NISAR Satellite

> ***Mains**: GS III - Science and Technology- Developments and their Applications and Effects in Everyday Life| Achievements of Indians in Science & Technology| Indigenization of Technology and Developing New Technology*

Why in News?

The Indian Space Research Organisation (ISRO) is planning to launch the NISAR satellite from Sriharikota on July 30 on board a GSLV Mk-II Rocket.

What is NISAR satellite?

- **NISAR** – It stands for **NASA-ISRO Synthetic Aperture Radar**
- **Built by** – It is a joint mission of NASA and ISRO.
- **Launch vehicle** – GSLV Mk-II
- **GSLV Mk-II** – It is also known as LVM3 (Launch Vehicle Mark 3), *a three-stage Indian launch vehicle* developed by ISRO.

> ***GSLV Mk-II** is designed to launch heavy satellites, particularly those weighing around 4 tons to geostationary transfer orbit (GTO) or about 10 tons to low Earth orbit (LEO).*

- **Aim** – To study changes on the earth's surface in fine detail, covering earthquakes, volcanoes, ecosystems, ice sheets, farmland, floods, and landslides.
- **Mission duration** – It is for three years.
- **Design lifetime** – At least five years.
- **Synthetic Aperture Radar (SAR)** – It is a type of radar that uses the motion of a radar antenna to *create high-resolution images* of the Earth's surface or other objects.
- **Aperture** – It refers to the opening used to collect radar data.
- The longer the opening, the better the radar's ability to distinguish between two closely spaced objects.
- **Radar** – It is an acronym for Radio Detection and Ranging.
- It is a system that uses radio waves to detect, locate, and track objects, as well as measure their speed and other characteristics.
- **Working of radar** – It works by *transmitting radio waves* and analysing the echoes that bounce back from objects in its path.

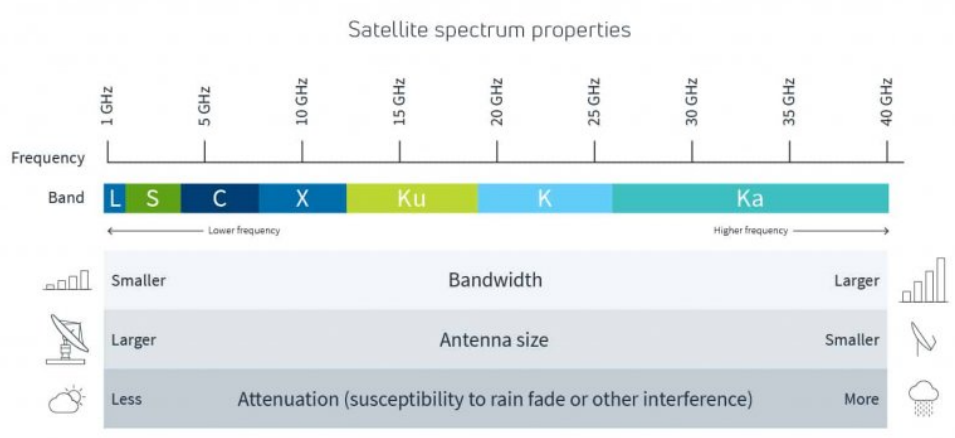
•Six goals of NISAR

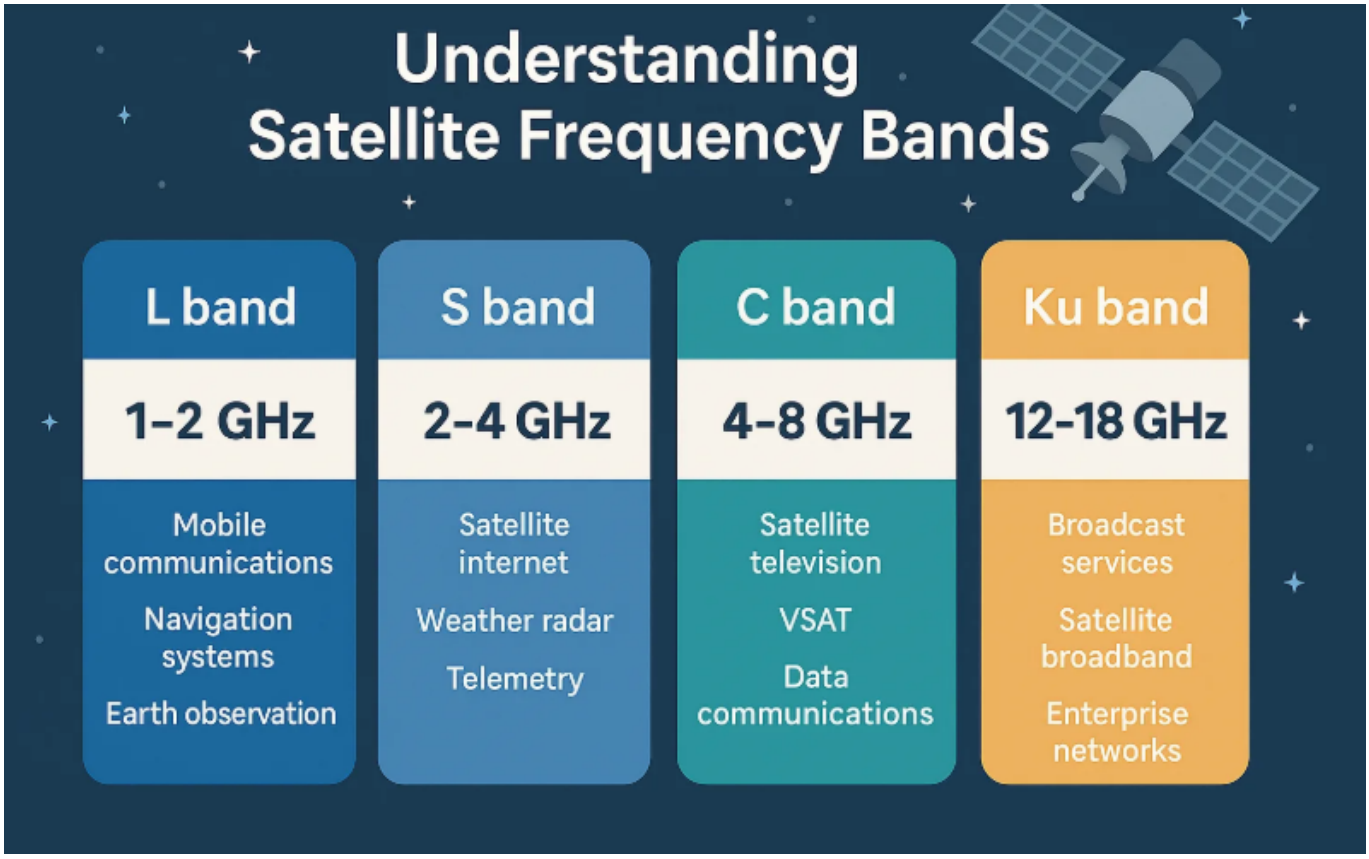
- Solid earth processes
- Ecosystems
- Ice dynamics
- Coastal and ocean processes
- Disaster response
- Additional applications – Tracking groundwater, oil reservoirs, and infrastructure like embankments, dams, and roads for subsidence or deformation and supporting food security research.

How was NISAR built?

- **Contribution of ISRO** – I-3K spacecraft bus,4 kW of solar power, the entire *S-band* radar electronics, high-rate Ka-band, telecom subsystem.
- A gimballed high-gain antenna, End-to-end launch services and documentation.
- **Contribution of NASA –** The complete *L-band* SAR system, all *radio-frequency electronics*, a 12-m antenna, a 9-m carbon-composite boom (the instrument structure that carries both radars.),
- The supporting avionics, including a high-capacity solid-state recorder, *a GPS receiver*, an autonomous payload data system, Ka-band payload communications subsystem.

I-3K spacecraft bus *is the platform that houses the controls to handle command and data, propulsion, and attitude.*





- **combining of Parts** – The spacecraft was to be integrated at the ISRO Satellite Centre in Bengaluru after the two radars were coupled at Jet propulsion laboratory (JPL) in USA.
- **The final observatory-level tests –** It has taken place on Indian soil.
- **Mission procedures** – The mission operations are to be centred at the JPL Mission Operations Centre.

How NISAR will be operated by US and India?

- **Flight operations** – Day-to-day flight operations will be led from the ISRO Telemetry, Tracking and Command Network in Bengaluru.
- **Transfer of data** – Most of its data will be sent through NASA's Near-earth Network facilities in Alaska, Svalbard (Norway), and Punta Arenas (Chile).
- They can together *receive around 3 TB of radar data per day*.
- They will be complemented by ISRO's ground stations in Shadnagar and Antarctica.
- **Processing of data** – India's National Remote Sensing Centre will process and distribute all data required for Indian users.
- **Earmarking the S-band** – Although NISAR will operate globally at L-band, ISRO has reserved routine, planned acquisitions with the S-band SAR over India.
- The S-band acquisitions have extended sensitivity to biomass, better soil-moisture retrieval, and mitigate ionospheric noise.
- **Prominence to L-band** – Because the L-band radar is the principal tool for NASA's mission goals, the instrument is expected to *operate in up to 70% of every orbit*.
- **Reduction of conflicts** – Operating both radars together is an *official implementation goal* so that mode conflicts over the Indian subcontinent are minimised.

How does NISAR work?

- **Placing of satellite** – Once it is launched, NISAR will enter a sun-synchronous polar orbit.
- It will be placed at *747 km altitude and an inclination of 98.4º*.
- **Bouncing of radar waves** – From here, instead of snapping pictures, the SAR will bounce radar waves off the planet's surface.
- It measures how long the signal takes to come back and how its phase changes.
- **Recording the echoes** – As the spacecraft moves forward, it transmits a train of radar pulses and records the echoes.
- **Combining of echoes** – A computer coherently combines all those echoes.
    - NISAR will combine an L-band SAR (1.257 GHz), which *uses longer-wavelength radio waves* to track changes under thick forests and soil and deformations on the ground.
    - *S-band SAR (3.2 GHz), which uses shorter-wavelength radio waves* to capture surface details, such as crops and water surfaces.
- **Use of different polarisation** – SAR will transmit and receive radar signals with horizontal or vertical polarisation.

> *Polarisation is the direction in which the electric field of some electromagnetic radiation, like radio waves, oscillates.*

- It will allow the instruments to identify the structure and types of different surface materials, like soil, snow, crop, or wood.
- **Bandwidth** – The breadth of the bands on the ground the SARs will scan, is an ultra-wide 240 km.
- **Transmission of Beam** – This scan-on-receive method allows the 240-km swath without compromising resolution.
- **Scan results** – The resulting scans will have a spatial resolution of 3-10 m and centimetre-scale vertical mapping.

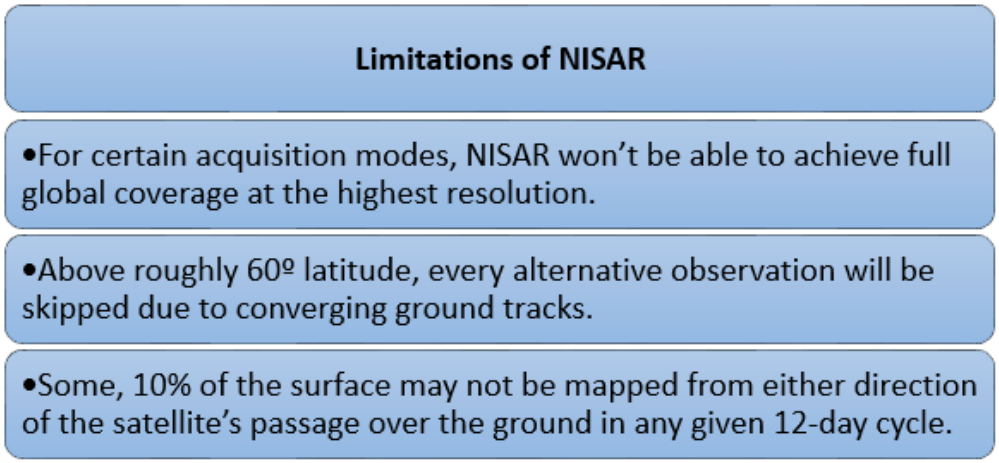
***For example**, it is enough to spot impending land subsidence in cities*

- **Operational extent** – Each spot on the ground will be scanned *once every 12 days*.

What are the significances of NISAR?

- **Dual band radar** – It is the first major earth-observing mission with a dual-band radar.
- It will allow to observe changes more precisely than any other satellite.
- **All weather usage** – It will be able to see through clouds, smoke, and even thick vegetation, both at day and night.
- **Descriptions of climate changes** – It provide critical information by taking snapshots of the constantly changing earth's surface.
- **Periodical maps** – It will produce annual maps of aboveground woody biomass of 1 ha resolution.

- It will also produce quarterly maps of active and inactive cropland.
- High-resolution maps of flooded versus dry areas will be available.
- **Proxy maps data** – It can also collect data for damage proxy maps during disasters.
    - The maps will be delivered within five hours.
- **Free availability of data** – The data will be freely available to all users.



Reference

The Hindu| NISAR Satellite

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