



NISAR'S UNIQUENESS – SCIENCE & TECHNOLOGY

NEWS: On March 2025, ISRO set to launch the 2.8-tonne NISAR satellite by a GSLV Mk-II rocket.

WHAT'S IN THE NEWS?

Introduction to the NISAR Mission

- **Launch Details:**
 - The 2.8-tonne NASA-ISRO Synthetic Aperture Radar (NISAR) satellite is scheduled for launch in March 2025.
 - It will be launched aboard the GSLV Mk-II rocket by the Indian Space Research Organisation (ISRO).
 - NISAR is a ₹5,000-crore India-US collaborative project that began in 2009.
- **Orbital Placement:**
 - The satellite will operate at an altitude of 750 km above Earth in a near-polar orbit.
 - **Significance:** NISAR marks a landmark collaboration between NASA and ISRO, leveraging both agencies' expertise in low-cost, high-capability space missions.

Unique Features of NISAR

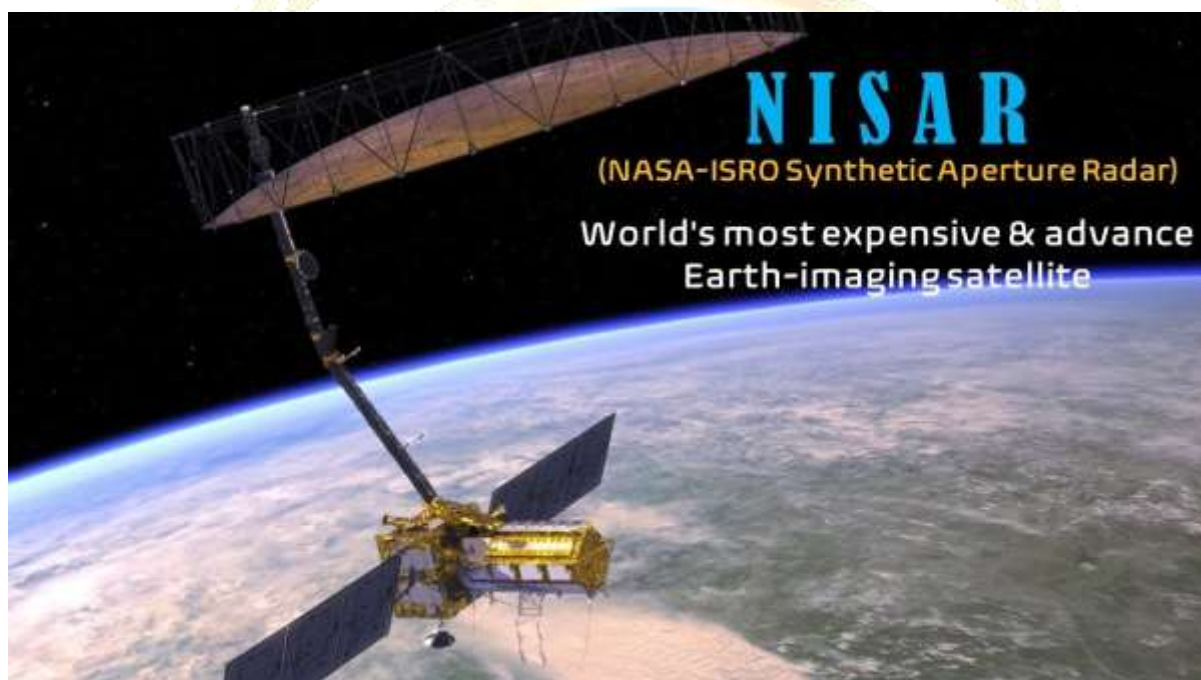
- **Synthetic Aperture Radar (SAR):**
 - Unlike optical satellites, SAR satellites transmit radio frequency signals and capture their bounce-backs, enabling imaging in all weather conditions and through obstacles like clouds, darkness, and vegetation.
 - NISAR offers significantly sharper imaging capabilities compared to its predecessors.
- **Dual-Frequency Radar System:**
 - **L-Band Radar (1.2 GHz):** Developed by NASA, it penetrates vegetation, ice, and other obstructions more effectively.
 - **S-Band Radar (3.3 GHz):** Designed by ISRO, it provides higher resolution for detailed imaging.
 - The integration of these bands allows complementary imaging, ensuring a comprehensive view of Earth's surface processes.
- **Bi-Directional Antenna with Digital Beam Forming (DBF):**
 - The antenna (12 meters long, 2.4 meters wide) can transmit and receive signals simultaneously.
 - DBF technology ensures:



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- Independent signal transmission and capture by individual antenna elements.
- Steering of beams digitally without physically moving the antenna, enabling greater coverage and sharper resolution.
- Reduced data rates from 20 gigabits per second to 3.5 gigabits per second optimize data transmission efficiency.
- **Optimal Swath Width and Resolution:**
 - Swath width of 240 km balances coverage and resolution (10 meters), surpassing many existing satellites.
 - For comparison, NASA's MODIS satellite has a swath width of 2,330 km but lower resolution.



Historical Context of Collaboration

- **NASA's Initial Plans:**
 - NASA initially sought collaboration with Germany's DLR, but their aerospace center was engaged in other projects.
 - Budget constraints led NASA to explore partnerships with ISRO, recognizing its expertise in cost-effective missions like Chandrayaan-1 (2008) and RISAT-2 (2009).
 - **Formal Collaboration:** The NASA-ISRO Synthetic Aperture Radar mission was formally established in 2014, combining NASA's radar expertise with ISRO's low-cost engineering capabilities.

Applications of NISAR

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- **Earth Monitoring:**
 - Measures minute surface movements, such as subsidence (land sinking) or shifts in ice sheets and glaciers.
 - Identifies structural misalignments in critical infrastructure like bridges, dams, and levees, enabling timely interventions.
- **Climate Change Studies:**
 - Tracks changes in vegetation, ice cover, and land deformation to study the impacts of climate change.
 - **Disaster Management:** Monitors natural disasters, including earthquakes, floods, and landslides, by detecting surface deformations before or after events.
- **Revisit Cycle:**
 - NISAR completes a 12-day revisit cycle, observing Earth's surface changes at regular intervals.
 - Polar-to-polar coverage ensures comprehensive data collection globally.

Technological Highlights

- **High Data Output:** NISAR will generate 26 terabits of data daily, providing extensive datasets for analysis.
- **Advanced Imaging Techniques:** The use of digital multiplication and addition in DBF technology enhances imaging sharpness while minimizing onboard equipment.
- **Proven Dual-Frequency Expertise:** The dual-frequency SAR capability was also employed in India's Chandrayaan-2 mission in 2019, although with different radar specifications.

Key Challenges Addressed by NISAR

- **Detecting Subtle Movements:** Capable of identifying movements as small as fractions of an inch, critical for monitoring geological and structural stability.
- **Balancing Coverage and Resolution:** NISAR achieves an optimal combination of swath width and resolution, setting a benchmark in SAR technology.
- **Global Access:** NISAR's ability to observe Earth's dynamic processes aids in building a global understanding of environmental and structural phenomena.

Contributions from NASA and ISRO

- **NASA's Contributions:**
 - Provided the advanced L-band radar system and the high-performance bi-directional antenna.



- Spearheaded the development of DBF technology for optimal performance.
- **ISRO's Contributions:**
 - Developed the S-band radar, optimized for high-resolution imaging.
 - Ensured cost-effective engineering and launch capabilities, leveraging its expertise in reliable, low-cost missions.

NISAR as a “New Frontier” in Space Exploration

- **Technological Superiority:**
 - Former ISRO scientist Rakesh Bhan emphasized that NISAR’s DBF technology surpasses conventional methods, making it a milestone in SAR technology.
 - Its capability to capture high-quality, multi-frequency images revolutionizes Earth observation.
- **Expanding Scientific Horizons:**
 - With its advanced specifications, NISAR will enhance our understanding of Earth’s dynamic processes and strengthen disaster response mechanisms.
 - Its data will play a pivotal role in addressing global challenges like climate change and infrastructure monitoring.

Conclusion: Significance of NISAR Mission

- **Symbol of Collaboration:**
 - NISAR exemplifies successful international cooperation in space exploration, combining NASA’s technological prowess with ISRO’s cost-efficient engineering.
- **Future Implications:**
 - The mission opens new avenues for advancements in Earth observation and environmental monitoring.
 - It sets a benchmark for future collaborations in space science and technology, reinforcing the importance of joint efforts in addressing global challenges.

Source: <https://www.thehindubusinessline.com/business-tech/why-nisar-is-a-unique-satellite-a-remarkable-mission/article68988804.ece#:~:text=NISAR%20is%20designed%20for%20a,'strips'%20of%20the%20earth.>