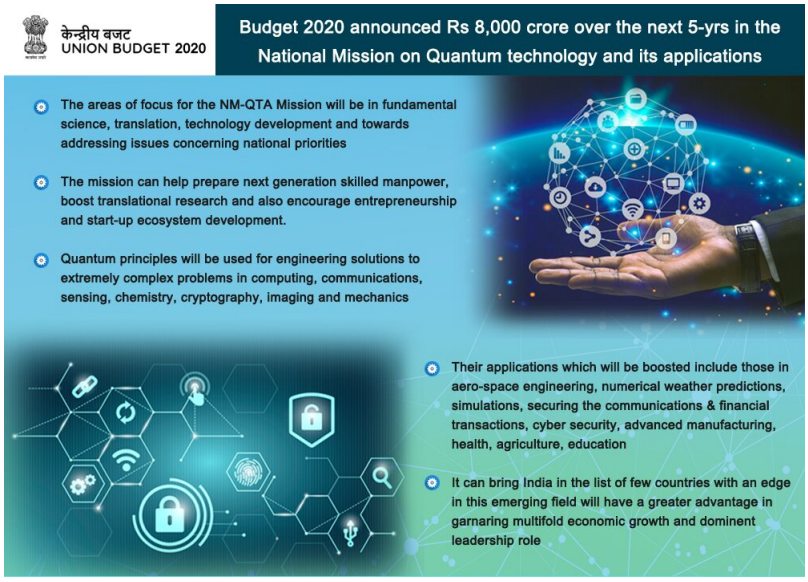
Quantum Technology

Why in News

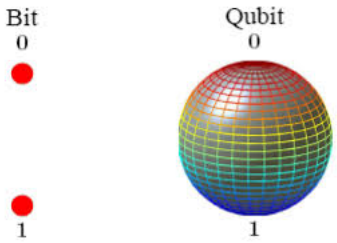
The detailed project report for a **National Mission on Quantum Technology and Applications (NMQTA)** has been drawn out and finalised.

- **Union Budget 2020-21 proposed** to spend **Rs 8,000 crore** on the newly launched **NMQTA.**
- In 2018, the **Department of Science & Technology** unveiled a programme called **Quantum-Enabled Science & Technology (QuEST)** and committed to investing Rs. 80 crore over the next three years to accelerate research.
    The mission **seeks to develop quantum computing linked technologies amidst the second quantum revolution** and make **India the world's third-biggest nation in the sector** after the US and China.



Key Points

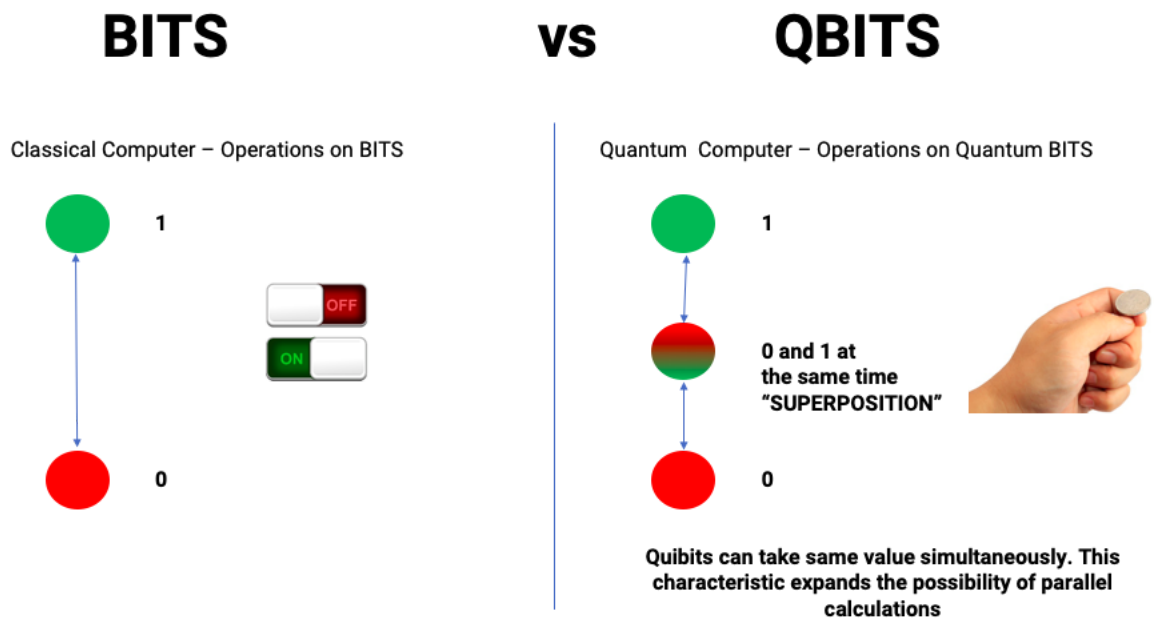
- **About Quantum Technology/Computing:**
    - Quantum Technology is **based on the principles of Quantum mechanics that was developed in the early 20th century** to describe nature at the scale of **atoms and elementary particles.**
    - The first phase of this revolutionary technology has **provided the foundations of our understanding of the physical world, including the interaction of light and matter,** and led to ubiquitous inventions such as **lasers and semiconductor transistors.**
    - A second revolution is currently underway with the **goal of putting properties of quantum mechanics in the realms of computing.**
- **Difference Between Conventional and Quantum Computing:**
    - **Conventional computers** process information in **'bits' or 1s and 0s,** following classical physics under which our computers can process a '1' or a '0' at a time.
    - **Quantum computers** compute in **'qubits' (or quantum bits).** They exploit the properties of quantum mechanics, the science that governs how matter behaves on the atomic scale.
        - In this scheme of things, processors can be a 1 and a 0 simultaneously, a state called quantum superposition.
        - Because of quantum superposition, a quantum computer — if it works to plan — can **mimic several classical computers working in parallel.**



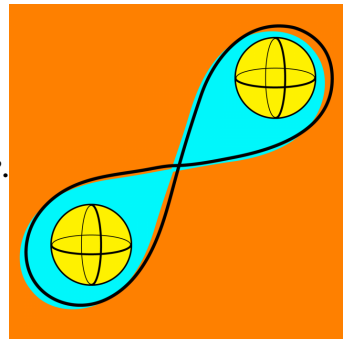
- **Properties of Quantum Computing:**

  The basic properties of quantum computing are s**uperposition, entanglement, and interference.**

  - **Superposition:**
    - It is the ability of a quantum system to be in **multiple states simultaneously.**
    - The example of superposition is the flip of a coin, which consistently lands as heads or tails—a very binary concept. However, when that coin is in mid-air, it is both heads and tails and until it lands, heads and tails simultaneously. Before measurement, the electron exists in quantum superposition.



  - **Entanglement:**
    - It means the two members of a pair (Qubits) exist in a single quantum state. Changing the state of one of the qubits will instantaneously change the state of the other one in a predictable way. This happens even if they are separated by very long distances.
    - Einstein called spooky **'action at a distance'.**



  - **Interference:**

    Quantum interference states that elementary particles(Qubits) can not only be in more than one place at any given time (through superposition), but that an individual particle, such as a photon (light particles) can cross its own trajectory and interfere with the direction of its path.

- **Applications of Quantum Technology:**
  - **Secure Communication:**
    - **China recently demonstrated** secure quantum communication links between terrestrial stations and satellites.
    - This area is **significant to satellites, military and cyber security** among others as it promises unimaginably fast computing and safe, unhackable satellite communication to its users.
  - **Research:**
    - It can **help in solving some of the fundamental questions in physics related to gravity, black hole etc.**
    - Similarly, the quantum initiative could give a big boost to the **Genome India project**, a collaborative effort of 20 institutions to enable new efficiencies in life sciences, agriculture and medicine.
  - **Disaster Management:**
    - **Tsunamis**, **drought**, **earthquakes** and **floods** may become more predictable with quantum applications.
    - The collection of data regarding **climate change** can be streamlined in a better way through quantum technology.
  - **Pharmaceutical:**

    Quantum computing **could reduce the time frame of the discovery of new molecules and related processes** to a few days from the present 10-year slog that scientists put in.
  - **Augmenting Industrial revolution 4.0:**
    - Quantum computing is an integral part of **Industrial revolution 4.0.**
    - Success in it will help in **Strategic initiatives aimed at leveraging other Industrial revolution 4.0 technologies** like the **Internet-of-Things**, machine learning, **robotics**, and **artificial intelligence** across sectors will further help in laying the foundation of the Knowledge economy.
- **Challenges Associated with Quantum Computing:**
  - The dark side of quantum computing is the **disruptive effect that it can have on cryptographic encryption, which secures communications and computers.**
  - It might pose a challenge for the government also because if this technology goes into wrong hands, all the **government's official and confidential data will be at a risk of being hacked and misused.**

Way Forward

- Long after the birth of social media and artificial intelligence, there are now demands to regulate them. **It would be prudent to develop a regulatory framework for quantum computing before it becomes widely available.**
- It will be better to **regulate it or define the limits of its legitimate use, nationally and internationally** before the problem gets out of hand like nuclear technology.

Source:TH