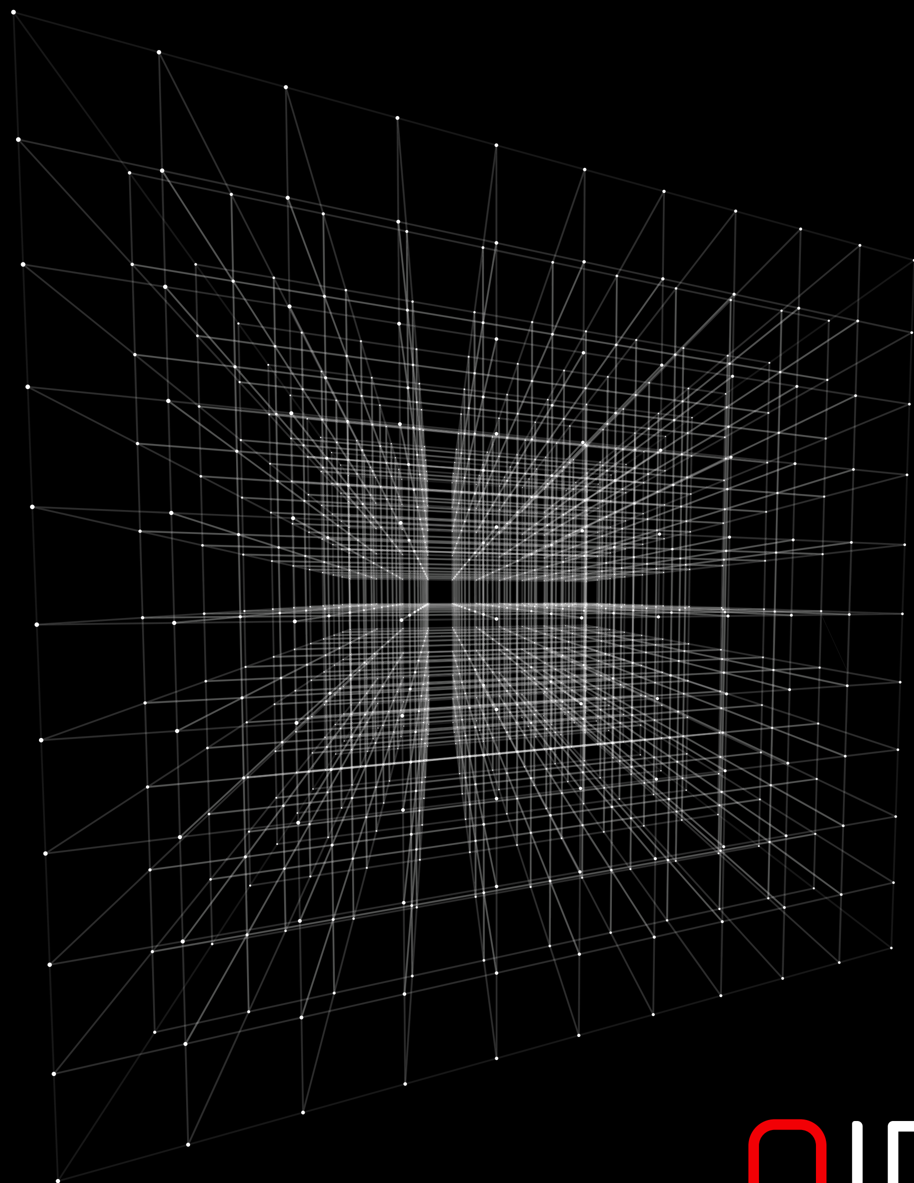

QIR

Quantum Index Report 2025

MIT INITIATIVE ON THE DIGITAL ECONOMY

How to cite this report

Ruane, J., Kiesow, E., Galatsanos, J., Dukatz, C., Blomquist, E., Shukla, P., "The Quantum Index Report 2025", MIT Initiative on the Digital Economy, Massachusetts Institute of Technology, Cambridge, MA, May 2025.

Interactive website and public data

The Quantum Index Report 2025 is accompanied with interactive tools available on our website (qir.mit.edu) and we share our raw data with the community available to download from our website (qir.mit.edu/data).

In memory of Shawneric Hachey, whose unique talent and dedication shaped the way this project is presented today.

Center for Quantum Networks
A National Science Foundation Engineering Research Center

This work was supported by the Engineering Research Centers Program of the National Science Foundation under NSF Cooperative Agreement No. 1941583. Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect those of the National Science Foundation.

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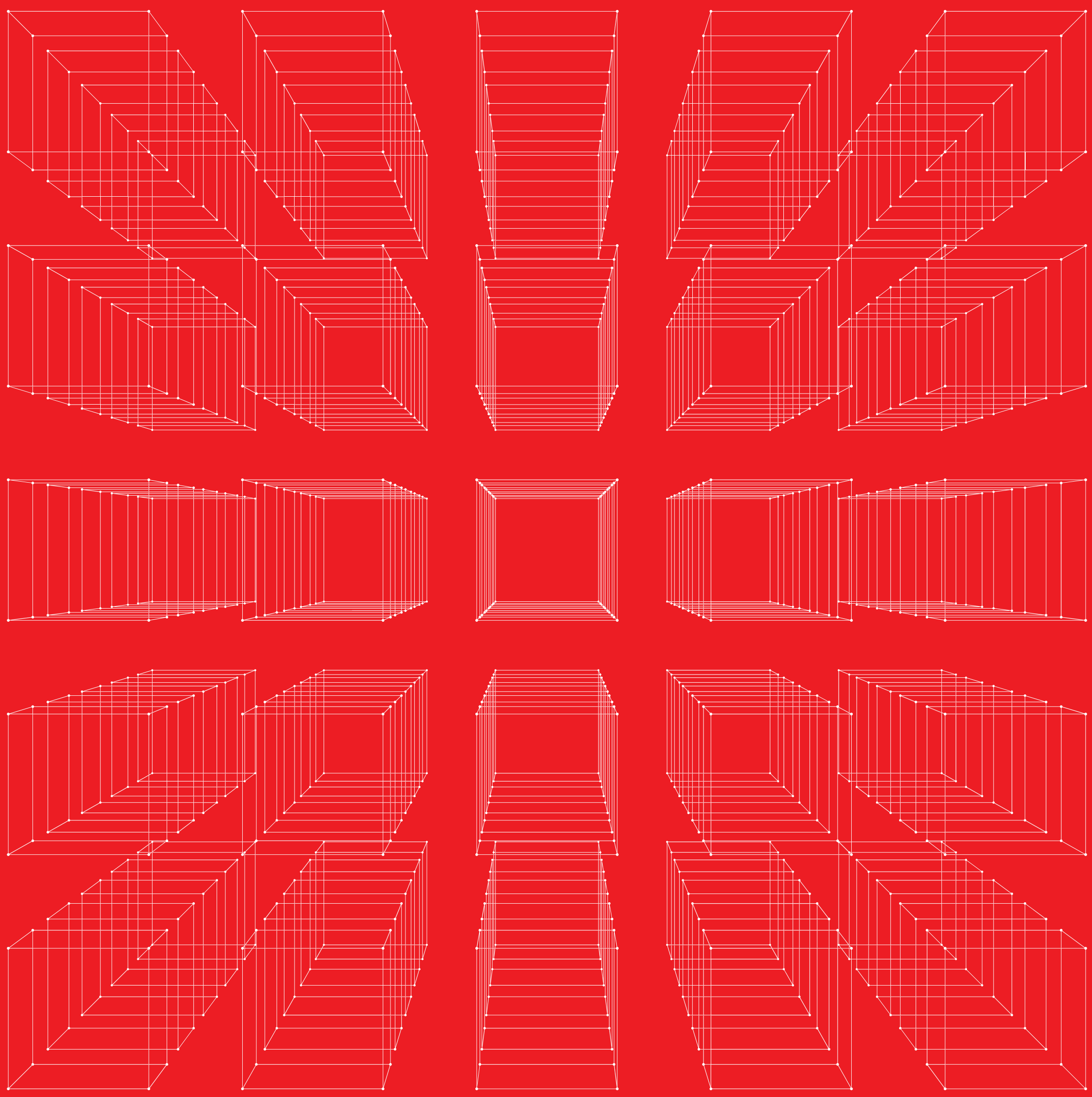
This research is a collaboration between Accenture and the MIT Initiative on the Digital Economy (IDE) and was performed under the MIT and Accenture Convergence Initiative for Industry and Technology.

Table of Contents | 2025 Quantum Index Report



1 | Patents

As quantum technologies transition from the lab to the marketplace, patents and other forms of Intellectual Property (IP) are becoming increasingly important strategic assets in the race for quantum leadership. As well as serving as key indicators of general innovation activity, the growth in volume of quantum-related patent filings reflects both the maturing of research efforts and the intensifying competition among companies, institutions, and nations.

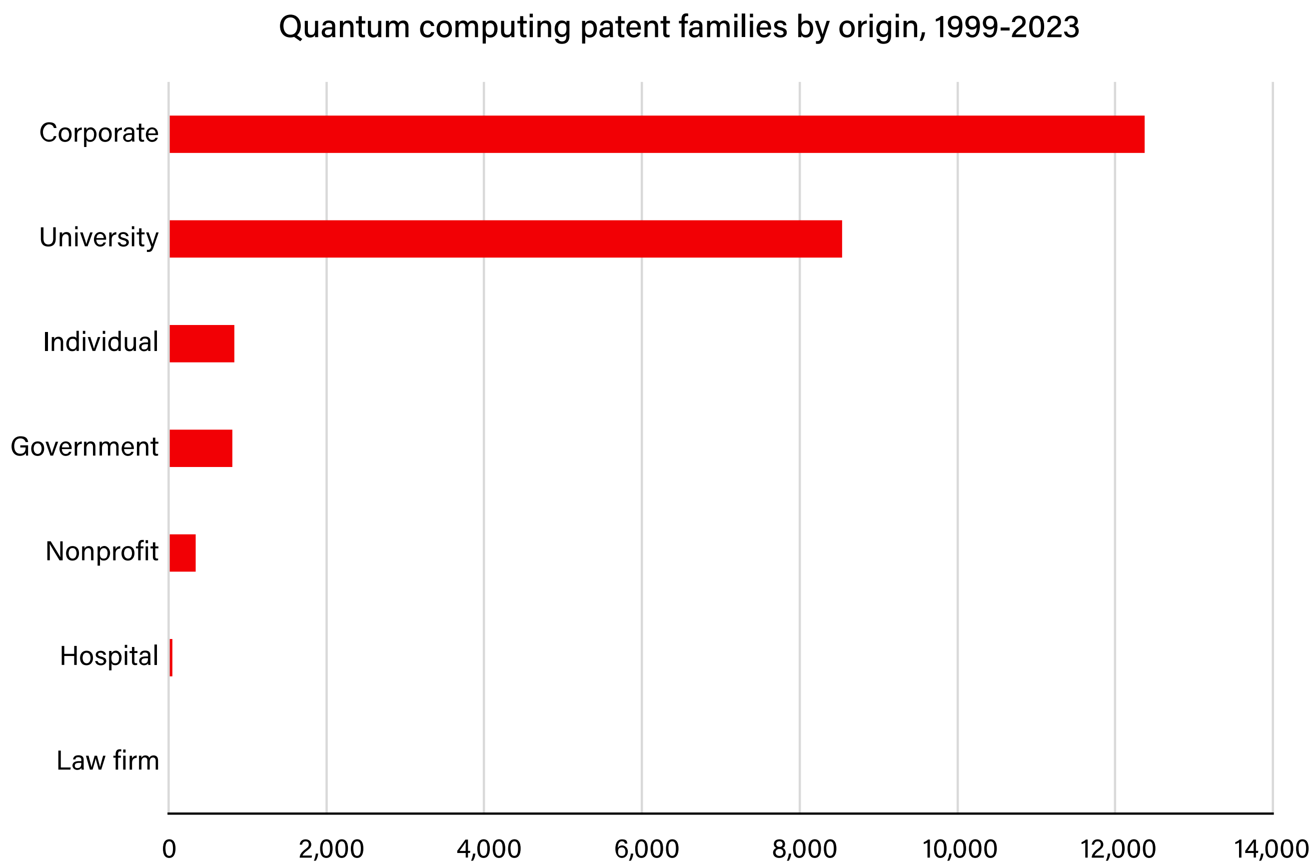
The quantum IP landscape is being shaped not only by traditional hardware systems and foundational qubit architectures but also by new frontiers such as quantum error correction[1], hybrid classical-quantum algorithms[2], and novel materials and qubit fabrication processes.

This report tracks patent data based on patent families. A patent family consists of multiple patent applications covering the same fundamental invention, filed in different countries. Therefore patent families serve as a better metric for analyzing new technology developments because they provide a comprehensive view of innovation scope and global market intentions. Unlike individual patents, patent families account for variations in filing requirements across jurisdictions. This interconnected structure allows researchers to track how inventors protect their IP across international borders, revealing both the breadth of innovation and possible geographic expansion plans.

Furthermore, patent families help normalize comparisons between regions with different patent systems and requirements, offering a more accurate picture of global innovation trends.

The data for this chapter was provided by Accenture Research in cooperation with The Quantum Insider.

1.1 | Patents by entity

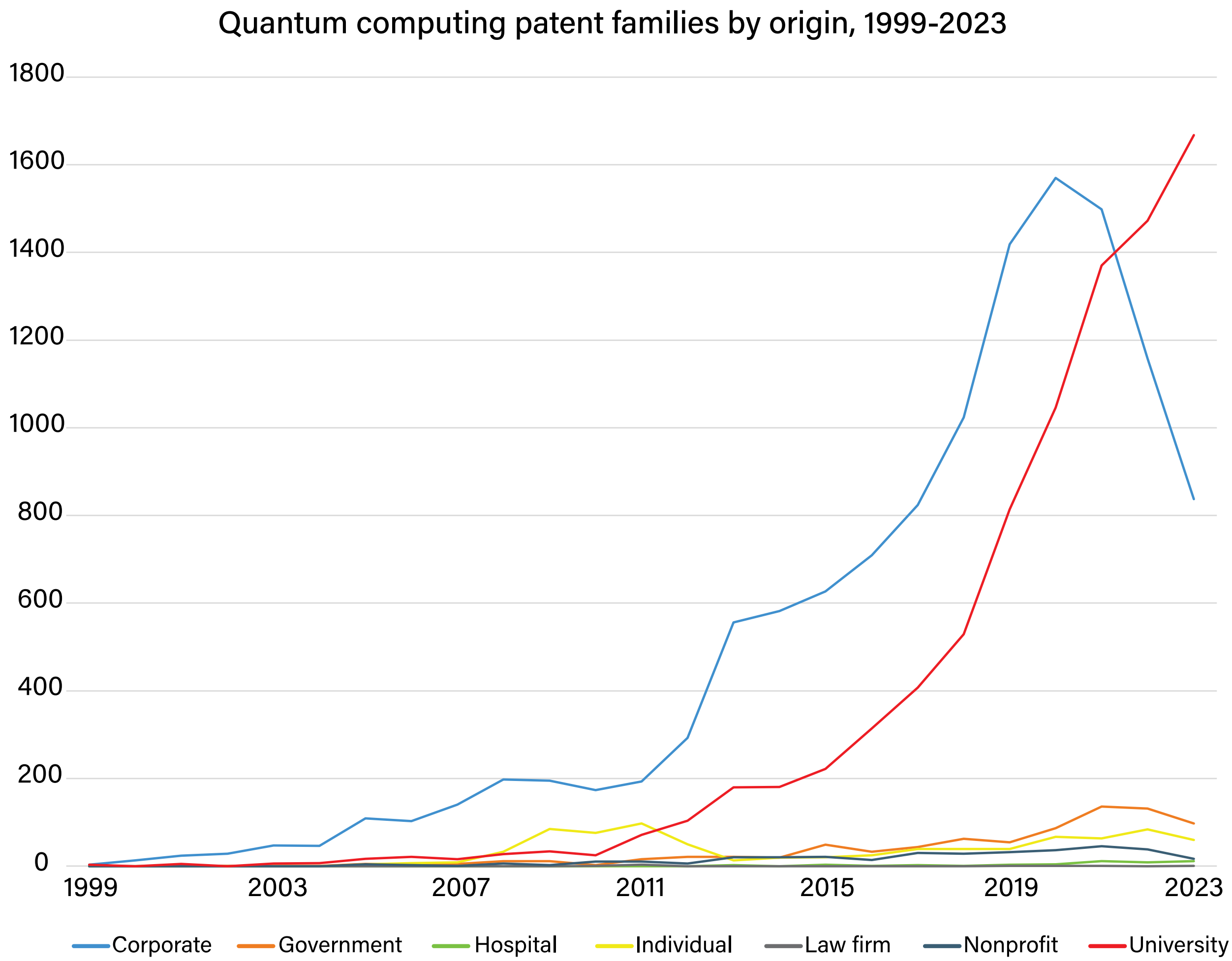


Corporations have emerged as the dominant force in quantum computing patent development, demonstrating significant investment in intellectual property protection. Recent data shows that global players such as IBM, Google, Microsoft, Intel, and Baidu are among the top patent filers.[3]

Corporate entities lead the landscape with 54% of total patents, followed by universities with 37%. Together, these two sectors account for 91% of all quantum computing patents, demonstrating a high concentration around these two categories. Individual inventors hold the third position with 3.6%, closely followed by government institutions at 3.5%. Nonprofit organizations contribute 1.5%, while hospitals and law firms show minimal participation.

During the early development period from 1999 to 2004, initial patents came primarily from corporate and university sectors, while government entities entered the patent landscape in 2002. This slow-growth period saw annual totals remain

> Over the 2016-2021 period, quantum computing patent family filings increased by over 300%.



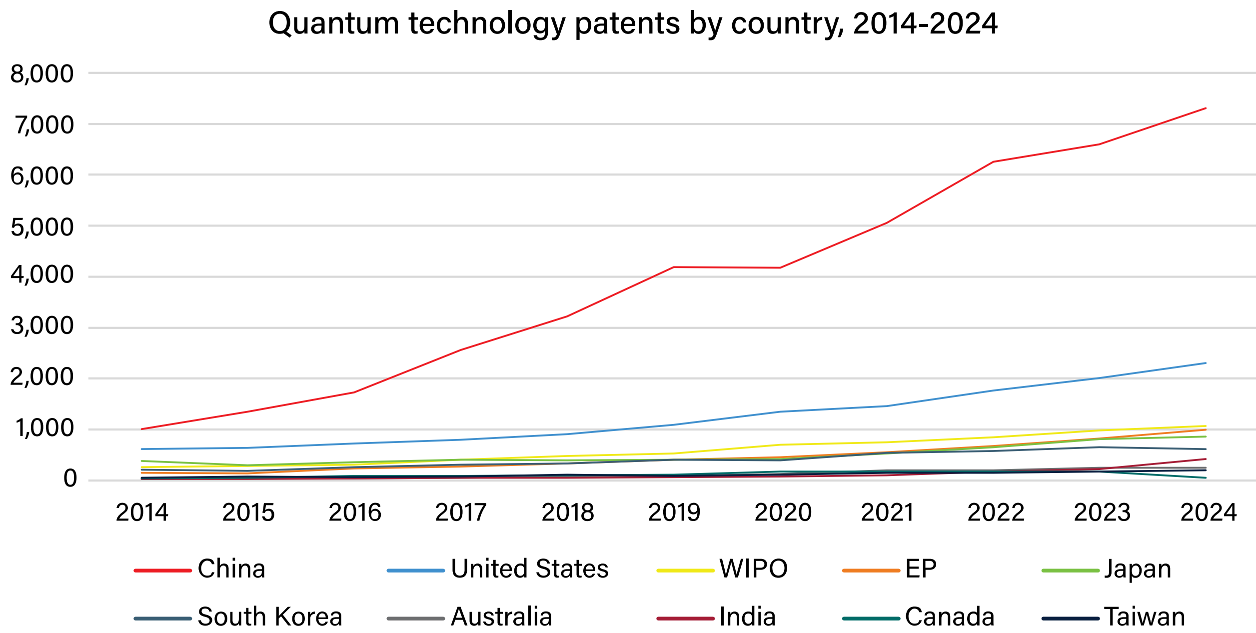
under 150 patent families, indicating the challenges associated with building research capabilities in the nascent field.

The transition period from 2005 to 2012 marked a significant shift in patent activity. Beginning in 2005, corporate patents jumped notably. Individual inventors began making more substantial contributions after 2008.

A period of rapid expansion occurred from 2013 to 2019 driven almost entirely by corporations and universities. Recent trends from 2020 to 2023 show continued evolution in patent activity. The corporate sector reached its maximum of 1,570 patents in 2020, while universities continued strong growth to reach 1,668 patents in 2023. Government participation accelerated notably after 2019. 2023 also marked the first significant decline across most categories except for universities, suggesting potential market adjustments. Throughout this entire period, universities and corporations consistently led patent development efforts, maintaining their positions as primary drivers of quantum computing innovation.

In 2023, 837 patent family filings were made by corporations while 1668 were made by universities — indicating substantial commitment to quantum technology development by public and private institutions.

1.2 | Patents by country



In the period 2014-2024, the total number of quantum technology patent filings grew significantly, representing a five-fold increase over this period. The growth has been particularly pronounced since 2020.

China emerged as the dominant location for quantum technology patent filing, growing from 1,011 patents in 2014 to 7,308 in 2024. The United States maintained second position throughout the period, increasing from 613 to 2,301 patents, while the World Patent Office secured third place, growing from 265 to 1,072 patents.

Analyzing growth patterns during the 2014-2016 period, the total number of patents grew moderately. This period saw relatively balanced growth across regions, with China holding a lead over the United States. A significant acceleration occurred in 2017, marking the beginning of a more rapid growth phase. This surge was driven by China with an expansion from 1,726 to 2,560 patents, accompanied by increases in the United States and WPO.

The period from 2018 to 2020 saw sustained growth momentum, including the emergence of India as a new player.

The most recent years (2021-2024) have witnessed continued strong growth rates. China's leadership became increasingly pronounced, while the United States maintained strong growth, and India demonstrated accelerated expansion.

Throughout 2014-2024, the geographic distribution of patent activity has become increasingly concentrated. China's market share expanded from 42% in 2014 to 60% in 2024, while the United States maintained the second place with a relatively stable share around 19%, and the World Patent Office held steady at approximately 9%. Together, these three entities controlled 88% of all quantum computing patents in 2024, indicating a highly concentrated intellectual property landscape in this technology sector. It is important to note that, in terms of individual countries, Japan is placed as the third in total patent filing numbers after China and the US across this period.

According to recent patent research reports by QuIC[4] and by QEDC[5], China has established itself as the global leader in quantum communications patents. The country's strong emphasis on quantum communications research likely resulted in significant patent activity, with Chinese institutions leading the field. Organizations such as QuantumCTek, Ruban Quantum Technology, and Beijing University of Posts & Telecom are among the major patent holders in this domain.[6]

QED-C research on patents states that the US Patent and Trademark Office (USPTO) has issued more quantum computing patents than any other country’s office, and that the Chinese patent office has issued the most quantum communications patents.

The disparity in patent numbers between China and the US highlights the competitive dynamics in quantum technology development, with each nation pursuing different aspects of the quantum technology ecosystem with different prioritization levels.

1.3 | Future research

We intend to provide the community with ongoing monitoring of the rapidly evolving quantum technology patent landscape. We aim to investigate geographic and market concentration evolution, tracking emerging patent hubs and their technological specializations. For future iterations of this section, we are interested in breaking down patents by quantum technology subfields and analyzing patent families across different technical classifications. Stakeholders interested in sharing data regarding these aspects of the quantum technology patent landscape are encouraged to contact us.

You can reach us at contact@qir.mit.edu.

Footnotes

[1] Matt Swayne, 'US Leads in Steady Rise of Patents Covering Key Quantum Performance Measures' (The Quantum Insider, 30 April 2024) <https://thequantuminsider.com/2024/04/30/us-leads-in-steady-rise-of-patents-covering-key-quantum-performance-measures/> accessed 3 April 2025.

[2] Yudong Cao, Jonathan P Olson and Eric R Anschuetz, 'Hybrid Quantum-Classical Computer System and Method for Performing Function Inversion' <https://patents.google.com/patent/US20200394547A1/en> accessed 3 April 2025.

[3] A Portrait of the Global Patent Landscape in Quantum Technologies' (QuIC 2024) <https://www.euroquic.org/wp-content/uploads/2024/03/QuIC-White-Paper-IPT-January-2024.pdf> accessed 4 February 2025.

[4] ibid.

[5] Elliott J Mason QED-C, 'State of Quantum Industry Innovation – What Patents Tell Us' (11 December 2024) <https://quantumconsortium.org/blog/state-of-quantum-industry-innovation-what-patents-tell-us/> accessed 27 March 2025.

[6] ibid.

11 | Appendix

The data in this section is based on patent families and was based on data acquired by Accenture Research from LexisNexis Patent database based on select IPC codes relevant to quantum technologies. No screening was made regarding international patent families. The list of IPC codes used for this dataset can be found here:

IPC Code	Description	Sub-category
G06N0010200000	Models of quantum computing, e.g. quantum circuits or universal quantum computers [2022.01]	Quantum Computing
G06N0010600000	Quantum algorithms, e.g. based on quantum optimisation, or quantum Fourier or Hadamard transforms	Quantum Computing, Software
H04B0010700000	Photonic quantum communication	Quantum Communications, Quantum Networking
G06N0010000000	Quantum computing, i.e. information processing based on quantum-mechanical phenomena	Quantum Computing
B82Y0020000000	Nanooptics, e.g., quantum optics or photonic crystals	Quantum Computing, Hardware
G02F0002020000	Frequency-changing of light, e.g. by quantum counters	Quantum Computing, Hardware
G06N0010800000	Quantum programming, e.g. interfaces, languages or software-development kits for creating or handling programs capable of running on quantum computers; Platforms for simulating or accessing quantum computers, e.g. cloud-based quantum computing	Quantum Computing, Software
H01L0033040000	With a quantum effect structure or superlattice, e.g. tunnel junction	Quantum Computing, Hardware
H01S0005340000	Comprising quantum well or superlattice structures, e.g. single quantum well [SQW] lasers, multiple quantum well [MQW] lasers or graded index separate confinement heterostructure [GRINSCH] lasers (H01S 5/36 takes precedence)	Quantum Computing

G02F0001017000	Structures with periodic or quasi periodic potential variation, e.g. superlattices, quantum wells	Quantum Computing
H01L0029775000	With one-dimensional charge carrier gas channel, e.g. quantum wire FET	Quantum Computing
H01L0033060000	Within the light emitting region, e.g. quantum confinement structure or tunnel barrier	Quantum Computing
H10K0050115000	Comprising active inorganic nanostructures, e.g. luminescent quantum dot	Quantum Computing
B82Y0010000000	Nanotechnology for information processing, storage or transmission, e.g. quantum computing or single electron logic	Quantum Computing, Quantum Networking
B82Y0015000000	Nanotechnology for interacting, sensing or actuating, e.g. quantum dots as markers in protein assays or molecular motors	Quantum Computing
G06N0010400000	Physical realisations or architectures of quantum processors or components for manipulating qubits, e.g. qubit coupling or qubit	Quantum Computing
G06N0010700000	Quantum error correction, detection or prevention, e.g. surface codes or magic state distillation	Quantum Computing
G16C0010000000	Computational theoretical chemistry, i.e. ICT specially adapted for theoretical aspects of quantum chemistry, molecular mechanics, molecular dynamics or the like	Quantum Computing
H01L0029150000	Structures with periodic or quasi periodic potential variation, e.g. multiple quantum wells, superlattices (such structures applied for the control of light G02F 1/017; applied in semiconductor lasers H01S 5/34)	Quantum Computing
H04B0010000000	Transmission systems employing electromagnetic waves other than radio-waves, e.g. infrared, visible or ultraviolet light, or employing corpuscular radiation, e.g. quantum communication	Quantum Computing

Regarding the categorization of the patent data presented by origin, Accenture researchers applied the following methodology:

Step 1: For applicants with name but without type (e.g. university, corporate, etc.), search was filtered using keywords such as specific origin entity specific keywords (such as hospital, etc.) to categorize some of the applicants. The filtered results are stored as Result 1.

Step 2: Researchers identified those without keywords (over 1,000 names) using am AI LLM (Gemini-1.5-flash-001) to automatically detect their type. This result is stored as Result 2.

Step 3: Researchers merged the applicants with identified types (from both initial filtering and LLM results) with the applicants who originally had type information provided by the vendor.

Step 4: Merged data was manually controlled to ensure non-duplication and accuracy.

The data presented in patent applications by country was provided by Accenture in collaboration with The Quantum Insider (TQI). TQI acquired the patent data directly from patent offices. For national patents, national patent office data for each country (e.g. in the US patents are sourced from the United States Patent and Trademark Office (USPTO); in China patents are sourced from the China National Intellectual Property Administration). WO = World Intellectual Property Organization (WIPO), EP = European Patent Office. For "Other Countries" it is typically a longer tail of nations which have been aggregated. For some countries it is typically a longer tail of other countries which have been aggregated.

The TQI patent data was collected based on the following keywords:

Adiabatic Theorem, Bosonic Creutz Ladder, Dicke Model, Distributed quantum computation, Fault-tolerant quantum computation, gray zone assault, Hadamard Gate, Harrow Hassidim Lloyd, Harrow Hassidim Lloyd, HHL algorithm, ion traps, Josephson junctions, neutral atoms, Noisy Intermediate-Scale Quantum era, Open Quantum Systems, Photonic Quantum Computing, QAOA, qbits, qbytes, QEC, QNLP, QSVM, qtrits, Quantum accelerators, quantum annealing, Quantum Advantage, Quantum accelerators, quantum annealing, Quantum Advantage, quantum algorithms, Quantum applications, quantum approaches, quantum approximate optimization, quantum approximate optimization algorithms, quantum arithmetic, Quantum artificial intelligence, quantum backtracking, quantum bits, Quantum Bosonic Systems, quantum bytes, quantum chaos, quantum chaos, quantum chemistry, Quantum circuits, quantum classifier, quantum communication, quantum compiler, Quantum complexity, Quantum component, Quantum computation, Quantum computational, Quantum computer, Quantum Computing Architectures, Quantum Control, quantum correlation, Quantum cryptanalysis, Quantum cryptoalgorithm, Quantum cryptog, Quantum cryptographic, Quantum cryptology, Quantum cryptosystem, Quantum Cryptology, Quantum Cryptology, Quantum cryptosystem, Quantum decoding, quantum devices, quantum distillation, quantum dots, quantum dynamics, quantum dynamics, quantum eigensolver, quantum encryption, Quantum Entanglement, quantum entanglement distillation, quantum error correction, Quantum Error Detection, Quantum Field theory, quantum Fourier transform, Quantum gas sensors, Quantum gate, Quantum gate fidelity, Quantum gate-based, Quantum gates, quantum Grover, Quantum hardware, Quantum hardware security, quantum image sensor, quantum imager array, quantum information, Quantum information processing, Quantum information science, Quantum information systems, Quantum information theory, Quantum interference, Quantum ions, quantum Josza, Quantum Kernel, Quantum key, Quantum key distribution, Quantum key distribution network, Quantum key distribution protocol, Quantum key distribution systems, quantum key exchange, Quantum LDPC Codes, Quantum Linear Optics, quantum logic, quantum machine learning, quantum machines, quantum magic states, Quantum Maps, Quantum Measurement, Quantum Memristors, Quantum metrological, Quantum metrology, Quantum metrology standards, Quantum Monte Carlo, Quantum Natural Language Processing, Quantum Networks, quantum neural networks, Quantum Oscillator, quantum phase amplifiers, Quantum precision measurement sensors, Quantum process, Quantum processing, Quantum Programs, Quantum proof, quantum public key, Quantum Quantile Mechanics, Quantum Quantizer, Quantum random number, Quantum random number generation, Quantum random number generation device, Quantum random number generator, Quantum random number sequences, Quantum safe network, Quantum sensing, Quantum sensing technology, Quantum sensor, Quantum sensor networks, quantum sensors, Quantum shared key, quantum Shor, Quantum Signal Processing, quantum simulation, Quantum Simulator, quantum single photon, quantum software, Quantum Speedup, quantum spin, quantum spintronics, quantum state, Quantum Subroutines, Quantum superposition, quantum supremacy, quantum supremacy, quantum switches, quantum systems, Quantum Technologies, quantum teleportation, quantum tensor, quantum toffoli gate, Quantum transmons, quantum variational, quantum video, Quantum Week, Quantum-enhanced, Quantum-enhanced, Quantum-resistance, qubits, qubytes, qudits, qumodes, qutrits, silicon qubits, VQE.

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