Quantum Technology and India

This editorial is based on **"A Four-Point Action Plan For Quantum Technologies"** which was published in Hindustan Times on 14/01/2022. It talks about the steps that India can take to move ahead in adopting quantum technology.

For Prelims: Quantum Technology and its applications, Semiconductor and its applications, Qubits, Quantum-Enabled Science & Technology (QuEST), National Mission for Quantum Technologies and Applications (NM-QTA), Quantum Key Distribution (QKD).

For Mains: Challenges to adopting quantum technology, India's initiatives for quantum technology adoption, applications of quantum technology.

In recent years, the global quantum industry has taken incredible strides and seen massive investments made by both governments and the private sector.

Countries like the US, France, Germany, China and Russia have already been investing resources and human capital on **Quantum Technology** since the last decade, however, India may have to work overtime to bridge the gap in its bid to gain supremacy in this field.

While much progressive is not what India has done in the field of quantum tech yet, it is better late than never. India's willingness to be at par with other technologically advanced countries can be seen via the announcement of the **National Mission for Quantum Technologies and Applications (NM-QTA).**

Quantum Technology

- **About:** 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 understanding of the physical world** and led to ubiquitous **inventions such as lasers and** semiconductor transistors**.**
    - The second revolution is currently underway with the goal of putting properties of quantum mechanics in the realms of computing.
- **A Comparison between India and China:**
    - **R&D in China:** China started its research and development (R&D) in the field of quantum technology in 2008.
        - In 2022, China boasts of developing the **world's first quantum satellite,** creating a **quantum communication line** between Beijing and Shanghai, and **owning two of the world's fastest quantum computers.**
        - This was a result of decade-long research carried out in the hope of achieving critical breakthroughs.

    - **India:** Quantum Technology remains a field highly concentrated in long-term R&D in India.
        - Just a few hundred researchers, industry professionals, academicians, and entrepreneurs are in the field right now without a constant focus on R&D.
- **Quantum Tech and Private Sector:** Large Technology Corporations such as **Google, Microsoft, and IBM** have dedicated programmes for **quantum computing and its applications.**
    - Similarly, several **Indian startups** such as QNu Labs, BosonQ, and Qulabs.ai are also **doing remarkable work in developing quantum-based applications** for cryptography, computing, and cybersecurity.
- **India's Related Initiatives**:
    - 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.
    - In the 2020 Budget speech, the Finance Minister of India announced the **National Mission for Quantum Technologies and Applications (NM-QTA)** with a **total outlay of ₹8000 crore** over five years for strengthening the quantum industry in the country.
    - In October 2021, the government also **inaugurated C-DOT's Quantum Communication Lab** and unveiled the **indigenously developed** Quantum Key Distribution (QKD) solution.

Challenges Associated

- **Slow Progress in Legislative Procedures:** Although the NM-QTA was announced in the 2020 Budget speech, the **mission has still not received any approval and no funds were allocated,** disbursed or utilised under NM-QTA during the FY 2020-21.
- **Limited Private Sector Involvement in NM-QTA:** The Union Minister of Science & Technology has also claimed that for the NM-QTA, **no private sector partners had been identified yet** and no one from outside the government had been tapped for consultations for the national mission.
    - The government must recognise the leaps made by these companies.
- **Security Related Issues:** Quantum computing can have a **disruptive effect on cryptographic encryption**, which secures communications and computers.
    - It might pose a challenge for the government also because if this technology goes into the wrong hands, all the **government's official and confidential data will be at risk** of being hacked and misused.
- **Technological Issues:** The challenge lies in harnessing the properties of quantum superposition in a **highly controlled manner.** The **qubits** **tend to be very fragile** and lose their **"quantumness"** if not controlled properly.
    - Also, a **careful choice of materials, design and engineering** is required to get them to work.
    - On the theoretical front lies the **challenge of creating the algorithms and applications** for quantum computers.

Way Forward

- **Better Policy Making and Regulations:** The focus should be to develop an overarching strategy for the next 10-15 years. The strategy must **ensure that there is no misallocation of resources** and that the efforts put in are concentrated in key areas that provide both economic and strategic benefits.
    - Additionally, **adequate attention to those who can contribute to developing quantum technology** must be the **government's top priority.**
    - It would also be prudent to develop a **regulatory framework for quantum computing** before it becomes widely available, **defining the limits of its legitimate use,** nationally and internationally.
- **Establishing Centres of Excellence**: The primary focus must be on establishing centres of excellence **dedicated to quantum science and technology** within academic institutions as well as government research institutes.
    - A majority of the Indian **government's outlay has to be pumped into such institutions** specialising in quantum R&D. This can pay dividends in two ways:
        - It will **help create crucial intellectual property (IP) infrastructure** that can be used for the country's benefit.

        - The focus on research and academia will also **improve the talent pool** and strengthen the domestic quantum technology workforce.
- **Centre-State Coordination:** The state governments can **play an integral role in setting up semiconductor fabs** in the near future, quantum tech can benefit immensely from these domestic manufacturing facilities and units.
    - The **joint establishment of "quantum innovation hubs"** by Centre and states can help direct investments efficiently and **build a well-connected quantum research network** in the country.
    - The central and state governments should **establish a conducive fiscal and legal environment to foster innovation** and attract international firms while **involving local talent.**
- **Private Sector Involvement:** The power of startups and Big Tech corporations involved in developing quantum technology and applications must be harnessed.
    - While academic institutions are largely involved on the research side, quantum tech corporations and **startups are vital in converting and commercialising this research into applications** or products that can be of use.
    - Facilitations must be made by the government to **connect academic institutions and industry** to translate research into real-world applications.
- **International Cooperation:** The quantum value chain remains highly complicated and it will be **hard for India to remain self-reliant** to build a successful quantum ecosystem.
    - **Quantum technology agreements with the US, Australia, Canada, UK** and others should serve as a base for India to pursue a joint effort on projects related to quantum technologies.
        - India can also **pursue engagement with its allies** in key groupings such as Quad **and** BRICS.

Conclusion

The Government of India has taken the first step by acknowledging the importance of quantum technologies through its plan of kick-starting a national mission in the country. However, more needs to be done in the field of R&D and ensuring active participation from the private sector and academia, for which bilateral and multilateral partnerships can be leveraged.

Drishti Mains Question

Discuss the steps that India can take to establish a suitable ecosystem for adoption of quantum technology and its applications within the country.
