INDIA'S QUANTUM FUTURE - SCIENCE & TECHNOLOGY

Why in News?

India launched National Quantum Mission last year.
National Quantum Mission

About:

- It'll be implemented by **the Department of Science & Technology (DST)** under the Ministry of Science & Technology.
- The mission **planned for 2023-2031** aims to seed, nurture, and scale up scientific and industrial R&D and create a vibrant & innovative ecosystem in **Quantum Technology (QT).**
- With the launch of this mission, **India will be the seventh country to have a dedicated quantum mission** after the US, Austria, Finland, France, Canada and China.

Salient features of NQM:

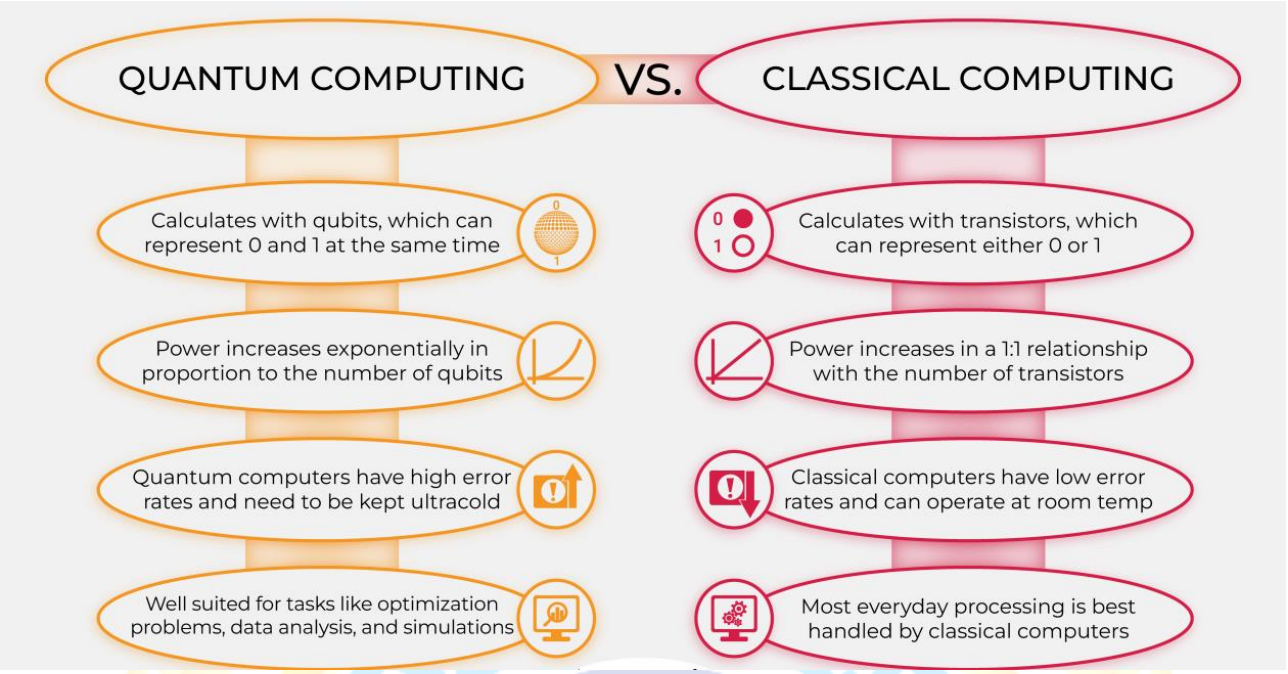
- It will target developing **intermediate scale quantum computers with 50-100 physical qubits in 5 years** and **50-1000 physical qubits in 8 years.**
- Just like bits (1 and 0) are the basic units by which computers process information, **'qubits' or 'quantum bits' are the units of process by quantum computers.**
- The mission **will help develop magnetometers** with high sensitivity for precision timing (atomic clocks), communications, and navigation.
- It will also support design and synthesis of quantum materials such as **superconductors, novel semiconductor structures** and topological materials for **fabrication of quantum devices.**
- The mission will also help developing:
- **Satellite based secure quantum communications** between ground stations over a range of 2000 km within India.
- **Long distance secure quantum communications** with other countries
- **Inter-city quantum key distribution** over 2000 km
- **Multi-node Quantum network** with quantum memories
- **Four Thematic Hubs (T-Hubs)** would be set up in top academic and National R&D institutes on the domains of Quantum Technology:
- **Quantum computation**
- **Quantum communication**
- Quantum Sensing & Metrology
- Quantum Materials & Devices

Significance:

- This will **accelerate QT led economic growth** and make India one of the leading nations in the development of Quantum Technologies & Applications (QTA) ranging from healthcare and diagnostics, defence, energy and data security.
- It will work towards **indigenously building quantum-based computers which are far more powerful** and are able to solve the most complex problems in a highly secure manner.
- **Quantum technology** is a field of science and engineering that deals with the principles of quantum mechanics, which is the study of the behaviour of matter and energy at the smallest scale.
- Quantum mechanics is the branch of physics that describes the behavior of matter and energy at the atomic and subatomic level.

Advantages of Quantum Technology

- **Increased Computing Power:** Quantum computers are very much **faster than the computers we today have.** They also have the capability to solve complex problems that are currently beyond our reach.
- **Improved Security:** Because they rely on principles of quantum mechanics, **quantum encryption techniques are much more secure** than traditional encryption methods.
- **Faster Communication:** Quantum communication networks **can transmit information faster and more securely** than traditional networks, with the potential for completely unhackable communication.
- **Enhanced AI:** Quantum machine learning algorithms can potentially enable **more efficient and accurate training of Artificial Intelligence models.**
- **Better Sensing and Measurement:** Quantum sensors can detect extremely small changes in the environment, making **them useful in areas such as medical diagnostics, environmental monitoring, and geological exploration.**


QUANTUM COMPUTING
VS.
CLASSICAL COMPUTING
Calculates with qubits, which can represent 0 and 1 at the same time
Calculates with transistors, which can represent either 0 or 1
Power increases exponentially in proportion to the number of qubits
Power increases in a 1:1 relationship with the number of transistors
Quantum computers have high error rates and need to be kept ultracold
Classical computers have low error rates and can operate at room temp
Well suited for tasks like optimization problems, data analysis, and simulations
Most everyday processing is best handled by classical computers