Atomic Clocks for One-Nation, One-Time

Source: LM

Why in News?

India aims to **deploy its own atomic clocks** across the nation, to enhance its **timekeeping infrastructure and national defence capabilities** for the future.

- The deployment of atomic clocks across India **aims to synchronise all digital devices with** Indian Standard Time (IST)**,** ensuring uniformity.
    - These atomic clocks are being installed by the **National Physical Laboratory (NPL) under the Ministry of Science and Technology and the Ministry of Consumer Affairs.**

What are Atomic Clocks?

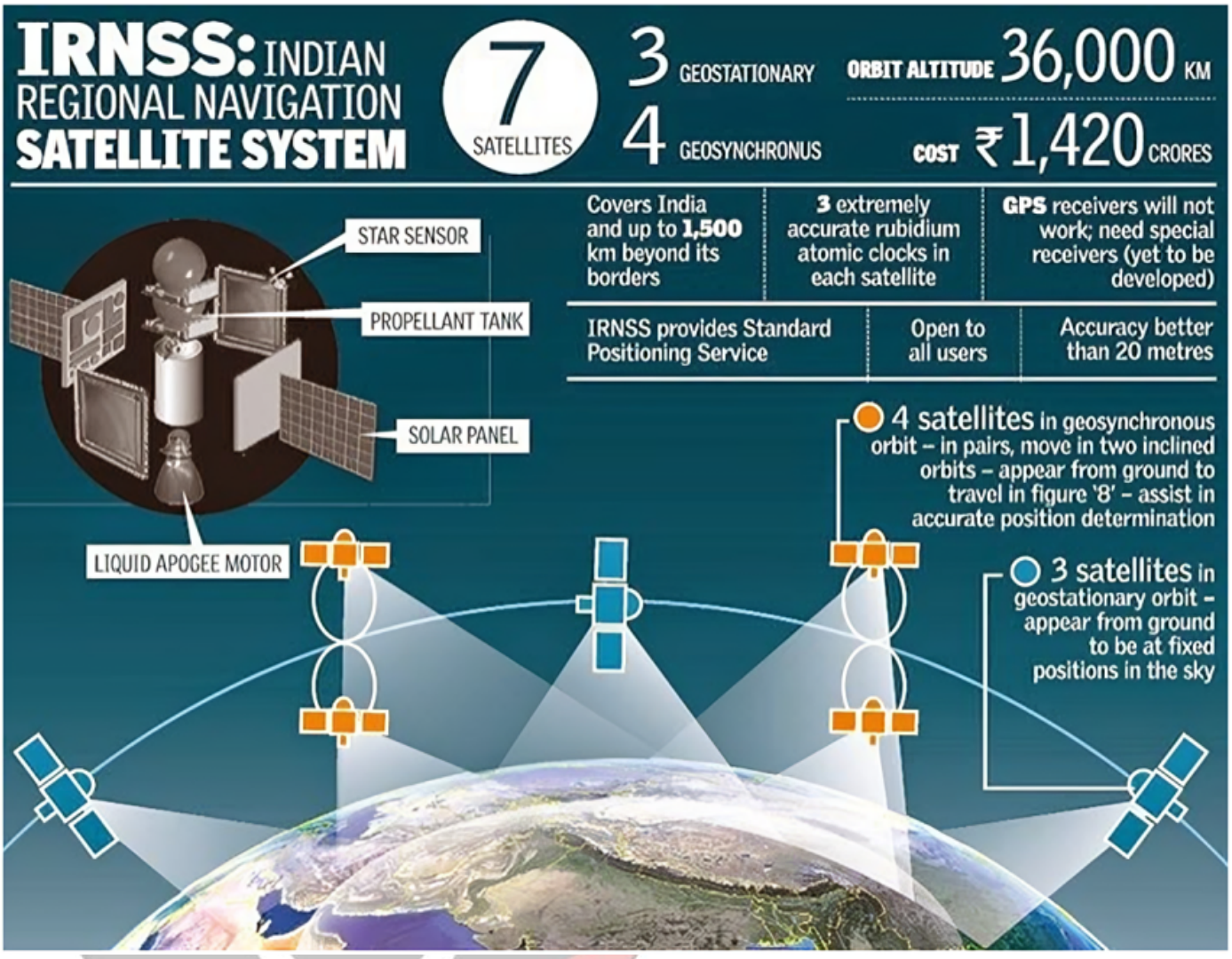
- **About:**
    - An atomic clock, is a clock, known for its **exceptional accuracy,** and functions by **utilising specific resonance frequencies of atoms, typically** cesium or rubidium.
    - It was invented in **1955** by **Louise Essen.**
    - The **extreme precision levels** of the atomic clocks can be interpreted by the fact that they will lose one second approximately every 100 million years.
    - **Currently, atomic clocks in India** are operational in Ahmedabad and Faridabad.
- **Types of atomic clock:**
    - Most commonly used are the **cesium atomic beam, the hydrogen maser**, and the **rubidium gas cell.**
    - The **cesium clock has high accuracy and good long-term stability.** The **hydrogen maser has the best stability** for periods of up to a few hours.
- **Working of Atomic Clocks:**
    - The electronic components of atomic clocks are governed by microwave electromagnetic radiation **(EM)**. Maintaining this radiation's precise frequency is essential to **induce quantum transitions in cesium or rubidium atoms.**
    - The quantum transition **(energy change)** of cesium or rubidium atoms is induced solely when the radiation is maintained at an exceptionally specific frequency.
    - In an atomic clock, **these quantum transitions are then observed and maintained in a feedback loop.** The waves generated in these quantum transitions are **then counted to arrive at the value of a second.**

Why is India Developing its Atomic Clocks?

- **Background:**
    - This initiative was started due to the **denial of** Global Positioning System (GPS) **information during the Kargil War.** The existence of **independent timekeeping capabilities** is crucial for **defence, cybersecurity, and online transactions.**
- **Need for Enhanced Security Measures:**
    - Efforts are underway to **connect atomic clocks via optical cables** to bolster security against **potential disruptions during emergencies** or wartime, complementing satellite-

based time dissemination.

- India is developing its atomic clocks to **reduce reliance on foreign atomic clocks,** especially for **critical infrastructure** like the **Indian Regional Navigation Satellite System (IRNSS),** also known as **NavIC.**
    - Developing indigenous atomic clocks allows India to have **complete control over its navigation systems,** which is vital for both **national security and technological independence.**



Read More- ISRO's new NavIC Satellite

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims:

Q.1 Which one of the following countries has its own Satellite Navigation System? (2023)

a. Australia
b. Canada
c. Israel
d. Japan

Ans: d

- Navigation Systems Operational in the World:
    - GPS from the U.S.

    - GLONASS from Russia.
    - Galileo from the European Union
    - BeiDou from China.
    - NavIC from India
    - QZSS from Japan.
- **Hence, option D is correct.**

Q.2 With reference to the Indian Regional Navigation Satellite System (IRNSS), consider the following statements: (2018)

1. IRNSS has three satellites in geostationary and four satellites in geosynchronous orbits.
2. IRNSS covers the entire India and about 5500 sq. Km beyond its borders.
3. India will have its own satellite navigation system with full global coverage by the middle of 2019.

Which of the statements given above is/are correct?

(a) 1 only
(b) 1 and 2 only
(c) 2 and 3 only
(d) None

Ans: (a)

Mains:

Q. Why is Indian Regional Navigational Satellite System (IRNSS) needed? How does it help in navigation? **(2018)**