

India's First Earth Observation Satellite Constellation

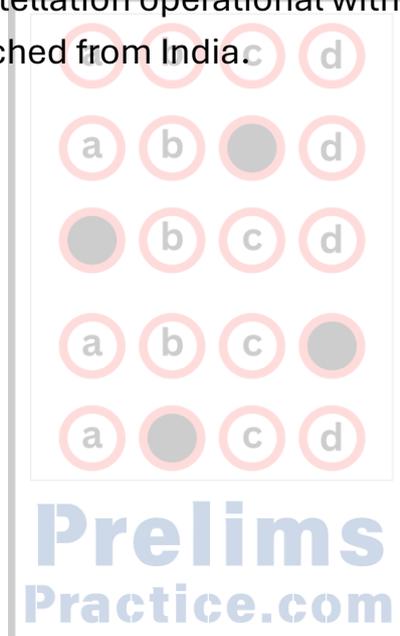
India is developing its first commercial Earth Observation (EO) satellite constellation, a 12-satellite network called 'Prithvi Drishti,' led by a private consortium including Pixxel, Piersight, Satsure, and Dhruva Space. This public-private partnership is being built with over ₹1,200 crore of private investment, not government funding, and will provide high-resolution data for various applications like agriculture, defense, and disaster management. The project aims to ensure data sovereignty, reduce reliance on foreign data sources, and position India as a leader in the global space economy.

Key details of the constellation

- **Name:** The constellation is nicknamed 'Prithvi Drishti'.
- **Public-private partnership:** It is a public-private partnership where the government provides strategic, technical, and policy support, while private firms handle the entire investment and operation.
- **Investment:** Private companies are investing over ₹1,200 crore, with the government providing zero financial support.
- **Satellites:** The constellation will consist of 12 satellites with advanced sensors, including:
 - **Optical cameras:** For very high-resolution imagery.
 - **Synthetic Aperture Radar (SAR):** Developed by Piersight, these satellites can image day and night, regardless of cloud cover.
 - **Hyperspectral and multispectral sensors:** Developed by Pixxel and Satsure, to provide detailed data on Earth's composition and land use.
- **Deployment:** The satellites will be deployed in phases over the next four years.
- **Applications:** The data will be used for a wide range of applications, including:
 - Agriculture (crop health, soil quality)
 - Infrastructure monitoring
 - Disaster management
 - National security and defence
 - Climate change monitoring
 - Marine surveillance

A new era for India's space sector

- **Strategic importance:** This initiative is a major milestone for India's private space industry, demonstrating its capability and maturity to undertake large-scale, technologically advanced missions. It signals a new era where public and private capabilities will work together to drive innovation and self-reliance.
- **Data sovereignty:** The constellation will enhance India's data sovereignty by providing indigenous satellite data and reducing dependence on foreign sources.
- **Commercial model:** Operating on a "satellite-as-a-service" model, the consortium will provide guaranteed data access to Indian agencies while also selling imagery and analytics to commercial customers worldwide.
- **Timeline:** The first satellite is expected to launch within two and a half years, with the full 12-satellite constellation operational within five years. All satellites will be manufactured and launched from India.



Explanation of Exam Oriented Key Terms

01

Earth Observation (EO) satellite

What are Earth Observation (EO) satellites?

EO satellites, also known as remote sensing satellites, are designed to monitor and collect data about Earth's physical, chemical, and biological systems from orbit. This data is used for both civilian (environmental monitoring, resource management) and military (surveillance) purposes.

Technology and functioning

- **Active vs. Passive sensors**

- **Active:** These satellites emit their own energy (e.g., microwaves) toward Earth and measure the reflected signal. This allows for all-weather, day-and-night imaging, as seen with Synthetic Aperture Radar (SAR).
- **Passive:** These satellites detect the natural radiation reflected or emitted from Earth's surface, such as visible light and infrared. Their operation is dependent on sunlight and is affected by cloud cover.

- **Key payloads/technologies**

- **Synthetic Aperture Radar (SAR):** An active system that creates high-resolution 2D or 3D images, essential for surveillance, mapping, and disaster management.
- **Electro-Optical (EO) Sensors:** Captures images in visible and infrared bands, used for surveillance, environmental monitoring, and tracking natural disasters like fires.
- **Hyperspectral and Multispectral Imaging:** Provides more detailed spectral information than normal cameras, useful for agriculture, mineral exploration, and environmental analysis.
- **GNSS-R (Reflectometry):** Uses reflected navigation satellite signals to measure surface properties, such as ocean winds, soil moisture, and cryosphere conditions.

Orbits used by EO satellites

- **Sun-Synchronous Polar Orbit (SSPO):** This is the most common orbit for EO satellites. It allows a satellite to pass over a section of the Earth at the same local solar time, ensuring consistent lighting conditions for imaging. The orbit also passes over polar regions.
- **Geostationary Orbit (GEO):** Satellites in this orbit appear fixed relative to a point on Earth. While less common for detailed remote sensing, it is used by meteorological satellites for continuous, real-time monitoring of a specific region.

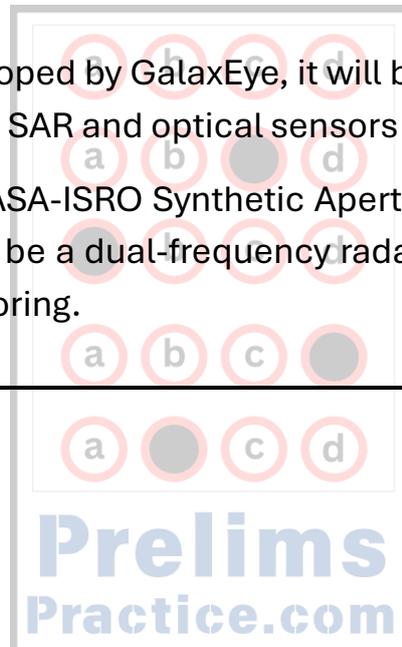
Applications of EO satellites

- **Climate Change Monitoring:** Tracking changes in climate patterns, melting polar ice caps, greenhouse gas concentrations, and sea-level rise.
- **Disaster Management:** Providing early warnings and real-time imagery of natural hazards like floods, cyclones, volcanic activity, and wildfires. This aids in damage assessment and recovery planning.
- **Agriculture and Food Security:** Assessing crop health and productivity, soil moisture, and mapping agricultural land for better resource management.
- **Resource Management:** Mapping and monitoring land, water, and mineral resources, as well as tracking deforestation and marine pollution.
- **Urban and Rural Planning:** Facilitating urban infrastructure development, land use mapping, and monitoring population changes.
- **National Security and Defence:** Providing crucial intelligence, border surveillance, and post-attack damage assessment.

India's EO satellite program

- **Legacy:** India's EO program, formerly known as the Indian Remote Sensing (IRS) program, began with experimental satellites like Bhaskara-1 (1979) and Bhaskara-2 (1981), and became operational with IRS-1A in 1988.
- **Key Satellite Series:**
 - **EOS Series:** ISRO has adopted a new naming scheme, integrating thematic satellites into the EOS series. Notable launches include EOS-01, EOS-04 (Radar Imaging Satellite), EOS-06, and EOS-07.

- **RISAT Series:** Radar Imaging Satellites (e.g., RISAT-2B, RISAT-2BR1) provide all-weather imaging capabilities using SAR technology.
- **Cartosat Series:** Specialised for cartography and high-resolution mapping, with Cartosat-3 being a third-generation agile satellite.
- **Oceansat Series:** Designed for oceanographic studies, such as mapping ocean topography.
- **Private Sector Participation:** The Indian National Space Promotion and Authorisation Centre (IN-SPACe) is encouraging private investment in the space sector.
- **PixxelSpace-led consortium:** A private consortium is building India's first commercial EO satellite constellation with panchromatic, multispectral, and SAR sensors.
- **Mission Drishti:** Developed by GalaxEye, it will be the world's first multi-sensor EO satellite, combining SAR and optical sensors on a single platform.
- **Joint Missions:** The NASA-ISRO Synthetic Aperture Radar (NISAR) mission, set for launch in 2025, will be a dual-frequency radar satellite for global ecological and cryospheric monitoring.



Practice Questions:

1. With reference to India's Earth Observation (EO) satellites, consider the following statements:

- I. ISRO's constellation of remote sensing satellites predominantly operates in sun-synchronous orbits, providing varied temporal and spectral resolution data
- II. The Cartosat series of satellites are specifically designed for high-resolution imaging to support cartographic and urban planning applications
- III. The Oceansat series uses Synthetic Aperture Radar (SAR) payloads to monitor ocean colour, sea surface temperature, and wind vectors
- IV. The NISAR mission, developed in collaboration with NASA, will utilize a dual-band SAR for high-resolution global imaging in all weather conditions

How many of the statements given above are incorrect?

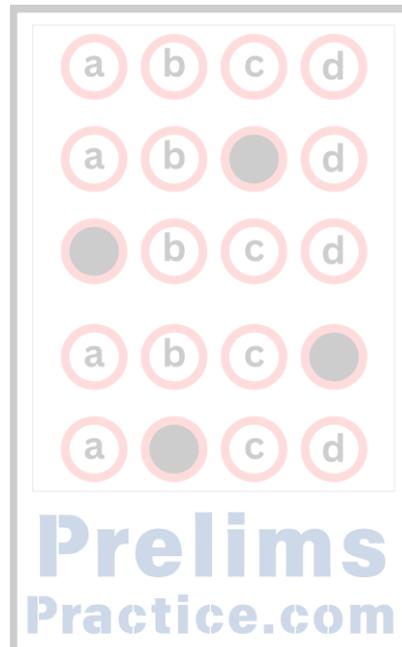
- a) Only one
- b) Only two
- c) Only three
- d) All four

Answer: a

Explanation: Statement I is correct- India has a large constellation of remote sensing satellites, many of which operate in sun-synchronous orbits (SSO), which allows them to pass over the same spot on Earth at the same local solar time. This consistency is crucial for monitoring environmental changes over time. **Statement II is correct-** The Cartosat series, which includes Cartosat-3, provides high-resolution imagery for cartographic applications, urban and rural development, and infrastructure planning. **Statement III is incorrect-** The Oceansat series carries payloads like the Ocean Colour Monitor (OCM) and scatterometers to measure ocean colour, sea surface temperature, and wind vectors. Synthetic Aperture Radar (SAR) technology is used by the RISAT series to provide all-weather, day-night imaging capabilities, which is a different technology from that primarily used by Oceansat. **Statement IV is correct-** The NASA-ISRO SAR (NISAR) mission is a joint project that will use a dual-band (L- and S-band) SAR to map the Earth's surface with high resolution and in all weather conditions. It is designed to observe complex processes like ecosystem disturbances and natural hazards.

For More Practice Questions, visit:

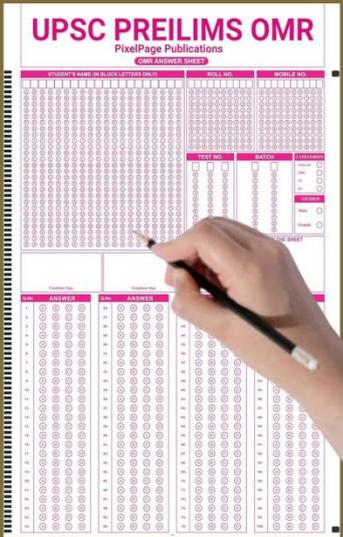
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