Indian Space Program and it's Future











S. K.PANDEY Scientist/Engineer-SG, Integrated Lucknow Facility ISRO Telemetry Tracking and Command Network



If we are to play a meaningful role nationally, and in the community of nations, we must be second to none in the application of advanced technologies to the real problems of man and society.





Dr. Vikram A. Sarabhai The Visionary who propelled India into the space age.



Looking Back.....



1969: India and USA : Space





The great Indian mathematician Aryabhat calculated the value of pi at 3.1416

Aryabhata (476-529)

CALCUTTA, SUNDAY APRIL 20, 1975

EDITOR-TULHAR KANTI CHOSH

BAISAKH 6, 1982

PRICE 36 PAISE

INDIA ENTERS SPACE AGE Satellite sent into orbit from USS

SPECIAL REPRESENTATIVE

READERS

And Personal Property in state



Indian salarinte Analysis we success fully hausched tuble the - Proto Patrika

Indo-Bangla border confee. from tomorrow

PT A MANY RAPORTER

Many ex-Govt. leaders beheaded

BANGSOR As 14 The Bouge ratio states in the

comprehensive deal with EEC FROM OUR SPECIAL REPRESENTATIVE NEW OFLIG: April 19. India that urged unipean Economic Community to extend the model of ome convention is other developing countries in Asia by

India insists on

comprehensive trade collaboration. UPROAR' IN KARNATAKA

ASSEMBLY



🚥 reddit

Khmer . Rouge Radio claims

Overview of ISRO

Space Centres in India









Google 100% Data attribution 2/16/2025

इसरो डिल्व

20 m Camera: 239 m 26°51'52"N 80°55'29"E 138 m

i

0



Space Science Experiments



X-ray Astronomy Aeronomy & Solar Physics



1975 Aryabhata





1992 & 1994 **SROSS** series

1985 Spacelab/



Cosmic Ray Experiment

Publ:31, Ph.D:4

Satellite Navigation



- Vehicle Tracking and Fleet Management
- Maritime Services & Port Operations
- Railway operations
- Civil aviation
- Disaster Management Support
- Geo-tagging/ Geo-fencing
- Location based services
- Survey Applications
- Infrastructure Planning
- Power Grid Synchronization
- Forest and Mining
- Precise Timing
- Mapping and Geodetic data capture
- Earth and Atmospheric Studies
- Search & Rescue

GAGAN (GPS Aided Geo Augmented Navigation)



Aviation



Maritime





Railways

Navigation



Roadways



Survey



AstroSat

India's Observatory in Space



Since 2015 variety of discoveries; UV, Optical & X-Ray (Multi Wavelength obs.) : High Energy Activities, Star system, Magnetic Field of Neutron stars, New X-Ray Sources,.



ISRO TELEMETRY TRACKING AND COMMAND NETWORK(ISTRAC)



32m Antenna at IDSN



BS

ctiviti

Galaxy AUDFs01 imaged by Astrosat's UVIT payload



INMCC Service Area



MEOSAR

TTC Support for Launch Vehicle and Satellite Missions

LEO, Lunar & Interplanetary Mission Operations

Operation of NavIC Ground Segment

Radar Systems Development & support

Science Data Archival and Dissemination

Search & Rescue & Disaster Management, Societal Services

> Space Situational Awareness



New MOX-1 DMCR facility



Gaganyaan Technical Facility



Antenna Array of 144 Patch elements



New 18m S/X band DSN Station at IDSN

GROUND STATIONS – WORLD WIDE NETWORK

Presently ISTRAC is operating Total 28 TTC stations (including 3 DSN stations, 3 Transportable terminal and 4 VHF/UHF Stations) across the globe.

isro



ISTRAC







MOX-1-







ILF

INC-2 LKO

ISTRAC LUCKNOW





Types of Antennas









4.6m Antenna





Radome



Wind Profiler Array

_____ 2.4m Antenna



Ground Station Network

India's Gateway to Deep Space



Drone view of Indian Deep Space Network (IDSN), Byalalu

ISTRAC Radar Systems

Design, development and operationalization of ground based radar systems to meet the emerging national requirements in the area of Radar and Tracking systems.



Indian Space Science Data Center

Prime Data Center for Lunar, Interplanetary and Space Science Missions of ISRO

Prime Functions

- Payload Data Ingestion
 Data Processing (LO, Ll)
- Archival (Active and Long term)
 - Dissemination (POC, PI & Public)

Missions Supported

Chandrayaan-I, Youthsat MeghaTropiques, AISSB/RS2, Astrosat, Chandrayaan-2, Mars Orbiter Mission, SARALChandrayaan-3,

https://www.issdc.gov.in

MOM-2

Ch-4

XPoSat,

Aditya-L₁,

• Venus Orbiter Mission,

Other Functions

Gearing up

- Application development
- OpsMsg Data Exchange
- Registration & Mosaicing, Peer review

<text>

PetaScale Space Science Data Center

Gateway to Space Science Data

Indian Mission Control Center (INMCC) Search and Rescue (SAR)

INMCC: 406 MHz UHF

INMCC is Operational since 1990

Indian region and 7 countries

- **LUT Terminals :**
 - Geostationary satellites: GEO-LUT
 - LEO satellites: LEO-LUT





Services offered: ICG, AAI, Defense, DG Shipping, DGCA National Beacon registration database 2234 Lives saved : 21-22- 42 lives in 16 incidents)

Sri Lanka,Bangladesh,Nepal,Seychelles,Maldives,Bhutan andTanzaniaSeychelles,



Space Situational Awareness (SSA)





ISRO System for Safe and Sustainable

Space Operations Management (IS⁴OM)

Space Situational Awareness



Energy and particle flux

Observation





NEtwork for space object TRacking & Analysis (NETRA)





ISRO System for Safe and Sustainable Space Operations Management (IS⁴OM) **Near Earth Objects and Planetary Defence**

Sho

Near Earth Asteroid (NEA)

Asteroids in vicinity of the Earth (with perihelion distance less than 1.3 au, 1 au = 1.5 million km)



| Diameter of Impacting Asteroid | Type of Event | | | |
|--|------------------------------------|--|--|--|
| 5 m | Bolide | | | |
| 10 m | Superbolide | | | |
| 25 m | 5 m Major Airburst | | | |
| 50 m Local Scale Devastation | | | | |
| 140 m | 140 m Regional Scale Devastation | | | |
| 300 m | 300 m Continent Scale Devastation | | | |
| 600 m Below Global Catastrophe Threshold | | | | |
| 1 km | 1 km Possible Global Catastrophe | | | |
| 5 km | Above Global Catastrophe Threshold | | | |
| 10 km | Mass Extinction | | | |

Potentially Hazardous Asteroid (PHA) - Bigger NEAs (size > 140 m) with orbits within 7.5 million km of Earth's orbit · Impact can wreak havoc like extinction of several species - Postulated to have caused dinosaur extinction



Asteroid Apophis 340 m sized Asteroid 99942 identified as the most hazardous asteroid

 Possibility of impact ruled out within next 100 years based on subsequent monitoring and analysis

Notable impacts

| Date | Impacting Object | Place of impact | Consequence |
|------------------------|-------------------------------------|-------------------------------|---|
| 05/02/2013 | Chelyabinsk meteor 20 m asteroid | Chelyabinsk Oblast, Russia | ~1500 injured ~7200 buildings damaged |
| 30/06/1908 | 30 m Asteroid | Tunguska, Russia | Destroyed 8 crores Trees |
| 6.5 crore years ago | 10-15 km asteroid | Mexico | Killed 70% of all species |





Artist's impression of a PHA impact on

Lonar lake impact crater in Maharashtra, India

Aim Detect any asteroid or comet potentially impacting Earth, either prevent or mitigate the risk









a planet





Risk assessmen

Push asteroid by continuous hitting of high

speed beam of ions.



Gravity tractor Contact-less deflection method: spacecraft used to create gravitational attraction and change the trajectory



Kinetic Impactors Deflection caused by impulsive transfer of momentum



warning time is short

Nuclear Impactors Nuclear explosives to mitigate impact when





SSA, Space Debris Mitigation, Long-term Sustainability





Space Object Proximity Analysis (SOPA)

Launch collision analysis (COLA)

ISRO System for Safe and Sustainable Operations Management (IS⁴OM)



NEtwork for space object TRacking & Analysis (NETRA)



Re-entry analysis

Space object observational data processing, OD, cataloguing

•Post mission disposal of S/C

R&D and modelling of space debris, space weather, Near-Earth Objects

Humble Beginning to Steller Heights





MIP Image Frames



Images captured by MIP before touch down





Far Side Image of MOON captured by TMC, Chandrayaan

Terrain Mapping stereo Camera



IMAGE OF PHOBOS





A close-up view of the lunar surface by OHRC

CHANDRAYAAN 2



Altitude: ~ 100 Km Pixel resolution: 30 cm Sun elevation angle: 7.8°

05 September, 2019













Chandrayaan-3 Rover while taking turn as viewed by Lander Imager







Vikram as seen by Pragyan August 30, 2023, 07:35 Hrs. IST













Pre and Post Hop Ramp images captured by Lander Imager–1 Camera

Ramp Deployed Position Captured on 25-08-2023

Ramp Deployed Position Captured on 03-09-2023 after post Hopping



Chandrayan-3 & Aditya-L1 Missions



Aditya-L1 mission – India's solar exploration

- Study of Solar Corona & Plasma Environment :
- 400kg Space Telescope is inserted into a Halo Orbit ~ 1.5 million km away from Earth around the Lagrange 1 point
- To study the 3 layers of Sun
 - Photosphere
 - Chromosphere
 - Corona



Aditya-L1 mission – India's solar exploration



Solar corona – studies from ground based observatories

- Only possible during total solar eclipse lasts for few minutes.
- Very rare, short duration. Visible from different locations in the world



Studies from halo orbit around Lagrangian point 1 (L1) - Aditya L1 mission

- 24 x 7 continuous observation
- Continuous viewing of the Sun without eclipses or Earth occultation.
- Outside Earth's magnetosphere hence avoids trapped charge particle background.
- Lagrangian point 1 is ~1.5 million km from the Earth on Sun-Earth line.
- S/C placed around L1 can maintain the orbit with small dV requirements which leads to longer mission duration.
- Ideal to study Sun and solar eruptive events

MARS ORBITER MISSION



Indian Space Program is one of the highest efficient Space Program in the world :

ISRO <u>Mars Orbiter Mission</u> proved interplanetary mission capabilities in the most economical way.

ISRO's Firsts in the World

First to reach the Moon's South Pole

- Chandrayaan-3 (2023)

Most satellites launched in a single mission - PSLV-C37 (104 satellites, 2017)

First Asian nation to reach Mars orbit

– Mangalyaan (2014)

First fully indigenous regional navigation system – NavIC (India's GPS)

First space agency to commercialize low-cost launches – Global leader in affordable space services

First to use electric propulsion in a communication satellite – GSAT-9

SPADEX Mission : Big Handshake



Preparing india for future challenging missions





RLV-LEX Mission Profile

ATR, Chitradurga

State of Art Satellites : NISAR





NISAR is a joint Earthobserving mission between NASA & ISRO with the goal to make global of measurements the and causes land consequences Of surface changes using advanced radar imaging.

Future: Indian Space Research Organisation (ISRO)





Model of Gagayaan Crew Module



Future Missions : Human Space Program

Major milestones planned



Future Missions : <u>Human Space Program</u>

Milestones achieved so far



Test vehicle for characterisation of Crew Escape System ready at SDSC



Indian Astronaut to ISS – Axiom-4 Mission Human Spaceflight Readiness by ISRO

• First Indian astronaut mission to the International Space Station (ISS) under a commercial collaboration.

 Mission: Axiom-4 (2024-25) by Axiom Space, USA – includes one Indian astronaut. Mr. Shubhankar Shukla as Mission Pilot.

• Part of India's **Gaganyaan mission preparation** – training, microgravity experience & international cooperation.

 Mission will include scientific experiments and operations onboard ISS.

• ISRO-NASA-Axiom partnership signifies India's progress in human spaceflight capability.

"A stepping stone toward Gaganyaan & sustained human presence in space"

Next Generation Launch Vehicle



Challenging Future Missions 1. Chandrayan-4 : Moon samples return to earth, By 2027

2. Venus Mission : March 2028

3. Next Gen Launch Vehicle by 2030

4. Bhartiya Space Station by 2035

5. human expeditions to the Moon by 2040.

Indian Space Policy & Space Vision 2047

- Indian Space Policy 2023 Key Highlights
- **Open ecosystem**: Private sector participation encouraged in satellite building, launches & data services.
- Four pillars:
 - ISRO R&D and advanced missions.
 - **IN-SPACe** Regulatory and promotional interface.
 - **NSIL** Commercial arm for service delivery.
 - **Private Sector** Innovation & competitiveness.
- Focus Areas: Remote sensing, communication, navigation, space science, and planetary exploration.
- <u>Space Vision 2047 India@100</u>
- **Global Leader** in low-cost, high-precision space technology.
- Human Spaceflight: Sustained missions post-Gaganyaan.
- **Space Station**: Indian Space Station by 2035.
- **Deep Space Missions**: Missions to Moon, Mars, Venus.
- Landing of Indian Astronaut on Moon : 2040
- **Commercial Space Hub**: Boost to startups & global collaborations.
- **Sustainability**: Debris mitigation and responsible space practices.
- "Aatmanirbhar Bharat in Space Empowering science, security & society"

Space Startups: A Success of India's New Space Policy

Rapid Growth of Space Startups Post Space Policy 2023

- 200+ startups emerged since liberalization
- Boost from IN-SPACe & ISRO's tech-sharing initiatives
- Startups now build satellites, launch vehicles & data platforms

Success Stories

- Skyroot Aerospace First private rocket (Vikram-S, 2022)
- Agnikul Cosmos 3D-printed engines, orbital launch readiness
- **Pixxel** Earth observation microsatellites
- Dhruva Space End-to-end satellite solutions

Global Momentum

- Rising VC investment, global collaborations
- India emerging as a hub for low-cost space tech innovation

A clear outcome of India's visionary space policy empowering private innovation.

ISRO Student & Institutional Engagement

Student Engagement Programs:

YUVIKA (Young Scientist Programme) – For Class 9 students Internships & Projects – For UG/PG students Competitions, Quizzes, Webinars

Institutional Engagement – RESPOND Scheme:

Research support for academic institutions Funding & technical guidance for space research More info: <u>https://www.isro.gov.in/RESPOND.html</u>

Get Involved:

Apply via ISRO portal or contact ISRO centres

Visit ISRO's Official Portal:

https://www.isro.gov.in

ISRO Research & Institutional Collaboration

ISRO Cell at IIT Kanpur

Promotes collaborative research in space science & technology. Supports student projects and innovation in aerospace applications.

IIIT-Allahabad Involvement

Engaged in ISRO-supported research and academic initiatives. Focus areas: AI, data analytics, and remote sensing for space science.

Space Science Data Access

- ISRO provides satellite and remote sensing data for institutional research.
- Applications: climate studies, agriculture, disaster management, astronomy.
- Access via platforms like Bhuvan, MOSDAC, and NRSC.
- **ISSDC : Space Science data for research :**
- https://www.issdc.gov.in/
- **Institutional Collaboration Opportunities**
- Programs like **RESPOND** and **Space Technology Cells** in premier institutions.
- Offers research funding, mentorship, and data access support.

What Need To Do ??

Demand-Based Mission Planning

Objective: Align missions with real, evolving needs

Stakeholders:

Government Ministries
Institutions (Academic & Research)
Private Sector

Approach:

•Identify demand \rightarrow Plan \rightarrow Execute \rightarrow Evaluate

Awareness & Interaction

- **Methods of** Engagement:
 - •Seminars
 - Conferences
 - •Workshops
 - •Symposiums
- Purpose:
 - •Share knowledge
 - Foster collaboration
 - Involve all stakeholders

Together, let's build missions that matter and awareness that empowers!



Space technologies have progressed to matured level in all dimensions. Now Users, Scientists, Researchers and Engineers have to explore it's benefit by making viable Programs & Projects in their required areas.

Endless opportunities : Space Present & Beyond...

EVERY **ENDING** IS REALLY JUST A **NEW BEGINNING**

Z4Slides

THANKS FOR INNOVATIVE THINKING TO START

इसंरो

isro