



STATE OF PROGRESS IN **INDIA'S** **QUANTUM STI** **ECOSYSTEM**

SEPTEMBER 2026





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As India advances toward Viksit Bharat 2047, our efforts to nurture quantum science and technologies represent one of the clearest expressions of that ambition - indigenous, ecosystem-driven, and built to place India among the world's leading scientific and economic powers.

Prof. Ajay Kumar Sood

Principal Scientific Adviser to the Government of India

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Research and innovations achieved through the National Quantum Mission of India are already impacting defence, space, telecommunications and medical technologies. Some of these have the potential to be global leaders, and the Department of Science and Technology is committed to the development of the enabling ecosystem.

Prof. Umesh V. Waghmare

Secretary, Department of Science & Technology, Government of India

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I. The Quantum Horizon

Quantum technologies leverage principles of quantum mechanics to perform tasks at a much faster pace than is possible with systems based on classical mechanics. The unprecedented capabilities of these technologies in computation, ultra-secure communication, and highly sensitive measurement systems warrant a strategic outlook. Globally, countries are recognising this potential of quantum technologies, as evidenced by the launch of national strategies for quantum by more than 20 countries till 2026. Cumulatively, countries across the world have invested around \$60 billion in quantum science and technology as of early 2026¹. While some countries are focusing on specific aspects of quantum (such as computing or communication), other countries (like India) are focusing on building capabilities across the quantum stack.

II. India's Quantum Efforts

Recognising the emerging potential of the quantum frontier, India has consistently seen it as one of its priority technological areas. From the Mission on Nano Science & Technology (launched in 2007), the Quantum-Enabled Science & Technology (QuEST) Program (launched in 2018), the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS, launched in 2018), the MeitY Quantum Computing Applications Lab (launched in 2021), the C-DOT India Quantum Alliance (launched in 2023) to the National Quantum Mission (NQM, launched in 2023), India has been pushing for development of indigenous capabilities in quantum.

The National Quantum Mission (NQM), launched in 2023 with an outlay of Rs. 6003.65 crore from 2023-24 to 2030-31, envisages establishing India as a global leader in quantum technologies by promoting indigenous capabilities in quantum computing, quantum communication & cryptography, quantum sensing & metrology, and quantum materials & devices. For India, Quantum holds strategic importance in enhancing technology security & competitiveness and safeguarding India's position in the global technology landscape. The NQM aims to augment various sectors, including communication, health, finance, and energy, with applications in drug design, space, banking, security, materials, etc. The Mission also provides complementarity to national missions such as the National Supercomputing Mission (NSM), National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) and the India AI Mission.

The Mission identifies the development of intermediate-scale quantum computers with 50-1000 physical qubits over an 8-year timeframe, along with the establishment of secure quantum communication systems and quantum networks as some of its objectives. Along with these, the

¹ QURECA, "Quantum Initiatives Worldwide 2026," QURECA, Jun. 19, 2026. [Online]. Available: <https://www.quireca.com/quantum-initiatives-worldwide/>. [Accessed: 2 July 2026].

Mission is also spearheading the development of magnetometers, atomic clocks and materials for quantum devices and applications in communications, sensing and metrology.

For the implementation of the national objectives, the mission has established thematic hubs (T-Hubs). These hubs are designed to drive innovation, skill development, and industry partnerships to deliver on the mission's targets. These hubs are also supporting long-term growth and the commercialisation of quantum technologies.

I Quantum Computing Thematic Hub at IISc Bengaluru

Objective: To develop intermediate-scale quantum computers with 20-50 physical qubits (in 3 years), 50-100 physical qubits (in 5 years) and 50-1000 physical qubits (in 8 years) in various platforms like superconducting and photonic technology.

II Quantum Communication Thematic Hub at IIT Madras in association with CDOT

Objective:

- To develop satellite-based secure quantum communications between two ground stations over a range of 2000 kilometres within India, as well as long-distance secure quantum communications with other countries.
- To develop inter-city quantum key distribution over 2000 km with trusted nodes using wavelength division multiplexing on existing optical fibre.
- To develop a multi-node Quantum network with quantum memories, entanglement swapping and synchronised quantum repeaters at each node (2-3 nodes).

III Quantum Sensing and Metrology Thematic Hub at IIT Bombay

Objective: To develop magnetometers with 1 femto-Tesla/sqrt (Hz) sensitivity in atomic systems and better than 1 pico-Tesla/sqrt (Hz) sensitivity in Nitrogen Vacancy centres; Gravity measurements having sensitivity better than 100 nano-meter/second² using atoms and atomic clocks with 10⁻¹⁹ fractional instability for precision timing, communications and navigation.

IV Quantum Material and Devices Thematic Hub at IIT Delhi

Objective: Design and synthesis of quantum materials such as superconductors, novel semiconductor structures and topological materials for the fabrication of quantum devices and development of qubits for quantum computing and quantum communication applications; single-photon sources/detectors, entangled-photon sources for quantum communications, sensing and metrological applications.

III. Key Insights

India's Quantum Science, Technology and Innovation (STI) ecosystem has exhibited steady progress over the past few years. It is being built on strong scientific foundations, growing institutional and industrial capacity and continued investments through public and private stakeholders.

Below are some of the key insights on the Quantum Science, Technology and Innovation (QSTI) Ecosystem in India:

A. Growth of Investments

- 1 Globally, commitments for public investments for the development of quantum science and technology have grown to around \$56 billion as of 2025, growing 29% from approximately \$44 billion in 2024². India has committed around \$700 million at the national level, while additional commitments and strategies have been announced at the state level by states like Andhra Pradesh³, Karnataka⁴ and Telangana⁵.
- 2 Globally, private investments are focused in Quantum Computing, Photonics and Sensing, while in India, the focus is on Quantum Computing and Cybersecurity⁶.
- 3 Globally, private financing in quantum technology startups has surged from approximately \$1.8 billion in 2022 to \$12.2 billion in 2025, driven by a 2025 inflection point⁷.
- 4 For the Indian quantum ecosystem, private capital investments rose from around \$7 million in 2022 to \$11 million in 2025, signalling a growing commercial interest and confidence in the technology⁸.
- 5 Instances of catalytic funding also saw an uptake in India, from a single \$1.2 million round in 2021 to \$51.5 million across three rounds in 2025⁹. In 2025, catalytic funding rose to 78% of the

² Quantum Economic Development Consortium (QED-C), "State of the Global Quantum Industry 2026," QED-C, Arlington, VA, USA, Apr. 2026. [Online]. Available: <https://quantumconsortium.org/publication/2026-state-of-the-global-quantum-industry-report/>. [Accessed: 10 July 2026].

³ Information Technology, Electronics & Communications (ITE&C) Department, "Andhra Pradesh Quantum Computing Policy (2025-30)," Government of Andhra Pradesh, Sep. 7, 2025. [Online]. Available: <https://cdn.apchambers.in/gos/1765115771520-AP-Quantum-Computing-Policy-1.pdf>. [Accessed: 14 July 2026].

⁴ Department of Electronics, IT, Bt and S&T, "Karnataka Information Technology Policy 2025-2030," Government of Karnataka, Bengaluru, India, 2025. [Online]. Available: https://eitbt.karnataka.gov.in/uploads/media_to_upload1764150308.pdf. [Accessed: 15 July 2026].

⁵ Government of Telangana, "Telangana Rising 2047: Vision Document," Hyderabad Metropolitan Development Authority (HMDA), Hyderabad, India, Jul. 2020. [Online]. Available: <https://www.hmda.gov.in/wp-content/uploads/2020/07/TelanganaRising-2047.pdf>. [Accessed: 14 July 2026].

⁶ Based on the primary areas of focus of companies being invested in.

⁷ H. Soller et al., "McKinsey Quantum Technology Monitor 2026: A commercial tipping point," McKinsey & Company, Apr. 28, 2026. [Online]. Available: <https://www.mckinsey.com/~media/mckinsey/business%20functions/technology/our%20insights/mckinsey%20quantum%20technology%20monitor%202026%20a%20commercial%20tipping%20point/quantum-technology-monitor-2026.pdf>. [Accessed: 10 July 2026].

⁸ Based on data collected from Tracxn platform (date Accessed: 10 July 2026). Private Financing has been calculated based on the publicly disclosed funding rounds where only private entities (whether individuals or institutions) have participated as investors.

⁹ Based on data collected from Tracxn platform (date Accessed: 10 July 2026). Investment rounds have been considered as 'Catalytic funding' where there is an instance of both public as well as private investors participating in a given round. Currently, it remains concentrated in two companies (QpiAI, QNu Labs), suggesting an emerging rather than broad-based pattern.

total disclosed quantum investment in India. Public anchors like the National Quantum Mission (NQM), I-Hub Quantum Technology Foundation, Department of Science and Technology (DST), etc., drawing in private co-investment within the same funding round, are emerging as a preferred pathway for investment.

- 6 Disclosed private investments in India are primarily led by Angel and individual investors, with limited participation being seen from VCs and institutional investors¹⁰. Private investor interest in quantum technology is rising, though heavy capital requirements and long commercialisation timelines are seen as constraints¹¹.
- 7 For the Indian quantum ecosystem, foreign capital-infused investment rounds total to approximately \$15 million, around 15% of the total disclosed investments over the last ten years (2016-2025). FDI in the Indian quantum ecosystem has been directed primarily at communication & cybersecurity and, more recently, at computing¹².
- 8 Private investments are placing more focus on building full-stack quantum systems, with approximately 84% of the private capital flowing into building full-stack systems. There exists limited emphasis on materials, sensors, and photonics-based components, which have attracted comparatively less investments¹³.
- 9 As of 2025, China and Germany have the highest amounts of public investment commitments in quantum technologies, while India stands approximately at the 12th position¹⁴.

B. Human Potential

- 10 India's broader quantum and allied R&D workforce¹⁵ is estimated at approximately 18,400 researchers over 2014–2024. Of the broader ecosystem, about 62% are early-career researchers, first publishing within the last five years. This indicates a rapidly expanding base of researchers in the field. The research ecosystem is concentrated at the Indian Institute of Science, IIT Bombay, Harish Chandra Research Institute, IIT Madras, Tata Institute of Fundamental Research and IIT Delhi, with Quantum Materials & Devices employing the largest share of researchers (14,180), followed by Quantum Computing (3,803).

¹⁰ Based on data collected from Tracxn platform [Accessed: 15 July 2026].

¹¹ A stakeholder consultation was organised by the Policy Analytics and Insights Unit of the Office of the Principal Scientific Adviser to the Government of India (OPSA-PAIU) and the Quantum Ecosystems Technology Council of India (QETCI) on 27 July 2026 involving experts from Industry, Academia and Government.

¹² Based on data collected from Tracxn platform [Accessed: 15 July 2026]. Here, 'Foreign capital infused investment rounds' have been calculated based on rounds where at least one confirmed foreign-headquartered investor participated. This is meant to provide an approximate measure for signalling foreign investor's focus and is not meant to specify exact figures on the same. Rounds with unverifiable investor domicile were excluded from calculation.

¹³ Based on data collected from Tracxn platform [Accessed: 10 July 2026]. Private Financing has been calculated based on the publicly disclosed funding rounds where only private entities (whether individuals or institutions) have participated as investors.

¹⁴ Office of the Principal Scientific Adviser to the Government of India, "International Technology Engagement Strategy (ITES) for Quantum," Government of India, New Delhi, India, Apr. 2025. [Online]. Available: https://www.psa.gov.in/CMS/web/sites/default/files/publication/ITES_QWEBSITE1.pdf. [Accessed: 17 July 2026].

¹⁵ Here, the R&D workforce includes only individuals who authored at least one quantum-related publication during 2014-2024. Of the 18,400 publishing researchers in the broader ecosystem, 3,081 have more than three publications. Employment records retrieved from their ORCID profiles indicate that 73% are currently in academia and 17% in government research institutions.

- 11 Quantum talent is significantly migrating from academia into the private sector. Out of the surveyed researchers previously in academia, 40.5% of the respondents have since moved into industry roles. The transition has been significant in recent years, especially post 2023¹⁶.
- 12 Researchers affiliated with Indian institutions form a meaningful share of the global quantum and allied workforce. Based on bibliometric data, the share of researchers who began publishing from Indian institutions and the share who later moved abroad declined, from about 5.5% (during 2004-2014) to 3.8% in the decade from 2014 to 2024. Among those who do relocate, the leading destinations are the United States, Germany, France, South Korea and Singapore¹⁷.
- 13 India's quantum and allied research workforce occupies 5.7% of the global quantum workforce, ranking 3rd among individual countries, behind only China and the United States¹⁸, and marginally ahead of Germany.

C. Institutional and Industrial Hotspots

- 14 India's quantum-focused academic and research programmes have expanded to 43 institutions across 17 states and 2 UTs, engaging 152 researchers through 14 Technical Groups and 17 Project Teams under the four Thematic Hubs. Formal quantum education has also been institutionalised through B.Tech. Minor and M.Tech. programmes launched with the All India Council for Technical Education (AICTE), with 23 institutions selected to host Teaching Labs in Quantum Technologies and nearly 2,000 faculty trained through Faculty Development Programmes¹⁹. Seventeen project teams have also been selected to advance the development of quantum software capabilities in India, focusing on quantum algorithms tailored for real-world applications.
- 15 The regional distribution of quantum startups in India is concentrated in technology hubs like Karnataka (with around 20%), Delhi-NCR (with around 15%) and Maharashtra (with around 15%)²⁰. Industrial capabilities are also emerging in other states like Andhra Pradesh, Telangana and Uttar Pradesh.

¹⁶ Based on the responses of the survey data. A survey was conducted to map the PhD/Postdocs and early career researchers working across the different domains of quantum in India. Among the 79 survey respondents previously in academia, 40.5% have moved to industry.

¹⁷ United States (128 researchers), Germany (56), France (29), South Korea (26) and Singapore (23)

¹⁸ behind China (32.3%, with 1,04,000 researchers) and the United States (14.5%, 47,000 researchers)

¹⁹ Press Information Bureau, Government of India, "Parliament Question: Women's Participation in Quantum Research and Entrepreneurship Including Fellowships," Apr. 30, 2025. [Online]. Available: <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2241761®=3&lang=1>. [Accessed: 17 July 2026].

²⁰ Compiled from Startup India Data and Tracxn.

D. Knowledge Intensity

- 16 India ranks 6th globally in total quantum publications at 4.47% of the global output over the decade (15,272 publications), behind China, the United States, Germany, Japan and the United Kingdom, with publication volume rising sharply after the implementation of the National Quantum Mission. Notably, the growth in highly cited publications has been larger than the growth in total publications. Over the decade, total output grew while top-10% highly cited publications output grew about six-fold and top-1% output 10-fold²¹.



Fig 1: Indexed Growth in India's Quantum Publications (2014-2024)

Source: OpenAlex [Accessed: 10 August 2026]

- 17 Globally, country-to-country collaborations on publications have intensified over the past decade, and India's co-authorships are led by US institutions (26.5% of India's international co-publications), followed by Germany, South Korea, the United Kingdom and China, concentrated especially in the sub-fields of Quantum Materials & Devices and Quantum Computing. While the international co-authorship rate remains largely the same over the decade, the number of partner countries per sub-field has risen to about 60 countries. Certain country collaborations are specific to particular quantum sub-fields. For instance, South Korea's prominence is confined to Materials and Devices, while Canada and Poland's collaborations with India are majorly evident in Quantum Computing.

²¹ Publication, citation and collaboration indicators are derived from OpenAlex bibliographic metadata (2014-2024). Data were retrieved and processed using a systematic bibliometric retrieval and validation methodology.

India's International Quantum Collaborations (2014-2024)

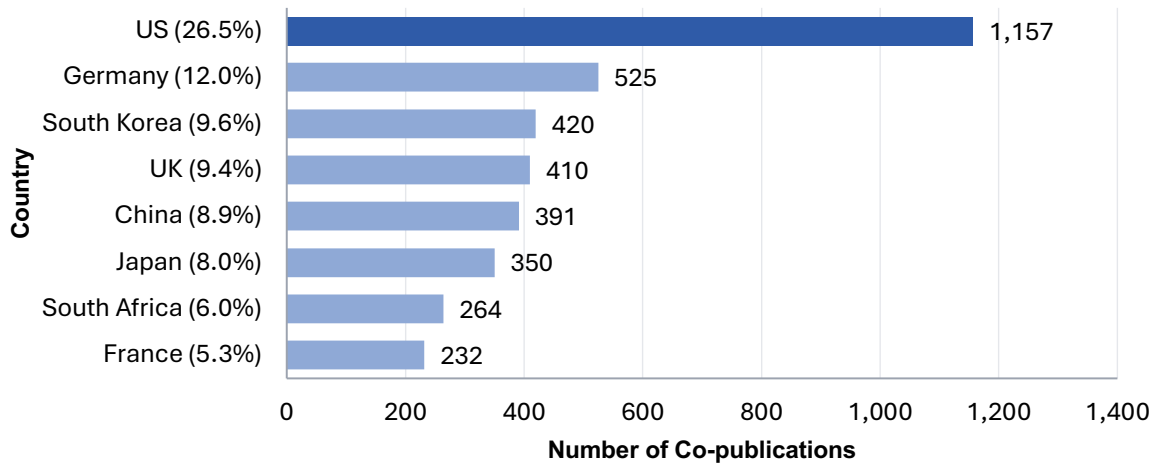


Fig 2: India's Top Collaborators in Quantum Publications (2014-2024)

Source: OpenAlex [Accessed: 20 July 2026]

E. Innovation Capacity

- 18** Patent filings²² in India have grown from 42 in 2014 to 226 in 2023, a more than five-fold increase (totalling 648 filings over 2014–2024)²³. These filings are concentrated in Quantum Computing, which accounts for 85% of the filings, indicating that computing is closest to commercialisation.

Cumulative Quantum Patent Filings in India (2014-2024)

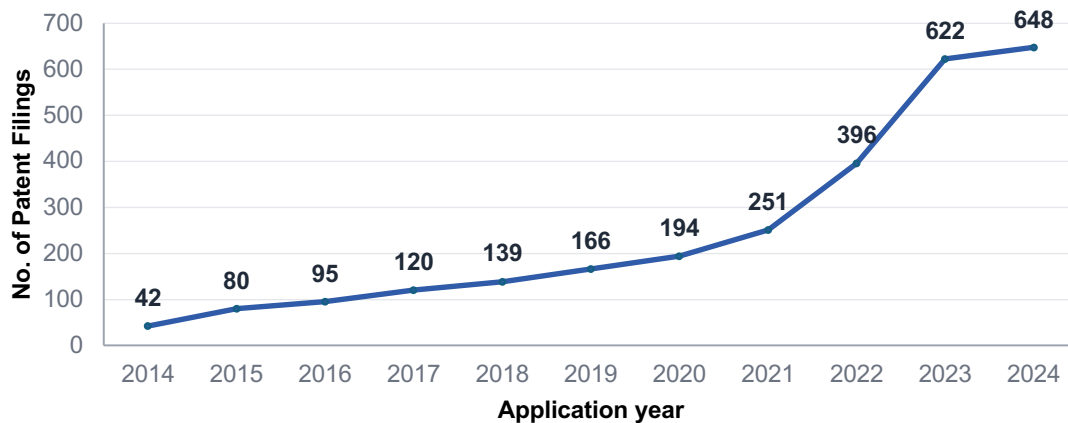


Fig 3: Cumulative Quantum Patent Filings in India (2014-2024)

Source: Lens [Accessed: 20 July 2026] | Note: 2024 figures are provisional due to the publication lag.

²² Patent records were retrieved through the [Lens platform](#) using a defined patent retrieval and validation methodology.

²³ Patent filings whose applicant country is India, regardless of its jurisdiction. Filings for 2024 are provisional in nature due to lag in publishing timelines.

- 19 Of the Indian companies that filed quantum patents over the decade, about 63% of the companies seek protection beyond India (12 of 19 identified corporate filers), indicating that Indian quantum companies are pursuing global markets.
- 20 In the last ten years, leading global quantum players have been increasingly filing at the Indian Patent Office: Microsoft (55 filings)²⁴, IBM (38), Google (17) and Samsung (16), recognising India as an emerging commercial market for quantum technologies. These companies have increased their presence in India, and about 40.7% of the patents filed in India are of foreign origin, most of them filed after 2018.
- 21 The patents majorly belong to the sub-fields of Quantum Computing and Quantum Materials & Devices. Foreign entities have owned about 68% of the patents²⁵ filed at the Indian office, and the overall filings have nearly tripled in recent years from 104 (2021) to 298 (2024).

F. Industrial Integration

- 22 Globally, the quantum startup ecosystem has scaled to over 2000 companies, with the Indian ecosystem having grown to around 120 startups²⁶.
 - a. Startups supported by NQM funds have increased to 17, encompassing the sub-technologies of computing, materials & devices, communication & cryptography and sensing²⁷.
 - b. Indian quantum startups are predominantly concentrated in quantum computing and quantum communication & cryptography, with emerging activity in quantum materials & devices²⁸.
 - c. The majority of the Indian quantum startups are primarily at the Ideation stage, followed by the validation stage²⁹.
- 23 Indian quantum startups are beginning to build IP ownership, with about 8% of the startups holding or filing at least one patent, predominantly in quantum computing and quantum communications & cryptography. The earliest filings date to 2021, and patent activity remains highly concentrated among three firms - QNu Labs, QpiAI, and Quanfluence - which account for most filings.

²⁴ Microsoft has 7.1% of its global quantum patents filed in the Indian jurisdiction, during the period 2014-2024.

²⁵ Based on the assignee's country.

²⁶ Compiled from Startup India Data and Tracxn.

²⁷ Ministry of Science & Technology, "National Quantum Mission achieves 1,000-km secure communication milestone in under 3 years of its launch: Dr. Jitendra Singh," Press Information Bureau, Government of India, Apr. 8, 2026. [Online]. Available: <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2250162®=3&lang=1>. [Accessed: 8 July 2026].

²⁸ Compiled from Startup India Data and Tracxn.

²⁹ Compiled from Startup India Data.

- 24 The global quantum technology market reached approximately \$2 billion in 2025, with projections of it reaching \$4 billion by 2028³⁰, while the Indian quantum technology market stood at approximately \$100 million in 2025³¹.
- 25 Indian companies, primarily within the BFSI and Pharmaceutical sectors, are exploring adopting quantum technologies as an accelerator to their domains³². They are focusing on use cases for quantum cybersecurity and drug modelling and discovery.
- 26 The expanding presence of global technology players like Amazon (AWS) and Google, and global BFSI players³³ like Goldman Sachs and JPMorgan Chase, via Global Capability Centres (GCCs), acts as a crucial catalyst for India's quantum ecosystem^{34, 35, 36}. Even without explicit quantum research and innovation mandates, their operations are accelerating the domestic quantum ecosystem by creating quantum-adjacent capabilities in India.
- 27 While dependencies exist in the supply chains across different quantum domains, efforts by the industry and the government have led to significant headway in developing domestic capacity. In the last five years specifically, indigenisation has increased considerably across all quantum domains, with the communication space reporting the most notable advancements.
- 28 Signals of maturity can be seen for the quantum technology ecosystem in India based on recent achievements, notably the demonstration of a 1,000-km secure Quantum Key Distribution (QKD) network by QNu Labs and the development of the 64-qubit superconducting quantum processor unit (QPU) by QpiAI^{37, 38}. Some of these milestones have been listed below.

³⁰ Quantum Economic Development Consortium (QED-C), "State of the Global Quantum Industry 2026," QED-C, Arlington, VA, USA, Apr. 2026. [Online]. Available: <https://quantumconsortium.org/publication/2026-state-of-the-global-quantum-industry-report/>. [Accessed: 10 July 2026].

³¹ Grand View Research, "India Quantum Computing Market Size & Outlook, 2026-2033," Grand View Research, Jun. 2026. [Online]. Available: <https://www.grandviewresearch.com/horizon/outlook/quantum-computing-market/india>. [Accessed: 17 July 2026].

³² A stakeholder consultation was organised by the Policy Analytics and Insights Unit of the Office of the Principal Scientific Adviser to the Government of India (OPSA-PAIU) and the Quantum Ecosystems Technology Council of India (QETCI) on 27 July 2026 involving representatives from Industry, Academia and Government.

³³ BFSI refers to firms involved in fields related to Banking, Financial Services, and Insurance sectors.

³⁴ A. Jain, "Amazon \$48 Billion, Google \$15 Billion: Global CEOs' India Investment Push," NDTV News, Jun. 25, 2026. [Online]. Available: <https://www.ndtv.com/india-news/amazon-48-billion-google-15-billion-global-ceos-india-investment-push-11687717>. [Accessed: 8 July 2026].

³⁵ "15 Plus Global Banks Probing the Wonderful World of Quantum Technologies," The Quantum Insider, Mar. 27, 2026. [Online]. Available: <https://thequantuminsider.com/2026/03/27/15-plus-global-banks-probing-the-wonderful-world-of-quantum-technologies/>. [Accessed: 9 July 2026].

³⁶ ANSR, "Case Study: How Goldman Sachs' India GCC Evolved into the Company's 2nd Headquarters," ANSR, Apr. 19, 2024. [Online]. Available: <https://ansr.com/case-study/how-goldman-sachs-india-gcc-evolved-into-the-2nd-headquarters/>. [Accessed: 8 July 2026].

³⁷ BW Online Bureau, "Bengaluru's QpiAI Rolls Out 64-Qubit Superconducting Quantum Chip," BW Businessworld, Nov. 4, 2025. [Online]. Available: <https://www.businessworld.in/article/bengaluru-s-qpi-ai-rolls-out-64-qubit-superconducting-quantum-chip-578184>. [Accessed: 9 July 2026].

³⁸ Ministry of Science & Technology, "National Quantum Mission achieves 1,000-km secure communication milestone in under 3 years of its launch: Dr. Jitendra Singh," Press Information Bureau, Government of India, Apr. 8, 2026. [Online]. Available: <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2250162®=3&lang=1>. [Accessed: 9 July 2026].

S.No.	Milestones Achieved
1.	1,000-km secure QKD network developed by QNu Labs (supported by NQM)
2.	QpiAI (supported by NQM) developed Kaveri (64-qubit) Quantum Processor Unit (QPU)
3.	At the Amaravati Quantum Valley, Qbit Force and Qubitech built a dilution refrigerator with 85% indigenous parts, reaching an ultra-low temperature of 4 Kelvin (-269°C)
4.	The PQuest Group (Group under IIT Bombay's Quantum Sensing & Metrology T-Hub) launched India's first indigenous Quantum Diamond Microscope (QDM)
5.	Prenishq (supported by NQM) developed a high-precision diode laser

- 29 India's quantum infrastructure is progressing from research-lab-scale facilities to dedicated fabrication, hardware, and hub infrastructure at the national and state levels. Under the NQM, two major state-of-the-art Quantum Fabrication and Central Facilities are being established at IIT Bombay and IISc Bengaluru, with two additional smaller-scale facilities at IIT Delhi and IIT Kanpur³⁹. These facilities focus on quantum sensing & metrology, quantum computing chip fabrication (superconducting, photonic, and spin qubits), and quantum materials & devices. A push from the private sector can also be seen for quantum infrastructure, with the recent launch of the 8-inch quantum chip foundry in Bengaluru by QpiAI, capable of fabricating superconducting processors of up to 128 qubits⁴⁰.

G. Global Engagement

- 30 India is increasing its international partnership footprint through strategic and bilateral partnerships such as the Technology Security Initiative (TSI)⁴¹ between India and the UK, T.R.U.S.T. between India and the US⁴², and the India-Canada-Australia Technology and Innovation (ACITI) Partnership⁴³. International collaboration is also being explored with partners like Japan (through a letter of intent between the Indian Institute of Science and

³⁹ Ministry of Science & Technology, "PARLIAMENT QUESTION: ESTABLISHMENT OF QUANTUM FABRICATION AND CENTRAL FACILITIES," Press Information Bureau, Government of India, Dec. 17, 2025. [Online]. Available: <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2205358®=48&lang=2>. [Accessed: 21 August 2026].

⁴⁰ M. Abdel-Kareem, "QpiAI Inaugurates 8-Inch Quantum Chip Foundry in Bengaluru Targeting 10,000-Qubit QPUs," Quantum Computing Report, Aug. 17, 2026. [Online]. Available: <https://quantumcomputingreport.com/qpiai-inaugurates-8-inch-quantum-chip-foundry-in-bengaluru-targeting-10000-qubit-qpus/>. [Accessed: 21 August 2026].

⁴¹ Ministry of External Affairs, Government of India, "The UK-India Technology Security Initiative," Ministry of External Affairs, Government of India, Jul. 24, 2024. [Online]. Available: https://www.mea.gov.in/bilateral-documents?dtl/37995/The_UKIndia_Technology_Security_Initiative. [Accessed: 8 July 2026].

⁴² Office of the Principal Scientific Adviser to the Government of India, "US - India TRUST Initiative (formerly iCET)," Principal Scientific Adviser, Jul. 7, 2026. [Online]. Available: <https://www.psa.gov.in/icet>. [Accessed: 8 July 2026].

⁴³ Ministry of External Affairs, Government of India, "Joint statement by the Government of India, the Government of Australia and the Government of Canada," Ministry of External Affairs, Government of India, Nov. 22, 2025. [Online]. Available: https://www.mea.gov.in/bilateral-documents?dtl/40321/Joint_statement_by_the_Government_of_India_the_Government_of_Australia_and_the_Government_of_Canada_November_22_2025. [Accessed: 8 July 2026].

Yaquimo Inc.)⁴⁴, Germany (through the India-Germany Joint Declaration of Intent⁴⁵, focusing on quantum communication, and through discussions with Thuringia⁴⁶ and Bavaria⁴⁷ on quantum), Canada (through discussions on quantum computing collaboration)⁴⁸ and Israel (through an invitation to Israeli quantum startups to collaborate under the National Quantum Mission)⁴⁹. Through a culmination of these efforts, India is actively pursuing international engagement in quantum science and technology.

- 31 India is also engaging with global quantum R&D and infrastructure initiatives such as the Open Quantum Institute (OQI). Indian experts being part of the advisory committee of the OQI strengthens India's role in the pursuit of global anticipatory governance in quantum technologies.

⁴⁴ Ministry of External Affairs, "Fact Sheet 2.0: India-Japan Economic Security Cooperation," Government of India, New Delhi, India, Jul. 2026. [Online]. Available: https://www.mea.gov.in/bilateral-documents?dtl/41396/Fact_Sheet_20_IndiaJapan_Economic_Security_Cooperation. [Accessed: 29 July 2026].

⁴⁵ Ministry of Communications, "India and Germany Reaffirm Cooperation in Telecommunications and Digital Transformation Following Signing of Joint Declaration of Intent," Press Information Bureau, Government of India, Feb. 18, 2026. [Online]. Available: <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2229761®=48&lang=2>. [Accessed: 21 August 2026].

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IV. Way Forward

India's quantum STI ecosystem is transitioning towards building deployment-ready capabilities and solving real-world use cases. The signals of maturity visible across domains of communication, computing, sensing and materials are all testaments to mark this transition. The next phase of India's quantum efforts will focus on converting these capabilities into commercially and strategically consequential deployments. Given the strategic importance of quantum technologies, three priorities are specifically crucial to translating this potential into solidifying India's position as a global quantum power.

A. Accelerating the Adoption of Post-Quantum Cryptography (PQC)

Given the rapid advancements in the development of quantum systems and the evolving estimates for the arrival of the "Q-Day"⁵⁰, an immediate focus towards a 'quantum-safe' ecosystem is crucial. Parallel risks emerging from strategies like "Harvest Now, Decrypt Later" and "Trust Now, Forge Later"⁵¹ further compound this threat, especially for critical sectors of defence, financial systems and communication. Recognising these threats, the Department of Science and Technology (DST) and the National Quantum Mission (NQM) released the report on "Quantum-Safe Ecosystem in India: Roadmap to Quantum Resiliency"⁵² in May 2026. The roadmap sets out phased measures for India's transition to Post-Quantum Cryptography (PQC), together with a framework for the testing and evaluation of quantum-safe products and solutions.

The roadmap to PQC transition is proposed through phased milestones, with Critical Information Infrastructure (CII) sectors⁵³ to establish quantum-safe foundations by 2027, migrate high-priority systems by 2028, and complete full PQC adoption by 2029; enterprises are to follow a parallel timeline through 2033. This upcoming transition, while a strategic need, also presents an avenue for growth and further indigenisation of quantum-safe technologies, aligning with the objectives of the NQM.

B. Rolling out QKD-based Communication at Commercial Scale

Quantum Key Distribution (QKD) secures communication through the laws of quantum physics, under which any attempt to intercept a transmitted key is inherently detectable. India's efforts in this domain are anchored in the NQM's Quantum Communication Thematic Hub, hosted at IIT Madras in association with C-DOT. The T-Hub is working towards inter-city quantum key

⁵⁰ Q-Day is commonly referred to as the point at which cryptographically relevant quantum computers can break widely deployed public-key cryptography systems.

⁵¹ These strategies focus on decrypting collected information once quantum capabilities mature.

⁵² Task Force on Implementation of Quantum Safe Ecosystem in India, "Quantum-Safe Ecosystem in India," Department of Science and Technology, Ministry of Science and Technology, Government of India, New Delhi, India, Rep., Feb. 2026. [Online]. Available: <https://dst.gov.in/sites/default/files/Quantum-Safe-Ecosystem-in-India.pdf>. [Accessed: 10 August 2026].

⁵³ CII sectors are referred to sectors spanning government, strategic, defence, power, telecom, transport, and BFSI.

distribution over 2,000 kilometres using trusted nodes on existing optical fibre, and satellite-based secure quantum communication between ground stations up to 2,000 kilometres within India and with partner countries. This capability has already seen considerable progress, as demonstrated at the national scale, with QNu Labs (supported by NQM) establishing a 1,000-kilometre secure QKD network.

Building on this foundation, the DST-NQM roadmap envisages an inter-city QKD backbone linking multiple intra-city QKD networks across Indian cities, operating within a composite QKD-PQC architecture. With considerable demonstration shown for the underlying technology and the backbone infrastructure under development, translating this capability into a commercially available service, offered at scale, is a crucial step going forward.

C. Progress towards Portable Quantum Gravity Sensors

Quantum gravimeters, which can measure minute variations in gravitational acceleration with atomic-scale precision, hold considerable value for areas where conventional sensors face limitations in sensitivity and portability. In recognition of the wide-ranging applications of quantum gravity sensors, the NQM, through the Quantum Sensing and Metrology Thematic Hub, is working towards making portable gravity measurements a reality. The Quantum Sensing and Metrology Thematic Hub has set an objective of achieving gravity-measurement sensitivity better than 100 nano-meter/second² using atom-based systems, alongside allied advances in magnetometry and atomic clocks.

India's quantum journey has progressed from the early cross-cutting missions of the 2000s and 2010s to the National Quantum Mission's structured, full-stack approach. The insights set out in this paper point to an ecosystem gathering momentum - a widening research and industrial base, rising publication and patent output, an expanding startup landscape and deepening international partnerships. Going forward, the phased deployment of quantum-safe cryptography, quantum-secure communication and quantum sensing will be central to India's progress towards becoming a global leader in Quantum Science and Technology.

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