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What is India's first orbital data centre satellite?

What is an orbital data centre? Why are global firms interested? What does the Pixxel-Sarvam partnership involve?

Why in News?

Pixxel, a Bengaluru-based satellite imaging startup, has partnered with **Indian AI firm Sarvam AI** to develop **India's first "orbital data centre" satellite named *Pathfinder*.** Scheduled for launch by the fourth quarter of 2026, the mission aims to place data-centre-grade **Graphics Processing Units (GPUs)** in **low Earth orbit** to process artificial intelligence workloads directly in space.

What is an Orbital Data Centre?

- **About:** An orbital data centre is a **network or constellation of satellites** equipped with powerful computing hardware (like GPUs) designed to process data directly in space.
  - Traditional satellites generally collect raw data (images, signals) and transmit massive volumes of it back to Earth for analysis. Orbital data centres employ **edge computing,** processing the **data at the source and sending the actionable insights back to ground stations.**
- **Significance:**
  - **Terrestrial Constraints:** Ground-based data centres are increasingly hitting limits regarding **land availability, water for cooling, and energy consumption**, all of which are exacerbated by the massive power demands of **generative AI.**
  - **Continuous Energy:** In the right orbit, **solar power is effectively continuous**.
    - This offers **"free" electricity,** which is the strongest economic argument for moving high-intensity computation to space.
  - **Data Bottlenecks:** Earth observation satellites generate massive, high-resolution files that are expensive and slow to downlink.
    - Processing this data in orbit eases the bandwidth bottleneck.
  - **Strategic Scaling:** Future iterations of **Starlink (V3)** combined with the high-payload capacity of Starship could potentially deliver up to 100 GW of power to orbit, making large-scale space-based computing constellations commercially viable.

Challenges of Computing in Space

- **Thermal Management (Heat Dissipation):** Space is a vacuum, preventing **convection-based cooling**(the natural process of heat transfer on Earth).
  - Heat generated by GPUs must therefore be dissipated through radiative cooling systems using heat-transfer loops and radiating panels.
- **Radiation Exposure:** Commercial GPUs are highly susceptible to **cosmic radiation,** which can cause **"bit flips"** (random changes in computer code) and long-term semiconductor degradation. Shielding these components adds weight and complexity.

- **Miniaturisation Constraints:** Fitting power-hungry data centre components into a small 200-kg satellite requires extraordinary engineering in payload miniaturisation and power management.
- **High Initial Costs:** Launching and maintaining advanced computing hardware in orbit involves significant capital expenditure compared to terrestrial cloud servers.
  - Unlike a terrestrial centre, a satellite cannot be easily repaired. High levels of redundancy must be built in, and the system must account for **"eclipse periods"** where solar power is unavailable.
- **Scalability:** According to Pixxel, nearly 100–500 satellites may eventually be required to match the computing capability of a terrestrial data centre.
  - While edge processing in space is considered feasible in the near term, large-scale replacement of Earth-based cloud infrastructure remains a long-term possibility.

What is the Pathfinder Mission?

- **About:** Pathfinder is a **200-kg class satellite** designed to function as a demonstrator for in-orbit data processing.
- **Key Payloads & Technology:**
  - **Datacentre-grade GPUs:** Pathfinder will carry high-performance graphics processing units (GPUs) similar to those used in terrestrial data centres.
  - **Hyperspectral Imaging:** It will carry Pixxel's flagship **hyperspectral imaging camera**, capable of capturing high-fidelity data of the Earth.
  - **Sovereign AI Backbone:** Sarvam AI will provide **full-stack language models** and an AI inference platform. This allows AI training and inference to occur directly on the satellite.
- **Objective:** To validate real-time AI inference, power management, and thermal constraints in the harsh space environment, establishing the technical groundwork for commercial-scale orbital data centres.
- **Manufacturing:** The satellite will be built at **Gigapixxel**, Pixxel's new manufacturing facility designed to scale satellite production.

How does Kerala plan to tackle oil spill hazards?

What prompted the drafting of the Oil Spill Contingency Plan? How will it help protect Kerala's coastline?

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G. KRISHNA KUMAR

Why in News?

Kerala has finalised a draft **Oil Spill Contingency Plan (OSCP)** to protect the state's **590 km coastline**, following recent maritime disasters off the Kerala coast involving the **MSC Elsa 3** and **MV Wan Hai 503**.

- It has been developed under the **National Oil Spill Disaster Contingency Plan (NOS-DCP)** guidelines.

What are the Key Facts Regarding Kerala's Draft Oil Spill Contingency Plan?

- **Environmental Sensitivity Mapping:** The plan includes **Environmental Sensitive Index (ESI)** mapping to identify and protect vulnerable marine ecosystems, including mangroves and fish breeding grounds.
- **Shoreline Response & Management:** The OSCP establishes a clear chain of command for shoreline clean-up, incorporating **Net Environmental Benefit Analysis (NEBA)** and specific wildlife response protocols.
- **Technological Integration:** It utilizes **hydrodynamic and oil spill modelling** to predict the trajectory of hazardous cargo, such as the **calcium carbide** and **plastic nurdles** lost during the MSC Elsa 3 sinking.
- **Jurisdiction & Scope:** The plan covers marine spills within **12 nautical miles (Territorial Waters)** and extends **40 km** into inland riverine systems affected by tidal action.

What is the National Oil Spill Disaster Contingency Plan?

- **About:** NOS-DCP is India's **apex** policy framework for responding to **oil and chemical spills** in Indian waters. Originally formulated in **1993** and promulgated in **1996**, the plan was significantly **updated in 2024** to address growing maritime traffic, larger tankers, offshore exploration, and emerging risks from **offshore wind energy**.
- **Core Objectives:** Establish seamless coordination among various **ministries, ports, oil companies**, and **coastal states**.
  - Identify and protect ecologically sensitive zones (like **mangroves** and **coral reefs**) that require immediate protection during a spill.
  - Ensure that the **"Polluter Pays" principle** is enforced through legal and financial mechanisms.
- **Key Features of NOS-DCP (2024 Updates):**
  - **Integrated Digital Tracking:** Use of real-time satellite imagery, **Automatic Identification System (AIS)**, and the Online Oil Spill Advisory (OOSA) system for tracking and trajectory modelling of oil spills.
  - **Tiered Response Refinement:** The 2024 guidelines clarified the specific "Trigger Points" for different spill sizes:
    - **Tier 1 (Small):** Handled by the individual **port or oil facility** (Up to 700 tonnes).
    - **Tier 2 (Medium):** Requires regional resources/**District administration** (700 to 10,000 tonnes).
    - **Tier 3 (Large):** Becomes a National Disaster, handled by the **ICG** and National Authorities (Over 10,000 tonnes).
  - **Enhanced Chemical Preparedness:** With the increase in chemical transport, there is a heightened focus on **Hazardous and Noxious Substances (HNS)**.

- **Dispersant Policy:** New chemical dispersants were approved in 2024, focusing on **"low-toxicity" variants** to minimize the impact on marine life compared to older chemical standards.
- **Inclusion of Offshore Wind Farms:** It includes specific response protocols for the burgeoning offshore wind energy sector in India's **Exclusive Economic Zone (EEZ)**.

▪ **Institutional Framework:**

Entity	Role under NOS-DCP
Indian Coast Guard (ICG)	**Indian Coast Guard (ICG)** serves as the **Central Coordinating Authority** and maintains the **National Inventory** of pollution response equipment.
Directorate General of Shipping	Handles **legal issues**, ship-related regulations, and salvage operations.
INCOIS (Hyderabad)	Provides **"Oil Spill Trajectory" models** to predict where the oil will drift based on wind and currents.
Ministry of Environment (MoEFCC)	Identifies and prioritizes "**Environmentally Sensitive Areas**" (ESAs) for protection.

Major Exercise: The ICG conducted the **10th National Level Pollution Response Exercise (NATPOLREX-X)** off the coast of **Chennai** in October 2025 to test the efficiency of **inter-agency coordination** between the ICG, coastal states, and international observers (from 32 countries).

National Technology Day: Committed to making U.P. India's 'Deep Tech Capital', says Yogi Adityanath

CM Yogi Adityanath commits to make U.P. as India's 'Deep Tech Capital' adding that the state is emerging as a leading hub in IT parks, start-ups and manufacturing today

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Why In News?

India observes **National Technology Day** every year on **May 11** to commemorate the anniversary of the **1998 Operation Shakti (Pokhran-II)** nuclear tests.

About National Technology Day

Origin

- Former Prime Minister **Atal Bihari Vajpayee** declared **National Technology Day** in **1999**.
- Celebrated annually on **May 11** to honor the contributions of **scientists, engineers, and technologists** towards national development.
- The day honors the successful **Pokhran-II nuclear tests** (code-named **Operation Shakti**) which the **Indian Army** and scientists conducted on **May 11, 1998**.

Theme and Focus for 2026

T**heme**: **"Responsible Innovation for Inclusive Growth"**. The theme highlights the **ethical and sustainable use of technology** and aims to bridge **rural-urban economic gaps**.

Key focus areas include **Responsible Artificial Intelligence (AI)**, **inclusive healthcare**, **agriculture innovation**, and **digital governance** to ensure technology benefits every citizen.

India's Current Technological Achievements

Global Innovation and Startup Ecosystem

India secures the **38th position in the Global Innovation Index 2025** and ranks **6th in global intellectual property (IP) filings**.

World's **3rd largest startup ecosystem**, over **2 lakh recognised startups** as of December 2025, with nearly half emerging from Tier-II and Tier-III cities.

Government funds research through the **₹1 Lakh crore Research, Development and Innovation (RDI) Scheme** to incentivize private sector participation in deep-tech and sunrise sectors.

Established the **Anusandhan National Research Foundation (ANRF)** to transform the R&D ecosystem and fund high-impact research areas.

Space Exploration and Deep Sea Missions

ISRO achieved a historic milestone in 2023 when the **Chandrayaan-3** mission soft-landed near the lunar south pole at **Shiv Shakti Point**.

In **2025**, India became the 4th nation to master space docking via the **SpaDeX mission**.

Wing Commander **Shubhanshu Shukla** became the first Indian on the **International Space Station (ISS)** in 2025, conducting microgravity research during the **Axiom-4 mission**.

ISRO and NASA launched the **NISAR satellite** in **2025**, the world's first dual-frequency synthetic aperture radar for disaster management and earth observation.

Future plans include the **Gaganyaan** crewed space mission and deep-sea exploration at 6,000 metres using the indigenous **MATSYA submersible**.

Semiconductors and Indigenous Microprocessors

The Union Budget 2026–27 introduced **India Semiconductor Mission (ISM) 2.0** with a ₹1,000 crore provision to push for semiconductor self-reliance and achieve advanced **3-nanometre and 2-nanometre technology nodes by 2029**.

Tata Electronics is building India's first commercial semiconductor fab in **Dholera, Gujarat**.

Centre for Development of Advanced Computing (C-DAC) launched **DHRUV64**, a fully indigenous 64-bit microprocessor based on the open-source **RISC-V architecture**, designed to power 5G infrastructure and IoT devices securely.

Nuclear Capabilities and Defence Indigenisation

India advances its **Three-Stage Nuclear Power Programme** as the **Prototype Fast Breeder Reactor (PFBR)** at Kalpakkam nears completion, aiming to tap extensive **thorium reserves**.

The **Indian Navy** solidified India's **Nuclear Triad** with successful deterrence patrols by the **INS Arihant**.

Defence indigenization continues with the **Tejas LCA**, the **INS Vikrant** carrier commissioning, and enhancements to the **BrahMos cruise missile**.