



ISRO'S SPACE DOCKING MISSION – SCIENCE & TECHNOLOGY

NEWS: ISRO's Space Docking Experiment (SpaDeX), a key milestone, is scheduled for launch on December 30, 2024, at 10 PM from Sriharikota.

WHAT'S IN THE NEWS?

Overview of ISRO's SpaDeX Mission

- The mission will demonstrate India's capability to dock two satellites in space, paving the way for future space station development, lunar sample return, and human missions to the Moon.

What is Space Docking?

- **Space Docking** involves manoeuvring two spacecraft into the same orbit, bringing them closer, and finally joining them.
- Critical for assembling heavy spacecraft in orbit, refueling, and transferring astronauts or equipment.
- Examples:
 - **International Space Station (ISS)**, assembled in orbit and maintained through periodic docking of modules from Earth.
 - India's planned **Bharatiya Antarisksha Station**, requiring docking to bring together five modules by 2035.

Significance of SpaDeX for India

- A critical step towards achieving:
 1. India's **space station plans** by 2035.
 2. Upcoming **Chandrayaan-4 mission** to return lunar samples.
 3. Autonomous docking systems for future interplanetary missions.

SpaDeX Mission Details

1. Satellite Configuration:

- Two identical satellites, **SDX01 (Chaser)** and **SDX02 (Target)**, each weighing 220 kg.
- Satellites will be injected into a **470-km circular orbit**.



2. Docking Procedure:

- Satellites will initially drift apart to a distance of 10-20 km.
- **Target satellite (SDX02)** will fire its propulsion system to stop drifting further.
- **Chaser satellite (SDX01)** will gradually approach the target, reducing the distance in stages (5 km, 1.5 km, 500 m, etc.) until docking occurs.
- A **video camera tilt mechanism** will monitor the docking process.
- Once docked, the satellites will transfer **electrical power** between themselves.

3. Post-Docking Plans:

- Satellites will undock and move to separate orbits to conduct experiments for two years:
 - **SDX01:** High-resolution camera for surveillance applications.
 - **SDX02:** Multispectral payload for resource monitoring and radiation studies.



New Technologies Demonstrated

1. New PSLV Integration Method:

- First mission where the PSLV was integrated in the **new PSLV facility** and transported to the launch pad on a moving platform.



- Reduces the lead time for missions compared to assembling directly on the launch pad.
2. **Advanced Sensors:**
 - **Laser Range Finder, Rendezvous Sensor, Proximity and Docking Sensor** for precise docking operations.
 3. **Navigation System:**
 - New processor based on satellite navigation systems for determining relative position and velocity.
 - A precursor to fully autonomous docking systems for future missions.
 4. **Special Testing Facilities:**
 - **Docking Mechanism Performance Test:** To validate docking operations.
 - **Vertical Docking Experiment Laboratory:** Controlled docking tests.
 - **Rendezvous Simulation Lab:** Real-time validation of algorithms.

Experiments on the Fourth Stage (POEM Module)

- The fourth stage of the PSLV will function as the **PS4 Orbital Experiment Module (POEM)**, carrying out **24 experiments**.
1. **Biological Experiment:**
 - **CROPS Experiment (Compact Research Module for Orbital Plant Studies):**
 - First biological experiment on an ISRO mission.
 - Focus: Germination and sustenance of a plant up to the two-leaf stage.
 2. **Debris Capture and Robotic Arms:**
 - **Debris Capture Robotic Arm:** Uses object motion prediction and visual feed for space debris capture.
 - Moveable robotic arm for **future satellite servicing** in space.
 3. **Technology Demonstrations by Startups:**
 - **10 technologies** developed by startups and educational institutions will be tested.

Importance of SpaDeX in Future Missions



1. Space Station Plans:

- First module of the **Bharatiya Antarisksha Station** to be launched in **2028**, requiring docking for assembly.

2. Chandrayaan-4 Lunar Mission:

- Docking critical for returning lunar samples to Earth through a multi-stage mission:
 - Docking of lander-ascender with transfer module in lunar orbit.
 - Transfer module docking with re-entry module in Earth orbit.

3. Autonomous Docking Systems:

- SpaDeX technologies lay the groundwork for future docking capabilities without ground-based navigation support.

Conclusion

- The **SpaDeX mission** marks a significant milestone in India's space journey.
- Its success will enhance ISRO's technological capabilities for interplanetary exploration, human spaceflight, and building an independent space station.
- The experiments on the POEM module further showcase ISRO's commitment to innovation and collaboration with startups and research institutions.

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