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Global initiatives in quantum computing: The role of international collaboration

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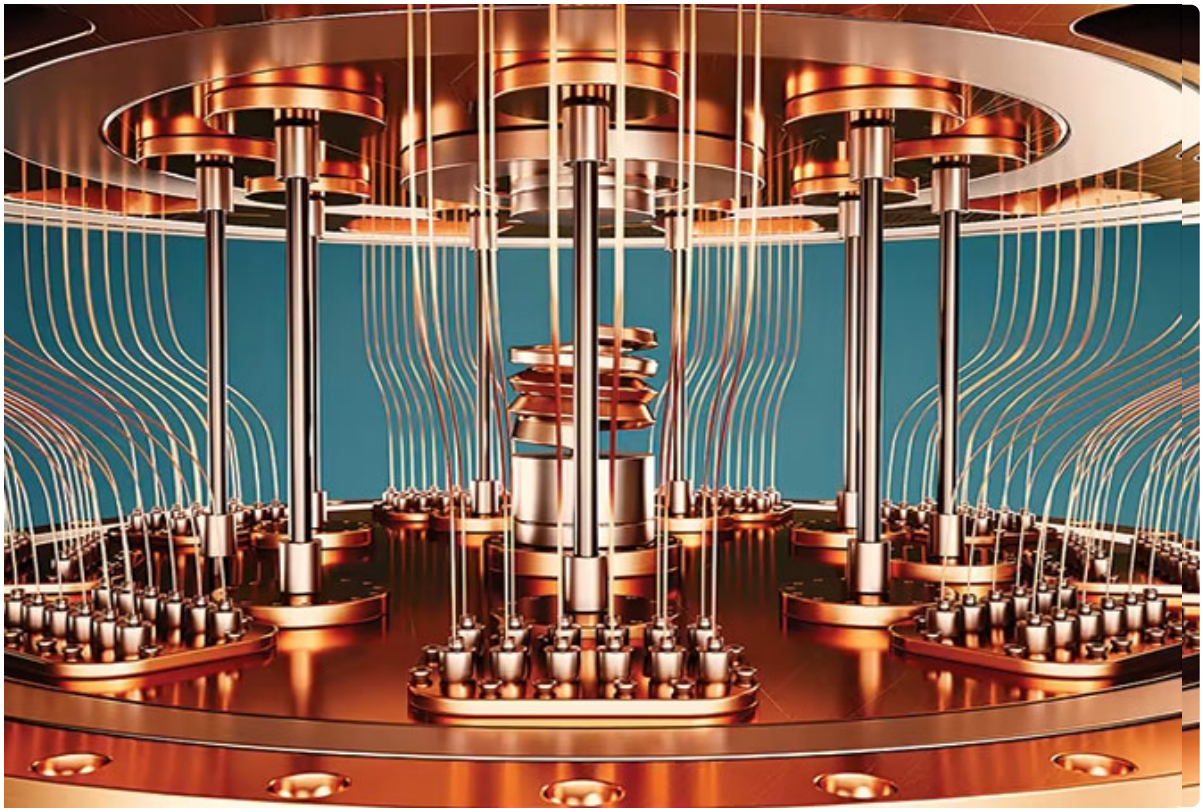
Quantum computing is a novel technology that requires international cooperation for its growth. This should continue unabated despite the incumbent threats.



AUKUS | CYBERSECURITY | GLOBAL INITIATIVES | INVESTMENT | QUAD | QUANTUM COMPUTING | QUANTUM TECHNOLOGIES | TECHNOLOGY EXCHANGE

Quantum computing is one of the fastest-growing areas in technology in recent times. It is also one of the most attractive investment avenues, both from the public and private sectors, reaching about US$35.5 billion globally in 2022. This is chiefly due to the unprecedented leap in computing speed in comparison to classical computers and the paradigm shift in cybersecurity that they offer. In addition, they are increasingly finding applications in other areas such as quantum chemistry, medicine, agriculture, and countering climate change.

Annealing models of quantum computers are already being used to solve a large class of optimisation problems, which were previously unsolvable using classical computers. The possibilities are endless and seem to be limited only by our own imagination.

This has largely been made possible due to widespread international collaboration among governments and private sector corporations around the world. Owing to the novel nature of this technology, humanity's understanding of the field is still quite limited, which substantiates why international cooperation continues to play a critical role in its development. This article focuses on some of the major international initiatives in quantum computing and the hurdles they may face in the future.

Table 1: Major international quantum computing collaborations

Inter-Governmental Initiatives	Private Initiatives
1. Quantum Technologies Flagship	1. IBM
2. AUKUS	2. Google
3. Quad	3. D-Wave
4. CERN Quantum Technology Initiative	4. Amazon
5. Quantum Leap Africa	5. IonQ
6. One Quantum	6. Infosys

Source: Author's collation

Quantum Technologies Flagship

The Quantum Technologies Flagship was established in 2018 by the European Union (EU), with a budget of about 1 billion euros. Funded by the EU's Horizon 2020 (now Horizon Europe) programme, it aims to bring together research, private, and public institutions, and consolidate European leadership in the field of quantum technologies over a period of 10 years. One of its key initiatives is the International Cooperation on Quantum Technologies (InCoQFlag) project, which targets critical areas for collaboration with countries investing substantially in quantum technologies such as the United States (US), Canada, and Japan. InCoQFlag hopes to achieve the sharing of technologies, infrastructures, skills, and knowledge with international partners through various workshops and networking sessions.

AUKUS

AUKUS is a trilateral security arrangement set up between Australia, the United Kingdom (UK) and the US in September 2021. One of the "pillars" of the agreement is to produce joint advanced military capabilities and interoperability, with an effort to develop and integrate quantum technologies in particular. The AUKUS Quantum Arrangement initiated in 2022, aims to accelerate investments in "generation-after-next" quantum capabilities. The chief objective here is to maintain a strategic and technological advantage over China, particularly in the field of quantum computing and cryptography.

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Quadrilateral Security Dialogue

In 2021, the Quad leaders agreed to establish a Critical and Emerging Technology Working Group to ensure that the standards and frameworks for key technologies such as 5G, Artificial Intelligence (AI) and Quantum Computing are governed by "shared interests and values." Subsequently, the Quad Investors Network (QUIN) was launched on 20 May 2023. It comprises a network of investors who seek to encourage investment in these novel technologies. The QUIN launched the Quad Centre of Excellence in Quantum Information Sciences on 9 June 2023, with the objective of linking together researchers and institutions across the Quad countries "to drive greater technological cooperation, market access, and cross-border investments" in the field of quantum information sciences and build resilient and reliable supply chains.

CERN Quantum Technology Initiative

The European Council for Nuclear Research's (CERN) Quantum Technology Initiative is a comprehensive R&D and academic programme initiated in 2020, which aims to set up collaborations between its 23 member states as well as international initiatives in quantum technologies and develop new computing, detector and communication systems, in addition to advancing knowledge of quantum systems and information processing. It will also assess the potential impact of quantum technologies on future programmes while preparing skills and resources required for future generations of researchers to further investigate their application to specific research fields such as computational chemistry, materials science, high-energy physics, and space applications. CERN is also one of the partners of the Open Quantum Initiative, a global centre for quantum technology announced by theGeneva Science and Diplomacy Anticipator (GESDA) , which is set to be established in Geneva by 2027.

Private sector initiatives

IBM hopes to continue its legacy as a leader in technological innovation with its foray into the realm of quantum computing. At the G7 Summit held in May 2023, IBM announced a US $100-million initiative with the University of Tokyo and the University of Chicago to develop a 100,000-qubit quantum computer over the next 10 years. In 2022, the Indian Institute of Technology, Madras became the first Indian institution to join the IBM Quantum Network, which aims to advance quantum computing skills development and research in the country. Recently, BosonQ PSI became the first Indian quantum computing startup to follow suit.

> Based in Canada, D-Wave is the first company in the world to make quantum computers commercially available.

Claiming "quantum supremacy" in 2019 itself, Google has also emerged as a major player in quantum computing by partnering liberally with several quantum computing startups such as IonQ, QSimulate, and Pasqal. In 2021, it launched the Digital Future Initiative, a US$ 1-billion investment over five years in Australian infrastructure, research, and partnerships. It has set up an outpost of its Quantum Artificial Intelligence Lab in Sydney and is collaborating with several universities to find new applications for quantum computers.

Based in Canada, D-Wave is the first company in the world to make quantum computers commercially available. It is also the only company working on both annealing and gate-model quantum computers.[1] It has worked extensively with NASA and Google in setting up one of their Quantum Artificial Intelligence Labs. In 2020, D-Wave launched its cloud service in India, giving developers and researchers real-time access to its quantum computers. It has also worked with the Australian Department of Defence to demonstrate the use of hybrid quantum computing technology to optimise how autonomous vehicles can be used to resupply army forces. In India, Infosys has been pioneering the development of quantum computing and related technologies. It has partnered with Australian quantum cybersecurity firm QuintessenceLabs to create a quantum random number generator which can work with classical encryption systems, thereby significantly amplifying their cybersecurity capabilities. It is also working with Amazon Web Services, QuintessenceLabs, and QCWare to set up its "Quantum Living Labs," which offers innovative solutions to its clients by leveraging quantum computing technology.

Impediments to international cooperation

Despite the extensive level of international cooperation in the field of quantum computing, some recent developments are threatening to hamper the process. The chief cause of concern has been the growing dominance of China in the field, its "Thousand Talents Plan" serving as

one of the main catalysts. Thousand Talents is a recruitment programme meant to entice scientists from all over the world to bring their research to China by offering them a significant hike in their salaries. However, several cases have come to light of scientists illicitly providing China with technology and research findings, and the US has subsequently accused the country of intellectual property theft. While on one hand, this has provided the imperative for cooperation among like-minded states, it has also created an atmosphere of suspicion and paranoia amongst countries as they have now become much more wary of sharing their research with other countries. For instance, the UK, Israel, and Switzerland were excluded from the EU's aforementioned Quantum Technologies Flagship programme, supposedly to comply with intellectual property rules.

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Consequently, the pursuit of building the first quantum computer is slowly devolving into a race, with each nation vying to overtake the other. There is a pressing need to ensure that this does not continue to be the case in the future. Quantum computing is still an incipient technology and true progress cannot be achieved by diminishing members of a community which is already quite limited to begin with. This does not imply, however, that there should be no limitations on the exchange of technology whatsoever. Intellectual property rules and other legal frameworks should always be abided by, not to mention ethicality. Inklings of an incumbent threat, however, should not drive the way forward when it comes to this evolving and potentially ground-breaking technology.

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[1] In the gate model of quantum computers, the logic gates of classical computers are replaced by quantum logic gates which can then manipulate qubits to achieve the desired outcome. This is the most popular model of quantum computers and is the focus of most of the research in the field. The annealing model uses properties of quantum physics like entanglement, superposition and tunneling to arrive at the optimal solution to a given computational problem.