.95

IRS-P3
21.03.96

INSAT-3C
24.01.02

IRS-1D
29.09.97

INSAT-2E
03.04.99

INSAT-3B
22.03.00

IRS-P4
26.05.99

INSAT-3A
10.04.03

TES
22.10.01

RESOURCESAT-1
17.10.03

GSAT-2
08.05.03

EDUSAT
20.09.04

PSLV
25

HAMSAT
05.05.05

CARTOSAT-1
05.05.05

INSAT-4A
22.12.05

CARTOSAT-2
10.01.07

CHANDRAYAAN-I
22.10.08

INSAT-4CR
02.09.07

INSAT-4B
12.03.07

OCEANSAT-2
23.09.09

W2M MEGHATRO
21-12-08

HYLAS
26-11-11

GSAT-8
21-05-11

GSAT-12
15-07-11

GSAT-10
29-09-12

IRNSS-1A
01-07-13

GSAT-14
05-01-14

INSAT-3D
26-07-13

SARAL
25-02-13

RISAT-1
26-04-12

RESO-2
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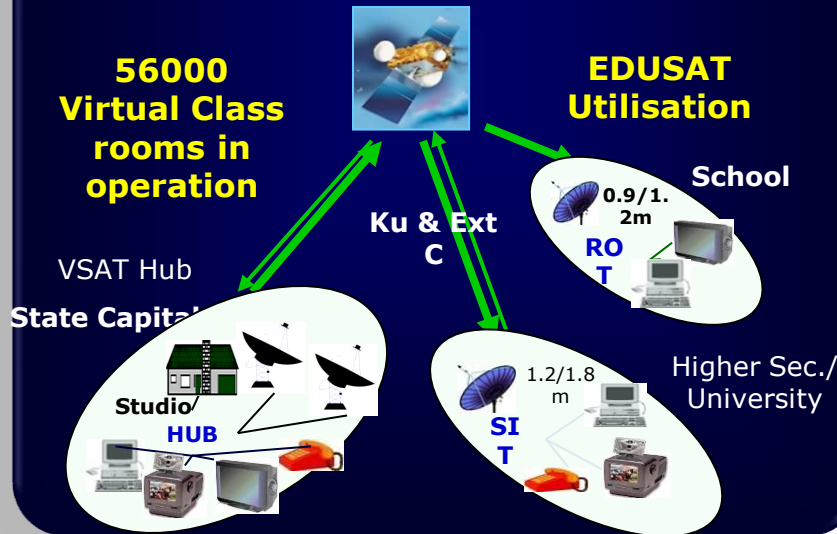
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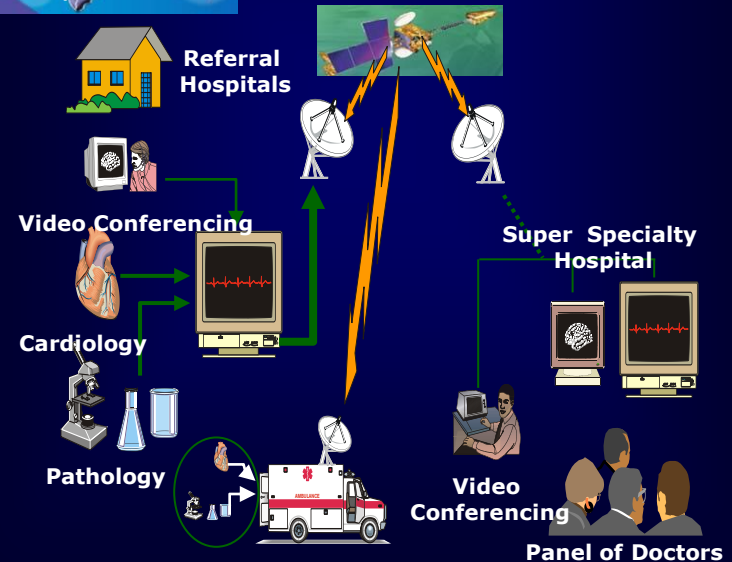
Tele-Education

- Training & Development Communication Channel (TDCC - 1995)
- Jhabua Development Communications Project (JDCP - 1996)
- GRAMSAT Pilot Project (GPP)



Tele-Medicine

- >380 Hospitals
- ~235 Dist/ Rural
- > 43 Super Specialty
- > 3 Lakh patients treated



BROADCAST

- Television Broadcasting
- Direct To Home (DTH)
- TV & Radio Networking



COMMUNICATION

- Speech Circuits on Trunk Routes
- VSAT Connectivity

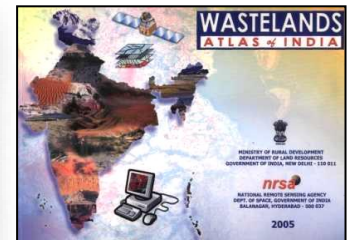
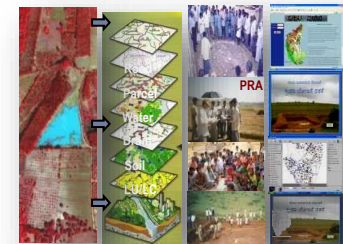
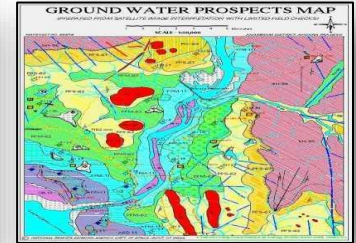
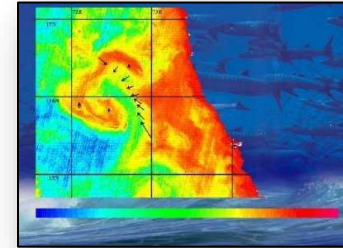


OTHERS

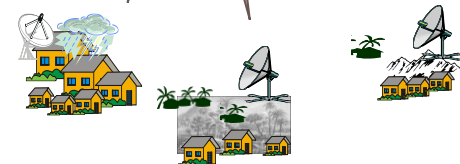
- Mobile Satellite Service
- Search and Rescue
- Satellite Navigation

Natural Resources Management

- Agricultural Crop Inventory
- Watershed Development Planning & Monitoring
- Irrigated Command Area Monitoring
- Irrigation Infrastructure Monitoring
- Potential Ground Water Zones
- Potential Fishing Zones
- Urban /Infrastructure Planning
- Biodiversity at Landscape level

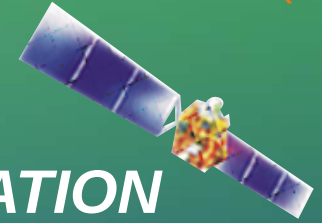
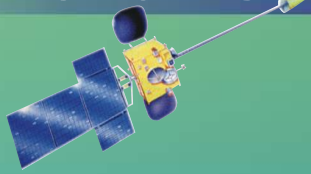


**Earth Observation
based Info. &
Digital Connectivity**

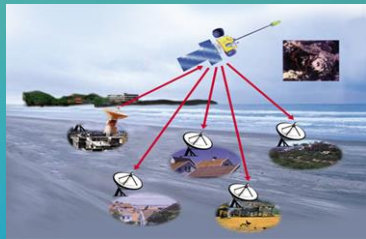


Village Resources Centre (490)

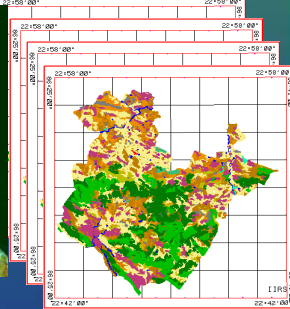
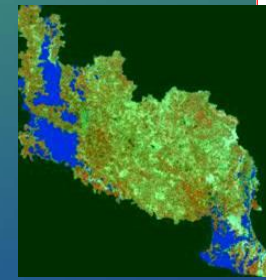
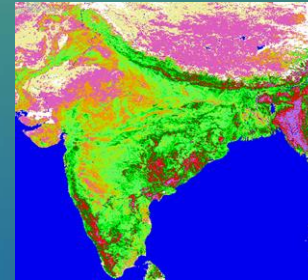
SPACE & DISASTER MANAGEMENT



SPACE FOR CONNECTIVITY & OBSERVATION



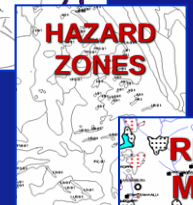
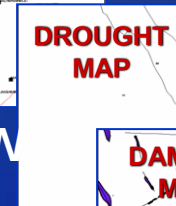
OBSERVATION FOR INFORMATION



INFORMATION FOR DECISION



DECISION FOR ACTION



ISITE Facilities

BONDED
STORES

HILS
FACILITY

TEST & EVALUATION LAB

ELECTRONIC FABRICATION LAB

SUN SIMULATOR
AT LEOS

6 . 5 M THERMOVAC
CHAMBER

UNFURLABLE ANTENNA
DEPLOYMENT FIXTURE

SPACE CRAFT
CHECKOUT

PHYSICAL PARAMETER
MEASUREMENT SYSTEM

VIBRATION TEST
FACILITY

COMPACT ANTENNA
TEST FACILITY

ACOUSTIC
TEST FACILITY

GAGAN MASTER CONTROL
CENTRE AT KUNDALAHALLI

SENSOR FABRICATION
FACILITY AT LEOS

AIT CLEAN ROOM, ISITE

RECENTLY LAUNCHED SATELLITES

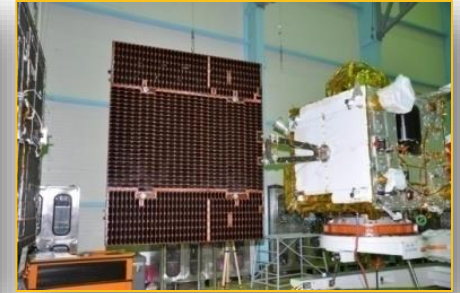
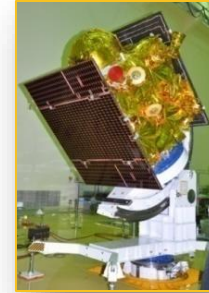
SARAL

26.02.13



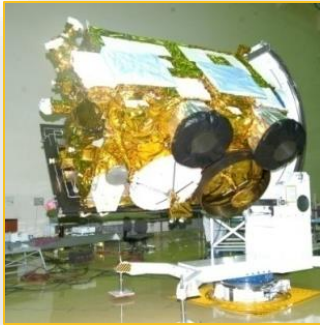
IRNSS-1A

01.07.13



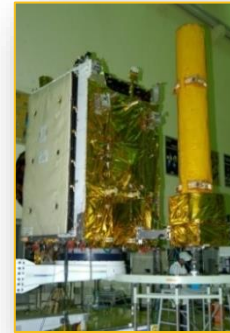
INSAT-3D

26.07.13



GSAT-7

30.08.13



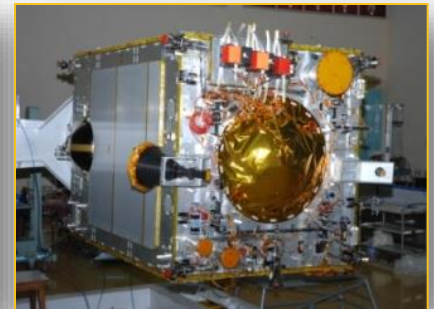
MARS

05.11.13



GSAT-14

05.01.14

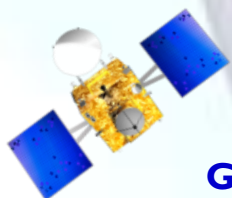


COMMUNICATION SATELLITE PROGRAMME

-Uniquely tailored to develop innovative grass root level applications



I-1K BUS



GSAT-12

15.07.11
12.Ext C



Kalpana-I

12.09.02
VHRR

I-2K BUS



GSAT-7

30-08-13



INSAT-3D

26-07-13

HYLAS

26.11.11



INSAT-4CR

02.09.07

12 Ku



INSAT-3E

28..9.03

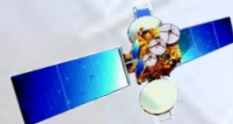
24 Nor C, 12 Ext C



INSAT-3A

10.04.03

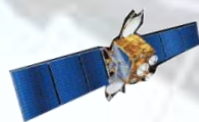
112 C, 6 Xc, 6 Ku,
VHRR, DRT, SAR



INSAT-3C

24.01.02

12 x C, 3 Ku, 1 MSS

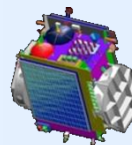


INSAT-3B

22.03.00

12 x C, 3 Ku, 1 MSS

I-3K BUS



GSAT-10

29.09.12

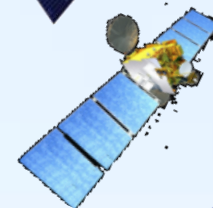
12. Ku, 12 Nor-
C, 6 Low-Ext C



GSAT-8

21.05.11

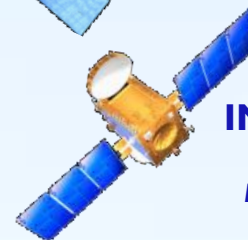
24 Ku



W2M

21.12.08

32 Ku



INSAT-4B

12.03.07

12 Ku, 12 C



INSAT-4A

22.12.05

12 Ku, 12 C

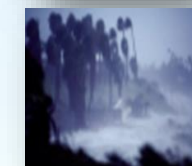
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Telecommunication



TV Broadcasting



Meteorology

■ C-band Fixed Satellite Service ; Ku-band Fixed Satellite Services ; Broadcast Satellite Services ; and Mobile Satellite Services

■ World's largest domestic satellite communication system (206 transponders & growing)

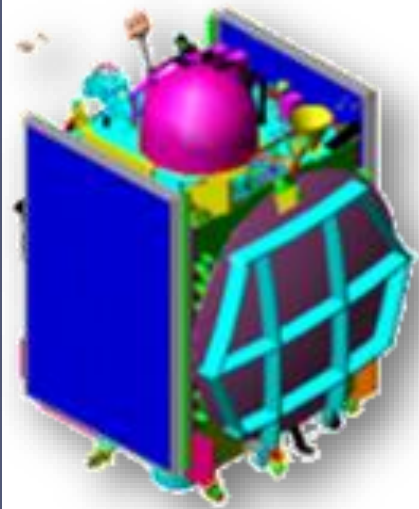
GSAT-14



The spacecraft is envisaged to enhance communication transponder capacity of the INSAT system. It is built around ISRO's I-2K Bus carrying 6 Ext C band, 6 Ku band transponders & 2 Ka Band Beacons. The spacecraft was successfully launched onboard GSLV-D5 with indigenous Cryogenic stage on 5th of January 2014.

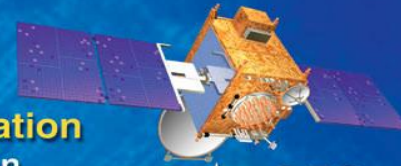
SPACECRAFT SALIENT FEATURES

Orbital Location	: 74° E longitude
Communication Payload	: 6 Ext C band, 6 Ku band Transponder & 2 Ka Band Beacons
Mass	: 2018 Kg
Power	: 2.6 KW
Mission Life	: > 11 Years
Launcher	: GSLV- D5



GAGAN

GPS Aided Geo Augmented Navigation
Indian Satellite Based Augmentation
System



ARCHITECTURE

GAGAN Coverage 82°E

GEO (GSAT/INSAT)
(L1,L5)

GEO (GSAT/INSAT)
(L1,L5)

GPS

GPS

GPS

INRES

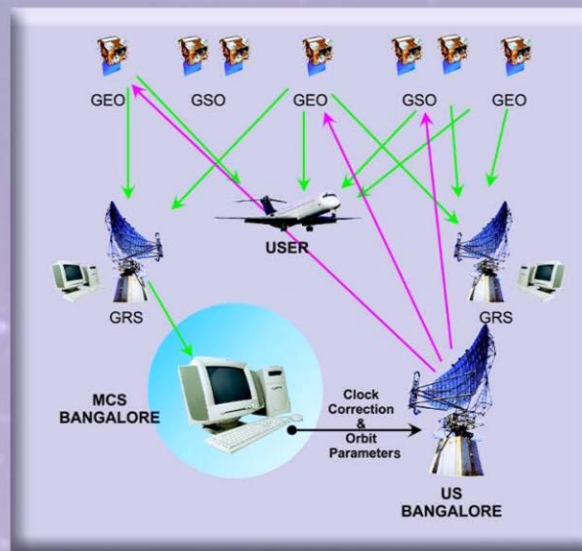
INMCC

FIBRE OPTIC

INLUS

- ★ Total Electron Content Station (TEC)
- Indian Reference Station (INRES)
- Indian Land Uplink Station (INLUS)
- Indian Master Control Station (IMCC)

GAGAN system is certified by DGCA (Director General of Civil Aviation) for en-route /non precision approach service operations over Indian region. GAGAN system is the fourth Satellite Based Augmentation System (SBAS) to be certified in the world



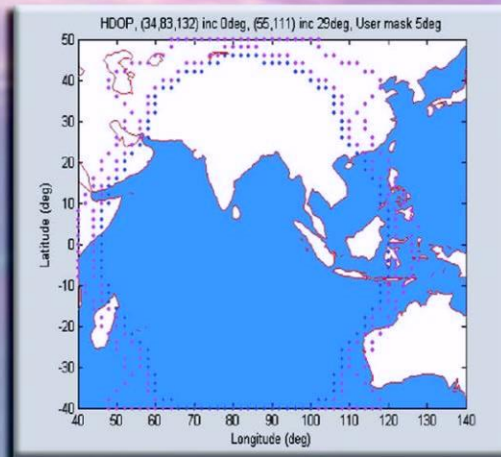
IRNSS SPACE SEGMENT

IRNSS CHARACTERISTICS

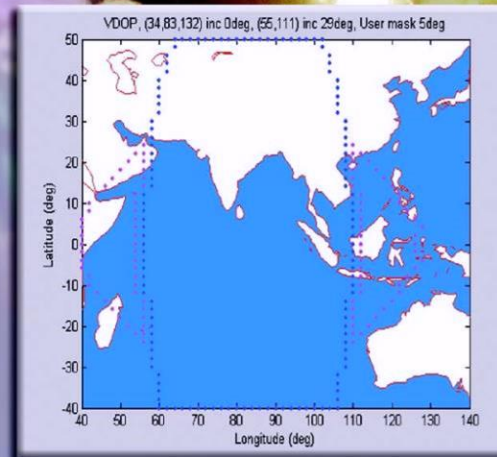
- A Regional Navigation System for Indian Region
- An independent, self-reliant and civilian system
- 7 Spacecraft (3 GEO + 4 GSO) Constellation
- GSO Longitudes: E 55 deg and E111 deg
- GSO Inclination: 29 deg
- GEO Longitudes: E 34, E 83 and E 132 deg
- 7 Independent Launches of PSLV
- 1304 Kg Satellite Mass at Lift-off
- Dual Frequency downlinks for user
- Position Accuracy = 18.3 m (1-sigma)

IRNSS

INDIAN REGIONAL NAVIGATION SATELLITE SYSTEM



PROJECTED ACCURACY – HORIZONTAL <20 m



PROJECTED ACCURACY – VERTICAL <20 m

IRNSS APPLICATIONS

NAVIGATION

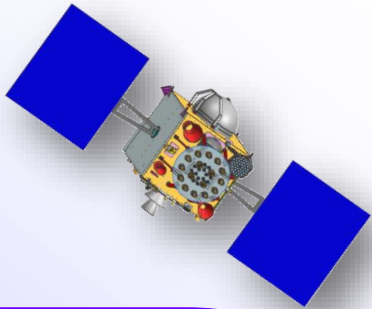
- Space Craft
- Aircraft
- Ship
- Vehicle
- Fleet Movement
- Routing/Alignment
- Timing

SCIENTIFIC RESEARCH

- Atmospheric Studies
- Ionospheric Scintillations

IRNSS-1A

Develop an independent satellite based navigation system capable of providing uninterrupted navigation services. Navigation system provides Standard positioning service and Restricted Service with encryption. Constellation of seven spacecraft to be in place by 2015.



SPACECRAFT SALIENT FEATURES

Orbital Location	: Geosynchronous with 29 Deg inclination
Bus	: I-IK Bus
Payload	: Navigation Payload and Ranging Payload operating in S and L5 bands
Power	: 1600 Watts
Spacecraft Mass	: 1426.74 Kg
Mission Life	: 10 Years
Application	: Regional Navigation application
Launch Date	: 01 st July 2013



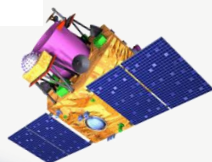
EARTH OBSERVATION SYSTEMS

Cartography & large scale mapping application

RISAT-1
26.04.2012
SAR ANTENNA



Cartosat-2B
12.07.2010
PAN CAMERA



Cartosat-2A
28.04.2008
PAN CAMERA



Cartosat-2
10.01.2007
PAN CAMERA

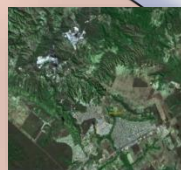


IMS-1
28.04.08

SRE-1
10.01.07



Resourcesat-2
20.04.11
LISS-4, LISS-3, AWIFS



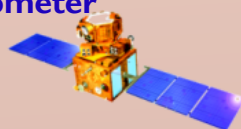
YOUTHSAT
20.04.11



Oceansat-2
23.09.09
OCM, ROSA
Ku Band
Scatterometer



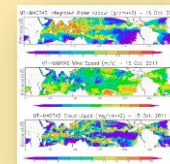
Resourcesat-1
17.10.03
LISS-4, LISS-3 &
AWIFS



Land & Water Resources Management

Environmental monitoring & Atmospheric research

Meghatropiques
12.10.2011
MADRAS, SAPHIR,
SCARAB, ROSA



SARAL
25-02-13
ALTIKA, ARGOS,
SCBT



**Technology
Experiment
satellite**

22.10.01
PAN CAMERA



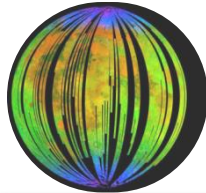
PSLV

SPACE SCIENCE & PLANETARY EXPLORATORY MISSIONS



Chandrayaan-1

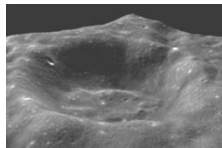
22.10.08



DISCOVERY OF
WATER



TRI COLOUR
ON MOON



CRATERS
ON MOON

FACILITIES ESTABLISHED

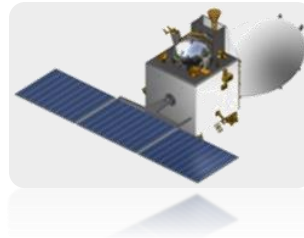
Indian Deep Space Network



18m Terminal

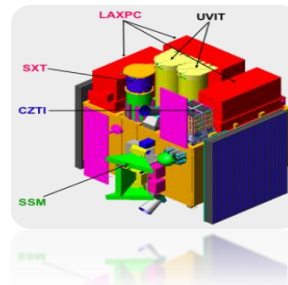


32m Terminal



MARS ORBITER MISSION

Study of Martian surface, Martian Atmosphere and Ionosphere



ASTROSAT

Multi-wavelength Astronomy Satellite for observation of galactic objects



CHANDRAYAAN-2

Landing in a high latitude region
First Rover-based in-situ studies of lunar chemistry & volatiles



ADITYA-1

A Space based Advanced Solar Coronagraph to study solar corona

MARS ORBITER MISSION

India's first interplanetary mission to Mars to study surface features, morphology, topology and mineralogy of Mars and constituents of Martian atmosphere.

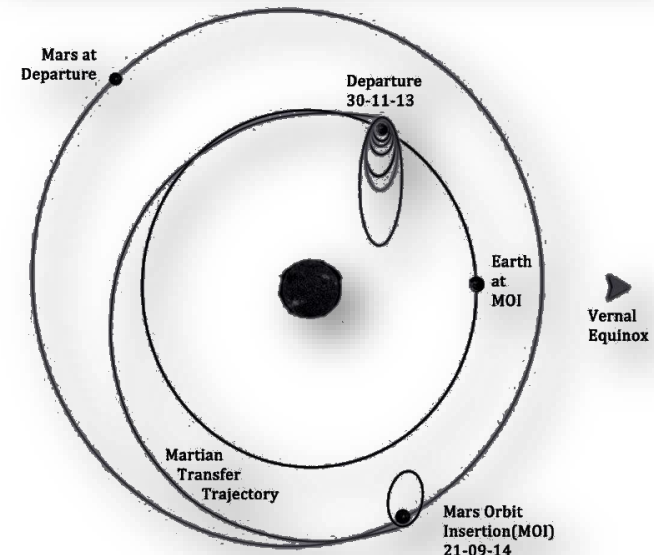
SALIENT FEATURES

Orbital Location	: 370 X 80,000 Km elliptical orbit
Voyage from Earth's orbit	: 300 Days
Mass	: 1350 Kg
Power	: 750 W
Mission Life	: ~ 6 Months
Launcher	: PSLV-XL
Launch	: 5 th November 2013

Payloads:

Lyman Alpha Photometer, Methane Sensor for MARS, Martian Exospheric Composition Explorer, MARS Color Camera and TIR Imaging Spectrometer

High Gain Antenna Deployment



CHANDRAYAAN-2

Chandrayaan- 2, a follow on mission to the first Indian lunar mission with a capability to soft land at a specified lunar site and to carry out in-situ chemical analysis of the lunar surface and will have Orbiter Craft and Lander craft equipped with rover.

SPACECRAFT SPECIFICATIONS

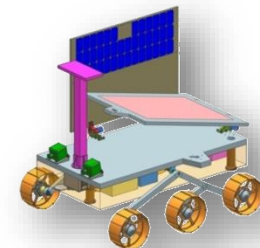
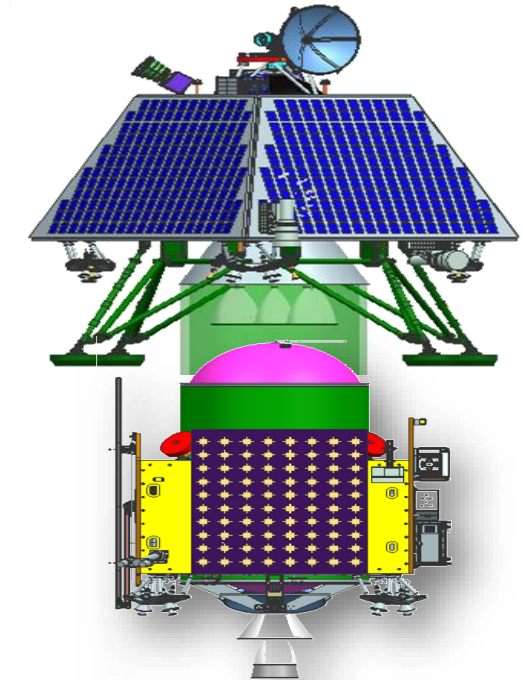
Orbit	: 170 x 17000km
Lift off mass	: 3200 Kg
Orbiter	: 2260 Kg
Lander	: 940 Kg

Lander payloads - 35 kg

1. Rover – 25 kg
2. RAMBHA
3. Dust Levitation Experiment
4. Temp and Thermal property
5. Seismometer

Orbiter Payloads:

1. CLASS- Chandrayaan-2 Large area soft X ray Spectrometer
2. SAR- Synthetic Aperture Antenna
3. IIRS - Imaging IR Spectrometer
4. ChACE 2- Chandra's Altitudinal Composition Explorer
5. TMC-Terrain Mapping Camera



SPACECRAFT ASSEMBLY & INTEGRATION



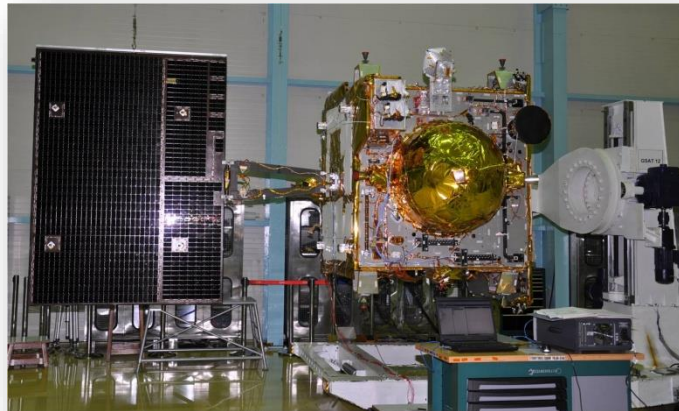
Structure
Assembly at Clean
Room



Panel Closure
Activities in Clean
Room



Loading to Thermovac Chamber



Solar Panel Deployment Test



Vibration Test



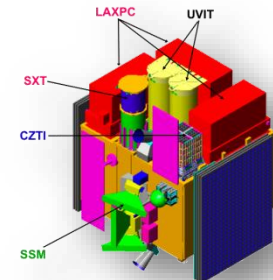
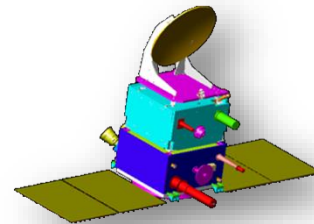
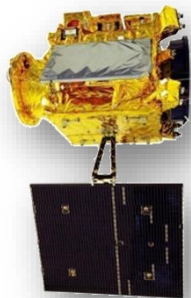
Acoustic Test



CATF Test

ISRO'S INTERNATIONAL SPACE COOPERATION

- Realisation of joint satellite missions (**MEGHA-TROPIQUES, SARAL**)
- Accommodation of payloads (**CHANDRAYAAN-I, OCEANSAT-2, ASTROSAT**)
- Disaster management (International Charter, Sentinel Asia, Search & Rescue)
- Capacity building (Centre for Space Science & Technology Education in Asia & the Pacific)
- Participation in Advisory Committees on Policy Regulations



Cooperative arrangements with 33 Countries & 3 multi-national bodies

Thank You

