Brief on Strengthening Quantum Applications Ecosystem in India

Redefining what's possible with quantum technology

An Ardent Co. submission

Ardent Co. is a multi-disciplinary advisory leveraging communications, research and public policy advisory for enabling purpose-driven interventions.

Background

The Department of Science & Technology (DST), which operates under the Ministry of Science & Technology, will be responsible for implementing **the National Mission for Quantum Technologies and Applications (NM-QTA)** between 2023-24 and 2030-31.

The mission involves a cost **of ₹ 6,003.65 crore** for the mentioned period. The goal of this initiative is to initiate, cultivate, and expand scientific and industrial research and development, and create a dynamic and inventive environment for Quantum Technology.

The following are the watershed moments depicting the trajectory of growth and development of Quantum Technology and Applications in India.

- **The Department of Science & Technology** launched a program named **Quantum-Enabled Science & Technology (QuEST)** in 2018, with a commitment to invest Rs. 80 crores over the next three years to expedite research.

- **The Finance Minister of India** announced the **National Mission for Quantum Technologies and Applications (NM-QTA)** in the 2020 Budget speech with a total allocation of **₹8000 crore** over five years to strengthen the quantum industry in the country.

- Additionally, in October 2021, the government inaugurated C-DOT's **Quantum Communication Lab** and unveiled a **Quantum Key Distribution (QKD)** solution that was developed indigenously. **The Ministry of Electronics and Information Technology (MeitY) partnered with Amazon Web Services (AWS)** to create the **Quantum Computing Applications Lab**, aimed at facilitating quantum computing-based research and development and promoting scientific advancements.

Economic and social manifestations globally

The United States

Quantum information technology has demonstrated its proficiency in tackling complex problems where classical computers may be capable of verifying a solution but struggle to identify the exact answer from among billions of potential solutions.

Given that public sector officials encounter such demanding challenges on a regular basis, quantum information technology is starting to offer genuine potential not only for solving problems but also for enhancing people's quality of life.

For instance, **Groovenauts**, a company based in Japan, employed machine learning powered by quantum computing to enhance the optimization of garbage collection routes in Tokyo. According to their pilot study, the use of quantum technology resulted in a substantial increase in efficiency and even demonstrated the potential for a nearly 60% decrease in carbon emissions.

In 2022, the US Federal investment in quantum technology accounted for less than 9% of the total quantum information technology market, despite nearly doubling the figure from two years ago. Furthermore, the industry as a whole is expanding at a **much quicker rate of 30.2% CAGR.** At this pace, by the time the market reaches an estimated worth of US$44 billion in 2028, direct public spending will be even less significant.

China

China initiated its research and development (R&D) efforts in quantum technology in 2008, and as of 2022, the country can claim several impressive achievements in this field. These include the development of the world's first quantum satellite, the establishment of a quantum communication line between Beijing and Shanghai, and ownership of two of the world's swiftest quantum computers. China has clearly emerged as one of the frontrunners in the space, largely owing to the government's active financial assistance. In 2022, the Chinese government allocated **$15.3 billion** in public funds for quantum computing investments, **which is more than double the amount invested by EU governments ($7.2 billion) and eight times the amount pledged by the United States ($1.9 billion).**

Economic and social manifestations in India

It is interesting to note that with the introduction of this mission, India will become the seventh country to establish a specialised quantum mission, following the United States, Austria, Finland, France, Canada, and China.

The initiative will accelerate QT led economic growth and make India one of the leading nations in the development of Quantum Technologies & Applications (QTA) in the following areas:

- Healthcare and diagnostics
- Defence
- Space and energy
- Data security

In other words, 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.

According to NASSCOM, India's plan suggests that the country will make significant progress in quantum infrastructure within the next five years, with the government playing a major role in its development.

The Indian government has planned to invest Rs. 8,000 crore (equivalent to US$1.2 billion) in quantum information and meteorology, quantum applications and materials, and quantum communications over the next five years. NASSCOM predicts that this investment will lead to a **45% increase in adoption of quantum technology** in industries such as manufacturing, high-tech, banking, and defence.

The quantum ecosystem in India is expanding rapidly with approximately 10-15 government agencies, 20-30 service providers, 15-20 startups, and 40-50 academic institutions currently involved in this field.

The Indian government's serious efforts to catch up with China and the US in the field of quantum technologies could lead to the adoption of such technologies contributing around **US$280 billion to US$310 billion to the Indian economy by 2030**.

The proposed initiative is in line with the national objectives such as **Digital India, Make in India, Skill India, Stand-up India, Start-up India, Self-reliant India, and the Sustainable Development Goals (SDG)**.

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Emerging trends

Prominent technology companies like Google, Microsoft, and IBM have established specialised programs focused on quantum computing and its potential applications. In a similar vein, several Indian startups, such **as QNu Labs, BosonQ, and Qulabs.ai**, are making notable contributions to the development of quantum-based applications related to cryptography, computing, and cybersecurity.

Additionally**, Tata Consultancy Services, HCL Technologies, Infosys, Tech Mahindra, Zensar, Mphasis, and Coforge**, along with some other companies are developing use cases and proof of concepts for clients using quantum technologies.

A couple of years ago, Horizon Quantum Computing, a company that is dedicated to creating software tools for quantum computers, secured additional funding in an extension of its initial funding round. The funding was led by **Sequoia Capital India**. Sequoia Capital India is a well-respected investor in the tech industry, and their involvement in this funding round is a strong vote of confidence in Horizon Quantum Computing's potential.

Similarly, in 2020, an Indian start-up QNu Labs raised funding from reputable venture capital firms like **Wavemaker Partners** and **Sequoia India**.

More importantly, India aims to develop a **50-qubit quantum computer by 2026**, while smaller quantum devices such as simulators and sensors are expected to be developed much earlier. Domain experts believe that India has the potential to become an appealing hub for quantum research and development, software creation, and manufacturing of components and equipment**.**

What you could discuss..

The following are **the list of recommendations** in order to facilitate growth of Quantum Technologies and Applications in India. The same has been categorised under three heads: Commercial ecosystem development, scientific and industrial research and development and quantum technology-led economic growth.

Commercial ecosystem development

According to NASSCOM, **the government is the primary supporter of quantum initiatives in India**, as about 92% of the 100 quantum projects initiated in the country are sponsored by the government. Therefore, the government must attempt to attract more private players. There is also **a critical requirement for creating a pool of skilled individuals** who can contribute to the quantum-applications ecosystem and drive the innovation and commercial growth of the sector. However, it's important to note that government is already undertaking projects in this direction, including propagating relevant courses in higher education setups.

Scientific industrial research and development

- **A comprehensive roadmap:** To ensure efficient and effective development of quantum technology in India, a comprehensive strategy must be established over the next 10-15 years, focusing on key areas that provide economic and strategic benefits.
- **Identification of significant players in the space:** Adequate attention must be given to those who can contribute to the development of quantum technology.
- **A well-defined regulatory framework**: A coherent regulatory framework must be established to define the legitimate use of quantum computing.
- **Centres of Excellence:** The Indian government should also prioritise establishing centres of excellence dedicated to quantum science and technology within academic institutions and government research institutes to strengthen the domestic quantum technology workforce and create crucial intellectual property infrastructure.

Quantum technology-led economic growth

- **State-Centre Partnership:** The central and state governments should collaborate to establish quantum innovation hubs and a conducive fiscal and legal environment to foster innovation and attract international firms while involving local talent.
- **Collaboration with private players:** The involvement of startups and Big Tech corporations is essential in converting research into real-world applications.
- **Multilateral engagements:** International cooperation with allies such as the US, Australia, Canada, UK, Quad, and BRICS should be pursued to build a successful quantum ecosystem.

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Bottom Line

India is making significant strides in the field of quantum technology and has committed significant resources to accelerate research and development and create a vibrant & innovative ecosystem. The country has launched programs such as **Quantum-Enabled Science and Technology (QuEST)** and **the National Mission for Quantum Technologies and Applications (NM-QTA)** with a total outlay of ₹8000 crore over five years. The Indian government has also initiated the **development of quantum communication labs** and unveiled indigenously developed **quantum key distribution (QKD) solutions**.

The focus must be on developing an overarching strategy for the next 10-15 years to ensure that the efforts put in are concentrated in key areas that provide both economic and strategic benefits. Furthermore, India plans to develop a quantum computer with about 50 qubits by 2026 and is expected to become an attractive destination for quantum R&D, software development, and component and equipment manufacturing. The adoption of quantum technologies in **India could potentially add US$280 to US$310 billion of value to the Indian economy by 2030**.

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