National Quantum Mission (NQM)

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National Quantum Mission Governing Board (MGB) conducted its first meeting to discuss the implementation strategy and timelines of NQM.

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About National Quantum Mission (NQM):

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- India has recognized the importance of quantum technology and launched a national mission

which covers **four verticals**: Quantum Computing & Simulations, Quantum Communications, Quantum Sensing & Metrology, and Quantum Material & Devices.
- The mission is implemented by **Department of Science and Technology (DST)** with a total outlay of Rs. 6003.65 Crore for eight years, covering the period from **2023-24 to 2030-31**.

Mission Objectives:

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- The objective is to **seed, nurture, and scale up** scientific and industrial R&D in Quantum

Technology (QT) to make India a leader in Quantum Technologies & Applications (QTA).
- Targets include developing **intermediate-scale quantum computers** with 50-1000 physical qubits in 8 years, utilizing platforms like **superconducting** and **photonic technology**.
- Mission also focuses on satellite-based secure quantum communications, long-distance secure quantum communications, inter-city quantum key distribution, and **multi-node Quantum networks** with **quantum memories**.

Focus Areas for Development:

- NQM emphasizes the **development of high-sensitivity magnetometers** in **atomic systems** and Atomic Clocks for precision timing, communications, and navigation.
- Support for the design and synthesis of **quantum materials**, including superconductors, novel semiconductor structures, and topological materials for **quantum device fabrication**.
- Development of single **photon sources/detectors** and **entangled photon sources** for applications in quantum communications, sensing, and metrology.

Mission Implementation:

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- **Four Thematic Hubs (T-Hubs)** will be established in top academic and National R&D institutes,

focusing on Quantum Computing, Quantum Communication, Quantum Sensing & Metrology, and Quantum Materials & Devices.
- The T-Hubs will engage in **basic and applied research**, promoting R&D in their designated areas.

Mission Coordination Cell (MCC):

- The MCC will be established as a **coordinating agency for the Mission**, working in coordination with the Mission Secretariat, DST.
- MCC will function under the overall supervision and guidance of the **Mission Technology Research Council (MTRC).**

Impact and Applications:

- NQM is expected to **elevate the country's Technology Development** ecosystem to global competitiveness.
- The Mission is anticipated to **benefit various sectors**, including communication, health, finance, and energy, with applications in drug design, space, banking, security, etc.
- It **aligns with National priorities** such as Digital India, Make in India, Skill India, Stand-up India, Start-up India, Self-reliant India, and Sustainable Development Goals (SDG).

Potential Benefits:

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- The Mission holds the potential to significantly benefit sectors like **communication, health,**

finance, and energy.
- It **aligns with various national priorities and goals**, providing a boost to initiatives like Digital India, Make in India, Skill India, Stand-up India, Start-up India, Self-reliant India, and Sustainable Development Goals (SDG).

About Quantum technology:

- Quantum technology encompasses a broad range of technologies that **leverage the principles of quantum mechanics**, the fundamental theory of physics that describes the behavior of matter and energy at the smallest scales.
- Unlike classical physics, which governs the behavior of everyday objects, quantum mechanics introduces unique phenomena such as **superposition and entanglement**, which form the basis for **various quantum technologies**.

key aspects of quantum technology:

Quantum Computing:

- Quantum computers use **quantum bits**, or qubits, to represent information.
- Unlike classical bits that can be in a state of 0 or 1, **qubits can exist in a superposition** of both **states simultaneously**.
- This property allows quantum computers to **perform certain types of calculations** much **more efficiently** than classical computers, particularly for tasks like factoring large numbers and solving complex optimization problems.

Entanglement:

- Entanglement is a quantum phenomenon **where two or more particles** become correlated in such a way that the **state of one particle is directly related** to the **state of another**, regardless of the distance between them.
- This property is used in quantum communication and quantum computing.

Quantum Tunneling:

- Quantum tunneling **allows particles to pass through energy barriers** that classical objects would not be able to overcome.
- This property is relevant in the design of certain quantum devices and sensors.

Quantum Communication:

- Quantum communication exploits the principles of quantum mechanics to **enable secure communication.**
- **Quantum key distribution (QKD)** is a prominent example, where quantum properties are used to **exchange cryptographic keys securely**.
- The security of quantum communication is based on the principles of quantum mechanics, making it theoretically immune to certain types of eavesdropping.

Quantum Sensing and Metrology:

- Quantum sensors can achieve **unprecedented levels of precision** in measuring physical quantities.
- Quantum-enhanced sensors are being developed for applications such as **ultra-precise timekeeping**, **magnetic field measurements**, and **gravitational wave detection**.

Quantum Imaging:

- Quantum technologies can **enhance imaging capabilities** by exploiting quantum properties.
- Quantum imaging techniques aim to **improve sensitivity, resolution, and efficiency** in various imaging applications, including medical imaging, microscopy, and remote sensing.

Quantum Materials:

- Researchers are exploring materials with **unique quantum properties** for various applications.
- Quantum materials are crucial for building components in quantum devices, such as qubits for quantum computers or detectors for quantum sensors.

Quantum Cryptography:

- Beyond quantum key distribution, other **cryptographic protocols** based on **quantum principles** are being explored to **enhance the security** of information transmission and storage.

