Indian Space Policy 2023 & Future missions

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NRSC User Interaction Meet - 2024
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Indian Earth Observation Programme: Dimensions

Enabling National development, improving quality of life, building resilient society and facilitating enhanced understanding of Earth System

Space Segment

Constellation of Satellites

- Land & Water
- Cartography
- Ocean & Weather

Ground Segment

- Data Acquisition & Processing
- Data Products Generation
- In-situ Observation Network
- Information Dissemination

Space Applications

- National Imperatives & SE develop.
- NR Management & Disaster Mgmt.
- Land-Ocean-Atm. Interactions
- Enabling Geospatial data & Applns.

EO SYSTEM

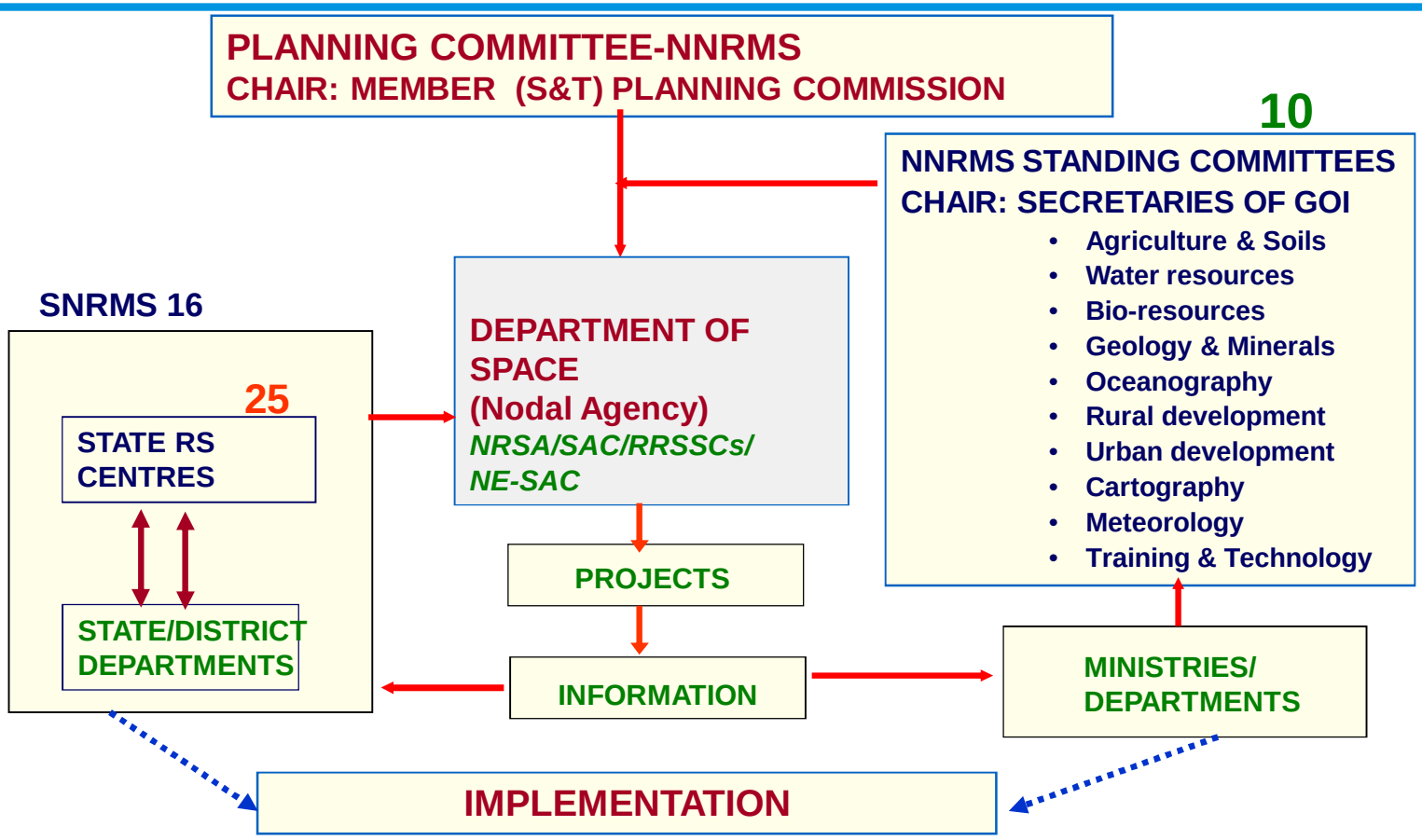
Institutional Linkages

- Ministries / Departments
- State Remote Sensing Centres
- Industry & Academia
- International Cooperation

GOALS

- Data Continuity
- Inventory of natural resources
- Meet evolving needs of stakeholders
- Decision tools / Info. Systems
- Maximize outreach

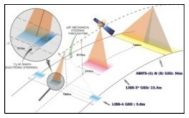
Erstwhile NNRMS

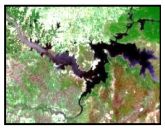


Remote Sensing Capabilities

Space Segment

RESOURCESAT & RISAT
Natural Resources & Disaster Management





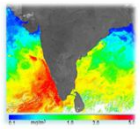
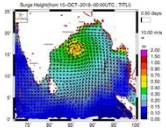
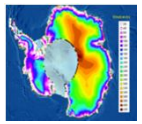
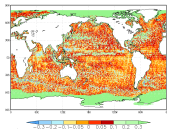

- Three tier imaging : 56 m / 23 m / 5.8 m
- Revisit Capability : 03 / 11 / 03 days
- C-Band SAR (3-50m resolution) / 17 to 24 days repetivity

CARTOSAT
Cartography & Large Scale Mapping



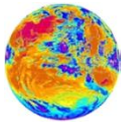
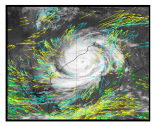
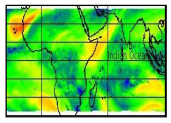
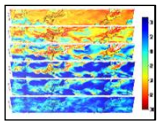

- 60 cm PAN & 1.5 m Multi-spectral
- 28 cm PAN & 1 m Multi-spectral

OCEANSAT-3, SARAL
Ocean State Forecast ; Ocean Altimetry, Wind Vector

- Ocean colour
- Sea-surface wind vector
- Ocean Altimeter

INSAT 3D, 3DR & 3DS
Weather Forecasting; Atm. and Climate studies

- 6 Channel Imager –48 images per day
- 19 Channel Sounder –Atm. Profiles

Aerial & UAVs


Terrestrial




Policies & Guidelines

Reforms in Space Sector 2020

NEED FOR REFORMS

The global space economy is currently valued at about USD 360 [1] billion. Despite being one among a few spacefaring nations in the world, India accounts for only about 2% of the space economy.

Potential to capture
9% of global market share by 2030

Promoting the private sector will enable the Indian space program to remain cost competitive within the global space market, and thus create several jobs ir the space and other related sectors.

1

Enable and promote Non-Governmental Entities (NGE) to carry out independent space activities

Provide a level playing field and favorable regulatory environment for players within the Indian private sector, to allow them to become independent actors in the space sector instead of being solely vendors or suppliers to the government program.

2

Open up ISRO Infrastructure and Facilities

The reform also aims to make national space infrastructure developed over the years, available for use by the private industry through a business friendly mechanism.

Facilities pertaining to testing, tracking and telemetry, launch-pads, and laboratories, created by ISRO, would also enable the private space industry to climb the value chain.

3

Demand-driven approach for development of space assets

Optimizing the utilization of space assets such as satellites and launch capacity by determining accountability amongst various stakeholders. Creation of new assets to be made contingent on confirmation of demand from user agencies/ entities.

4

Public sector to enable Transfer of Technology to Industries

Previously developed and already proven technologies/ platforms would be transferred to the non-governmental entities through Transfer of Technology mechanism.

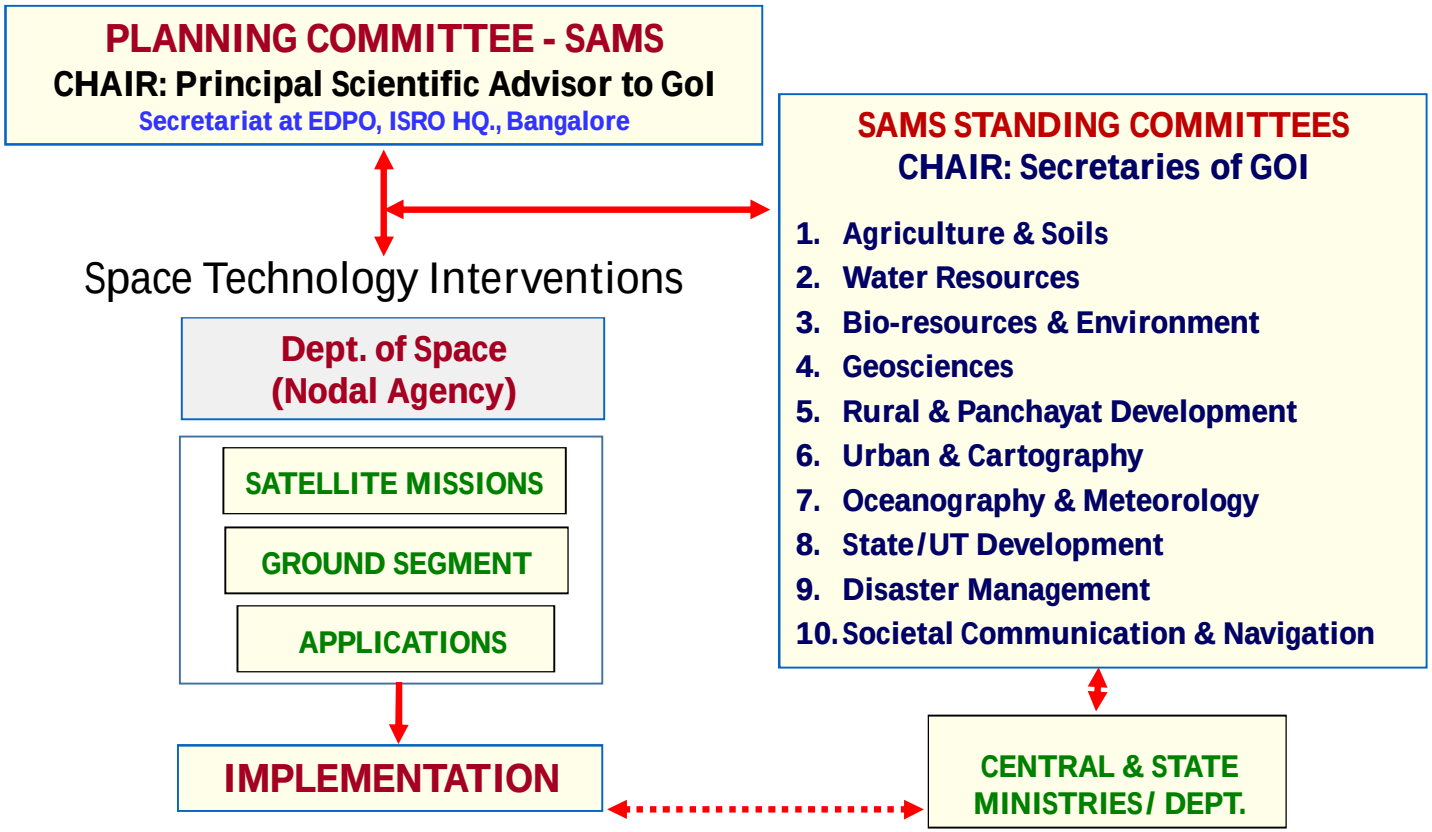
5

Provide a stable regulatory and policy environment

The reforms have strengthened the policy-making capacity of the Department of Space and an exercise has been initiated to create new business-friendly policy framework for Space sector covering remote sensing, satellite communication, navigation, technology transfer, space transportation, space situational awareness, human space flight, etc.

Space Applications Management System -Framework

Creating a forward looking Geospatial ecosystem to bring in new avenues for Research, innovative solutions, including employment generation.



Mandate of PC-SAMS

- Identify future EO missions based on requirements (**Demand Driven)**
- PC-SAMS will **review** the need aspect and utilization aspects of user Ministries
- Future EO missions will be **User Funded**
- **Cost-sharing mechanism** for all the approved EO missions

EDPO – Earth observation applications & Disaster management support Programme Office

Geo spatial Guidelines 2021

6. With the advent of publicly available geospatial services, a lot of Geospatial Data that used to be in restricted zone are freely and commonly available now and some of the policies/guidelines that used to regulate such information have been rendered obsolete and redundant. What is readily available globally does not need to be regulated.

(e) Geospatial Technology: Any technology including but not limited to Aerial / UAV Photogrammetry, Aerial / UAV LIDAR, drones, Radar Interferometry, street view or by other means of ground survey, satellite-based remote sensing techniques, AI, underwater mapping, and others.

xi. All Geospatial Data produced using public funds, except the classified geospatial data collected by security/law enforcement agencies, shall be made easily accessible for scientific, economic and developmental purposes to all Indian Entities and without any restrictions on their use. Such access shall be given free of any charges to Government agencies and at fair and transparent pricing to others. For attributes in the

Geo spatial Policy 2022

Vision and Goals

- To make India a world leader in Global Geospatial spacewith best-in-class ecosystem for innovation
- To develop a coherent national framework in the country for integrating data of various sectors in Distributed Environment
- To enable easy availability of valuable Geospatial data collected utilizing public funds, to businesses and general public
- To have a thriving Geospatial industry in the country involving private enterprise

- **Strengthening Geospatial Infrastructure**
  - **Geospatial Data Infrastructure -** National Geospatial Data Registry (NGDR), Unified geospatial Interface (UGI)
  - **Mapping Infrastructure** - deregulated
  - **Sub-surface and Hydrographic Infrastructure** - collection of sub-surface utilities
  - **Geospatial Knowledge Infrastructure** - integration of Geospatial data/technology/concepts
  - **National Digital Twin** -virtual replica of a physical assets, processes or services
- **Geospatial Education and Skill Development -** NIGST, IIRS
- **Geospatial enterprise** – Geospatial Industrial Development Board (GIDB)
- **Institutional framework** – Geospatial Data promotion and development Committee (GDPDC)

Indian Space Policy - 2023

The Indian Space Policy – 2023 has been formulated as an overarching, composite and dynamic framework to implement the reform vision approved by Cabinet

Vision

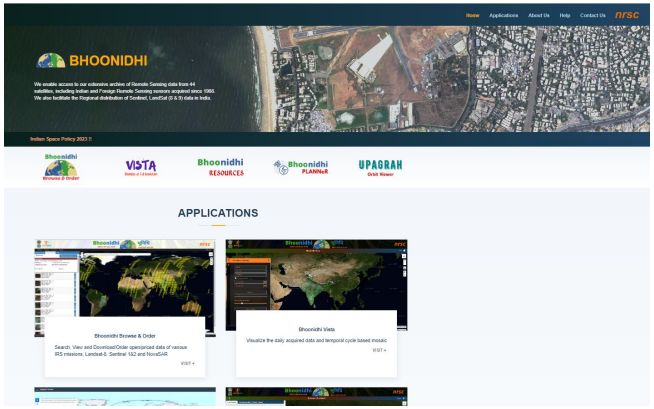
To **augment space capabilities**; **enable, encourage and develop a flourishing commercial presence in space**; **use space as a driver of technology development and derived benefits in allied areas**; **pursue international relations**, and **create an ecosystem for effective implementation of space applications** among all stakeholders; for, the nation's socio-economic development and security, protection of environment and lives, pursuing peaceful exploration of outer space, stimulation of public awareness and scientific quest.

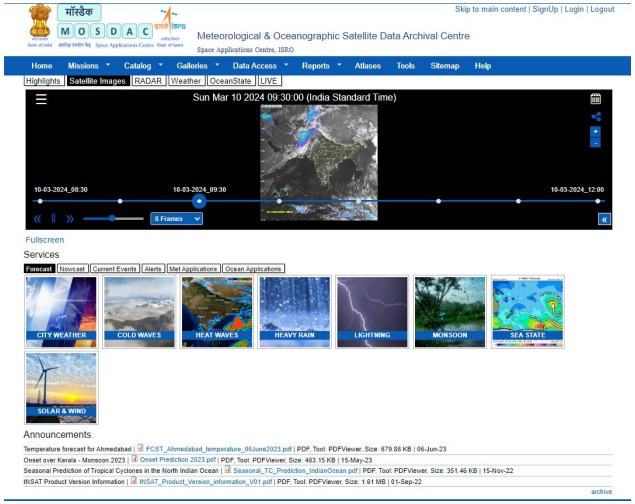
Responsibilities

NGEs	• Engage in end-to-end activities in Space Sector • Disseminate satellite based remote sensing data and applications • Develop and commercialise technologies and application
IN-SPACe	• Mandated to promote, hand hold, guide and authorize space activities in the country • Act as the Single window agency for the AUTHORIZATION • Authorization required for high resolution (GSD<=30 cm), Data above 30 cm GSDneeds intimation
NSIL एनसिल	• Commercialising space technologies and platforms created through public expenditure • Manufacture, lease or procure space technologies, platforms and other assets form private sector • Service the space-based needs of users
इसरो ISRO	• Will focus on research and development of new space technologies and applications • Carry out applied research and development of newer systems and newer space applications • Share technologies, products, processes and best practices with NGEs
DoS/ GoI	• Ensure the availability of continuous & improved EO capability and data to fulfil the national requirements • Participate in International efforts in disaster management and sustainable development goals

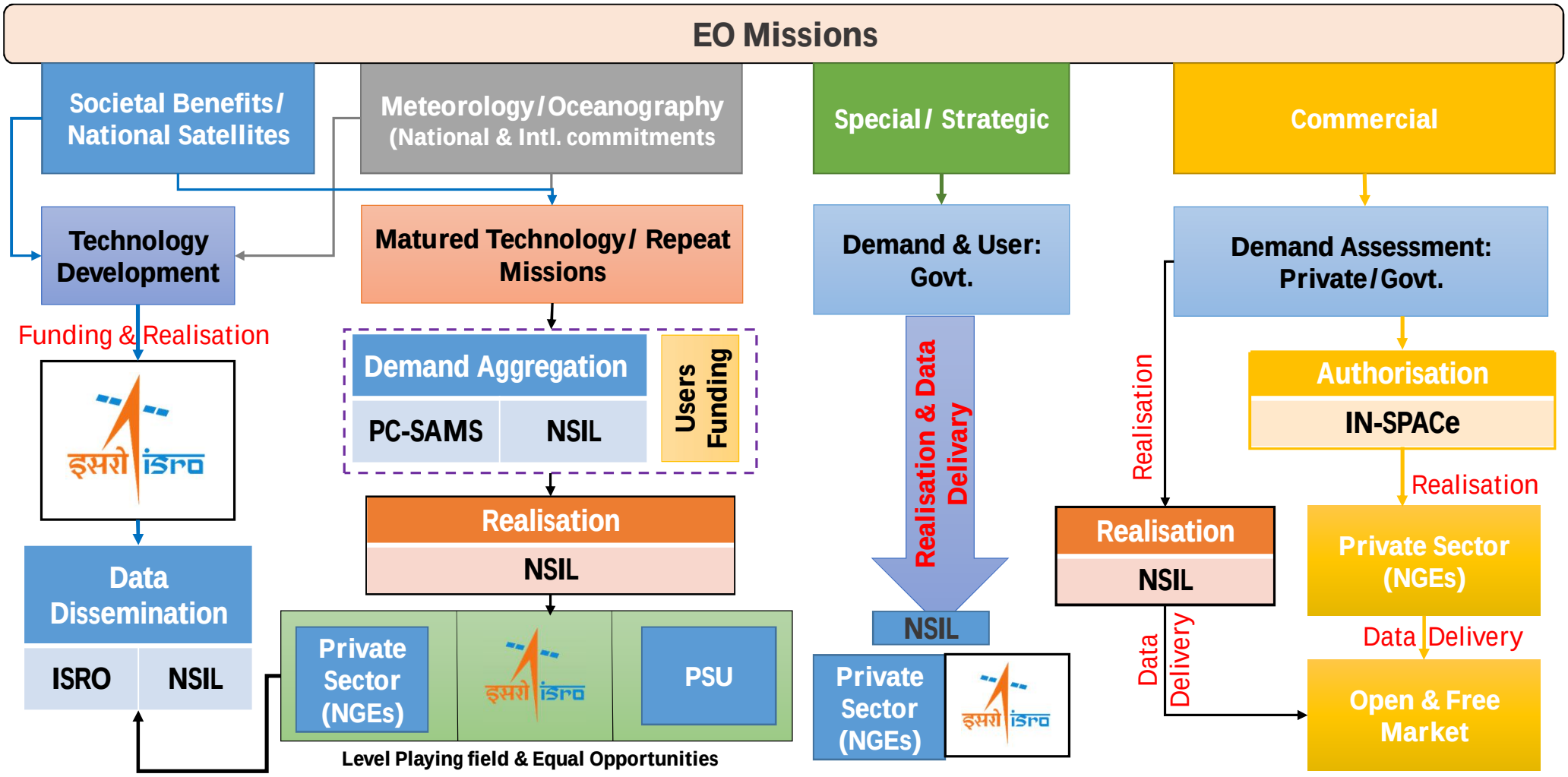
EO Data Dissemination Guidelines 2023

1. Data of 5 m Resolution and coarser (acquired by IRS):
   - Will be available for free download 24 hours after acquisition from Bhoonidhi and MOSDAC portals
   - The products will radiometrically and geometrically corrected
   - The data can be freely used, reused and redistributed with due credits to ISRO
   - All archived data (Data older than three months) also is available for free download
2. Data finer than 5m resolution:
   - Available free of charge to all Govt. Agencies
   - All other users can get this data from NSIL on chargeable basis.
3. Derived Thematic data:
   - Thematic data derived from >5 m res. data is freely available.
4. All commercial distribution of IRS data – fine resolution data, value added data will be done by NSIL.
5. There will not be any masking of sensitive areas. The publishers need to follow Geospatial guidelines on restrictions on attributes given as Negative list.



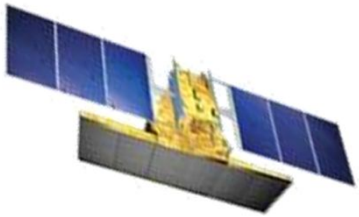


Mechanism for realising Future EO Missions



Upcoming Earth Observation Missions

RISAT-1 B



All-weather;
Day& Night Imaging

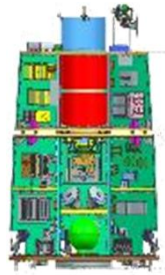
Oceansat-3A

Ocean Color & Wind vector – Continuity + SST

L & S Band SAR

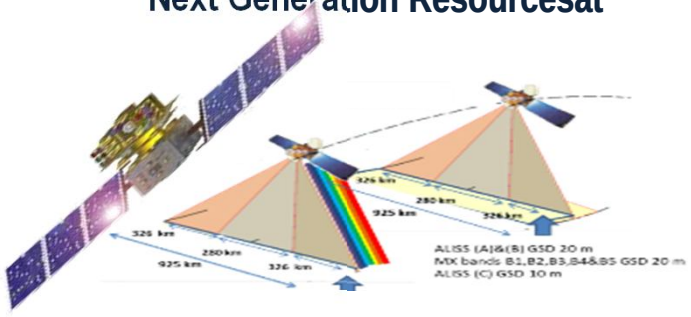
All-weather;
Day & Night Imaging

HRSAT



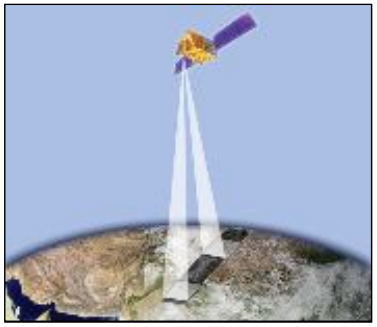
Daily re-visit of Area of Interest

Next Generation Resourcesat



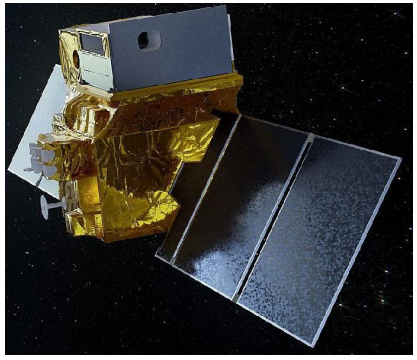
Wide Swath imaging with improved spatial resolution

High resolution Stereo



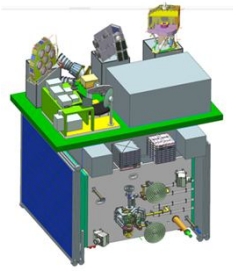
Concurrent Stereo & MX imaging

High res. TIR & VSNIR



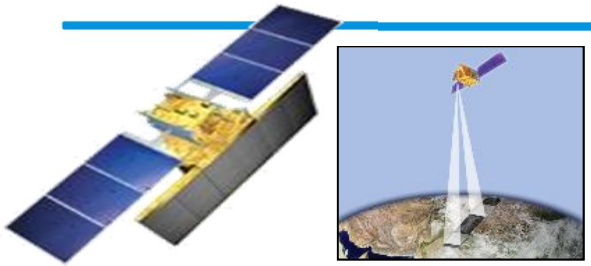
ThermalImaging

G20 Satellite



Environment & climate change

RISAT-1B: All Weather Images with C-Band SAR



Frequency	C-band (5.400 GHz)
Polarization	Single / Dual / Full-polarization/Hybrid Circular
Modes	FRS, HRS, MRS, CRS
Resolution	3 to 6 m, 25 m, 50 m
Swath	15 km to 240 km
Look Angle (deg)	11.28 – 49.09
Incidence Angle (deg)	12.25 – 55.02
Repetivity	17 – 24 days

	FRS-1 / FRS-2 / MRS / CRS	HRS
Swath (km)	25 / 25 / 115 / 223	10
Ground range resolution (m)	FRS1: 9.4 – 2.4 FRS2: 18.8 – 4.9 MRS: 37.7-9.8 CRS: 37.7-9.8	3.3-0.85

- Mapping of waterbodies/ Glacial lakes of > 10 ha
- Glacial Lake Outburst Flood (lake monitoring, early warning, damage estimation, etc.)
- Crop area mapping in irrigated commands
- Irrigation performance assessment (specially during Kharif season)
- Soil moisture, soil salinity
- Live storage & reservoir capacity estimation
- Snow cover and Glacier health mapping/assessment, mass balance, identification of crevasses
- Snow and glacial melt runoff estimation
- Flood inundation, flood plain zonation, river morphology
- Flood damage estimation, flood under vegetation

Oceansat-3A

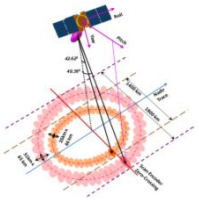
Orbit	Sun synchronous ; **720 km ; ECT: 12:00 Hrs**
P/L	**OCM-3 (13 bands: 402 to 1020 nm) : 360 m** **OSCAT-3 (Ku Band - 13.51 GHz)** **SSTM-1 (2 Bands: 11 &12 µm) : 1080 m**
Swath	1400 x 1400 km

SSTM specifications

S. No.	Parameter	Design Goal
1	Instantaneous Geometric Field of View (IGFOV) at nadir (m)	< 1080 m
2	Spectral bands (µm)	10.75 - 11.25 11.75 - 12.25
3	Band Width (µm)	0.5
4	Swath (km)	1440
6	NEdT @ 300K	< 150mK
7	Saturation temperature (K)	> 340

OCM-3 Band description and their applications

Band#	Central WL (nm)	Primary Application
B1	412	Differentiate yellow substance from chlorophyll
B2	443	Chlorophyll absorption maximum; low chlorophyll
B3	490	Moderate chlorophyll
B4	510	High chlorophyll; Total Suspended Matter (TSM)
B5	555	Reference baseline for Chlorophyll
B6 *	566	Phycoerythrin absorption , Trichodesmium bloom detection
B7	620	Turbidity in coastal Case 2 waters, Phycocyanin absorption
B8*	670	Baseline for fluorescence line height (FLH), chl secondary absorption
B9 *	681	Chlorophyll fluorescence
B10 *	710	Baseline for FLH, vegetation - chlorophyll fluorescence; atmospheric Correction
B11	780	Atmospheric correction; avoids O2 absorption Band
B12	870	Atmospheric correction; good assessment of spectral scattering
B13 *	1010	Atmospheric correction in turbid waters, aerosol – white foam discrimination

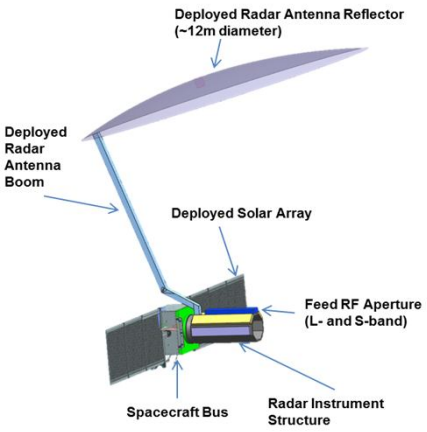


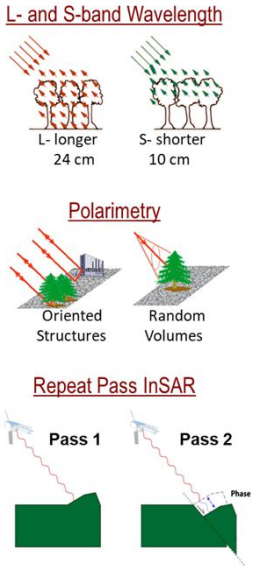
Ku band Scatterometer (13.515 GHz) ;

Orbits / day: 14 ½ ; Repeat cycle: 2 days

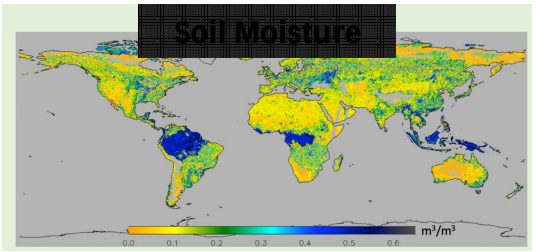
NISAR: L & S Band SAR

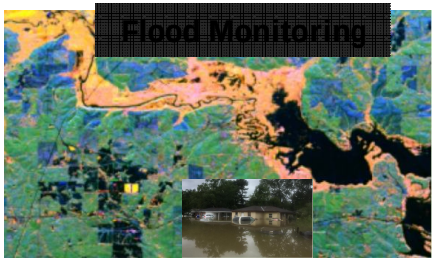
NASA-ISRO SAR (NISAR)

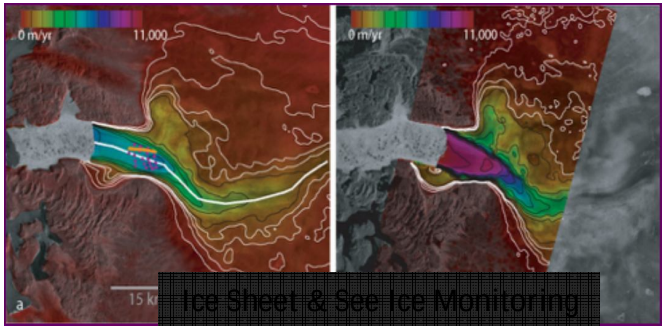


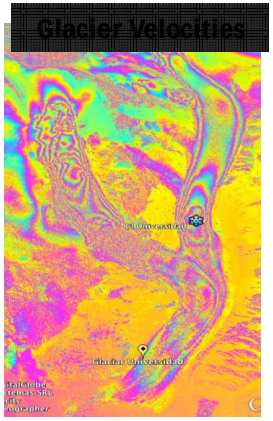


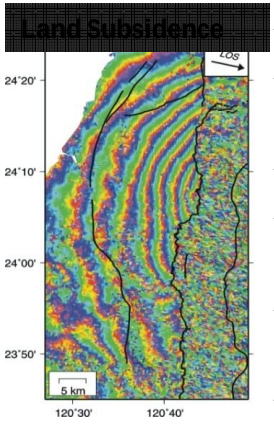
Parameters	S-Band	L-Band
Orbit	747 km, 98deg inclination	
Repeat	12-day	
Frequency	3.2 GHz+/- 37.5 MHz	1.257 GHz +/- 40 MHz
Polarization	Single, Dual, Quasi-Quad, Hybrid circular (in S band only), and Quad Pol (in L-band only)	
Swath Width	> 240 Km (except for S-band QQP Mode and L-band 80 MHz BW mode)	
Spatial Resolution	6m (Az); 2m-15m (Slant-Ra)	7m (Az); 2m-30m (Slant-Ra)
Incidence Angle Range	33–47 deg	







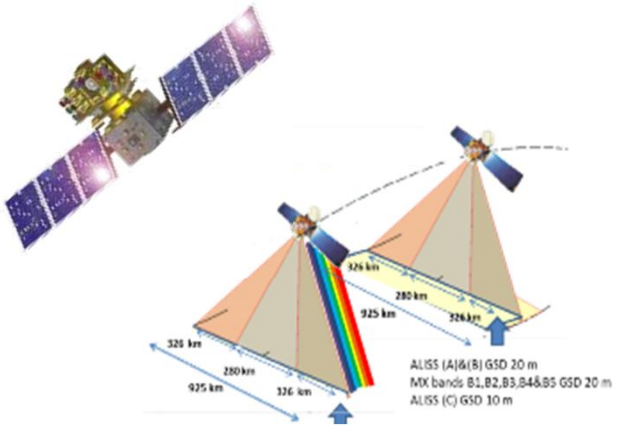




- Permafrost Monitoring
- Drought and the Rapidly Changing Landscape
- Flood under vegetation
- Radar-based Measurement of Levee Conditions (Dam safety)
- Glacial retreat, mass balance, crevasses mapping
- Palaeo-channel mapping

Resourcesat 3 & 3A: Wide Swath, High Resolution, Multispectral

Next Generation Resourcesat



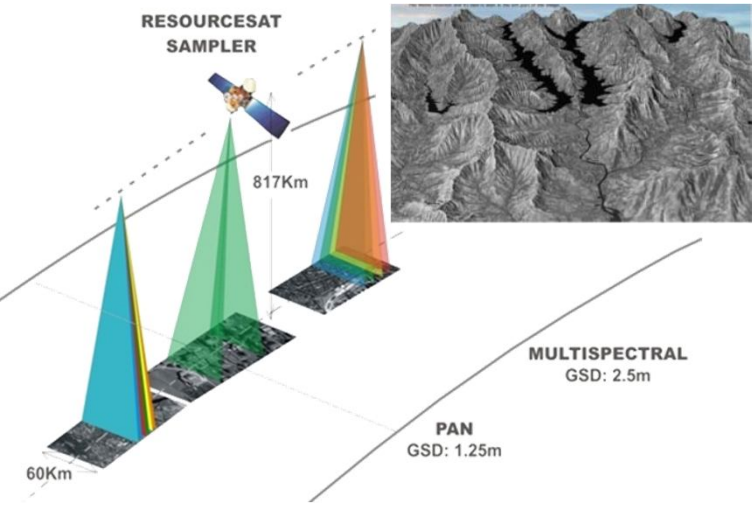
Wide Swath imaging with improved spatial resolution

Sensor	GSD	Swath	Revisit
ALISS-3 (A,B & C)	20 m	925 km	4 days
ALISS-3 (C)	10 m	280 km	11 days
ATCOR 0.4-1 µm	240 m		
Orbit: 795 km ; ECT: 10:30 Hrs			

- Weekly Water Spread (>1 ha)
- Weekly Snow Cover Area mapping
- Glacier, Glacial Lake mapping/monitoring
- Glacier health assessment: Velocity, Retreat, mass balance
- River morphology, bank erosion, embankment status assessment
- Inputs for hydrological modelling, Environmental studies
- Costal bathymetry, high resolution bathymetry of high altitude lakes
- Crop Acreage Estimation (Farm Level)/ Crop Yield Estimation
- Vegetation stress monitoring
- Water Management: Irrigation demand estimation
- Flood inundation mapping/ damage assessment
- Reservoir sedimentation/live storage assessment

Resourcesat 3S & 3SA: High Resolution Stereo & Multispectral

High resolution Stereo



Concurrent Stereo & MX imaging

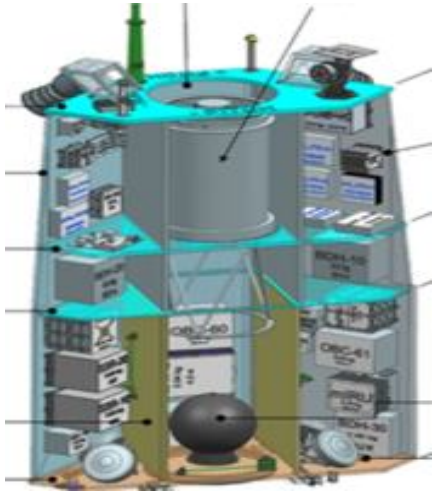
Sensor	GSD	Swath	Revisit
PAN	1.25 m	60 km	Revisit of 4 Days
MX	2.5 m	60 km	
Orbit: 633 km ; ECT: 10:30 Hrs			

PAN 1.25 m **Stereo**

Wide Mono with 106 Swath

- 3 m DEM with < 5m accuracy
- Inputs for planning, execution, monitoring of all the water resources projects (surface)
- HR Infrastructure mapping/Monitoring
- Initiatives like Accelerated Irrigation Benefit Programme (AIBP)
- Inputs of Geospatial data for Digital Twins
- Disaster management support
- High resolution mapping and monitoring of glacial lakes/high altitude lakes (vulnerable)
- High resolution of bathymetry of Glacial lakes/ costal lines
- Glacier mapping, retreat/ velocity assessment, mass balance

HRSAT: High-resolution Satellite



- PAN : 0.45 - 0.8 µm ,
- MX (3) : 0.52-0.59 µm ; 0.62-0.68 µm, 0.77-0.86 µm
- LWIR : 7.1-11 µm
- Constellation of 3 satellites launched in a single mission & phased 120 deg apart
- Systematic coverage of high resolution data of the country twice a year & feasibility of daily revisit of Area of Interest

Constellation of High-resolution Satellites

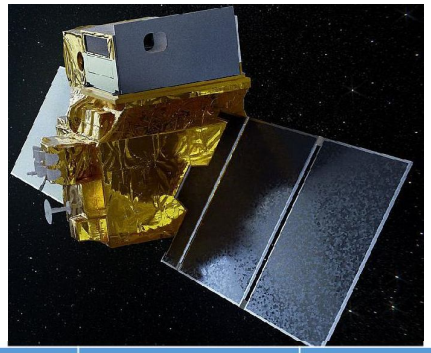
HRSAT (3 Nos.)

Sensor	GSD	Swath	Revisit
PAN	0.85 m	15 km	Daily (AOI)
MX	< 3.2 m	15 km	
LWIR	17 m	6 km	
Orbit: 660 km ; ECT: 9:30 Hrs			

- Creation of Large scale GIS Database
- Regional/ Urban Planning
- Urban/ Industrial Growth Corridor Development
- Road Alignment Planning
- Infrastructure/ Asset Planning & Monitoring
- Updation of Topographic Maps
- Transmission line Route Alignment and Asset Management

TRISHNA: High-resolution Thermal infraRed Imaging Satellite

TRISHNA (Thermal infraRed Imaging Satellite for High-resolution Natural resource Assessment)



Mission	Bands	Repetivity
TRISHNA (2026)	7 VNIR-SWIR (57m), 4 TIR(57m)	8-day (3 day revisit)

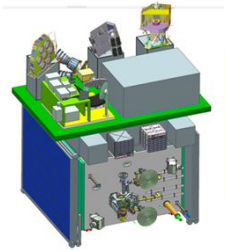
Payload Specifications

- **ISRO's P/L – VSWIR** :
  - Bands: 4 (VNIR), 2 (SWIR), 1 (WV)
  - Resolution: 57 m (Cirrus & WV;114 m)
  - Swath: 1060 km
- **CNE's P/L - TIR :**
  - Bands : 4 bands
  - Resolution: 57 m(Land) /1 km (Ocean)
  - Swath: 1060 km

Sector	Applications
AWM	• Actual ET, Stress index, crop management & yield modelling, drought, LAI product (3-days), soil wetness,
Coastal	• Coastal and inland water quality and thermal pollution monitoring, Harmful algal bloom
Hydrology	• Assessing irrigation needs, crop water requirements, irrigation / tanks water assessment.
Snow / Cryosphere	• Frequent update of Snow cover information and inputs to Hydrological models for snow-bound regions; Avalanche forecasting • Detecting hot-spots for snow accumulation & ablation pattern • Snow-melt runoff & debris thickness estimation, Snow cover change & metamorphism, Modelling snow energy fluxes, Estimating snow properties

G20 SAT: Satellite Mission for Environment & Climate Observation

A satellite to be realised on a collaborative basis among G20 nations to enable space-based observations of various variables that affect environment and climate change.



Potential Observables: Air pollution, Green House Gases and Forest fires, Humidity, Precipitation, Ocean surface Vector Winds, Currents, Waves, Soil Moisture, Radiation budget

India to provide spacecraft bus, Satellite Assembly, Integration and Testing, Launch of the G20 Satellite along with dedicated payloads for environment and climate observations.

Consultation with G20 nations for payload hosting opportunity and data products.

Indian payloads

- Polarization Sensor for Aerosol & Cloud Monitoring
- Environmental Sensor for Atmospheric Composition
- Sensor for Advance Climate studies & Forest Fire
- Mm-wave Temperature & Humidity Sounder

Realization ~ 36 months

Spacecraft Bus

Spacecraft Mass	~1350Kg
Spacecraft Power	3000W
Payload Mass & Power	~500 Kg & ~750 W
Payload area	2.5m x 1.5m

G20 Opportunity

Footprint Area	1m X 0.75m
Mass	300 kg
Power	400 W
Volume	1m X 0.75m X 0.5m

What Next...

- Currently an interim arrangement is in operation since the satellite missions were approved before the Reforms.
- Future Missions, have to be realised on User requests.
- MoES is working out requirements for INSAT 4th generation and also in making plans to have Scatterometer constellations, Temp/Humidity profilers, Radiometers etc.
- Other Ministries need to work out the requirements, possibly joint funding can be worked out.
- The joint working Groups formed between 30 ministries and ISRO need to work towards identifying the requirements and projecting new missions.

"Let us strive to be second to none in having an effective Space Infrastructure for meeting the evolving needs for the Sustainable development and resource management in the country"

Thank You

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