Recent Indian Space Missions

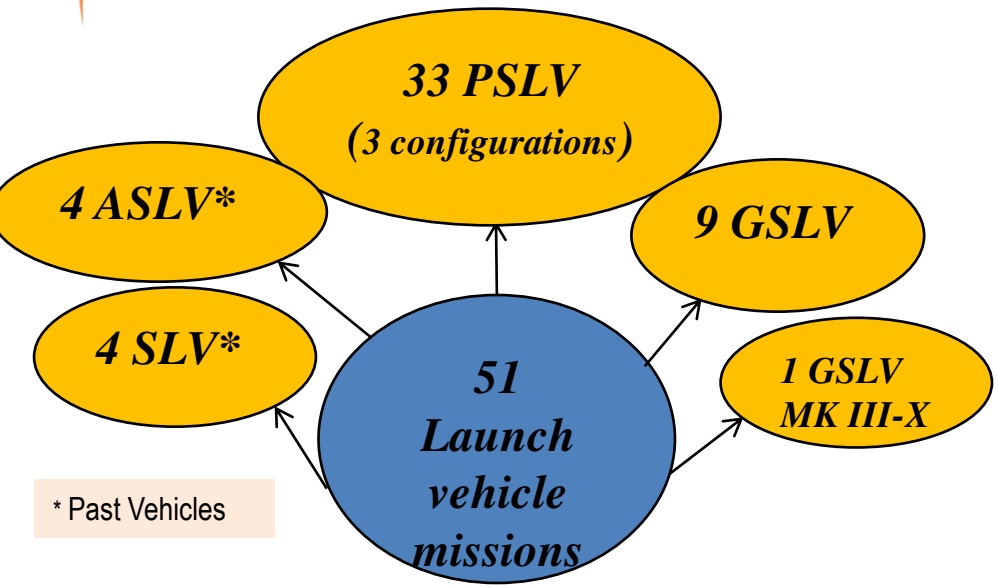
- Update as on Feb 2016

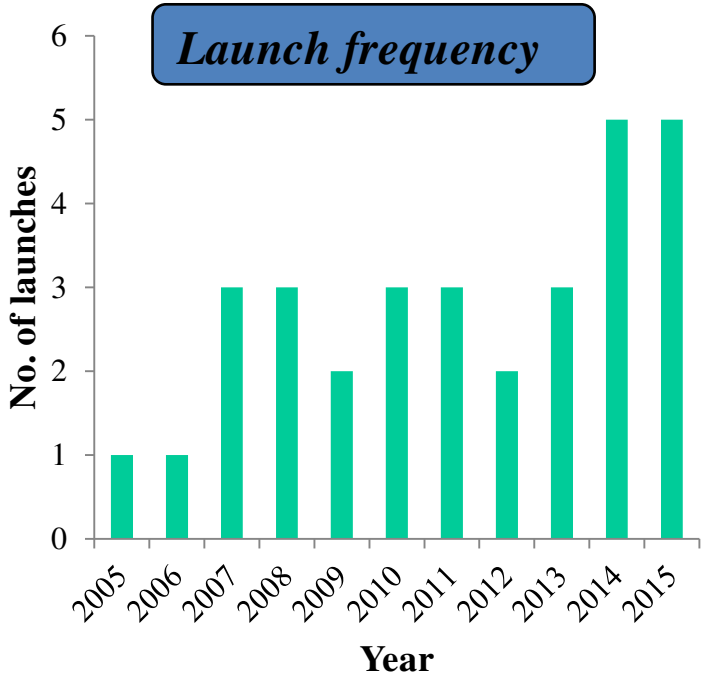
53rd session of Scientific & Technical Sub-Committee, UNCOPUOS

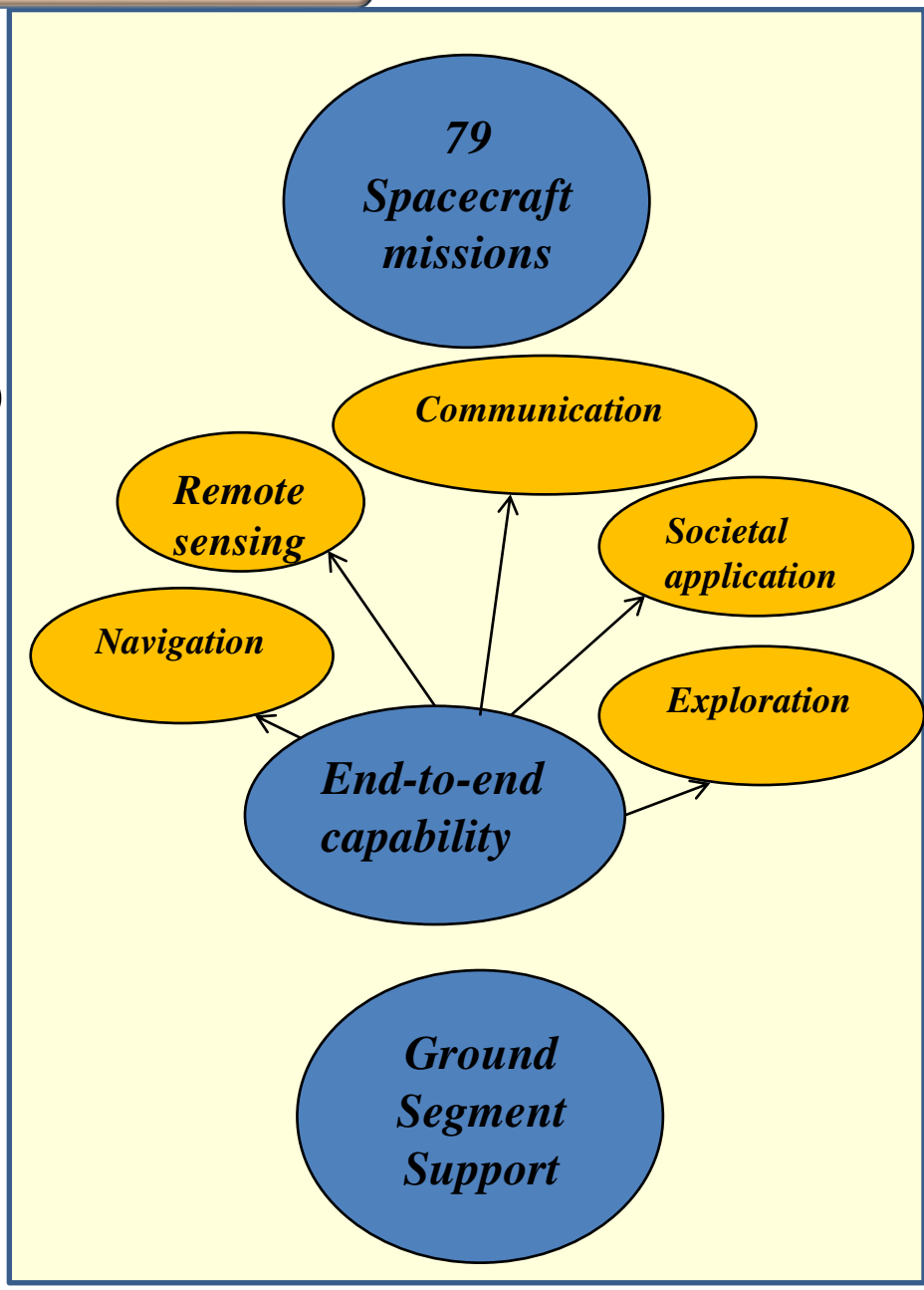
VIC, VIENNA

February 25, 2016

Indian Space Program







Recent Indian Satellite Missions (2011-2016)

Earth Observation


SARAL

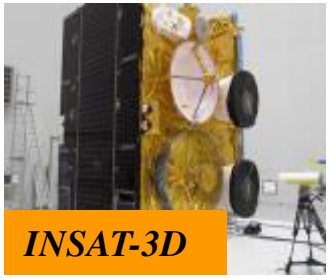

RISAT-1


Megha-Tropiques

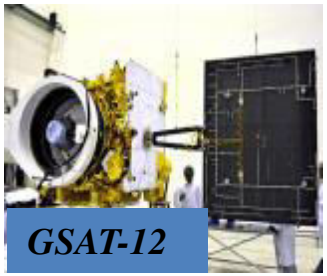

Resourcesat-2

Communication/Meteorological


GSAT-7


INSAT-3D


GSAT-10


GSAT-12


GSAT-15


GSAT-6

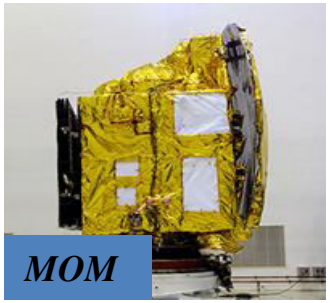

GSAT-16


GSAT-14

Exploration


ASTROSAT

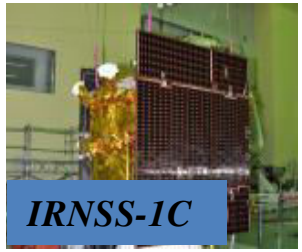

CARE


MOM

Navigation


IRNSS-1E


IRNSS-1D


IRNSS-1C

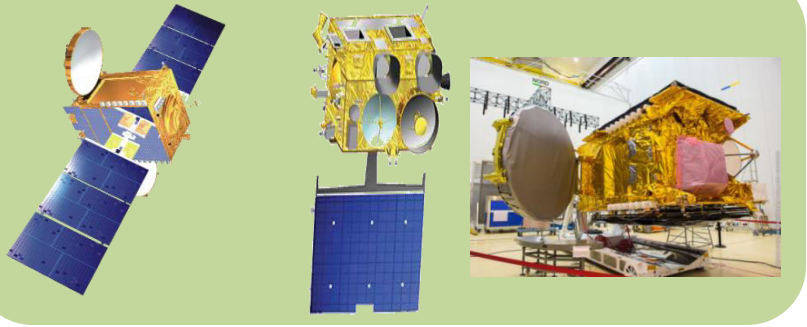

IRNSS-1B


IRNSS-1A

India's current Space Assets

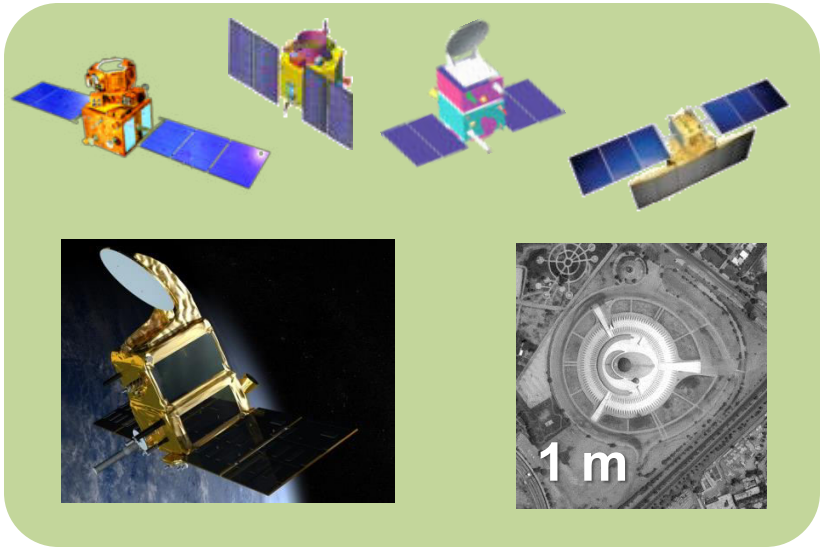
Communication Satellites

- 12 Operational (INSAT-3A, 3C, 4A, 4B, 4CR and GSAT-7, 8, 10, 12, 14, 16, 15)
- 260 Transponders in C, Ext C & Ku bands

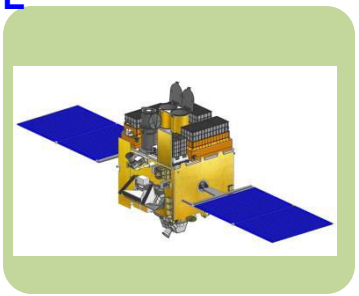


Remote sensing Satellites

- Three in Geostationary orbit (INSAT 3D, Kalpana & INSAT 3A)
- 9 in Sun-synchronous orbit (RESOURCESAT-2; CARTOSAT-1, 2, 2A & 2B; RISAT-1 & 2; OCEANSAT 2; SARAL)
- Equatorial orbit (MEGHA TROPIQUES)
- Both Optical & Microwave Sensors providing wide range of spatial, spectral, radiometric & temporal resolutions

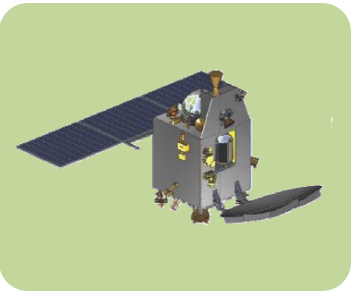


Navigational Satellites : IRNSS 1A, IB, 1C, 1D and 1E



Inter Planetary Probe: Mars Orbiter Mission

Exploration: ASTROSAT



Launch Missions: 2015-16

- PSLV C27/ IRNSS-1D - 28 March 2015
- PSLV C28/ DMC3 - 10 July 2015
- GSLV D6/GSAT-6 - 27 August 2015
- PSLV C30/ ASTROSAT - 28 September 2015
- PSLV C29/TeLEOS-1 - 16 December 2015
- PSLV C31/IRNSS-1E – 20 January 2016

PSLV C27 and PSLV C31: Navigation Satellites

- An Indigenous navigation system of seven-satellite constellation designed for providing position, navigation and timing services over Indian region
- Five satellites already in orbit; 6th Satellite to be launched in March 2016
- Constellation planned to be completed by 2nd quarter of 2016

Coverage area is about 1500 km beyond Indian territory

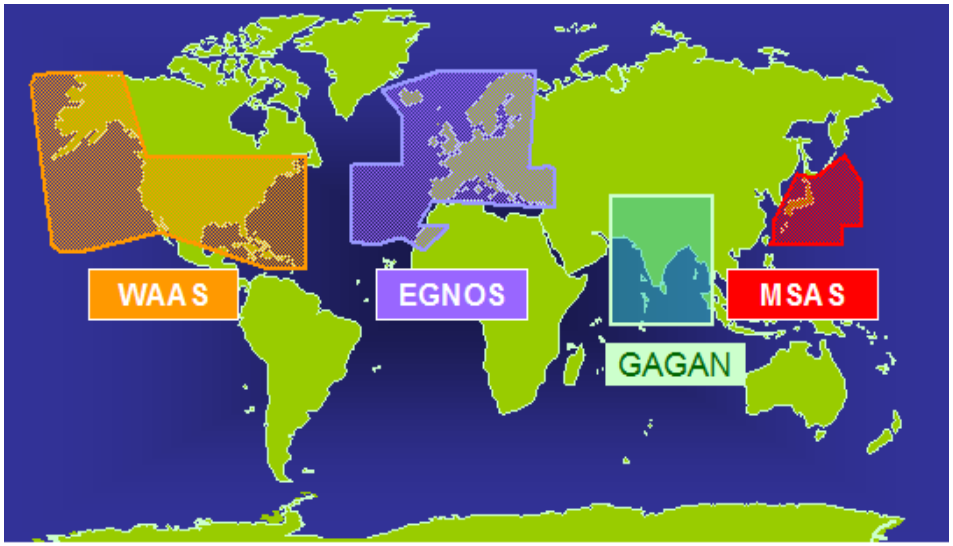
Estimated positional accuracy ~ 10m

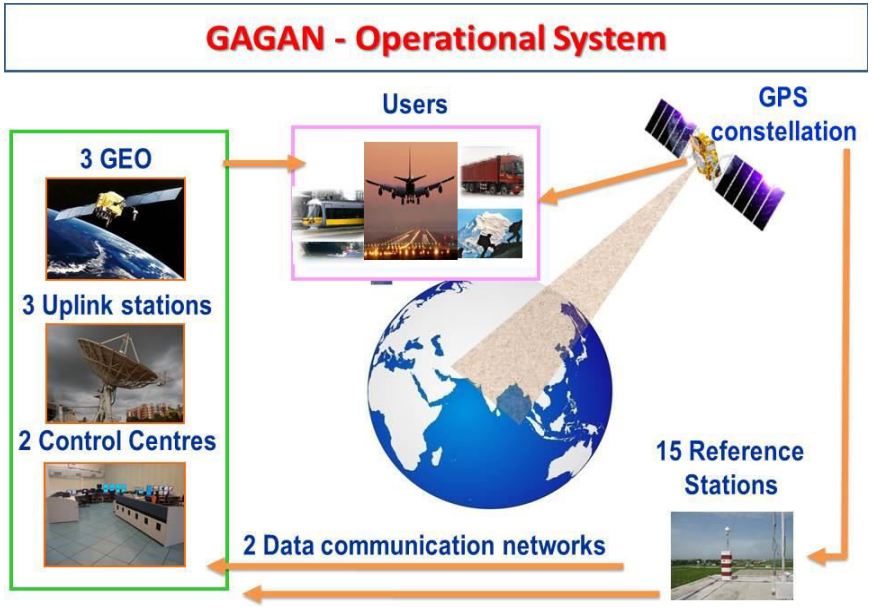
- Navigation and ranging payloads
- Navigation payload – L5 band and S band, Rubidium atomic clock
- Ranging – C band transponder

GAGAN: Augmented Navigation

- **GAGAN : GPS Aided GEO Augmented Navigation**
  - Jointly implemented by ISRO & Airports Authority of India
- **Configuration**
  - Ground Component (15 ref stn; 3 uplink stn, 2 control stn)
  - Space Segment : Payloads on GSAT8, GSAT10 and GSAT15
- **Certification**
  - APV 1 certification granted to GAGAN on 21 April 2015 approving the capability of GAGAN to offer precision approach services over the Indian land mass.
  - APV1 certified GAGAN signals are being broadcast with effect from 29 May 2015.

Interoperable global system





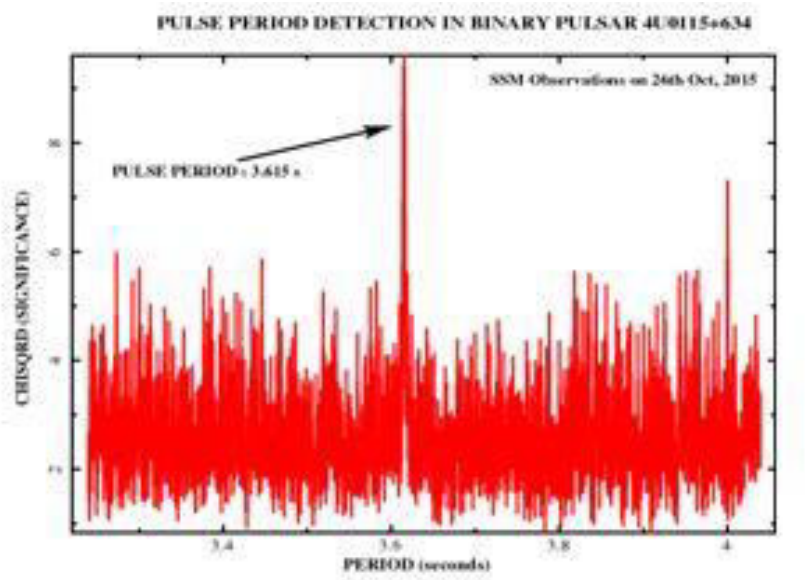
PSLV C30: ASTROSAT Mission

Multi-wavelength space based observatory of India, launched on September 28, 2015

Performance verification phase – half way

Five payloads for astronomy

NUV (200-300nm) image of Galaxy NGC 2336 taken using UV Imaging telescope (UVIT)



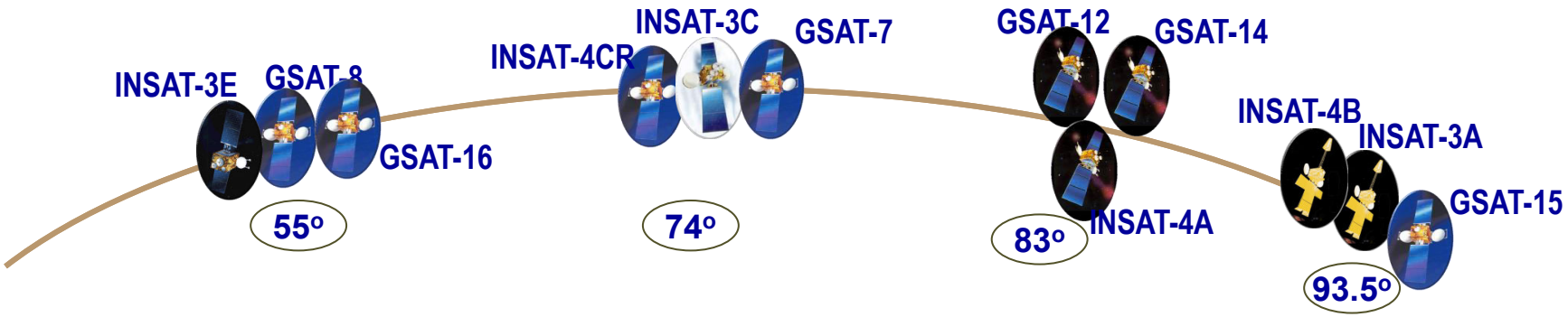
Scanning Sky Monitor (SSM) - to scan the sky in order to detect and locate X-ray transients in the energy range of 2-10 keV.

Stares performed on neutron star binary pulsar 4U0115+63. Figure shows the detection of the 3.6s rotation period of the neutron star using this payload.

GSAT 15: Communication Satellite

Launch Mass:	**3164 kg**
Dimension:	**2.0 m x 1.77 m x 3.1 m cuboid**
Power:	**Solar array providing 6200 Watts and Three 100 AH Lithium-Ion batteries**
Launched on:	**November 10, 2015**
Launched by:	**Ariane-5 VA-227**
Mission Life:	**12 Years**
Orbital Slot:	**93.5°E**

- **24 Ku-band transponders**
- **GAGAN payload in L1 and L5 bands**



260 Transponders in C, Ext C & Ku bands

GSLV MK III – The heavy-lift launch vehicle of ISRO

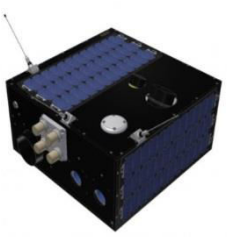
- 3 stage launch vehicle
- 4 tonne payload capability to GTO
- Total vehicle mass – 640 tonne
- Solid propellant boosters and Core Liquid engine qualified during the GSLV MKIII-X CARE mission.

Hot test of CE-20 Cryogenic engine accomplished on February 19, 2016

Full configuration flight expected in December 2016

International satellite launches in 2015

Kent Ridge 1
TeLEOS 1
SINGAPORE

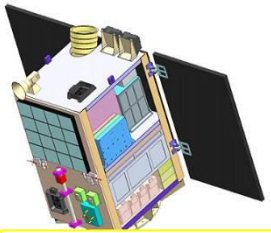


CBNT 1
SSTL, UK

LEMUR
USA

Deorbit Sail
SSC, UK

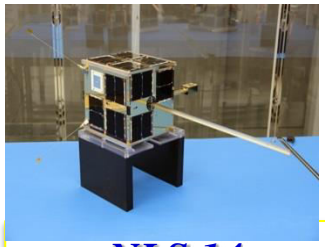
DMC3
SSTL, UK



Velox C1
SINGAPORE

LAPANA2
INDONESIA

17 International satellites in 2015
Re-start capability for upper stage



NLS 14
CANADA

Space technology for Governance

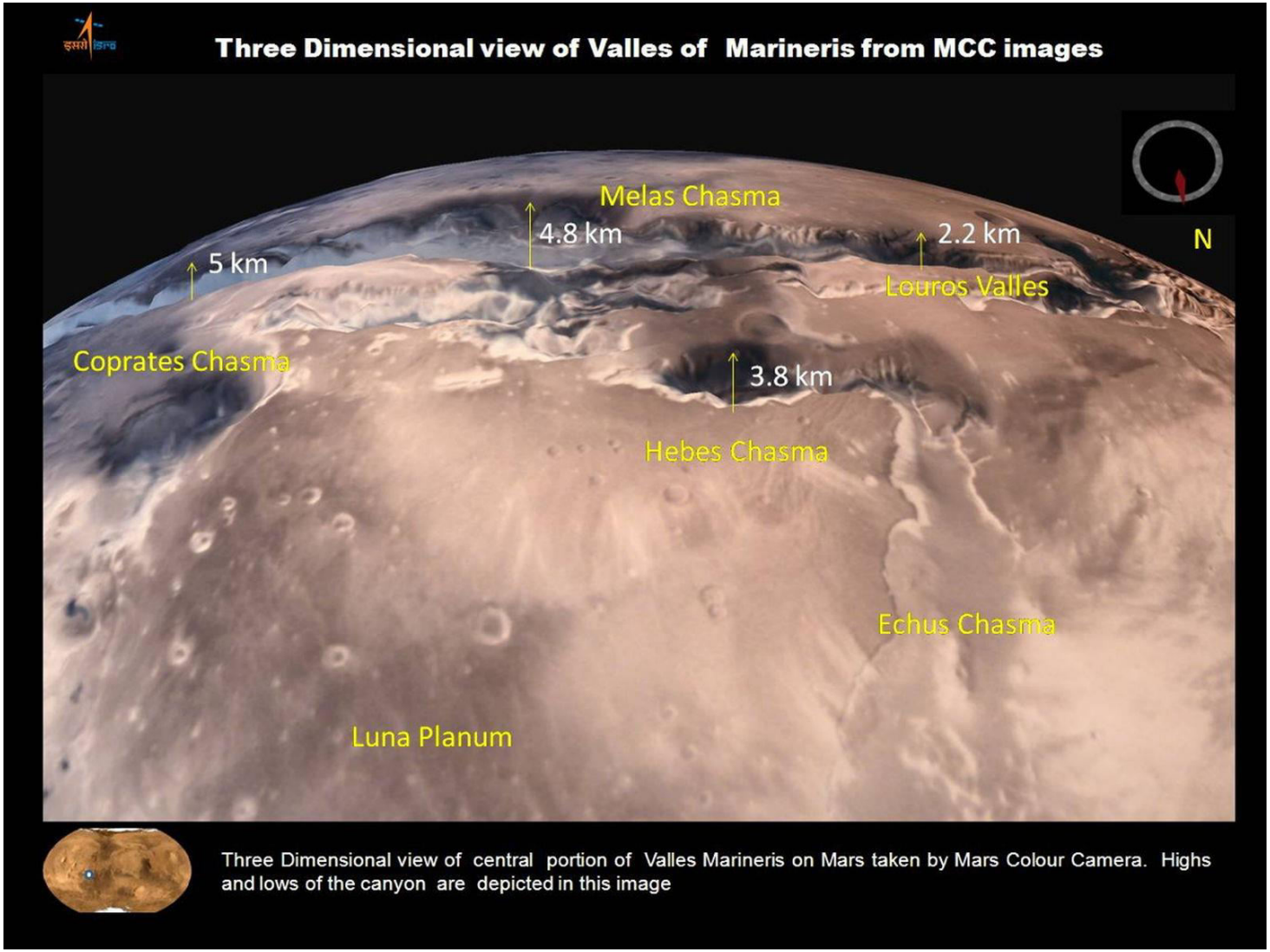
- National Meet on Promoting Space Technology based Tools and Applications in Governance and Development – September, 2015
- 'No Space should be left between the common man and Space technology' - PM
- Nine theme sessions – Agriculture, Energy & Environment, Infrastructure Planning, Water Resources, Technology Diffusion, Developmental Planning, Communication & Navigation, Weather & Disaster Management and Health & Education
- Close to 1,500 officials from the Centre and state governments
- The Secretaries of Central Ministries/Departments presented joint action plans on effective utilization of Space Technology to enhance functional effectiveness, facilitate planning and decision making

Upcoming Missions (2016)

Mission	Application
IRNSS 1F – PSLV C32 – Q1	Navigation
IRNSS 1G – PSLV C33 – Q2	Navigation
Cartosat 2C – PSLV C34 – Q2	High resolution RS
Resourcesat 2A and SCATSAT-1 PSLV C35 – Q3	RS and Ocean monitoring
INSAT 3DR (GSLV) – GSLV F05 – Q3	Meteorology
GSAT 18 – Ariane 5 – Q3	Communication
GSAT 19A - GSLV MK III – Q4	Communication

International Cooperation

- IRS Data support for International Charter, Sentinel Asia, UN-SPIDER
  - Drought assessment for Sri Lanka under UNESCAP-DRR
- CEOS & GEO participation
- CSSTE-AP
- IRS Data Reception
  - Resourcesat-2 at Cuiaba (Brazil), RISAT-1 by KSAT (Norway)
- NASA ISRO SAR (NISAR) Mission
  - Dual frequency (L&S) SAR Mission
- CNES ISRO Agreement on TIR Mission
- DLR-ISRO Workshop 2015
- SAARC satellite
- ISRO-UAE space agency MoU on peaceful uses of outer space
- BRICS constellation on Remote Sensing


Three Dimensional view of Valles of Marineris from MCC images
Melas Chasma
4.8 km
2.2 km
5 km
Louros Valles
N
Coprates Chasma
3.8 km
Hebes Chasma
Echus Chasma
Luna Planum
Three Dimensional view of central portion of Valles Marineris on Mars taken by Mars Colour Camera. Highs and lows of the canyon are depicted in this image

Thank You