Orbital Computing

Mains: *GSIII – Science and Technology*

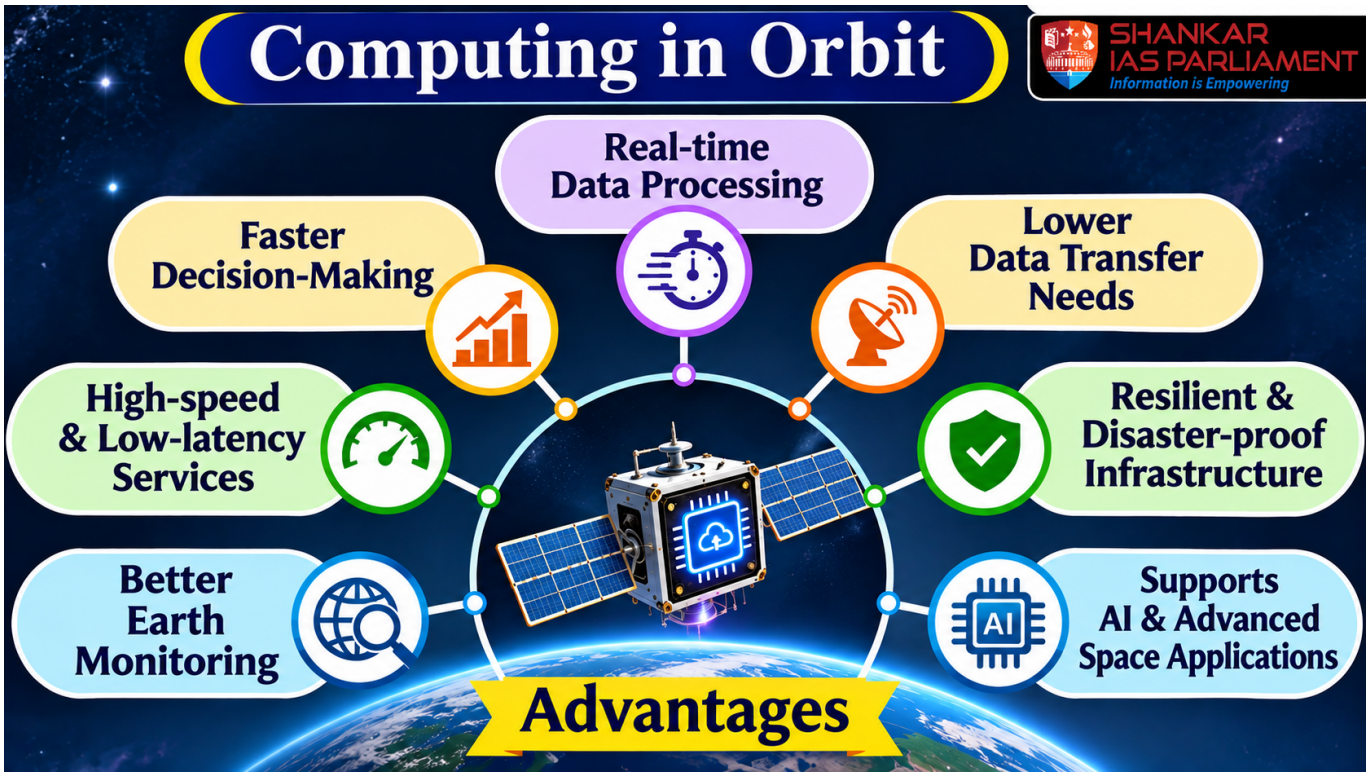
Why in News?

Orbit computing or computing in orbit can reduce data transmission delays, improve decision-making and enable shared computing resources in space.

What is Computing in Orbit?

- **Computing in orbit** – It refers to processing and analysing data directly onboard satellites instead of transmitting all raw data to ground stations.
- It uses onboard computers and Artificial Intelligence (AI) to identify, filter and transmit only relevant information.
- **Aim** – To transform individual satellites into interconnected, distributed computing systems.

What are the Applications of Computing in Orbit?



- **Disaster Management** – AI can identify flood-affected areas, damaged infrastructure and submerged roads, transmitting critical information quickly to response teams.

- **Maritime Monitoring** – Enables identification and tracking of ships in specific maritime regions.
- **Precision Agriculture** – Analyses crop health and agricultural conditions using satellite imagery.
- **Earth Observation** – Filters images affected by cloud cover and prioritises important observations for faster analysis.
- **Distributed Space Computing** – Satellites can communicate through optical inter-satellite links, sharing data and computing tasks to form interconnected computing networks.
- **Existing Developments** – Advancements in onboard computing and storage are enabling increasingly complex data processing in space.
    - European Space Agency's Phi-Sat-1 – Demonstrated the use of AI to select Earth-observation images for further analysis on the ground.

What is Computing Resources as a Service?

• Similar to cloud computing on Earth, computing resources could be offered as an on-demand service onboard operational satellites.
• Researchers, universities, start-ups and businesses could access satellite computing facilities without building and launching their own satellites.
• **Potential Benefits** –
- Reduces the cost of accessing space-based computing infrastructure.
- Encourages innovation and wider participation in space technology.
- Enables researchers to test AI models using satellite datasets and onboard processing facilities.
• **Prerequisites** –
- Reliable computing infrastructure and standardised software interfaces.
- Adequate computing capacity, cybersecurity and affordable service costs.

What are the Challenges of Computing in Orbit?

- **Power Constraints** – Satellites depend on solar panels and batteries, requiring computing systems to share *limited onboard energy resources.*
- **Thermal Management** – Absence of air in space makes heat dissipation difficult, requiring specialised thermal management systems.
- **Radiation and Temperature Extremes** – Electronic components must withstand radiation exposure and extreme temperature variations.
- **Hardware Reliability** – Satellite components are difficult to repair or replace, requiring redundancy and error detection and recovery mechanisms.
- **High Economic Costs** – Satellite construction, launch expenses, power generation and limited servicing increase operational costs.
- **Technological Limitations** – Space-qualified processors, secure software and reliable communication systems are essential for successful deployment.

India's Potential in Orbital Computing

• India has established capabilities in satellite technology, launch vehicles and space-based applications.
• **Indian Space Policy 2023** – Provides opportunities for private sector participation in space technology development.
• **IN-SPACe** – Facilitates and promotes private sector participation in India's space ecosystem.

What is the Way Forward?

- **Increase investments in indigenous** space-qualified processors and computing systems.
- **Strengthen research**, testing infrastructure and in-orbit technology demonstrations.
- **Promote collaboration among ISRO**, private companies, academic institutions and end users.
- **Develop secure,** standardised and affordable space-based computing services.

What lies ahead?

- Orbital computing can transform satellites from data-collection platforms into intelligent processing systems.
- Its wider adoption requires technological reliability, economic viability and stronger public-private collaboration, enabling India to emerge as a contributor to global space infrastructure.

Reference

The Hindu| Orbital computing could let scientists rent ‘brainpower’ in space

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