Indian Space Programme
Country Report
3rd Dec, 2015
PG Diwakar
NRSC
Indian Space Vision – Shared, Nurtured, and Enriched over the Decades

**PEOPLE-CENTRIC, APPLICATION-DRIVEN**

- Space Sciences and Exploration
- Space Applications
- Satellite Communication
- Launch Vehicles
- Satellite Navigation
- Earth Observations
Accomplishments in Space

- Realized 29 successive successful flights of PSLV
- Development of GSLV with Indigenous Cryogenic Stage
- Development of Heavy Lift Launcher GSLV Mk III
- State-of-the-Art Remote Sensing Satellites
- State-of-the-Art Communication Satellites
- Indian Regional Navigation Satellite System
- GAGAN (GPS Aided GEO Augmented Navigation)
- Mission to Moon and Mars
- Operationalisation of Space Applications
- 8” Wafer FAB made operational
- Launched 51 satellites of 19 countries
India’s Launch Vehicles

Two launch pads in Sriharikota

<table>
<thead>
<tr>
<th>Lift-off weight (Tonnes)</th>
<th>17</th>
<th>40</th>
<th>295</th>
<th>450</th>
<th>644</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payload (kg)</td>
<td>40 (LEO)</td>
<td>150 (LEO)</td>
<td>1750 (SSO)</td>
<td>2200 (GTO)</td>
<td>4000 (GTO)</td>
</tr>
</tbody>
</table>

SLV-3 (1980)
ASLV (1988)
PSLV (1994)
GSLV (2000)
GSLV MK III (2014)

Self Reliance through systematic learning
Current Space Assets & Capabilities

**Launch Vehicles**
- PSLV - 1800 kg SSO / 1400 kg GTO
- GSLV - 2200 kg GTO
- GSLV Mk III - 4000 kg GTO (Under Dev.)

**Satellites**
- 11 Communication Satellites
- 10 Earth Observation Satellites
- 4 Navigational Satellites (7 by Jun, 2016)

**Ground Segment**
- 2 Launch Pads in Sriharikota
- Integrated Multi-mission Ground Segment for EO Satellites (IMGEOS)
- Ground Observing Network (AWS, AMS, DWR, Flux Towers)

**Communication Payloads**
- Transponders (C, Extended C, Ku, S-band)
- Satellite Aided Search & Rescue
- Data Relay Transponder

**EO & Meteorology Payloads**
- Optical, Microwave, Scatterometer, Altimeter
- Resolution - 0.8 m to 8 km
- Swath - 10 km to 6000 km
- Half-hourly to 100 Daily
- Stereo-imaging
- Imager, Sounder, VHRR, CCD

Bhuvan, MOSDAC, India-WRIS, Bhuvan Panchayat
Earth Observation Satellites in Orbit & Near Future

**LAND & WATER**
- RESOURCESAT-1,2
- RISAT-1

**HIGH RESOLUTION**
- CARTOSAT-2
- CARTOSAT-1

**OCEAN**
- OCEANSAT-2
- SARAL

**WEATHER & CLIMATE**
- INSAT-3A
- KALPANA
- MEGHA-TROPIQUES
- INSAT-3D

**NEAR FUTURE**
- RESOURCESAT-2A
  - LISS-3, LISS-4, AWIFS
  - 2016

- GISAT
  - 2017
  - Geo-stationary multi spectral, hyper spectral

- NISAR (2020)

- CARTOSAT-2E
  - 0.65 m PAN
  - 2017

- LISS-3, LISS-4, AWIFS

- CARTOSAT-3
  - 0.25 m PAN with MX
  - 2018

- OCEANSAT-3/3A
  - OCM, Scat, SST
  - 2018/2020

- SCATSAT-1
  - Ku Scat
  - 2016

- INSAT-3DR
  - Imager, Sounder
  - 2015

- IN-PLORE (2019)

- NISAR (2020)
### Communication Satellites in Orbit

<table>
<thead>
<tr>
<th>Telecommunication</th>
<th>2.30 Lakh VSATs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Television and DTH services</td>
<td>100% National Coverage and &gt; 4.2 Crores DTH Subscriptions</td>
</tr>
<tr>
<td>News gathering</td>
<td>On-spot; Real-time news coverage</td>
</tr>
<tr>
<td>Radio-networking</td>
<td>415 AIR Stations</td>
</tr>
<tr>
<td>Mobile services</td>
<td>Emergency communication link</td>
</tr>
<tr>
<td>Search and Rescue services</td>
<td>13,800 Indian Beacons from Maritime and Aviation Agencies</td>
</tr>
<tr>
<td>MET DATA dissemination service</td>
<td>~1900 AWS and ~1200 Rain Gauge Stations ; 40 Dissemination Stations</td>
</tr>
<tr>
<td>Tele-education</td>
<td>83 Networks covering 26 States &amp; 5 UTs</td>
</tr>
<tr>
<td>Tele-medicine</td>
<td>60 Specialty Hospitals; &gt; 300 Remote Hospitals</td>
</tr>
</tbody>
</table>
IRNSS: Indian Regional Navigational Satellite System

- Consists of 7 Satellites, 3 in Geo-Stationary & 4 in Geo-Synchronous
- The first four Satellites are already launched
- Coverage area ~ 1500 km beyond Indian territory.
- Estimated horizontal position accuracy of 10-20 m in over India and adjoining areas

GAGAN: GPS & Geo-Augmented Navigation

- Augmentation of existing Global system: Improved Positioning Accuracies (from 30m to 6m)
- Payloads in GSAT-8, GSAT-10 & GSAT-15
- Applications: Aviation and Non-Aviation
- Certified by DGCA to provide Non-Precision Approach services for “En-route Navigation” over Indian Airspace.
- India is the fourth country to offer safety of life navigation services to aviation sector
Applications for Societal Outreach

Natural Resources Management

- Landuse/ Landcover Inventory/ Monitoring
- Agricultural Crop acreage & production
- Watershed Management & Monitoring
- Irrigation & Command Area Monitoring
- Water Resources Info. Systems
- Potential Fishing Zones
- Urban /Infrastructure planning
- Islands Monitoring/ Biodiversity
- Environmental monitoring

Tele medicine
Tele education
Village Resources Centre
Disaster Management Support
Geo-Platforms

http://www.bhuvan.nrsc.gov.in

- 18TB Data from 7 Sensors
- 30 State Portals
- 15 Thematic Layers
- 64 Web Apps
- Data Download

http://www.nnmrs.gov.in

NR Database (1300 Layers)

http://www.mosdac.gov.in

- Met. & Ocean Data
- In-situ Data Downloads
- Science Data
- Weather Forecasts
- Cyclone Predictions

http://india-wris.nrsc.gov.in

- 12 major info
- 35 sub-info
- 95 spatial layers
- > 700 attributes
Disaster Management Support

**FLOODS**
- Inundation Mapping
- Hazard Zonation
- Early Warning

**FOREST FIRE**
- Fire Detection
- Fire Alert (within 30 min. of acquisition)

**CYCLONE**
- Damage Assessment
- Landfall Prediction
- Early Warning

**LANDSLIDE**
- Inventory
- Early Warning

**EARTHQUAKE**
- Damage Assessment

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**Daily Fire Alert**

**Kashmir Floods - 2014**

**Kedarnath - 2013**

**Kashmir Floods - 2014**

- Disaster Communication Network
- Decision Support Centre
- National Database for Emergency Management
- North Eastern Regional Node for Disaster Risk Reduction
Forecast & Early Warning

- Input to IMD, NCMRWF & International Organizations
- Prediction of Cyclogenesis, Track & Intensity
- Prediction of Thunderstorms, Cloudbursts
- Early Warning for Flood, Landslide

Landslide (rainfall triggered) Early Warning along Pilgrimage Routes in Uttarakhand

Flood Forecast Hydrograph at Perur (2013)

Computed Discharge
Observed Discharge

CYCLONE HudHud: Prediction and Tracking

Predicted track using Lagrangian Advection Model

Actual Track Monitoring
Nepal – Trans boundary Disasters

- A massive landslide blocked the Sun Koshi river in Northern Nepal on 02-Aug-2014.
- Possible formation of a lake.
- Flood threat for several villages downstream in Bihar, India.
Artificial Lake formation

Landslide Blocking the Valley - NEPAL

Major landslide blocked the valley resulting in an Artificial lake.
Due to massive Earthquake in Nepal
Phuktal River Landslide, Lake formation..

Cartosat-2 (After)

Landslide debris

Cartosat-1 (Before)

Landslide Crown

Surface cracks
2009
Upto 5m for Indian region
(5m—Synthetic L4MX, 24m—L3 full India, 50m—AWIFS full India)

2010
Global coverage with 50m
(50m—AWIFS Global mosaic)

2011
NOEDA Tiles
(AWIFS & LISS-3 Tiles)

2013
2.5m Color mosaic for Indian states

2014-15
1m Color mosaic > 260 Indian Cities

2015
1m Color for entire India
2.5m Color of Year 2013

2015 Onwards Yearly update of 1m HR data
• Project specific requirements will be with higher periodicity

Bhuvan - Satellite Data Content Updates
ISRO’s Satellite Data Support for various disasters 2015

- **Nepal**: Apr, Earthquake
- **Myanmar**: Jul, Sep, Flood
- **Bangladesh**: Sep, Fire
- **Japan**: Sep, Typhoon
- **Pakistan**: Jul, Oct, Earthquake
- **India**: Feb, Oct, Flood
- **Vietnam**: Aug, Oil Spill
- **Philippines**: Oct, Typhoon
- **Taiwan**: Aug, Earthquake
- **Indonesia**: Feb, Oct, Flood
Satellite Data Support to Sentinel Asia
2008-2015

Country | No. of Events
---|---
Indonesia | 11
Philippines | 5
Vietnam | 5
Australia | 4
Japan | 4
Myanmar | 4
Nepal | 4
Pakistan | 3
China | 2
Laos | 2
Thailand | 2
Bangladesh | 1
Bhutan | 1
Cambodia | 1
India | 1
Kazakhstan | 1
Malasiya | 1
Solomon | 1
Srilanka | 1
Taiwan | 1
Tajikistan | 1
Tonga | 1
ISRO Active in Global Disaster Management

International Charter – ISRO provided leadership during Apr – Oct 2015

ISRO’s Support - 2015-16
- Intl’l Charter – > 142 Scenes
- Sentinel Asia – > 30+ Scenes
- UNESCAP – Drought: Srilanka all season support; Nepal feasibility study done
- UN-SPIDER – International Workshop on DRR in Mar 2016
## Capacity Building

**Indian Institute of Remote Sensing (IIRS)**

Under Indian Technical Economic Cooperation (ITEC) sponsored by MEA

**UN affiliated Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP)**

<table>
<thead>
<tr>
<th>Post Graduate courses</th>
<th>Duration</th>
<th>Dates</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Remote Sensing &amp; GIS</td>
<td>9 Months</td>
<td>July-March</td>
<td>10</td>
</tr>
<tr>
<td>2. Satellite Meteorology</td>
<td>9 Months</td>
<td>August-April</td>
<td>10</td>
</tr>
<tr>
<td>3. Space &amp; Atmospheric Science</td>
<td>9 Months</td>
<td>August-April</td>
<td>10</td>
</tr>
<tr>
<td>4. Satellite Communications</td>
<td>9 Months</td>
<td>August-April</td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Short Courses</th>
<th>Duration</th>
<th>Dates</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Disaster Risk Reduction</td>
<td>4 Weeks</td>
<td>April-May</td>
<td>20</td>
</tr>
<tr>
<td>2. Small Satellite</td>
<td>2 weeks</td>
<td>April-May</td>
<td>20</td>
</tr>
</tbody>
</table>

More than **1600 officials from 93 Countries** were benefited by training at IIRS & CSSTEAP
ISRO’s International Space Cooperation

- **Realisation of joint satellite missions** (MEGHA-TROPIQUES, SARAL, NISAR)
- **Accommodation of payloads** (CHANDRAYAAN-1, OCEANSAT-2, ASTROSAT)
- **Telemetry, Tracking & Command (TTC) stations** at Brunei, Indonesia & Mauritius
- **Disaster management** (International Charter, Sentinel Asia, UN-ESCAP, SPIDER, SARSAT)
- **Participation in Advisory Committees on Policy Regulations** (UNCOPUOS, IADC, SFCG, CGMS, CEOS, GEO, ICG, ISECG)
- **Capacity building** (CSSTEAP & IIRS/ITEC)

Cooperative arrangements with 35 Countries & 3 multi-national bodies
Space Science & Planetary Exploration

CHANDRAYAAN-1 (2008)
• Indian Deep Space Network (IDSN);
  Spacecraft Control Centre (SCC) &
  Indian Space Science Data Centre (ISSDC)

MARS ORBITER MISSION (2013)
• Exploration of Mars Morphology, Mineralogy
  and Martian Atmosphere
• ASTROSAT (2015): Astronomical Studies

Upcoming Space Science Missions
• ADITYA: Advanced Solar Coronagraph
• CHANDRAYAAN-2: Orbiter, Lander & Rover
On the second anniversary of the MOM launch, a book “From Fishing Hamlet to Red Planet” is released.

The e-version of the book is available on ISRO Website for download www.isro.gov.in
**Mars Orbiter Mission:** Launched Nov 05, 2013

- Entered Mars orbit Sept 24, 2014
- Orbiter with elliptical orbit
- Five science payloads for exploration of Mars surface features, morphology, mineralogy and Martian atmosphere
- **Completed 1 Year 2 Months in orbit.**

**ASTROSAT:** Launched on 28 September 2015

- A Multi-wavelength (UV to X-ray) studies of astronomical object.
- **Ultraviolet Imaging Telescope** (UVIT) – Observations in Visible & Ultra Violet
- **Large Area X-Ray Proportional Counter** (LAXPC) – Study variation in the emission of X-Rays
- **Soft X-Ray Telescope** (SXT) – Study X-Ray spectrum coming from celestial objects that varies with time
- **Cadmium Zinc Telluride Imager** (CZTI) – Sensing X-Rays of High Energy
- **Scanning Sky Monitor** (SKM) – Monitoring of Bright X-Ray sources from Binary Stars
Mars Orbiter Mission (MOM) views the Valleys of Marineris: A Large Martian Canyon

Images of Valles Marineris and adjoining regions of Mars taken by Mars Colour Camera on board Mars Orbiter Mission on 05-12-2014 at a spatial resolution of 1.2 km from an altitude of 24000 km. Valles Marineris is largest canyon system about 4000 km and 200 km wide and 7 km deep.
THANK YOU

GSLV-D6 launch with indigenous Cryogenic Upper Stage (CUS)