6. NITI Aayog & IBM Unveil Roadmap to Make India a Top-3 Quantum Economy by 2047- Economy

The NITI Aayog's Frontier Tech Hub, in partnership with International Business Machines-IBM, has released a national roadmap to transform India into one of the world's top-three quantum economies by 2047

Introduction

Quantum technology leverages the laws of quantum mechanics—superposition, entanglement, tunnelling—to build capabilities that are unattainable using classical physics. By 2035, quantum technologies are projected to create USD 1–2 trillion in global economic value across computing, defence, finance, pharmaceuticals, logistics, telecommunications, and precision manufacturing. India entered the global quantum race with the launch of the National Quantum Mission (NQM) in 2023, spanning 2023–24 to 2030–31, placing India among major quantum nations (US, EU, China, Japan).

National Quantum Mission (NQM)- Purpose and Scope

Objective- To seed, nurture, scale and industrialise quantum R&D and create an end-to-end quantum innovation ecosystem.

Mission Dimensions

1. Establish quantum labs, testbeds, and national facilities
2. Foster academia–industry collaboration
3. Build quantum computers of increasing qubit capacity
4. Promote quantum secure communication networks
5. Develop indigenous quantum materials and sensors
6. Strengthen IP creation and global competitiveness

Key Pillars of Quantum Technologies

Quantum Computing

Uses qubits, which can exist in multiple states simultaneously (superposition), enabling exponential speed-ups for certain problems.

Applications

1. Drug discovery and molecular simulation
2. Optimization problems in logistics and finance
3. Cryptography and code-breaking
4. Climate modelling and material discovery

Quantum Communication

Enables **ultra-secure** communication through Quantum Key Distribution (QKD) and entanglement-based protocols.

Interception becomes detectable due to quantum measurement principles.

Use Cases- Defence, banking, government communication, space-based QKD.

Quantum Sensing & Metrology

Uses quantum coherence and entanglement to achieve unprecedented measurement precision.

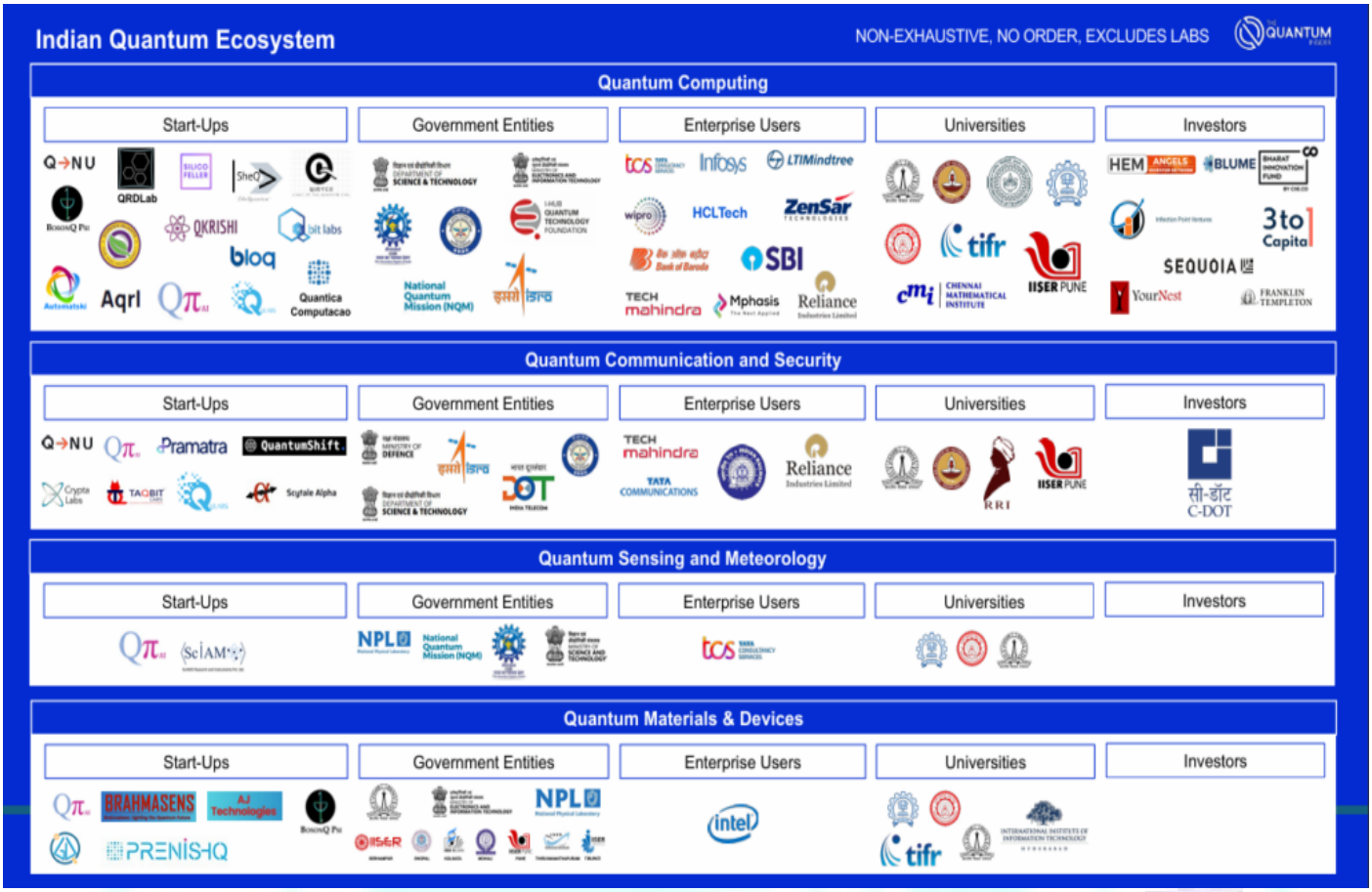
Examples

1. Atomic clocks (for satellite navigation, 5G/6G timing)
2. Quantum magnetometers (for medical imaging, mineral exploration)
3. Quantum gyroscopes (navigation without GPS)

Quantum Materials

Materials engineered to show quantum properties- high-temperature superconductors, topological materials, qubit substrates.

Critical for scalable quantum hardware.



India's Vision for Quantum Leadership by 2035

India envisions the following strategic outcomes- Create at least 10 quantum startups, each exceeding USD 100 million in valuation and revenue. Capture 50% of the global quantum software & services market, leveraging India's software leadership. Scaled deployment of quantum technologies across defence, telecom, space, energy, healthcare, weather prediction, and finance.

Command leadership in the global supply chain—chips, control systems, cryogenics, quantum networking tools.

Generate breakthrough fundamental research, producing globally competitive IP and scientific discoveries.

SWOT Analysis of India's Quantum Ecosystem

Strengths

Strong STEM talent pool and world-class mathematics–computer science base.
Large IT services and engineering sector capable of delivering quantum software globally.
Government initiatives like NQM, Digital India, and high R&D commitment in strategic technologies.
Growing ecosystem of quantum startups and incubators in Bengaluru, Pune, Chennai, Hyderabad.
Strong strategic support from DRDO, ISRO, MEITY, DST.

Weaknesses

Limited fabrication and deep-tech hardware manufacturing capabilities (e.g., cryogenics, superconducting circuits, photonic qubits).
Low private-sector R&D investment compared to global peers.
Shortage of specialised quantum engineers and hardware scientists.
Fragmented research ecosystem and slower lab-to-market transition.
Dependence on imports for scientific instruments and materials.

Opportunities

Rapidly expanding global market for quantum software and cybersecurity.
Possibility to leapfrog into new strategic domains- quantum internet, post-quantum cryptography, and quantum cloud services.
Geo-economic advantage as countries diversifies semiconductor and quantum supply chains away from single-country dependency.

Strong potential for public–private partnerships with global technology firms.
Applications across space tech, telecom, disaster management, agriculture modelling, and national security.

Threats

Aggressive quantum investments by China, US, and EU increasing geopolitical competition.
Export controls (e.g., US CHIPS Act, Wassenaar Arrangement) may restrict access to critical quantum components.
Brain drains due to better global opportunities and lack of domestic quantum hardware labs.
Vulnerability of digital infrastructure to quantum-enabled cyberattacks unless India adopts post-quantum cryptography (PQC) rapidly.

Steps Needed for India to Become a Quantum Economy

Expand the Quantum Workforce

Increase skill pipeline by an order of magnitude—scientists, engineers, cryogenic experts, quantum algorithm developers.
Establish national quantum training academies and fellowship programmes.
Integrate quantum computing modules in IITs, IIITs, IISc, and private universities.

Accelerate Lab-to-Market Transition

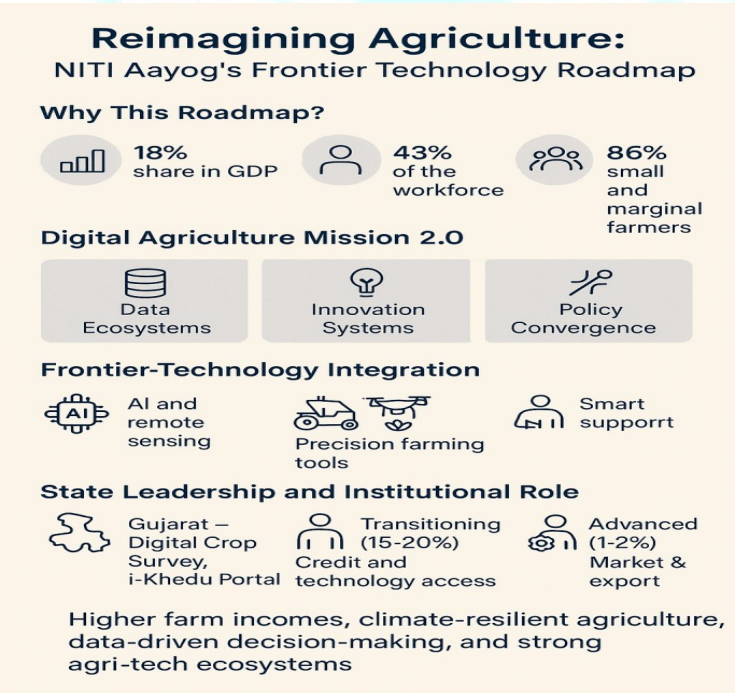
Simplify procurement and IP rules for research labs.
Provide shared testbeds for startups to validate quantum hardware.
Create quantum industrial parks with fabrication, cryogenics, and materials facilities.
Promote incentives similar to PLI for quantum hardware manufacturing.

Strengthen Domestic Start up Ecosystem

Ensure >90% deep-tech quantum startups remain domiciled in India.
Facilitate access to long-duration patient capital and government procurement pipelines.
Build export-friendly regulations to support global expansion.

Lead Global Standard Setting

Actively participate in ITU, ISO, IEEE quantum working groups.



Shape standards for QKD networks, post-quantum cryptography, quantum materials, and cloud-based quantum services. Influence the development of global certification frameworks.

Strengthen Trade and Supply Chains

Build trusted trade corridors for import/export of quantum components.
Engage with QUAD, EU, UK, and Israel for strategic tech partnerships.
Develop domestic substitutes where supply chain risks are high.

NITI Frontier Tech Hub – Strategic Role

The NITI Frontier Tech Hub functions as an action tank for Viksit Bharat, complementing national missions in quantum, AI, biotech, semiconductors, and space.
Works with over 100 experts across government, academia, industry, and global partners.
Aims to build a 10-year frontier technology roadmap covering 20+ emerging sectors such as-

1. Quantum technologies
2. AI and robotics
3. Synthetic biology
4. Space tech and satellites

5. Clean energy technologies
6. Aerospace and defence industry innovations

It supports policy design, regulatory sandboxes, standards-setting, and industry scaling pathways.

Conclusion

India stands at an inflection point where quantum technologies can redefine national security, industrial competitiveness, digital sovereignty, and scientific leadership.

The National Quantum Mission, combined with a strong startup ecosystem and the NITI Frontier Tech Hub's long-term planning, positions India to emerge as a global quantum power by 2035—provided workforce expansion, hardware capability development, international collaboration, and strong supply-chain strategies are executed effectively.

Source- https-//www.newsonair.gov.in/niti-aayog-ibm-unveil-roadmap-to-make-india-a-top-3-quantum-economy-by-2047/